EFFECTIVENESS OF PRODUCTIVE THINKING MODEL ON PROBLEM SOLVING ABILITY IN PHYSICS AND SELF-CONCEPT OF IX STANDARD STUDENTS

Thesis
Submitted for the Degree of
DOCTOR OF PHILOSOPHY IN EDUCATION

By

ATHIRA V.

Supervised by

Dr. BINDHU C.M.
Professor & Head

DEPARTMENTOF EDUCATION
UNIVERSITY OF CALICUT

2024

DECLARATION

I, **Athira V.**, hereby declare that the thesis entitled "**Effectiveness of Productive Thinking Model on Problem Solving Ability in Physics and Self-Concept of IX standard students**" is based on the original work done by me under the guidance of **Dr. Bindhu C.M.,** Professor & Head, Department of Education, University of Calicut and has not been included in any other thesis submitted previously for the award of any degree. The contents of the thesis are undergone plagiarism check using iThenticate software at C.H.M.K. Library, University of Calicut, and the similarity index found within the permissible limit. I also declare that the thesis is free from AI generated contents.

ATHIRA V.

Dr. BINDHU C.M.

Place: C.U. Campus,

Date 30-4-2025

Dr.Bindhu C.M.
Professor
Department of Education
University of Calicut

CERTIFICATE

This is to certify that the thesis entitled, **"EFFECTIVENESS OF PRODUCTIVE THINKING MODEL ON PROBLEM SOLVING ABILITY IN PHYSICS AND SELF CONCEPT OF IX STANDARD STUDENTS"** is an authentic record of research work carried out by **Athira V.**, for the Doctor of Philosophy in Education, Department of Education, University of Calicut, under my supervision and guidance and that no part thereof has been presented before any other Degree, diploma or Associateship in any other University. Both the adjudicators have not recommended any modifications or suggestions and therefore the original thesis is resubmitted as such. The soft copy is attached is the same as that of resubmitted copy.

Dr. BINDHU C.M
(Supervising Teacher)

Place: C.U. CAMPUS
Date: 30-4-2025

UNIVERSITY OF CALICUT

CERTIFICATE ON PLAGIARISM CHECK

1.	Name of the Research Scholar	**Athira V**	
2.	Title of thesis / dissertation	EFFECTIVENESS OF PRODUCTIVE THINKING MODEL ON PROBLEM SOLVING ABILITY IN PHYSICS AND SELF-CONCEPT OF IX STANDARD STUDENTS	
3.	Name of the Supervisor	Dr. Bindhu C. M.	
4.	Department/Institution	Department of Education, University of Caicut	
5.	Similar content (%) identified	Non Core	Core
		Introduction/ Theoretical overview/Review of literature/ Materials & Methods/ Methodology	**Analysis/Result/Discussion/ Summary/Conclusion/ Recommendations**
		5	**2**
	Acceptable maximum limit (%)	10	10
6.	Software used	iThenticate	
7.	Date of verification	04-09-2024	

**Report on plagiarism check, specifying included/excluded items with % of similarity to be attached.*

Checked by (with name , designation & signature)

JAMSHEER N. P.
Assistant Librarian
University of Calicut
Malappuram - 673 635

Name and signature of the Researcher Athira.v, Ath

Name and signature of the Supervisor.

The Doctoral Committee* has verified the report on plagiarism check with the contents of the thesis, as summarized above and appropriate measures have been taken to ensure originality of the Research accomplished herein.

Dr. Bindhu. C. M

Name & Signature of the HoD/HoI (Chairperson of the Doctoral Committee)

**In case of languages like Malayalam, Tamil etc..on which no software is available for plagiarism check, a manual check shall be made by the Doctoral Committee, for which an additional certificate has to be attached.*

Acknowledgement

At the outset, I would like to thank Almighty for giving me the wisdom and knowledge in doing this work, you are the one who progresses my life with the glow of knowledge and endured me with the essential ability to complete this work.

I am grateful for having a chance to meet so many wonderful people and professionals who led me through this research.

Looking back and recollecting the varying experiences I have gone through, it would be too difficult an act to mention each person by name, who have supported me in completing this research. At the same time, I too believe that it would be great unfair an act if I do not mention the name of at least a few explicitly.

I feel extremely felicitous to have the opportunity to work under the guidance of my esteemed supervisor Dr. Bindhu C.M, Professor & Head, Department of Education, who continually supported me throughout my research. My sincere respect and gratitude for her sincere guidance, inspiring words, valuable suggestions and patience during research.

The investigator acknowledges her gratitude to. Prof. (Dr). P. Usha & Prof. (Dr.) K.P. Meera, former Professors, Department of Education, university of Calicut for her great support and help throughout the research. Investigator express her heartfelt gratitude to Prof. (Dr.) C. Naseema, Prof. (Dr.) K Abdul Gafoor, Dr. Vasumathi. T, Dr. Manoj Praveen, Dr. Reesha Karally, Dr. Jibin V.K. for their concern. My deep concern and warm thanks to my family members, my dear husband Mr. Midhun. V, who lit my path and lightened my journey with care and inspiration. This work would not have been possible without his constant encouragement. I record my unfathomable indebtedness to my dearest daughter Nami.

The sincere service of Mr. Balu, Bina Photostat, Mr. Praveen in giving a perfect outlook to the thesis cannot be forgotten.

The investigator extend her loving respect and thanks to the Section Officer, Nisharani N., Mrs. Navamani P., Mrs. Praseetha T.P. and other non-teaching staff, for their deep concern and enduring help.

I would like to express my special gratitude and thanks to Mr. Arjun, Mr. Satheesh P.T, Nimisha C.K, Rajini, Anjana, and all other Research scholars for providing necessary information regarding this research and also for their support in completing this endeavor.

My thanks and appreciations also due to my friends, colleagues and people who have willingly helped me with their abilities

Athira V.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

The present study is an attempt to implement Productive Thinking Model and find its effectiveness over Existing Method of Teaching on Problem Solving Ability in Physics and Self-Concept of Standard IX students. Productive Thinking Model is a Model widely used in marketing field to increase productivity. here, the investigator made an attempt to implement it in the sphere of education. Other researchers already tried to develop such a Model in Elementary schools but their works only focused on the development of Productive Thinking Model as a teaching model not extended to implement the model and finding the effectiveness of such a model in the schools. Investigator with the help of supervising teacher made necessary changes and modifications by considering existing Models of teaching in order to make it appropriate in educational field.

The method adopted for the study was experimental in nature. Solomon Four Group Design was the research design adopted for the study. Two control groups (control group I and control group II) and two experimental groups (experimental groups I and II) are included in this design. The Productive Thinking Model was used to instruct Experimental Groups I and II. The Kerala state syllabus was used to teach the control groups utilising the present method of instruction used in Standard IX. Only one Experimental group and one Control group received pre-tests out of the four groups. While post-tests was given to all the four groups. Students in Kerala state syllabus schools enrolled in standard IX were the population under consideration for the experimental study. Four intact standard IX classrooms with about 40 pupils each made up the study's sample. All together 170 students from four divisions of these two schools. 88students were given experimental treatment (Experimental group I & II) and 84 were given control treatment (Control group I &II).

The study was conducted in two phases. In the first phase the investigator conducted an interview on Secondary School Physics Teachers to find out their views on Instructional Strategies, Methods and Models using a Semi-Structured Interview

Schedule. In the second phase the actual experimentation was conducted to know the impact of Productive Thinking Model over Existing Method of Teaching on Problem Solving Ability in Physics and Self concept of standard IX students.

The findings of preliminary survey revealed that teachers understand the desired effects of many strategies including logical thinking, reasoning, technology advancement, and knowledge sharing. However, the majority of teachers are unwilling to implement such methodologies in the present classroom environment. Also teachers are aware of multiple methods for providing education, but they confront certain obstacles in executing them like, time constraints, classroom management, assessment challenge etc. Again the physics teachers in secondary schools had proposed various solutions to get beyond the limitations they face while putting techniques, strategies, and models of instruction into practice. As per the result from the experimental phase the Productive Thinking Model can be considered as an effective model to develop Problem Solving Ability and Self concept among standard IX students over Existing Method of Teaching.

Results also shows that the Pre-tested and non pre-tested groups significantly differed both in their Problem Solving Ability in Physics and Retention. In both cases, Pre-tested and non pre-tested Experimental groups were seen to be Superior over the Control groups. This underlies the advantage of Productive Thinking Model over Existing Method of Teaching with regard to Problem Solving Ability in Physics. From the results of analysis it is evident that student who taught through Productive Thinking Model Perform well than that of students who taught through Existing Method of Teaching. It highlights the need for new method or way of teaching other than existing one.

Key words: Productive Thinking Model, Problem Solving Ability in Physics, Self-Concept, Standard IX students.

സംഗ്രഹം

നിലവിലെ പഠനം, ഉൽപ്പാദനപരമായ ചിന്താ മാതൃക നടപ്പിലാക്കുന്നതിനും സ്റ്റാൻഡേർഡ് IX വിദ്യാർത്ഥികളുടെ ഭൗതികശാസ്ത്രത്തിലും സ്വയം-സങ്കൽപ്പത്തിലും പ്രശ്നങ്ങൾ പരിഹരിക്കുന്നതിനുള്ള നിലവിലുള്ള പഠിപ്പിക്കൽ രീതിയെക്കാൾ അതിന്റെ ഫലപ്രാപ്തി കണ്ടെത്തുന്നതിനുള്ള ശ്രമമാണ്. ഉൽപ്പാദനക്ഷമത വർദ്ധിപ്പിക്കുന്നതിന് വിപണന മേഖലയിൽ വ്യാപകമായി ഉപയോഗിക്കുന്ന ഒരു മാതൃകയാണ് പ്രൊഡക്റ്റീവ് തിങ്കിംഗ് മോഡൽ. ഇവിടെ, അന്വേഷകൻ അത് വിദ്യാഭ്യാസ മേഖലയിൽ നടപ്പിലാക്കാൻ ശ്രമിച്ചു. മറ്റ് ഗവേഷകർ പ്രാഥമിക വിദ്യാലയങ്ങളിൽ ഇത്തരമൊരു മാതൃക വികസിപ്പിക്കാൻ ഇതിനകം ശ്രമിച്ചിരുന്നുവെങ്കിലും അവരുടെ കൃതികൾ ഉൽപ്പാദനപരമായ ചിന്താ മാതൃക വികസിപ്പിക്കുന്നതിൽ മാത്രമാണ് ശ്രദ്ധ കേന്ദ്രീകരിച്ചത്. മേൽനോട്ടക്കാരനായ അധ്യാപകന്റെ സഹായത്തോടെ അന്വേഷകൻ നിലവിലുള്ള അദ്ധ്യാപന മാതൃകകൾ പരിഗണിച്ച് ആവശ്യമായ മാറ്റങ്ങളും പരിഷ്കാരങ്ങളും വരുത്തി, അത് വിദ്യാഭ്യാസ മേഖലയിൽ അനുയോജ്യമാക്കുന്നു.

പഠനത്തിനായി സ്വീകരിച്ച രീതി പരീക്ഷണാത്മക സ്വഭാവമുള്ളതായിരുന്നു. സോളമൻ ഫോർ ഗ്രൂപ്പ് ഡിസൈൻ ആണ് പഠനത്തിനായി സ്വീകരിച്ച ഗവേഷണ രൂപരേഖ. രണ്ട് നിയന്ത്രണ ഗ്രൂപ്പുകളും (നിയന്ത്രണ ഗ്രൂപ്പ് I, നിയന്ത്രണ ഗ്രൂപ്പ് II) രണ്ട് പരീക്ഷണ ഗ്രൂപ്പുകളും (പരീക്ഷണ ഗ്രൂപ്പുകൾ I, II) ഈ രൂപകൽപ്പനയിൽ ഉൾപ്പെടുത്തിയിട്ടുണ്ട്. പരീക്ഷണാത്മക ഗ്രൂപ്പുകൾ I, II എന്നിവയെ പഠിപ്പിക്കാൻ ഉൽപ്പാദനപരമായ ചിന്താ മാതൃക ഉപയോഗിച്ചു. സ്റ്റാൻഡേർഡ് IX-ൽ ഉപയോഗിച്ചിരിക്കുന്ന ഇന്നത്തെ പഠനരീതി ഉപയോഗിച്ച് കൺട്രോൾ ഗ്രൂപ്പുകളെ പഠിപ്പിക്കാൻ കേരള സ്റ്റേറ്റ് സിലബസ് ഉപയോഗിച്ചു. നാല് ഗ്രൂപ്പുകളിൽ നിന്ന് ഒരു പരീക്ഷണ ഗ്രൂപ്പിനും ഒരു കൺട്രോൾ ഗ്രൂപ്പിനും മാത്രമാണ് പ്രീ-ടെസ്റ്റുകൾ ലഭിച്ചത്. നാല് ഗ്രൂപ്പുകൾക്കും പോസ്റ്റ് ടെസ്റ്റ് നൽകിയപ്പോൾ. കേരള സ്റ്റേറ്റ് സിലബസ് സ്കൂളുകളിൽ ഒമ്പതാം ക്ലാസിൽ ചേർന്ന വിദ്യാർത്ഥികളാണ് പരീക്ഷണ പഠനത്തിനായി പരിഗണിച്ചിരുന്നത്. കേടുകൂടാതെയിരിക്കുന്ന നാല് സ്റ്റാൻഡേർഡ് IX ക്ലാസ് മുറികൾ, ഏകദേശം 40 കുട്ടികൾ വീതം പഠനത്തിന്റെ സാമ്പിൾ ഉണ്ടാക്കി. ഈ രണ്ട് സ്കൂളുകളിലെയും നാല് ഡിവിഷനുകളിൽ നിന്നായി 172 വിദ്യാർത്ഥികൾ. 88 വിദ്യാർത്ഥികൾക്ക് പരീക്ഷണാത്മക ചികിത്സയും (പരീക്ഷണാത്മക ഗ്രൂപ്പ് I & II) 84 പേർക്ക് നിയന്ത്രണ ചികിത്സയും നൽകി (നിയന്ത്രണ ഗ്രൂപ്പ് I & II).

രണ്ട് ഘട്ടങ്ങളിലായാണ് പഠനം നടത്തിയത്. ആദ്യ ഘട്ടത്തിൽ അന്വേഷകൻ സെക്കൻഡറി സ്കൂൾ ഫിസിക്സ് അധ്യാപകരെക്കുറിച്ചുള്ള ഒരു അഭിമുഖം നടത്തി, ഒരു സെമി-സ്ട്രക്ചേർഡ് ഇന്റർവ്യൂ ഷെഡ്യൂൾ ഉപയോഗിച്ച് ഇൻസ്ട്രക്ഷണൽ സ്ട്രാറ്റജികൾ, രീതികൾ,

മോഡലുകൾ എന്നിവയെക്കുറിച്ചുള്ള അവരുടെ കാഴ്ചപ്പാടുകൾ കണ്ടെത്തും. രണ്ടാം ഘട്ടത്തിൽ, സ്റ്റാൻഡേർഡ് IX വിദ്യാർത്ഥികളുടെ ഭൗതികശാസ്ത്രത്തിലെ പ്രശ്നപരിഹാര കഴിവിലും സ്വയം ആശയത്തിലും നിലവിലുള്ള അധ്യാപന രീതിയെക്കാൾ ഉൽപ്പാദനപരമായ ചിന്താ മാതൃകയുടെ സ്വാധീനം അറിയാൻ യഥാർത്ഥ പരീക്ഷണം നടത്തി.

യുക്തിപരമായ ചിന്ത, ന്യായവാദം, സാങ്കേതിക പുരോഗതി, അറിവ് പങ്കിടൽ എന്നിവയുൾപ്പെടെ നിരവധി തന്ത്രങ്ങളുടെ ആവശ്യമുള്ള ഫലങ്ങൾ അധ്യാപകർ മനസ്സിലാക്കുന്നുവെന്ന് പ്രാഥമിക സർവേയുടെ കണ്ടെത്തലുകൾ വെളിപ്പെടുത്തി. എന്നിരുന്നാലും, ഇന്നത്തെ ക്ലാസ് റൂം പരിതസ്ഥിതിയിൽ അത്തരം രീതിശാസ്ത്രങ്ങൾ നടപ്പിലാക്കാൻ ഭൂരിഭാഗം അധ്യാപകരും തയ്യാറല്ല. കൂടാതെ, അദ്ധ്യാപകർക്ക് വിദ്യാഭ്യാസം നൽകുന്നതിന് ഒന്നിലധികം രീതികൾ അറിയാം, എന്നാൽ സമയപരിമിതി, ക്ലാസ് റൂം മാനേജ്മെന്റ്, അസസ്മെന്റ് ചലഞ്ച് തുടങ്ങിയ ചില തടസ്സങ്ങൾ അവർ അഭിമുഖീകരിക്കുന്നു. സെക്കൻഡറി സ്കൂളുകളിലെ ഫിസിക്സ് അധ്യാപകർ അവർ അഭിമുഖീകരിക്കുന്ന പരിമിതികൾ മറികടക്കാൻ വിവിധ പരിഹാരങ്ങൾ നിർദ്ദേശിച്ചു. വിദ്യകൾ, തന്ത്രങ്ങൾ, പ്രബോധന മാതൃകകൾ എന്നിവ പ്രായോഗികമാക്കുന്നു. പരീക്ഷണ ഘട്ടത്തിൽ നിന്നുള്ള ഫലം അനുസരിച്ച്, നിലവിലുള്ള അധ്യാപന രീതിയെക്കാൾ സ്റ്റാൻഡേർഡ് IX വിദ്യാർത്ഥികൾക്കിടയിൽ പ്രശ്നപരിഹാര കഴിവും സ്വയം സങ്കൽപ്പവും വികസിപ്പിക്കുന്നതിനുള്ള ഫലപ്രദമായ മാതൃകയായി ഉൽപ്പാദനപരമായ ചിന്താ മാതൃകയെ കണക്കാക്കാം.

ഫിസിക്സിലും നിലനിർത്തലിലുമുള്ള പ്രശ്നപരിഹാര ശേഷിയിൽ മുൻകൂട്ടി പരീക്ഷിച്ചതും മുൻകൂട്ടി പരീക്ഷിക്കാത്തതുമായ ഗ്രൂപ്പുകൾ കാര്യമായ വ്യത്യാസമുണ്ടെന്ന് ഫലങ്ങൾ കാണിക്കുന്നു. രണ്ട് സാഹചര്യങ്ങളിലും, കൺട്രോൾ ഗ്രൂപ്പുകളേക്കാൾ മുൻകൂട്ടി പരീക്ഷിച്ചതും മുൻകൂട്ടി പരീക്ഷിക്കാത്തതുമായ പരീക്ഷണ ഗ്രൂപ്പുകൾ മികച്ചതായി കാണപ്പെട്ടു. ഭൗതികശാസ്ത്രത്തിലെ പ്രശ്നപരിഹാര കഴിവുമായി ബന്ധപ്പെട്ട് നിലവിലുള്ള അദ്ധ്യാപന രീതിയെ അപേക്ഷിച്ച് ഉൽപ്പാദനപരമായ ചിന്താ മാതൃകയുടെ നേട്ടത്തിന് ഇത് അടിവരയിടുന്നു. നിലവിലുള്ള അദ്ധ്യാപന രീതിയിലൂടെ പഠിപ്പിച്ച വിദ്യാർത്ഥികളേക്കാൾ ഉൽപ്പാദനപരമായ ചിന്താ മാതൃകയിലൂടെ പഠിപ്പിച്ച വിദ്യാർത്ഥി മികച്ച പ്രകടനം കാഴ്ചവയ്ക്കുന്നുവെന്ന് വിശകലന ഫലങ്ങളിൽ നിന്ന് വ്യക്തമാണ്. നിലവിലുള്ള രീതിയല്ലാതെ പുതിയ രീതിയുടെയോ പഠിപ്പിക്കൽ രീതിയുടെയോ ആവശ്യകത ഇത് എടുത്തുകാണിക്കുന്നു.

പ്രധാന വാക്കുകൾ: പ്രൊഡക്റ്റീവ് തിംങ്കിംഗ് മോഡൽ, ഭൗതികശാസ്ത്രത്തിലെ പ്രശ്നങ്ങൾ പരിഹരിക്കാനുള്ള കഴിവ്, സെൽഫ്-കൺസപ്റ്റ്, ഒൻപതാംക്ലാസ് വിദ്യാർത്ഥികൾ.

Chapter I

INTRODUCTION

- Need and significance
- Statement of the Problem
- Definition of Key Terms
- Variables of the Study
- Objectives of the Study
- Hypotheses of the Study
- Methodology
- Tools, Techniques and other materials used for the study
- Statistical Techniques Used
- Scope of the Study
- Delimitations of the Study
- Organization of the Report

INTRODUCTION

An entire nation's development is based on education, which is the purest form of wealth. Education is recognized as the soul for all countries for the sake of their development and advancement. Therefore, the prosperity and development of a nation only depend on the education of its people. Each and every person in a nation is transformed by education into respectable, responsible citizens, and this improvement among citizens ensures the achievement of a higher standard of living. And this advancement again is possible only by changing raw human beings into human resources by giving proper education.

The primary goal of education is to develop a child's natural abilities and bring them into the mainstream. For various people, education may serve a variety of purposes. Some people see education as a tool for bringing about social change, while others see it as a source of income and still others as a way to live in harmony with nature. Therefore, education with a variety of goals is essential to every human being. Education is the methodical process of acquiring knowledge, beliefs, abilities, and habits. It describes the intellectual and moral upbringing that gradually broadens the range of information, cultivates character as well as mental faculties, and creates a clear pattern of interaction between a person and society. Education takes into account students overall growth, and this can only be accomplished by providing them with the appropriate education, which involves integrating all of a person's developmental features.

The major objective of National Curriculum Frame work (2005) is reduce the burdened school curriculum and to bring prominence from rote memorization to conception of the concept, synthesizing and application through well organized and integrated approach to teaching and learning. In order to support students in creating knowledge and meaning, teachers are viewed as facilitators of their learning. The teacher participates in the teaching learning process as a co-knowledge creator. The Kerala Curriculum Framework (2007) addresses three main teaching strategies in the classroom: Issue based approach, Social constructivism and Critical pedagogy. The educational system needs to provide students the capacity to create knowledge through dialogue and sharing. Instead of continuing the practice of passive listening, learners must take an active role in the creation of new knowledge. They should confront all societal inequalities and analyse their experiences critically. It is essential to consider many viewpoints and create an integrated perspective (KCF, 2007).

Science is a living, breathing corpus of knowledge that explores new areas of experience. Within a forward-thinking and progressive society, science can have a genuinely liberating effect (Rawat, 2011). People can adopt new perspectives on the world through science education. Science related knowledge gives students the ability to identify and investigate the intricacy of natural events. Undoubtedly, science offers a chance to showcase and cultivate many inquiry methodologies. Science education improve our minds, explore unknown depths, and lead to breakthroughs and inventions that change the world and add wonder to life. The goal of science education is to increase comprehension of scientific phenomenon and critical thinking abilities. Scientific inquiries offer a way to look into, address issues, and analyse scientific occurrences. They can also serve to make abstract ideas more concrete and can bring excitement and motivation among students. Science is fascinating and thought-provoking. Science lessons in the classroom should provide students with an opportunity to learn about the nature of science.

Among different subjects in science, Physics is one of the main scientific areas that have a significant impact on society in many domains. Without physics, none of the factors such as, social, human, environmental, or economic can be considered in terms of development. Physics is indeed a subject that fosters creativity among students. It encourages them to think critically, solve problems and explore how the natural world works. Solid foundation in physics has a significant indirect influence on the development of rational thinking, enthusiasm, self-control, unquenchable curiosity, self-discipline, and boldness all are fundamental components of creativity. Physics is one of the important branches of science in today's world of research and technology because it forms the basis of scientific reasoning and enables humans to govern and dominate the physical universe that mesmerizing us since the beginning of time. One distinctive feature of physics is that the majority of its ideas may be used to solve issues in everyday life and are applicable to real-world scenarios. Physics instruction in schools fosters scientific thinking, curiosity, and an attitude in addition to helping pupils understand the fundamentals of the subject. Their ability to solve mysteries and improve society is a result of their inventiveness and scientific temperament. In addition, the majority of students struggle to understand and apply physics topics. When compared to other science subjects, high school students felt that physics topics are most challenging to understand, as seen by their low academic performance. When it comes to academic performance in Physics, one of the main areas that students struggle with is problem solving. This might be the result of improper comprehension of the physics foundational ideas. Therefore, the actual joy of studying physics is no longer present in the classroom. Even if the curricula in today's educational system are quite comprehensive, student's priority is to preparing themselves with informational knowledge than making real comprehension of the subject matter.

Fundamental ideas and facts form the basis of a subject like physics and the vast majority of these concepts are abstract in nature. In order to understand such concepts and apply it to new and unfamiliar situation students requires highly focused and systematic thinking called scientific thinking. So scientific thinking is essential for meaningful learning, understanding and application of various concepts in physics. Observation, comparison, organisation, prediction, experimentation, assessment, application, inference, and Problem Solving are some of the many abilities connected to scientific thinking (Kuhn, 2010). And among these, Problem Solving is the one that cognitive psychologists believe needs more attention and is connected to scientific thinking. Problem-solving skills are among the most significant cognitive factors that researchers wish to investigate in the current educational environment. Solving problems is innate to human nature. Every human being completes a variety of duties in his everyday life in order to address various issues. Solving problems is the most important component of human behaviour and a key to success. According to global educational Large Scale Assessments (LSAs), Problem Solving is a fundamental subject that provides different perspectives to the typical notion of learning school courses.

In order to foster Problem Solving Ability among students and to create good problem solvers teachers should use different teaching methods, strategies and models that better suit the particular subject or topic. In this changed society, sticking on the same method and process of teaching is utter foolishness. There must be researches and discoveries to develop new strategies and models of teaching that overcome the draw backs of the outdated methods of teaching. Teachers who stick to rigid teaching methods are unable to accomplish a range of learning goals, for which education is intended and executed. Additionally, they fall short of meeting the demands of students with complex personalities and diverse learning preferences. Teachers should employ various teaching tactics to align with the aims of instruction and the diverse learning styles and personalities of their students in order to complement such inadequate implications (Passi, Singh & Sansanwal, 1991). The strength of education, according to Dunn and Dunn (1990), Fischer and Fischer (1979), Joyce and Weil (1980), and others, lies in the clever use of a wide range of methodologies, matching them to various objectives and modifying them to fit the personalities and styles of the students. Teaching competency is derived from the ability to connect with a variety of students and provide them with a rich, multifaceted learning environment.

The term "Models of Teaching" originated from Joyce and Weil's (1972) search for a range of teaching pedagogies or tactics to accommodate different learning styles. An engineer does not create a building according to a bridge model. It is intended to serve a specific function. Models are interpreted in the field of education like they are in to the context of, bridges, dams and other structures. Consequently, instructional models outline the actions required to achieve the intended result. A teaching model, according to Joyce and Weil (1972), is a design or strategy that is useful to create an active interaction in classrooms and in other locations, as well as to shape curriculum and extended courses of study. A lot of focus has been placed on enhancing the teaching process during the past 20 years, leading to the creation of numerous teaching models by different researchers. These models are all grounded in theories, hypotheses, postulates, empirical studies, and intuitions. According to Joyce (1990), "we need to design appropriate instructional strategies which help our students grow emotionally, physically, socially, and intellectually in order to provide an all-around development." Theoretical understanding and real classroom instruction still differ greatly. It is necessary to integrate teaching models as methods into our instructional practices. Different teaching philosophies have developed to create curriculum. Joyce and Weil's seminal study from 1980 compiled 24 such instructional approaches. Due to their interactive, participative, adaptive, implementable, and compelling qualities, these teaching methods offer a great deal of promise for accomplishing the goals and objectives of instruction. They are divided into four groups: 1. Models of Information Processing; 2. Models of Social Interaction; 3. Models of Personality; and 4. Models of Behaviour Modification.

Here, the researcher used an innovative model that comes under information processing family to teach physics in the classroom. The name of the model is Productive Thinking Model and is developed by Tim Hurson (2007). In order to do this, the researcher thoroughly reviewed a variety of cutting-edge teaching models, instructional tactics, and their effects on the teaching and learning process, particularly with regard to problem-solving techniques. Thinking creatively is more than Critical and imaginative thinking. Productive Thinking is a fruitful result of the synchronized fusion of analytical and creative thinking. "Creative Thinking reveals the kind of thinking that leads to new insights, new approaches, fresh perspectives, and entire new ways of understanding and conceiving of things," according to Eragamreddy (2013). The American Psychological Association lexicon defined "Creative Thinking" as "mental processes leading to a new invention, solution, or synthesis in any area." Creative thinking empowers the individuals to create novel and genuine products, discover fresh approaches, and arrive at a synthesis.

The investigator sheds light on the Productive Thinking Model, demonstrating how it can be incorporated into science education in a novel way and avoiding functional fixedness which stands in the way of productivity, and emphasizing ideational fluency, which unlocks productivity.

The study of essential elements of "self," or the Self-Concept, has received more attention in recent decades. This is because understanding and forecasting the many dimensions of human behaviour is crucial to the educational process. Self Concept has crucial role in one's life, successes and other positive life events which guide towards strengthening one's Self-Concept while breakdown, stress, and other demeaning occurrences will take in to decline one's notion of oneself. Self-Concept is becoming seen as being crucial in the field of education as well. Since it has been shown to have strong relationships with a number of individual characteristics, including learning, motivation, attitudes, perception, and adjustment, which all influence the academic and additional achievements both within and outside of the classroom. A student's ability to meet learning objectives is directly linked to their Self-Concept, which encompasses their beliefs, ideas, actions, and self-evaluations. So it can be concluded that Self-Concept is the ability of an individual to recognize oneself. A shift from conventional method of teaching which stresses more on high achievement and getting greater grades for future admission may cause refreshment among students. Students will get a chance to get out of the box and think freely and collect their own ideas and fix the right one after self evaluation. So, this study also tries to know whether Productive Thinking Model of teaching has any impact on Self-Concept of students.

Need and significance

In a developing and forward-thinking society, Science has the potential to actually liberate people, enabling people escape the tragic cycle of poverty, lack of education and credulity (National Curriculum Framework - 2005).The fundamental premise is that, science is a subject that may alter people's perspectives and attitudes. So science education can lead to social change. According to the National Education Policy (NEP- 2020), each subject's curriculum should be pared down to its most fundamental components and allow for more comprehensive, research-based, analysis-based and argument-based learning along with critical thinking. The content should focus on important topics, components, facts, theories, consequences, and Problem Solving. Interactive classroom environments which support questions from students are foremost in teaching and learning process. In order to provide deeper and more experience based learning to students the classroom activities must be entertaining, creative, investigative and life related.

Since we are living in the "Age of Creative Science", Physics contributes to scientific advancements by giving the knowledge needed to accomplish the objectives. Knowledge in Physics enhances one's capacity for professional and practical growth as well as subjective and scientific understanding. Even though the constructivist class room provides motivation to learn and make teaching learning process interactive the students in the classroom are still unable to comprehend the concepts in physics easily. As a result, excellent designing was needed for the teaching of physics during the teaching-learning process. Problems with learning challenges in science education have been the subject of international science research and the PISA programme (Programme for International Student Assessment).

Nowadays the teaching learning processes in schools has been changed a lot. There is a great shift from mere rote learning to activity oriented, child centered learning. Even though these changes are taking place in most of the class rooms in India they are emphasizing more on high academic achievement and ways of getting better grades. In this scenario, our educational system should be in tune with the changes in the society and it should be able to get along with the advancement of science and technology. In order to face real life challenges and to be successful in life education should high spot the significance of problem solving. So our classrooms should be able to create good problem solvers rather than students who score high grades.

Instead of increasing information, education should open up a student's potential for invention and discovery (Duckworth, 1964) and provide them with the skills they need to overcome obstacles and stay up with the developments in science. However, these goals are not satisfied by the classroom teaching strategies now in use. It's true that as science has become so popular, teaching science in schools has become more difficult than it has ever been. And a variety of options need to be instilled in the young minds in a way that is suitable, dynamic, and ever-evolving. Students should be able to learn about the framework of science through science education. Teachers need to give students structured tasks, guidelines, and constructive criticism as they reflect on and analyse their science-related doubts.

Scientists and science teachers today felt that science teaching to be redesigned to better suit the needs of the modern world and make science more engaging for students. As a physics teacher, the investigator believes that teaching physics is distinct from teaching other subjects. Physics instruction ought to be grounded in student's curiosity, inventiveness, objectivity, sensibility, and spirit of inquiry (Smitha & Praveen, 2018). The investigator believes that most students in our classes simply learn the definitions of topics without understanding what they meant. In the classroom, students are passive listeners who lack mental activity, which entails interpreting and assimilating fresh data. In this regard, the researcher looked for an instructional model that would uncover each child's learning potential, offer a suitable framework for creating the particular learning objectives, and bringing a fresh creative perspective to students.

In this study the investigator has chosen independent variable as Instructional strategy which includes Productive Thinking Model and Existing Method of Teaching. Dependent variables in this study were Problem Solving Ability in Physics and Self-Concept. Productive Thinking Model offers an organised framework for coming up with original solutions to challenges. Foundation, Ideation, Evaluation, Stabilisation, Implication, and Application are the six steps that make up this model. The Productive Thinking Model was created by Hurson (2007) specifically for management studies. However, the researcher has tried to apply it to the sphere of education. The models that are now available are taken into consideration, and the necessary components are added. These days, there is a growing need to develop new teaching methods. Because rather than focusing on high achievement levels to land better employment that would provide financial security, we need good problem solvers who are confident enough to take on difficulties in future or to find answers to complicated problems in life. Additionally, in order to help students to develop a stronger sense of self, teachers should provide them complete flexibility to overcome obstacles in the classroom. Therefore, the researcher felt that Productive Thinking Model might have an impact on student's Problem Solving Ability and Self-Concept.

Additional reading on the Productive Thinking Model unveil that the model sparked a sincere and natural curiosity and guided the researcher in determining how useful it was for instruction. Any significant effort to develop a new teaching approach will be very beneficial and a cure for the current boring way of instruction. Therefore, the purpose of the study is to determine how well the Productive Thinking Model affects secondary student's Problem Solving Ability in Physics and Self- Concept.

Many studies have showed proven benefits of models of teaching (Titus & Bincy, 2016; Alam, 2017; Varshney, 2017; Mir & Tandon, 2022; Ambarini, Faridi, Sukarno & Yuliasri, 2023) on Achievement. Siswanto, Susantini & Jatmiko (2018) found the effectiveness of the IBMR teaching model to improve physics Problem Solving skills. Also a study conducted by Olaniyan & Omosewo (2018) developed a Target –Task Problem Solving model and proven its positive effect up on creativity skills in physics. Hence, compared to academic success in physics or any other topic, the number of studies that created specific teaching models that influence students' capacity to solve problems in physics is extremely less in number. Chaudhary & Pariksha (2002); Suryaneli, Sudjarwo & Risma (2021); Lali (2020); Rani (2015) found positive effect of models of teaching on self concept of students. Pinto & Clare (2018), in their study shows that Autonomous learner models is positively related to Self esteem too. Studies on relationship between models of teaching and its impact on Self-Concept are found less in number. Need analysis study conducted by Tyas, Harjana and Wahyuningsih (2021) shows that there is high demand of creative teaching materials including learning media with the support of pictures and videos with a large model that is capable of developing Problem Solving Ability among students. Qotrunnada (2022) conducted a study with the intention of analyzing the elements that cause secondary school students to struggle with Problem Solving in physics class. The study's findings indicate that the models of teaching applied must be meaningful as they are essential components to examine secondary school students Problem Solving Ability

There exist lots of researches in the field of education that use Problem Solving Ability as its main indicator. But not much of the recognized research attempted to create a teaching model that would foster student's abilities to solve problems in physics. Especially no such studies are there which connect Productive Thinking Model and Problem Solving Ability in Physics. Therefore, present study tries to implement Productive Thinking Model among secondary school students that might affect the Problem Solving Ability in Physics and Self-Concept of students. This is a modest but earnest attempt to add to the body of knowledge so that educators can develop methods for fostering their student's Problem Solving Ability.

These observations prompted the investigator to ask the following questions,

1. Is there any effect of Productive Thinking Model on Problem Solving Ability among standard IX students?

2. Is there any effect of Productive Thinking Model on Self -Concept of students?

3. Is this Productive Thinking Model is capable of replace Existing Method of Teaching in terms of student's ability to solve problems in Physics?

To find out answers to these questions, the investigator decided to conduct a study on "Effectiveness of Productive Thinking Model on Problem Solving Ability in Physics and Self -Concept of IX standard students."

Statement of the Problem

The problem statement describes the challenges to be addressed, the variables chosen, and the goal of the research. This study aimed to find out the effectiveness of

Productive Thinking Model over Existing Method of Teaching on Problem Solving Ability in Physics and Self-Concept of Standard IX students. Problem Solving Ability is one of the important life skills and is foremost in our daily lives, at house, at school, and at work place. The educational system, in recent years has been increasingly emphasizing on higher-order skills. Problem Solving Ability is one of the important 21st century skills that one has to acquire for successful living. This study is an attempt to inculcate Problem Solving Ability among students through the introduction of Productive Thinking Model.

As an attempt to find answers to the above questions the problem is stated as, Effectiveness of Productive Thinking Model on Problem Solving Ability in Physics and Self- Concept of standard IX students.

Definition of Key Terms

Effectiveness

Effectiveness is defined as the capacity to generate the desired outcome (Oxford Advanced Learner's Dictionary, 2000). The degree to which goals are met, problems that are specifically addressed are handled, or a purpose is fulfilled is referred to as Effectiveness (Cuddon, 2013).

Effectiveness is operationally defined as a notable improvement over the desired results, such as student's Self -Concept and their Problem Solving Ability in Physics.

Productive Thinking Model

It is a methodical technique to Problem Solving or developing innovative ideas. This model incorporates many strategies that are done at different stages of the process. (Hurson, 2007)

In the present study, Productive Thinking Model is a teaching model in which the physics concepts are taught through six stages. Researcher employed the six staged lesson plan to teach the content.

Problem Solving Ability in Physics

Problem Solving Ability is a mental procedure aimed towards obtaining a goal, when no possible solution becomes apparent to the problem solver (Mayer and Wittrock, 2006).

In the present study, student's "Problem Solving Ability in physics" was defined as their capacity to solve a problem using previously covered physics ideas, taking into account the elements of understanding the problem, making sense of the problem, and coming up with a solution. Mean score taken from Problem Solving Ability test prepared based on the main components sensing the problem, comprehending the problem and finding solution to the problem are considered as the Problem Solving Ability in physics of students in this study.

Self- Concept

"The person's belief about themselves, taking into account their characteristics and sense of self" (Baumeister, 1999)

In the context of this study, Self-Concept is defined as IX standard student's optimism, self-acceptance, and self-confidence in their abilities and potentials. And is measured using the mean scores obtained from Self-Concept scale prepared with dimensions optimism, self-acceptance, and self confidence.

IX standard students

IX standard students means, students studying in secondary levels in schools recognized by the Kerala state Government.

Variables of the Study

The primary goals of the research were to determine the superiority of the Productive Thinking Model over the Existing Method of Teaching and to examine the impact of Productive Thinking Model on Problem Solving Ability in Physics and Self-Concept of standard IX students in Kerala State. Here is a description of the Independent, Dependent, and Control variables.

Independent Variables

The independent variable selected for the study were,

- Models of teaching (Productive Thinking Model)
- Method of teaching (Existing Method of Teaching)

Dependent variables

The following dependent variables were assessed:

- Problem Solving Ability in Physics
- Self- Concept

Control variables

The control variables selected for the study are,

Pre-test score of Problem Solving Ability in Physics

With relation to the subjects of the experimental and control treatments, this is the students' initial academic standing. It might have a significant impact on ultimate success.

Pre- test scores of Self Concept

With relation to the subjects of the experimental and control treatments, this is the students' initial Self Concept score. It might have a significant impact on ultimate success.

Verbal intelligence

The impact of verbal intelligence on academic achievement is significant. The influence of intelligence could be the cause of any changes in the dependent variables after treatments.

Socio-Economic status

Students' educational opportunities are directly influenced by their family's Socio-Economic status. The high Socio-Economic position of the family may potentially be the cause of the dependent variable’s change in the present study.

Objectives of the Study

The assertions that assist or guide the investigator in analysing the variables and their effects are regarded as objectives. The study's main objective was to find out how well the Productive Thinking Model worked in comparison to the Existing Method of Teaching for improving standard IX student’s Problem Solving Ability in Physics and the development of their Self- Concept.

Based on the main objective some specific objectives have been developed:

1. To identify the prevailing and innovative Instructional Strategies, Methods and Models adopted by teachers to teach Physics at Secondary School Level.
2. To find out the issues (if any) experienced by the Physics teachers in implementing innovative Instructional Strategies, Methods and Models at Secondary School Level and to suggest measures (if any) to overcome the constraints in implementing the innovative Instructional Strategies and Models at Secondary School Level.
3. To compare the mean post-test scores of Problem Solving Ability in Physics of experimental and control groups for the Total sample, Boys and Girls.
4. To compare the mean post-test scores of Self-Concept of experimental and control groups for the Total sample, Boys and Girls.
5. To compare the mean gain scores of Problem Solving Ability in Physics of experimental group I and control group II for the Total sample, Boys and Girls.

6. To compare the mean gain scores of Self-Concept of experimental group I and control group II for the Total sample, Boys and Girls.

7. To compare the mean retention scores of Problem Solving Ability in Physics of experimental and controlled groups for the Total sample, Boys and Girls.

8. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability in Physics of pre-tested experimental and control group.

9. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability in Physics of non pre-tested experimental and control group.

10. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of pre-tested experimental and control group.

11. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of non pre-tested experimental and control group.

12. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on retention in Problem Solving Ability in Physics of pre-tested experimental and control group.

13. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on retention in Problem Solving Ability in Physics of non pre-tested experimental and control group.

Hypotheses of the Study

A study's conception and execution depend heavily on its hypotheses. A formalised hypothesis will compel us to consider the outcomes we ought to search for in an investigation. It was required to make certain assumptions about the studies anticipated results in this one as well.

The following hypotheses were intended to be tested by the current investigation.

1. There will be no significant difference in mean post-test scores of Problem Solving Ability in Physics of experimental and control groups for the Total sample, Boys and Girls.

2. There will be no significant difference in mean post-test scores of Self-Concept of experimental and control groups for the Total sample, Boys and Girls.

3. There will be no significant difference in the mean gain scores of Problem Solving Ability in Physics of experimental group I and control group II for the Total sample, Boys and Girls.

4. There will be no significant difference in the mean gain scores Self-Concept of experimental group I and control group II for the Total sample, Boys and Girls.

5. There will be no significant difference in the retention scores of Problem Solving Ability in Physics of experimental and control group for the Total sample, Boys and Girls.

6. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability in Physics of pre-tested experimental and control group.

7. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability in Physics of non pre-test experimental and control group.

8. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of pre-tested experimental and control group.

9. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of non pre-tested experimental and control group.

10. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on retention in Problem Solving Ability in Physics of pre-tested experimental and control group.

11. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on retention in Problem Solving Ability in Physics of non pre-tested experimental and control group.

Methodology

Method

Experimental method is used for the present study.

Design of the study

The design used for the study was Solomon Four Group Experimental design. The study included two experimental groups and two control groups. The two experimental groups were taught through Productive Thinking Model and control groups were taught through Existing Method of Teaching.

Sample Selected for the Study

The population selected was IX standard students studying under Kerala state syllabus. The researcher selected the sample from Poyilkav Higher Secondary School and Thiruvangoor Higher Secondary Schools from Kozhikode district. For the present study the investigator randomly selected a sample of 172 students from four divisions of these two schools. 88 students were given experimental treatment (Experimental group I & II) and 84 were given control treatment (Control group I &II). The experimental groups were taught using Productive Thinking model and control groups using Existing Method of Teaching.

Tools, Techniques and other materials used for the study

To complete the current investigation, the investigator employed the tools, techniques and other materials that are explained below. The researcher's own tools as well as those of others which were adopted also listed.

Semi- Structured Interview Schedule for Secondary school Physics Teachers (Athira & Bindhu, 2021)

The schedule was created to help secondary school Physics instructors learn about the existing and creative instructional strategies, methods and models they use when teaching Physics. The interview will also look into the constraints and obstacles they have when implementing new methods and making suggestions. Expert advice was gathered to validate the schedule.

Lesson Transcript for Productive Thinking Model (Athira & Bindhu, 2021).

The investigator prepared Lesson Transcripts in Productive Thinking Model for the selected chapter of IX standard Physics Text book under Kerala state syllabus. The selected chapter for the treatment was break down in to 13 sub topics. For treatment in the Experimental group I and Experimental group II the investigator developed Lesson Transcript based on Productive Thinking Model through the following stages of the model.

- Foundation
- Ideation
- Evaluation
- Stabilization
- Implication
- Application

Lesson Transcript for Existing Method of Teaching (Athira & Bindhu, 2021)

The most common approach used in Kerala State's Secondary Schools is the Process Skill Oriented Method. Based on the Process Skill Oriented Method, which has been validated by the subject matter experts, the lesson transcripts were created.

Problem Solving Ability test in Physics (Athira & Bindhu, 2021)

This test is meant to measure the Problem Solving Ability of the students in Physics. The investigator creates the test based on the specified topics, as previously mentioned. The Problem Solving Ability Test was developed by Athira & Bindhu (2021). Comprehending the Problem, Clarifying the Problem and Finding solution to the Problem were the major components selected while preparing the test. The test has been standardised and its validity and reliability have been verified.

Self-Concept Scale (Bindhu & Alphonsa, 2016)

For the study, Self-Concept was measured using the Self-Concept scale developed by Bindhu & Alphonsa (2016). The test consists of five sub components namely, Physical self concept, Moral self concept, Social self concept and Academic Self-Concept.

Verbal Group Test of Intelligence - VGTI (Kumar, Hameed, & Prasanna, 1997)

For the study, the Verbal Group Test of Intelligence (VGTI) developed by Kumar, Hameed & Prasanna (1997) was used to test the Verbal Intelligence of students. the test is a combination of five sub tests in which each sub tests consists of twenty multiple choice items (altogether 100 items). There are five components that constitute total score of verbal intelligence and they are namely Verbal Analogy, Verbal classification, Numerical Reasoning, Verbal Reasoning and Comprehension. The test should be completed by note more than an hour of time. The test has maximum score of 100 and minimum score of zero. The total score obtained will be the sum of five subtests and which is treated as the Verbal Intelligence of students

Socio-Economic Status Scale (Vineetha & Bindhu, 2018)

Socio-Economic Status (SES) is an extremely significant variable in social science education and researches. Socio-Economic Status of a family means the positioning of the family in the setting to which the family fits. Socio-Economic Status could be well defined approximately as access of one to economic, communal, civilizing and human investment source. A student's Socio-Economic Status includes educational achievement, work related status, and personal salary off parents. Review of literature on the basis of Socio-Economic Status Scale, the researcher selected four zones such as Education, Occupation, Material possessions and Economic/social position both in India and abroad. Under each area some alternatives were added and every alternative has its own score.

Statistical Techniques Used

To complete the analysis and to arrive at the conclusions, the researcher used the following statistical techniques, which include both descriptive and inferential statistics.

- Preliminary Analysis which includes Mean, Median, Mode, Standard deviation, Skewness and Kurtosis.

- Percentage Analysis to find opinions of Secondary school Physics teachers on various Instructional Strategies, Methods and Models.
- Mean difference Analysis to compare the mean scores of Problem Solving Ability test and Self-Concept
- One way ANOVA to compare the effect of Productive Thinking Model on Self -Concept and Problem Solving Ability in Physics.
- One way ANCOVA procedure was employed to find the effectiveness of Productive Thinking Model over Existing Method of Teaching on Problem Solving Ability in Physics and Self-Concept even after controlling the covariates singly and in combination.

The ensuing chapters call for a thorough examination of the data and a discussion of the findings.

Scope of the Study

Physics is a challenging subject mostly because it requires extensive learning procedures to comprehend. This subject demands the learners to handle with different types of demonstrations, including procedures, measurements, graphical representations, and also an abstract theoretical understanding (Saleh, 2014). According to Erdemir (2009), physics is regarded as the most difficult topic in all of science, and not many students are interested in studying it. Better learning environments can be produced and this hesitation can be removed with innovative and creative learning scenarios. Models of Teaching like Productive Thinking Model can be developed and implemented for Physics education in the secondary level. Researcher views the chance to interact directly with ground-breaking innovations in education, such as the Productive Thinking Model. Productive Thinking Model of teaching never go out of style, even in an age where instructional situations and virtual classrooms are common place.

The major objective of the present study was to find out the effectiveness of Productive Thinking Model over Existing Method of Teaching in terms of Problem Solving Ability in Physics and Self-Concept of IXth standard students. the design selected for the study was Solomon Four Group design. The appropriate tools, techniques, and materials were used for this study.

Researcher felt appeased with the outcome of study since it can be implemented by Physics teachers in the classroom. Numerous research, as indicated by the literature reviews demonstrate how well teaching models suit physics instruction. It is anticipated that the outcome will promote favorable ideas about delivering education in this manner.

In the current educational environment, a wide range of teaching approaches and models are available to accommodate various learning scenarios. Students in secondary school exhibit greater energy and a desire to learn. Their eagerness can be directed towards providing a forum for learning, reasoning, creating, discussing, and making decisions, as well as for putting their energy to use in other ways. In addition to all the academic benefits, educators have the power to shape their pupils into better people. A different instructional technique that is applicable to the current situation is the Productive Thinking Model, and it was included in the current research.

Productive Thinking Model is invented to increase the Problem Solving Ability and decision making power of students not only in the class rooms but also in their real life. The major aim of Productive Thinking Model is to improve the confidence level of students to face challenges and think out of the box and find the right solution to complex problems through creative thinking.

The investigator has selected a sample of standard IX students for the experimental study, and examined the student's Self-Concept and ability to solve physics problems in order to determine the impact of the Productive Thinking Model compared to the existing method of teaching for the content transaction. The investigator believes that it will provide a roadmap for future researchers and practitioners of cutting-edge instructional strategies. Therefore, physics teachers and students in secondary schools can profit greatly from this work.

Delimitations of the Study

The variables chosen for the current investigation were done with sufficient care by the researcher. Carefully chosen prior research on the factors under consideration was done, along with a thorough study of the literature.

Despite having overseen the entire experimental process, including the choice of variables, tactics used, instruments, methods, and supplies used, as well as the adequate data analysis with caution, certain restrictions might have crept into its route.

Since the researcher is a Post graduate in Physics, The experiment focused exclusively on Physics and was taught fully in English. The researcher solely considered standard IX students from Kerala state.

The sample included four distinct classes: Experimental Group I, Experimental Group II, Control Group I, and Control Group II. However, there may be early disparities in pre-experimental status in terms of Problem Solving Ability in Physics, Self-Concept, Verbal Intelligence, and Socio-Economic status and theses were statistically controlled using analysis of covariance. Therefore study guarantees a reliable outcome. Investigator did all possible attempts to negotiate the impact of extraneous variables, hence the investigator anticipates that the study's findings will be generalisable.

The chosen topic only covered one unit from the IX standard Physics textbook. The results may only apply to the state of Kerala, as the curriculum was based on a required textbook for students in Kerala .

Investigator has selected Problem Solving Ability in Physics and Self-Concept as the dependent variables for the study. Productive Thinking Model was selected as the independent variable. The researcher considered that the variables that were chosen had greater relevance among the cognitive and affective factors that influence learning.

The study was confined to two schools by the investigator purposefully for the better implementation of Productive Thinking Model. The researcher have spend lot time with in the school before the experimental phase for the purpose of understanding the student teacher relationships and to know the status of students, their attitude towards the subject physics and also their previous achievements. This is for establishing the equivalence of the groups to some extent.

Regardless of these delimitations, the researcher made every conceivable attempt to ensure that the current investigation was as legitimate as possible. The researcher hopes that this study will provide insightful information to Productive Thinking Model in physics classroom.

Organization of the Report

Introduction, Review of Related Literature, Methodology, Analysis, Summary, and Finding and Recommendations are the six chapters. And the whole thesis is organized in this manner. The explanation of each chapter and their subdivisions are provided below.

Chapter I: Introduction

This chapter goes into detail regarding the study's history, need, and importance. It also includes a synopsis of the Study's objectives, variables, definition of key terms, and hypotheses. This section depicts the study's limitations, scope, and methodology as well. The report's structure is described in detail in a later section of introduction chapter.

Chapter II: Review of Related Literature

The review of literature and previous research in the area of this study are covered in this chapter. The first section describes the theoretical underpinnings of the Problem Solving Ability in Physics and Self-Concept. Second part details about the Review of Related Studies on Models of Teaching and Problem Solving Ability, Self-Concept and Models of Teaching, Problem Solving Ability and Self -Concept.

Chapter III: Methodology

The third chapter is Methodology, which includes the study's sample, tools used, data collection procedures, and statistical techniques used.

Chapter IV: Analysis and Interpretation

The statistical procedures used to test the hypotheses and achieve the goals are covered in the fourth chapter.

Chapter V: Summary of Findings

Comprises an overview, the study's key findings and the plausibility of the hypotheses

Chapter VI: Recommendations of the Study

The final chapter is recommendations of the study and it includes educational implications derived, suggestions for further research and recommendations for more research.

Chapter II

REVIEW OF RELATED LITERATURE

- Theoretical Overview of the Variables
  - Models of Teaching
  - Productive Thinking Model
  - Problem Solving Ability in Physics
  - Self-Concept
- Review of Related Literature
  - Studies Related to Problem Solving Ability in Physics
  - Studies Related to Models of Teaching and Self-Concept
  - Studies Related to Models of Teaching and Problem Solving Ability in Physics
- Conclusion

REVIEW OF RELATED LITERATURE

A review of the literature is an essential component of every research. It includes a comprehensive framework regarding related ideas, other pertinent studies, the research design used, and also the relevance of the variables chosen to conduct the investigation. A review assists a researcher to have a detailed knowledge that will lead to establish a connection with the variables they have chosen. It also keeps them from doing redundant research. The present study aimed to find out the effectiveness of Productive Thinking Model on Problem Solving Ability in Physics and Self-concept of standard IX students of Kerala. The researcher has worked seriously to manage the evaluation of the sources that are now available for the chosen variables in the years leading up to 2023. The following headings organize the related studies and the theoretical framework.

- Theoretical overview of the variables
- Review of related studies

Theoretical Overview of the Variables

The essential theoretical aspects of the independent and dependent variables in the present study are explained in detail in this section. Independent variables of the study are Model of Teaching (Productive Thinking Model) and Existing Method of Teaching. The dependent variables include Problem Solving Ability in Physics and Self-Concept. Theoretical overview of the Independent variable for the current investigation, which is Model of Teaching (Productive Thinking Model) is described as follows:

Models of Teaching

Teaching models are the teaching process approach, which falls somewhere between the teaching method and the teaching approaches. It seems to be putting forward a specific, measurable method of dealing with students that fosters their growth more than any other method could. When employing the teaching models the teacher has a clear focus and frame of reference. It is helpful in structuring the course of study, creating teaching theories, organizing and planning instructional activities for young learners.

A teaching model offers suggestions for creating an environment and activities that are informative. Teaching models are developed from a variety of sources, including behavior modification, psychology, group dynamics, academy, and personal experiences. Models of teaching have been helped for the functional and structural guidelines to develop instructional materials. With the learning theory, supporting procedures, the available support technology, the learner's intellectual and personal qualities, and a social and cognitive goal, they are dynamically interactive. In order to rationalize them and divide learning outcomes into separate categories, they have a frame and point of reference. Learning contexts can be specified using teaching models. They support teachers in expanding their reach and providing a more stimulating and engaging learning environment for students.

Various educationists have given the phrase "Model of Teaching" varied interpretations. Nonetheless, models of teaching are perspective point-based instructional techniques (Eggen et al., 1979). Their ability to achieve certain learning objectives sets them apart from more generic teaching approaches.

Dececco and Crawford (1997) distinguished between a theory of teaching and teaching models, claiming that models lacked the rigor of Formal theories. They are purposefully and methodically designed to take into account every significant variable. Theory with empirical testing may eventually emerge from the model.

Hunt (1970) proposes a model for optimal growth that allows educators to tailor the learning environment to each student's specific needs. However, he views this as a teaching model.

A model of teaching is defined as "a term, imitation, condition, category, prototype representation considered as a standard of excellence to be envied, emulated and accentuated, of course, in teaching," according to Taneja (1989).

A teaching model does not take the place of an effective teacher. It is a kind of goes well with the latter. Numerous models have emerged from efforts to make society better, including the goal of drastically reforming it either on purpose or by accident.

"A model of teaching seeks the systematical exploration of interaction among educational purposes, pedagogical strategies, curricular designs or materials, and social and psychological theories," state Joyce, Weil and Showers (1991). The motto of instructional models is "teaching through creating environments."

According to Passi and Sansanwal (1991), a well-structured and demonstrable theory, the stipulations of both intentional and unintentional objectives, intellectual syntax expressed in terms of a step-by-step sequence, teacher's explicit reactions, and a description of classroom support are characteristics of a teaching model.

According to Brady (1985):

1. The models are not highly developed theories; rather, they represent guidelines for planning and carrying out instruction.
2. No single model is thought to be better than another, and no single model is able to achieve the variety of subjects and goals.
3. The models lack clear boundaries between each other, therefore they are not very discrete.
4. A comprehensive understanding of every model results in increased adaptability and effectiveness.

The development of instructional models is still in its early stages. As of right now, we know very little about how to support students development in a variety of phases, and even less about creating instructional models that appeal to students. The continuum that contains several paradigms can be found at two extremes: teacher-dominated and learner-centered. The teacher can more easily link a certain method or a specific model with a wider scheme by identifying the models on the continuum.

Classification of Models of Teaching

Joyce and Weil (1985) categorized teaching models into "four families" based on the educational goals attained through the use of various approaches.

1. Information Processing Family
2. Personal Family
3. Social Interaction Family
4. Behavioral Family

Information Processing Family

Information processing includes how people hold inputs from their environment, classify information, identify problems come up with ideas and solutions, and use both spoken and nonverbal symbols. While some information processing models focus on the learner's capacity for problem-solving and hence encourage creative thinking, others are more interested in the general intellectual concepts and knowledge found in academic subjects. It is important to note, nevertheless, that almost every model in this family also addresses social interactions and cognitive expansion of an unified, functioning self.

Information processing models demonstrate to students ability to think inductively, work with others to get knowledge, and reason in certain ways. They also help students strengthen their memory.

Information processing models aim to achieve the following:

- The proficiency with which the inquiry is processed.

- The understanding of information, ideas, and generalizations.
- The development of several cognitive abilities, including observation, drawing conclusions, making hypotheses, etc.

The table below provides specific information about models in the information processing family.

Table 1

Different models in Information Processing Family

Sl. No.	Model	Important theorists	Objectives or Goals
1.	Inquiry Training Model	Hilda Taba	Intended to support the development of inductive thought processes and academic reasoning, or theory construction.
2.	Science Inquiry Model	Joseph J. Schwab	Developed to teach the inquiry framework of an area of study.
3.	Concept Attainment Model	Jerome Bruner	This tool is mostly for inductive reasoning, although it can also be used to generate and analyse concepts.
4.	Inquiry Training Model	Richard Suchman	Instruction of planned inquiry
5.	Advance organizer Model	David Ausubel	Designed to improve the capacity to meaningfully take in and relate different collections of knowledge and to process information more efficiently.
6.	Development Model	Jean Piaget, Irving Sigel, Edmund Sullivan	Intended to promote overall intellectual growth, particularly in the area of logical reasoning

Personal Family

Personal models are focused on the growth of the individual. They place special emphasis on the methods by which people create and arrange their own reality. This approach focuses primarily on emotional life. The model's primary goal is to enhance interpersonal relationships by assisting people in creating dynamic relationships with their environment. Since every person is different, developing a cohesive, self-assured, and significant personality requires a personal approach. The teacher has a responsibility to enable learners to reach their full capability by implementing this strategy in teaching learning process

The major objectives of personal models are,

- To improve the perceptions of self-esteem among students.
- To assist students in their self-understanding.
- To assist students to set their learning goals.

The Personal Development Model Family includes four models: David Hunt's Conceptual System Model, Fritz Perls' Awareness Training Model, William J.J. Gordon's Synectics Model, and Carl Rogers' Non-Directive Model.

Social Interaction Family

The relationship between an individual and society or other individuals is highlighted by social interaction models. The main goal of the approach is to help people become better communicators, participate in democratic processes, and work kindly in and with society.

The models focus on a person's social associations, how they maintain relationships and fit in with society at large.

The goals of the models are,

- To assist students in working to recognize and resolve social and personal problems.
- To develop human relationship skills.
- To become conscious of one's own and society's social and personal values.

The social interaction methods include Group Investigation, Laboratory Method, Jurisprudential, Role Playing, Classroom Meetings, Social Inquiry, and Social Simulation.

Behavioral Family

Every model in this family shares a common theoretical foundation known as behavior theory. The learner's observable behavioral improvements are highlighted. The emphasis of these approaches is on reinforcement and feedback. The development of skills such as intellectual, social, personal, and psychomotor skills is the main objective. They also foster interpersonal skills, societal values awareness, and self-awareness.

Behavioural family models include desensitization, assertive training, direct training, self control, stress reduction, relaxation, and contingency management.

The researcher went over the specifics of teaching models, teaching tactics, and various techniques. The investigator selected a model namely Productive Thinking Model, created by Canadian author Tim Hurson (2007) specifically in the field of marketing. It was changed in the academic context by applying necessary changes and modifications with the help of supervising teacher in the current study to achieve better results. This model will fall under the information processing family when its structure and features are taken into consideration.

Productive Thinking

Productive thinking was first described by gestalt psychologists. Reproductive and productive thinking were the two processes they distinguished. Reproductive thinking is essentially the mechanical application of previously learnt and reinforced associations through habits and experience. Repetition, conditioning, habits, or well-known intellectual ground are linked to it. The practice of employing higher order thinking skills to create something new is known as productive thinking. Various types of cognitive activity are covered by constructive thoughts like, Inference, comprehension, causal reasoning, Problem-solving, creative thinking, assessment and critical thinking, as well as decision-making and conservative thinking. Constructing more complete and significant thoughts that transcend the information provided is made possible by higher order thinking, which is achieved through the combining and indirect application of knowledge. In an academic setting, productive thinking is frequently used to improve comprehension, evaluation, reasoning, and decision-making. The word "productive thinking" was also used by Romiszowski (1981) to refer to Bloom's (1956) higher level thinking processes, which include analysis, synthesis, and evaluation. He asserts that successful idea generation and comprehensive plans serve as a roadmap for decision-making. It is a type of thinking which will take steps to change brain and existence, making it a useful tool for those trying to interact with and survive in the world.

According to the definitions provided by researchers, productive thinking is the mental capacity to organize, reason rationally, analyze, synthesize, evaluate, and make decisions in order to arrive at a solution. Deduction, comprehension, reasoning, creative thinking, problem solving, evaluative thinking, decision making, and intelligent reasoning are the main areas of emphasis for productive thinking. Productivity thinking is regarded by Cunningham and Macyregor (2013) as a system of perspective shifts to address an issue. According to Alexander (2022), it is a synthesis of creative and critical thinking. It is described as a problem-solving strategy by Hurson (2007).

Conceptualization of productive thinking in science teaching

Because it incorporates higher order thinking components thinking productively is never a novel idea in the educational process but it is an essential component of it. Since science offers a vast amount of opportunity for these elements, developing the student's capacity for analysis, synthesis, and evaluation is our main priority while teaching science. Teaching productivity with thinking establishes a balance between both components in scientific learning so that students can learn something new instead of just memorizing drills and exercises.

Higher order thinking skills are essential to science, research and technology. Without critical and innovative thinking, science is extinct. All of the higher order thinking skills particularly in scientific classes can be enhanced in students through the use of productive thinking. It is an integrated application of critical and creative thinking to generate novel and valuable ideas as well as to make creative thinking useful.

Productive Thinking Model

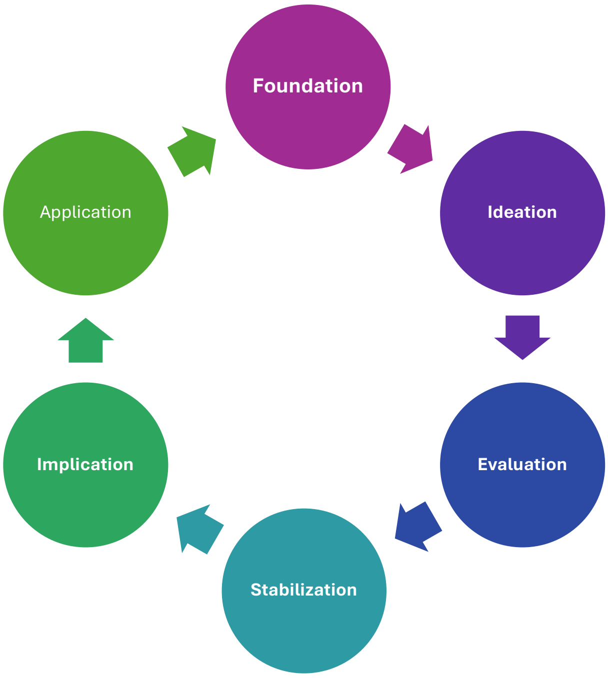
The ability to be creative is crucial for solving problems. Lack of creativity makes it difficult to comprehend the issues that surround a problem and to choose appropriate solutions. Also, you might not be able to resolve the issue. The answer to this is found in Hurson's Productive Thinking Model. It is a useful strategy for increasing creativity in Problem-solving. This model encourages innovation and critical reflection at each and every stages. This implies that you gain a deeper comprehension of the issues you encounter, leading to the generation of more creative concepts and solutions.

The Productive Thinking Model was developed by author Tim Hurson, and was published in his book Think Better in 2007. This is a six staged model and is an integration of creativity and Problem solving. The six steps include Foundation, Ideation, Evaluation, Stabilization, Implication and Application. Tim Hurson has developed Productive Thinking Model for Management studies. But the investigator has made an attempt to extend it in to the field of education. Necessary changes and modifications are done by considering the available models and adding the needed components.

This model can be included into the syllabus to teach scientific content. The Productive Thinking Model follows the processes shown in the illustration.

Figure 1

Processes of Productive Thinking Model



The six steps are,

Foundation

The idea behind this stage is that creativity never occurs in a vacuum. In order to achieve this, we must offer a knowledge base from which productivity can be derived. Since motivation, memory, creativity, and critical thinking all play a part in productive thinking, it is important to establish a foundational stage in which teachers manipulate students' prior knowledge to engage them in the material and use student-centered strategies like activities, technology-enhanced instruction, and demonstrations to teach.

Ideation

In this level, ideation fluency is prioritized over the creative part of productive thinking. The following ideas serve as the foundation for ideation.

- Quantity comes before quality.
- Innovation is hindered by functional fixedness.
- The obstacle preventing creation is criticism.

Students are free to think creatively and from a variety of angles by sticking to the previously mentioned principles. In this situation, a teacher's job is to pose an issue in a way that challenges students, upsetting their balance and encouraging them to come up with solutions. To do this, we must reduce criticism. That is criticism of oneself or criticism from others, as it prevents one from being creative and avoids emphasising memorization, drill, and skill. This methodology allows for the use of forced connection, brainstorming, creative free writing, and cognitive inquiry in this aspect of science education.

Evaluation

The critical thinking component of productive thinking is represented by this phase. It entails assessing creative thought through critical thinking in order to change the idea and make it workable. As critical thinking takes domain criteria into account, it gives the developing ideas value, strength, potential, usefulness, and appropriateness. Peer assessment and presentation are two tactics that can be used in science classroom instruction to assess concepts that are still in their infancy.

Stabilization

This is the fourth step in the productive thinking process. During this phase, teachers clarify any doubts students may have. Students then use strategies such as concept maps and summaries to solidify the topic. By doing this, students stabilise the topic in a disciplined fashion that will last for several days.

Implication

The fifth step of the productive thinking model distinguishes between creative and productive ideas. Following evaluation, the next step is to apply the idea to a real-life scenario to provide feedback. Productive ideas are those that can solve problems in real-life situations. After completing the five steps of constructive thinking, students will have a solution to the problem.

Application

In this stage of the model teacher should give similar situations to students to apply the learned ideas. Real life application comes in this step.

Metaphysical analysis of Problem Solving Ability

One of the higher order skills that one needs to develop in order to improve one's existence in the universe as it exists today is the Problem Solving Ability. In the study of psychology, Problem Solving is the process of reaching an objective that is not immediately apparent but may be reached by removing all obstacles. The Greek word "problema," which meaning impediment, is where the term "problem" originates. The term "problem" may refer to an issue or circumstance that is thought to be undesirable or dangerous and that requires investigation and resolution. People deal with a variety of problems with their daily lives for which there may not be a quick solution. Problems can be referred to as issues, disputes, obstacles, dilemmas, or difficulties depending on the context. But from a cognitive perspective, there are questions that need to be answered. An issue that arises when someone has a condition of affairs, a series of events, or a goal they wish to effectively bring about or reach but they are unsure of how to get there. According to Newell and Simon (1972), To analyse a scenario, three key pieces are required: the starting problem state, operators that convert it to new states, and operators that judge if it is a solution. A problem is described as a controversial or challenging issue that has to be resolved and is challenging to comprehend, carry out, or handle (Concise Oxford Dictionary, 1995). According to Hayes (1989), an issue arises whenever there is a difference between where you are and where you want to be and you are unable to figure out how to get across it. A problem is one that has sets of starting states, target states, and path restrictions (Wood, 1983).The components of a problem are called givens, which are the elements, relations, and conditions that determine the original state; the components of an obstacle are the qualities of the problem solver or the circumstances of the problem that make it difficult to change the initial state into the desired state (Davidson, Deuser & Sternberg, 1994).

It is clear from the several definitions of problem that there are two things in common: an obstacle and a goal. A goal is an objective that a person has previously set out to achieve. Distinct people have developed distinct goals. A student claims that his objective is to master the material. He may set objectives and sub-goals to accomplish the purpose of the subject learning in order to do that Setting goals is the most important and vital step in solving problems. The limitations or barrier we encounter when trying to solve problems make up the second component of the obstacle. These obstacles prevent us from achieving the goal right away. For instance, when a student is attempting to solve a problem related to their course work, they thoroughly analyze the issue, come up with solutions, assess the solution, and use various tactics to reach the objective. The learner's degree of expertise, the nature of the problem, and the topics could be the barriers that need to be removed in order to achieve the objective.

An organized study up on a challenge or inability in order to discover a solution is known as Problem Solving Ability. Reflective thinking is the process of carefully considering the facts, one's own judgment, and other elements of one's mental experience in order to arrive at conclusions that are reasonable in relation to a given issue or inadequacy. Finding a way out of a situation or around an obstacle to achieve a goal that was not immediately reachable is known as Problem Solving (Polya, 1981). Mayor (1992) summarizes the following three key elements of the Problem Solving definition: a) The reason Problem Solving is cognitive is that it takes place inside intellectual system of the problem solver. b) Problem Solving is a procedure because it requires a problems solver to manipulate or perform operations on their knowledge, and c) it is directed because the problem solver is trying to accomplish a certain objective. It involves organizing an issue in student’s brains to stimulate eager, thoughtful thought that leads to a logical solution. Three elements seem to be of concern in this instance: which presents an incapacity, problem, or awkwardness that needs to be solved, a goal or aim involving a situational feature for which a direct response cannot be given, and an aspiration or desire that motivates an effort to find a solution. Problem Solving occurs when the problem solver gives the situation enough weight to be solved, but his planning or behavior is insufficient or inappropriate to enable him to come up with a workable solution. In cases such as these, workable solutions will only come to pass when he acquires new information or makes use of connections that he previously did not recognize.

The majority of Problem Solving is a cognitive process, and several theorists have provided various explanations and descriptions of it. There are two categories of problem solvers that we can consistently identify: general problem solvers and high spotters of two types of thought processes associated with Problem Solving abilities. According to Newell and Simon (1972), they comprehend processes and search processes. And the other is a skilled problem solver, who views Problem Solving as a sophisticated process that involves defining and expressing the issue, identifying potential solutions, investigating potential courses of action, implementing those solutions, and then reflecting on and assessing the results of those actions (Bransford & Stein, 1984). Problem Solving is a cognitive process that calls for the identification and examination of a specific issue, the expansion of potential courses of action, and the application of skills and knowledge to overcome obstacles and arrive at a suitable solution. The approach we'll take in relation to the nature of the issue. Psychologists use a cycle to explain how they solve problems (Bransford & Stein, 1984; Hayes, 1989: Stenberg, 1986). The cycle's main parts include problem identification, problem representation, strategy planning, information organization, resource allocation, progress tracking, and assessing the solution.

Problem Solving – Distinct viewpoints

Behaviorists view Problem Solving as a process that can be replaced. That is, when someone approaches a challenge, he or she subsequently demonstrates a conduct that was shown effective in a prior occasion. As a result, effective behavior is developed by a trial-and-error approach based on Thorndike's (1898) law of effect. Thus, the viewpoint on Problem Solving also holds that if an individual tries to solve an issue by using the trial and error approach and comes up with a solution, that stimulus response connection that gives strength to the problem and solution will be retained more.

Gestalt psychologists view resolving problems as a useful endeavor. They assert that when an issue is being thought through, we can restructure the problem depiction in a way that could trigger an unanticipated epiphany that would help us solve the problem. Gestalt psychologists view a problem as a whole, as opposed to breaking it down into its component pieces. This progress addresses two categories of barriers to effective problem solving: the Einstell effect and functional fixedness. The Einstell effect refers to a person's tendency to become ill from or adhere to a single approach as well as a person's tendency to use a particular strategy that he keeps private, even when there are alternative, more effective ways to address that particular issue. It highlights the detrimental effects of prior experience on Problem Solving and discourages us from choosing better answers to the problem at hand. Functional fixedness is a collection of cognitive biases that lead someone to believe that an object or technique originally intended for one particular event should only be used for that occasion, without considering the object's or method's potential uses for other purposes.

Psychologists who specialize in cognitive processes In 1972, Newell and Simon researched insight difficulties. They proposed labeling generic problem solvers (GPS) with computational theory. This hypothesis falls within the category of traditional cognitive psychology theories of information processing. The problem is given to the solvers with the beginning state, goal state, and operator to move from one state to another, according to Newell and Siomon (1972) and Mayer (1992). In order to construct movements or transition from the initial state to the objective state through intermediate stages, solutions to that type of move problem involve the implementation of operators sequentially. Thus, insight is a key component in the negotiating move problem since it helps to design a fruitful move at multiple stages, according to cognitive theorists. The PISA (Program for International Student Assessment) framework from 2003 states that the following four reasoning skills are part of the fundamental competencies for problem solving.

1. Analytical reasoning: characterised by an incident in which the learner must apply formal logic principles to determine required or sufficient conditions or to establish causation between the restrictions and conditions presented in the problem stimulus.

2. Quantitative reasoning: characterised by circumstances in which the learner must employ mathematical properties and procedures to solve a given problem.

3. Analogical Reasoning: characterised by circumstances in which the learner must solve an issue using a context that is similar to the problem. The learner is familiar with or incorporates a problem framework that they have previously solved. The characteristics or context in the stimulus material vary, but the driving force or casual mechanism remains the same. The student should be able to answer the problem by interpreting it in terms of previous experiences with similar situations.

4. Combination Reasoning: characterised by instances in which the learner must analyse a range of components, consider all combinations in which they may exist, evaluate each of these different combinations in relation to the same objective constraint, and then select from, rank, and order the combinations.

Analytical conception – Problem Solving Ability

Problem Solving is considered one of the composite intellectual activities. Because it is a higher-order cognitive procedure, we can change talents depending on the nature of the situation. Over the last century, psychologists have been interested in travel over problems solving. There are various approaches for researching problem solving, including as task analysis, experimentation, introspection, factor analysis, psychological exams, cross-sectional and longitudinal studies. There are numerous theoretical formulations on problem resolution presented by experts in this field. Several of them are highly spotted below,

According to Walla's description (1926), the issue-solving process consists of a range of methods to obtain a solution, including 1. Preparation, which comprises describing the problem and conducting trials to find a solution.2. Incubation - having done a lot of tries to solve the problem and couldn't reach the solution, and then the problem is laid aside for some time with the aim that the answer would pop in to the mind of the problem solver while the solver is thinking of it. 3. Illumination is the process by which a solution arises unexpectedly, and 4. Verification is the evaluation of the solution to determine whether it works on the problem (Sadler Smith, 2015). Dewey (1933) emphasised the importance of cognitive processes that help individuals adapt with a new hostile environment, and reflective thinking exists in such settings. When a person experiences doubt and attempts to clear it up. He divides the reflective phase into two stages: pre-reflection and post-reflection. And the level of thought that occurs between the two stages. According to Ducker (1945), Problem Solving necessitates a sequence of interpretations of the issue, each one lead to new vaguely interpreted expression till the end solution is gained. Ducker described Problem Solving as the observation of what people actually say while solving a laboratory challenge. The theoretical formulations imply that when a person attempts to solve a problem, he progresses through the phases from a broad scope to a practical solution to a concrete solution. Gagne's (1965) approach organises learning into eight sets in a hierarchical structure. Such abilities include sign or signal learning, stimulus response learning, chaining, verbal association, multiple discrimination, idea and principle learning, and problem solving. According to Gagne (1965) Problem Solving is the greatest coniguration of learnedness, and achieving the skill will naturally allow all other learning stages mentioned above to follow in order, with the exception of signal learning.

In their book Human Problem Solving, Newell and Simon (1972) distinguish problem space theory from other Problem Solving approaches. According to this idea, individuals can solve problems by distinguishing in a problem space. The problem space is divided into three sections: initial state or current state, goal state, and all possible states in between. In order to shift from one state to another, we must take specific actions. Such activities are referred to as operators. The person's knowledge domain assists him in selecting operators, but they provide heuristics in the event of new problems. There are three heuristic techniques:

1. Repeat state avoidance or back up avoidance which implicit individual will avoid such behaviours that may lead to a past problem

2. Difference reduction or hill- climbing, the individual will choose these actions that help find a similarity between the beginning state and goal states.

3. Means ends analysis - is a composite heuristic that, using difference reduction, identifies actions that must be completed in order to reach a conclusion.

The following are the different states to compare the two states, which are the initial state and the goal state: goal setting to resolve the differentiation between the two states, operator selection to resolve the differences, ensuring that the operators work for the goal that has already been set; if not, set a new goal that can be achieved with that operator and return to the previous step with the newly discovered goal set. To obtain operators, we can utilise one of three methods: trial and error, direct instruction, or analogies.

Duncker (1945) developed the funnelling theory of problem solving, which provided a novel description of various features of problem solving. Duncker suggests that issue-solving involves rephrasing the problem until a definitive solution is reached. Dunker's explanation focuses on what people actually do and say while attempting to solve laboratory-created problems. This analysis means that as one begins to solve problems, his concepts can be defined in terms of these major phases. That is, from a broad range of functional solutions to specific solutions.

According to Bransford and Stein (1984), successful problem-solving involves five processes. And they are: identify, define, explore, act, look, and learn. According to this theory, the initial step in the process is to recognise the problem, define and characterise the possible solution, or formulate a hypothesis. Next, we must test the hypothesis. Finally, we should review the solution and understand how it will assist us tackle sub problems. When a final satisfying answer is established, we can apply the IDEAL technique to a variety of challenges. Mayor High spots three crucial features when building a course on teaching problem solving.

1. Problem Solving ability can be developed by means of training and practice, and it can be taught as a single monolithic capability or as a group of smaller skills. Component skills can be taught separately. Mathematical Problem Solving and linguistic skills are examples of this.

2. To teach problem-solving, either focus on the outcome (e.g., correct answer) or the method used to solve the problem.

3. Problem Solving can be taught using a domain-free general framework so that students can transfer between domains rather than relying on knowledge for a specific domain or subject domain so that students can only apply strategies within that domain. Mayer argues that emphasising component skills over a single general ability will assist to teach Problem Solving more effectively. This indicates that we must prioritize procedure over product, and domain specific over context-free settings.

Marzano's model of Problem Solving (1997) proposed a six-step procedure for making Problem Solving easier. This model's processes include establishing the aim, determining potential methods for reducing limitations, selecting the best substitute, and evaluating the substitute's efficacy. According to Polya (1957), a well-known mathematics educator, Problem Solving skills can and should be taught in order to recognise the technique for problem solution. He proposed four fundamental principles. They are: Understand the situation, design a solution, implement the plan, then look back to reflect. Campell (1995) proposed a different stage approach for problem resolution known as P.A.C.E, where 'P' for problem' refers to the identification of a goal. 'A' stands for Alternative, which is the re-solution to the problem solution 'C'. Impose the consequence and 'E' for evaluation, which means selecting the most appropriate substitution.

Problem Solving Ability and its dominant components

According to Smith (1991), Problem Solving Ability is influenced by two factors: internal and external. Internal factors are those that are associated with the issue solver's personal characteristics, such as primary domain expertise, previous knowledge, or experience with identical problems. Knowledge of tactics and cognitive skills that help a person solve problems. It fully depends on the problem solver. External variables also influence the nature of the problem. Jonassen described five external characteristics that are associated with Problem Solving skills. Such as, 1. Structuredness: There are several types of problems based on their structure, such as well-structured problems and poorly organized problems. The eccentricity of ill-structured problems is (i) Problems that arise in daily life. (ii) They are not barriers to a specific content domain and are emerging, with no authorized methods of resolution. (iii) They must include different content domains to demonstrate their interdisciplinary nature. (iv) They have conflict aims, numerous solution methods, and use different criteria to evaluate the solutions. The well-structured difficulties (i) are associated with conventional education (ii) are established at the end of the textbook and in assessments. (iii) All of the information required to solve the problem is provided. (iv) To solve the problem, a restricted set of principles and rules should be applied sequentially. (v) obtain valid and convergent solutions (vi) have approved solution processes (Wood, 1983).

The second factor influencing problem solutions is context, which touches on the framework in which the problem is rooted. Well-structured problem categories, such as strong problems, reveal that the difficulty is founded in superficial story conditions that have no impact on the learners. On the other hand, ill-structured problems, like design difficulties, are so context-oriented that the problem has no importance outside of the settings under which it occurs (Jonassen,2006). The third component is complexity. Meacham and Emont (1989) discovered that there are challenges that differ in terms of complexity. Complexity refers to the interdependence of the internal and exterior components. Problem Solving difficulty is related to the way in which the problem solver interacts with the problem. The problem's significance to the problem solver, as well as the necessity or urgency of solving it. The total number of variables and functions related to the problems are also evaluated. In this approach, we can distinguish three types of complexity: components complexity, coordinate complexity, and dynamic complexity (Wood, 1993). The first two types deal with the number of elements and their interconnections, while dynamic complexity deals with changes in interactions over time and context. The fourth factor that mediates problem resolution is Dynamicity - This is another component that deals with the interactions and exchanges that can take place on the interactions in relation to the nature of the problem and the period of demand for these changes. The fifth aspect is domain or context specificity, which indicates that psychological issues within a certain domain are determined by the strategies associated with that area (Mayar, 1992; Smith, 1991; Sternberg & Frensch, 1991). Domain-specific techniques are significantly more effective than domain-general strategies. As a result, it is possible to conclude that Problem Solving is a cognitive process that involves a number of internal and external components.

Classifications of Problems

Besides Structure and regimen issues Jonassen (2000) identified eleven types of difficulties. They are:

1) Logic problems - They dictate the use of abstract logic tests. They are used to assess mental alertness, clarity, and logical reasoning. Examples of this category include the Rubic Cube and the Tower of Hanoi Challenge.

2) Algorithmic problems – These are those that use a predefined set of processes. They address the problem using a bit-by-bit approach, hence it cannot be considered a category of problem.

3) Story problems - They are word problems that appear at the back of the textbook after each unit is completed. Jonassen (2003) proposed several ways for solving story issues, including a collection of identifiers, a situational model, an equation builder, a structural model builder, and alternative representations of the problems' outcomes.

4) Rule indication problems - One example of this type is the operation of a steam engine, which has rules or procedures for solving problems.

5) Decision making problems - The problem solver chose this solution from a list of alternatives. In our daily lives, we must make decisions about a variety of conditions and choose the most appropriate criteria.

6) Trouble shooting problems- It is connected with technical jobs, although experts also use this strategy to modify or correct an existing system. This group of challenges necessitates domain and system knowledge, as well as techniques such as search and replace, serial elimination, and fault testing processes. These talents, together with the troubleshooter's experience, help to

repair the system. A mechanic attempting to start an engine is one of the examples.

7) Diagnosis solution problems- Like troubleshooting, one should be aware of the fault stage. First, after examining the error, the problem solver compiles appropriate suggestions for improving the system rather than quickly correcting the system, as in troubleshooting. Example of medical diagnosis and recovery of heart block comes under this.

8) Strategic performance problems- Strategic performance problems are those that require a more complex and unstructured approach to tackle. This immediate review of methods to satisfy the strategy is required in these problems. This type of problem can be illustrated by piloting a helicopter.

9) Policy problems - It is a poorly constructed problem, and we must effectively describe it and analyse the numerous perspectives before a solution becomes apparent (Jonassen, 1997). The solution is contextual since the problems are more context dependent. For example, consider efforts to enhance India's low crop production.

10) Design problems - These are the most poorly structured problems. (Jonassen 2000). This type of challenge makes extensive use of domain knowledge, has roughly defined or unclear goals, and is subject to unspoken restrictions. They have varied solutions, solution paths, and numerous criteria for evaluating solutions. This includes the design of electronic circuits and mechanical systems.

11) Dilemmas - Dilemmas are often complex social announcements with opposing viewpoints. It is also ambiguous and poorly structured. For this type of problem, there will be no bearable remedies because they will not be totally bearable to a group of arrogant people. Manufacturing a profitable product that is not environmentally safe is an example of a dilemma.

As a result, we can notice a wide range of challenges that we may encounter in both our daily lives and in the classroom. In light of these issues, the investigator advocated the development of new techniques for dealing with them and providing our younger generations with problem-solving skills

Theoretical framework - Self-Concept

Expansion of Self-Concept

The self-concept played an important role in considering an individual's actions in order to fully understand ourselves and overcome any disagreements that exist within one self. Also to describe the proficiency they had. So, a strong self-concept serves as a foundation for one's life (Cervone & Pervin, 2011). Regardless of Self-Concept, a person's innateness develops during the growth phases from childhood to adulthood. Self-concept develops as an individual interacts with his surroundings on a constant basis.

Burns (1897) emphasizes various aspects that are dependent on the development of Self-Concept. They are:

Overview of Self (Body Image):

Self-concept is a person's perspective on oneself knowingly or unknowingly. This comprises both understanding and suspicion regarding the body's size, look, and capability. Self-image is linked to personality. The world's perception of the individual has a significant impact on their psychological features. Accepting and appraising portions of the body can help to generate a sense of safety, reduce anxiety, and boost self-esteem.

Ideal self

Objectives or a specific person voting the individual's opinion of how one should conduct oneself in accordance to the standard of aspirations. Depending on the standard of aspirations, childhood is when the ideal self first begins to emerge in a person, mediated by those closest to them which will lead to adolescent wellbeing and beliefs.

Self esteem

Self-esteem is the individual's appraisal of how far he has come towards becoming his ideal self. Self-esteem is a highly dangerous intrusion during youth and old age. High self-esteem is linked to group effectiveness and other people's actions. Low self-esteem is linked to strained relationships and increased risk of depression.

Role

Role refers to a person's expected attitudes, behavioural beliefs, and aspirations in connection to their social position. Roles are established in which an individual has no other alternative, whereas acceptable roles are those of selected individuals.

Identity

Identity is an individual's idea of themselves based on observation and judgement, and encompasses several facets of the self concept. From childhood, the identity card began to evolve in tandem with the development of Self-Concept.

There are four basic aspects of self concept they are ,

1. How do people perceive themselves?
2. How do people view themselves?
3. How do people rank themselves?
4. How do you improve and comfort yourself?

An individual's Self-Concept as a youngster and as a teenager are completely different. At the initial level, our self-concept as children is unrealistic, but it is replaced by a new Self-Concept in accordance with his discovery or experience in subsequent phases

According to Hurlock (1979), a structured Self-Concept develops over time through a variety of experiences. Consider children as a basic factor for developing a Self-Concept. Subsequent experiences evolved from the core sections of the cycle. Every element of a new self idea is made up of elements from the previous Self-Concept, and that arrangement influences the structure of the next arrangement.

The fundamental and secondary self concepts are interrelated. This means that the creation of subsequent experiences is related to the basic composition. The previously possessed Self-Concept is not the true Self-Concept; both are distinct, and it differs from the self image that may not be preferred. During the construction of an ideal Self-Concept, it is influenced by previously existing Self-Concepts and other specialised Self-Concepts until a hierarchical Self-Concept emerges. Desires and expectations are not always obvious in one's life so that a realistic ideal Self-Concept can be developed by growing out of dissatisfaction with oneself, which is linked to self-image and the fundamental unit of Self-Concept ownership. This will have an impact on both behaviour and adaption. Because the combination of Self-Concept in a hierarchical fashion has been validated, it might be difficult for modification.

The ideal Self-Concept is derived from a realistic Self-Concept. This might motivate individuals to strive for greater success. Ideal Self-Concept can be associated with desires and aspirations to alleviate dissatisfaction and seek escape from others. As a result, a negative ideal self perception may limit adaptability. In Self-Concept formation, the concepts that someone possesses or desires, which may be in contradiction to reality, include dramatic intentions and assumptions which are extremely tough to achieve. Assuming a link uniting what is wish for and actuality, self-acceptance does emerge (Jersild, 1963).

According to Rogers, the individual recognises both the occurrence and the external object and assigns meaning to them. Individuals' phenomenological sphere is formed by the complete system of perception and meaning. The primary goal of the phenomenal field is to recognise one's self, sometimes known as "me" or "I." The self or self idea, represents a systematic and coherent understanding. Despite the fact that it changes, it always maintains, merges, and arranges the quality of the design. Rogers' self is more than just a small part of ourselves. It is a confined behaviour that occurs alone. However, the self is a collection of recurring perceptions held by individuals (Cervone et al., 2011).

Rogers realised that there are two levels of Self-Concept: actual self and ideal self. Rogers thought that people typically think about themselves in the present as well as in the future. As a result, they organised designs of perceptions of their ideal self, as well as patterns of perception about themselves. So, the ideal self is the self notion that the individual aspired to possess. Perceptions and meanings that are potentially necessary for oneself and strongly recommended by others create the ideal self. Rogers described our image of ourselves as consisting of two distinct elements: Consider your current self and your ideal self for the future.

Individuals develop their self-concept through interactions with others and their surroundings, rather than independently.

Functioning of Self-Concept

The Self-Concept is rooted in three key parts of human life: reflective consciousness, interpersonal interactions, and executive functioning, which drive decisive activity (Bauermeister, 1998). For optimal functioning, the underlying motivation and tremendous human impulse to preserve and protect positive self-images are critical (GeCas, 1991; Stets & Burke, 2003). People seek for authenticity by reflecting on their past, present, and future selves, ensuring consistency between behaviour and perceptions, and valuing themselves. According to Sheldon et al. (1997) and Stets and Burke (2000), self-efficacy refers to a sense of competence which act as motives for many aspects of the self, such as group membership (e.g., motive for self-worth) or self-actualization (e.g., motive for self-efficacy). The self-concept is then connected to a number of outcomes, including people's well-being, adaptive functioning, and academic performance (Oyserman et al, 2012; Sheldon et al, 1997).

Analytical context of Self-Concept

Rene Descartes' ideas of philosophy, published in 1644, marked a watershed moment in human inquiry on the metaphysical, inner self. Descartes argued that doubt was a fundamental tool of focused investigation, but he could not deny that he questioned. He reasoned that if he doubted, he was thinking, so he must exist. Thus, perception governs existence.

Sigmund Freud's (1990) writing was a second watershed moment in the development of Self-Concept theories. He helped to gain a better awareness of the importance of internal mental processes. When Freud and many of his followers were hesitant to include Self-Concept as a previous psychological factor in their theories, his daughter Anna (1946) made ego development and self-interpretation central to her views.

The Self-Concept theory has always had a stronger impact on the emerging counselling profession. Prescott Lecky (1945) believed that when it comes to human behaviour, self-consistency is the major motivator. Rainy (1948) proposed measurements of self-concept during counselling interviews and claimed that psychotherapy is primarily a method for changing how people perceive themselves.

Carl Rogers (1947) was by far the most influential and strong voice in Self-Concept theory, having constructed a comprehensive method of assisting based on the significance of the self. According to Rogers, the self is an essential component of human nature and adjustment. Rogers defined the self as a social product shaped by interpersonal relationships and a drive for stability. He stressed that humans have a natural desire for positive feedback from both others and ourselves. He also contended that every individual has a yearning for self-actualization and development, as long as it is permitted and fostered by an appealing environment (Purkey & Schmidth, 1987).

Self-Concept through psychological theories

The key theoretical views influencing study and thought about Self-Concept are:

1. The groundbreaking work of Jame
2. The concept of symbolic interaction, especially by Cooly and Mead
3. Erickson's work with identity
4. Phenomenology, particularly by Rogers

While many other theorists have investigated the Self-Concept (often in novel ways), the four techniques discussed above provide the most fascinating ideas about self theory.

The groundbreaking work of James

William James was the first psychologist to discuss the Self-Concept. James saw the Global Self as both me and I, distinguishing between different aspects of the same person, notably between pure experience (I) and the contents of that experience (me). Such a classification is pretty evident in linguistic terms, and it undoubtedly looks to be emphasizing the obvious by stating that we all recognize that humans have awareness, which allows us to be aware of our surroundings, one of which is ourselves. Regardless of how basic this distinction appears, it does raise psychological concerns since the self-reflexive effort required to recognise myself connects and combines the knower and the knowing. Each cannot exist independently; the self is both me and I.

It is difficult to imagine consciousness in an abstract form with no content, or content existing independently of the consciousness that enables awareness of it. Experience must involve some form of experience. James was aware of this argument and stated that, while language allows us to categorise as knower or known, these are only discriminating parts of the originality of experience, a common element that is identical to the individual themselves. James is thus presenting a model of a conceivable global self structure, which must be interpreted accordingly instead of reality.

For James, the self as known by or myself, refers to whatever a man may label his own. He defined every aspect of this objective self and ranked them in decreasing order of importance. This includes our mystical, substance, social, and physical selves. One characteristic of a complex civilisation is the ability to choose between numerous goals. We can set our own goals, each referring to a different facet of ourselves, and track our progress towards them, leading us to James Law. Everything relies on how you identify yourself. James discussed the aspects that determine a person's capacity for self-examination He claimed that self-worth is defined by a person's desired place in the world, despite whether he achieves or loses. Despite our desire to maximise all of our various selves, limited talent and time make this difficult. As a result, everyone of us has to pick the particular self for which we are laying down our salvation. After we've made our decision, our self-esteem can only be reduced by flaws (or enhanced by accomplishments) that are pertinent to our worries.

The fundamental problem with this argument is that it presupposes that being the best always results in high self-esteem. However, James did establish a rich and comprehensive formulation of the knowing self, which included analytic classifications, assessment, and emotion, as well as predictions for future concepts. He recognised the integrative characteristics of the Self-Concept.

The symbolic interactionists

During the first few decades of this century, the study of the Self-Concept switched from traditional psychology to sociology, with Mead (1934) and Cooley (1912) emerging as key thinkers. They were symbolic interactionists who offered a fresh take on the individual-society relationship.

Symbolic interactionism is founded on three key concepts. The first is that individuals respond to their circumstances based on what those environments mean to them as individuals. Second, such meanings arise as a result of interpersonal interaction, and third, these sociological or ethnic meanings are created by one's interpretation within the framework of collective interaction. Self and others are tightly connected since society, which is made up of the sum of the actions of the individuals who comprise it, puts societal limitations on each person's conduct. While it is possible to separate self and society analytically, interactionists believe that a thorough understanding of others is built on a mutually dependent connection. Cooley and Mead (1934) provided the key notions.

Cooley's initial position was that individual originate before society, but he later changed his mind and placed a greater emphasis on society, to the point where self and society are twin births, and the concept of an independent and distinct ego is a fiction. Individual behaviour and social pressures have a mutual influence. Mead's (1934) later thesis that the ego emerges from social conditions represented a further shift in focus.

Experimentally demonstrates that the other self, or how you believe others perceive you, is a significant aspect of the Self-Concept. The contents of the self as perceived by others and the self as you believe you are have regularly been shown to be very similar. Cooley was the first to emphasise the importance of subjectivity, viewing feedback from others as a fundamental source of information about the self. Cooley first proposed the hypothesis of the looking glass self in 1912. He contended that an individual's self-concept is significantly influenced by what he believes others think of him. The looking glass displays people's perceived attitudes towards one.

This looking glass identity emerges by means of symbolic interactions between individuals and their respective core groups. A group with direct interactions among its members gives feedback for the individual to assess and relate to his son. As a result, the Self Concept emerges from a process of experimentation in which beliefs, mindsets, positions and personalities are acquired.

In keeping with Cooley's concept of the looking glass self, Mead (1934) suggested that the self was primarily a social process within the individual involving two analytically distinct stages - the 'I' and the 'Me', which were initially found by James. Mead also stated that by comprehending a culture, a man can forecast both the conduct of other person and the assumptions made by other person about his own conduct. The individual can be described in the same manner as items, behaviours, and characteristics are. As a result, Mead felt that describing oneself as a specific member in a given relationship entailed acknowledging and expressing the significance and standards that others assigned you.

Mead (1934) explains how a kid develops a reciprocal, interpersonal perspective by playing alone, initially directly mimicking others and then taking on the roles of both parties in the imagined interaction as the roles of play (or, more accurately, the game) become clear. Role acting allows him to experience, or at least approximate, the type of reaction that his own actions generate in others. Communication with others is severely limited in the absence of a shared repertory of attitudes, feelings, and behaviours. A young child may play, but only until he understands the rules of a game and can manage his behaviour in light of the referee's perspective. In Mead's terms, 'the generalised other'-the child is merely playing, not gaming. This ensures a core commonality of attitudes while yet allowing for individual distinctiveness. These longitudinal changes in the form and functions of play correspond to the progression of images, thoughts, and language. And Self-Concept construction is well established. Social penalties, demands, rationales, and models are eventually transformed into personal values and integrated into the self-concept.

Individuals begin to respond to him and acquire self-attitudes that are Congruent with the beliefs of others in the universe he created. He appreciates himself just as much as others do: to the point where they reject and disregard him. The consequence is the same conclusion Cooley arrived in a very similar theory: the individual will perceive himself as possessing the characteristics and qualities that others attribute to him.

Erickson on Identity

Erickson employed the concept of identity rather than self in his literature, and he extended Freudian Theory by emphasizing ego formation in the cultural setting. He explained how cultures create an identity based on biological principles that are relevant to the culture in question and manageable by the individual. Erikson claimed that identity stems from culturally important achievement. Identity emerges from the progressive blending of all identities. Thus, it is vital for young students to connect with grownups with whom they identify. Erikson proposes eight stages of identity formation and expansion, as well as the unique conflicts that define each stage and the characteristics that appear as a result of overcoming them. Identity is a unique difficulty in adolescence, and Erikson paid great importance to the crisis and its impact on identity at that stage. He characterised identification as an internal process that promotes familiarity and consistency. However, he was uncertain to provide a stringent definition of Identity which encompassed not only the sum of rolls figured by the individual, but also appearing structures of identifications and abilities as a function of immediate knowledge of self and surroundings, as well as views on others' reactions to oneself. It was psychological in the sense that it considered an individual's relationship with their cultural environment.

This method of identity creation is comparable to the Cooley-Mead formation in terms of the function of the generalized other. However, Erikson argued that these procedures were primarily unintentional. He accused concepts like self-conceptualization, self-worth, and confidence of presenting a static viewpoint on what he regarded as an evolving process, stating that one's identity cannot be established as an achievement in a form of a personality shield or anything permanent or everlasting. Identity formation, like Rogers' beliefs on self-actualization, is a constant process of differentiation and condensation that fosters awareness of oneself and exploration of oneself. As life goes on, a sudden recognition of the inadequacy of one's present identity creates first confusion, followed by an examination of alternate identities and techniques for existence. Erikson claims that a possible feelings of identity understands wherever you going and has inner confidence.. The particular elements of an experience may be less important in determining an individual's identity than a capacity to recognise continuity - diverse experiences that represent the same being.

Phenomenological approach to the Self-Concept

The phenomenological approach to psychology seeks to understand man through the subject's impressions from the perspective of a spectator. It seeks to comprehend how an individual views himself, particularly how his desires, emotions morals, convictions, and distinct perceptions of his environment shape his behaviour. Behaviour is determined by the personal meanings associated with an ideal individual's view of past and present events. We can't control events, but we can modify how we see and understand them. Therapy cannot resolve an issue; rather, it helps the client view himself in a new perspective and adapt better. Perceptions is a key idea in phenomenology, and it encompasses the procedures of selecting, arranging, and analysing materials in order to build a cohesive psychological context. The perceptual field, psychological field, phenomenal field, and living space are some of the titles given to this environment. Apart from language, what matters to us are the individual meanings that each person has at any given moment and how those meanings impact his conduct. Only from the viewpoint of the person performing the behaviour can a phenomenologist comprehend it. Reality is a person's interpretation of an event, not the event itself. Due to distortions brought about by intentions, ambitions, attitudes, and defensive mechanisms, perceptions are selective and frequently inaccurate (Bruner and Goddman, 1947).

Self-Concept in Carl Rogers theory

With the perceived Self-Concept at its core, Rogers modified phenomenology to bolster his expanding client-focused psychotherapy frameworkHe was able to use a perceptual frame of reference to describe therapeutic improvement. The majority of Rogers' body of work is encompassed by the current state and formulation of self-contained theory, which is founded on his therapeutic experience.

The self is a construct that emerges from stimuli input as raw material via reflexive thought. Appraise and emotional perceptions are gathered around the notions, making each one either great or horrible. One absorbs these evaluative elements from others, from the social context, and from oneself. One way to conceptualise Rogers Self-Concept is as an ordered arrangement of self-perceptions. It consists of components including views of a single characteristic and one's own skills, values perceived as connected to experiences and objects, thoughts of oneself in connection to people and the environment, and objectives and ideas perceived as evoking either happy or negative emotions. According to Rogers, humanity is fundamentally good and is progressing towards socialisation, maturity, and self-actualization. According to him, Freud portrayed humanity as illogical, unsocialised, and harmful to both themselves and other people. Although someone might occasionally behave in this way, according to Rogers, they are neurotic and not acting in their capacity as a whole human being. Man is open to experience and capable of positive, reliable, and productive behaviour while operating in a free and unrestricted manner.

Generally speaking, the phenomenological approach has been a significant component of some psychologists' significant attempts to accept behaviour as it is in order to make sense of human experience. It may surpass scientific theories and it may omit important and crucial variables from study, which are its two main potential limitations.

The significant points of Rogers theory are,

1. The self theory, a component of personality theory, is phenomenological. The essence of phenomenology is that man exists fundamentally..

2. As a result of the environment's actualizing propensity, the self notion became differentiated. Transactions with the environment, specifically the social environment. Rogers does not go into depth about the method, although it is likely to follow the lines indicated by Cooley and Mead.

3. The self concept organises self-perceptions. When it comes to personality and behaviour, the self-concept is more significant than the true self.

4. How people respond to their environment is mostly connected to one’s Self-Concept. It regulated how people perceived the meanings assigned to the environment.

5. Others' positive regard for you is an acquired or innate need that grows with your self-concept. It appears plausible to incorporate this motivation as an aspect of self-actualization, even if Rogers prefers to credit it to learning..

6. According to Rogers, positive self-esteem can be learnt through internationalization or projections of others' favorable perceptions. Alternatively, it could be regarded a component of self-actualization.

7. Relying on external evaluations for high self-esteem might lead to inequality between the organism's experience and its own demands. Thus, there is an incongruence between self and experience, often known as psychological maladjustment. Mal adjustment is the result of seeking to maintain the presence of a Self-Concept in the face of conflicting experiences, resulting in selective perception and distortion. Alternatively, rejection of experience through wrong interpretation.

8. According to organism theorists, the organism has a single dynamic drive: self-actualization, which aims to preserve and improve the experiencing organism.

9. Developing a Self-Concept involves more than merely accumulating experiences, conditioning, and external definitions. The Self-Concept is a set of arrangements. The nature of the entirety could be drastically changed by altering one aspect. Thus, Rogers refers to an individual's self-perception as their "self-concept." The self-concept in Rogers' theory is not a managerial one. Such a position does not need to be posted. Since actualisation is the goal of every organism, it follows that the self notion, which is a part of the organism, also pursues actualisation through continuous activity.

10. Rogers' concept of the ideal self suggests that therapy can help individuals become more realistic and aligned with their ideal self.

Self-Concept - Types

According to Calhoun et al. (1976), there are two types of self-concepts: positive and negative.

Positive Self-Concept

People with a positive self-concept have a high level of self-awareness, which means they know themselves better. A positive Self-Concept is varied and consistent. People that have a positive Self-Concept can acknowledge and value the diverse aspects of who they are. He therefore thought well of himself and believed that he was able to understanding who he was.

Negative Self-Concept

Calhoun et al. (1976) distinguished between two types of negative self-concepts:

1. This category refers to those who have disorganized perceptions of themselves and lack sensations of firmness and completeness. People here have no idea who he is, his potential, or his weaknesses in life.

Individuals in this category have well-organized and consistent self-perceptions. This will be developed when individuals have received extensive education and have a solid foundation of information. As a result, he develops a strong self-image with no deviations from the set of standards that he has previously established.

Mainly there are two categories of self-concept. They are,

1. A positive Self-Concept includes the following aspects.

- Have confidence that he could overcome the challenge.
- Perceive uniformity with others.
- Accepting compliments without unwillingness or shame.
- Recognizing that each individual has unique desires, feelings, and characteristics that may not be entirely accepted by society.
- Have a knowledge or realization of his own flaws and are willing to work to correct them.

2. Negative Self-Concept can be distinguished as follows.

- Reacting to criticism, one can't always take criticism well. He perceived it as others efforts to lower his pricing therefore he frequently appears stubborn and attempting to justify his position with repeated justifications and incorrect logic.
- When someone receives praise but acts as though they don't care, it's still clear that they are enthusiastic.
- Being inclined towards feeling uncomfortable around strangers. When he realises that they are rivals, he will react by believing that he is a victim of a seriously defective social structure.

Fitts (1971) states that there are five aspects of the overall category within the self-concept. Those are: physical self-concept, personal self-concept, social self-concept, moral self-concept, and family self-concept.

Physical Self-Concept: This idea encompasses adolescents' perspectives, beliefs, fondness, and evaluation on their own. Individuals developed a physical self-concept when they looked positively at their body language, appearance, health, skin tone, and overall body shape. Individuals believe they have a bad Self-Concept when working on these unpleasant topics.

Personal Self-Concept: This idea refers to teenagers' perceptions, reasoning, and affection for their own self. A positive self-concept occurs when he sees himself as joyful, optimistic, capable of controlling themselves, and possessing a variety of abilities. Conversely, when people believe they are depressed, unyielding, incapable of controlling themselves, and subject to several limitations, they are considered to have a negative self-concept.

Social Self-Concept: It concept encompasses the behaviour of adolescent's perspectives, thoughts, judgments, and sentiments about the prevailing social system or himself. The social self notion linked it to the ability to engage with the environment around him. Affection, ability, and value in the context of social interactions will lead to a positive social Self- Concept if the individual is interested in others, understands others, finds it cool to accept and keep the feelings of others, and is always active in social activities. On the other hand, one is predisposed to have a bad social self image. If a person regards himself as being completely different from others, it is impossible to live happily with others, since he avoids social interactions and never pays attention to other people.

Moral Self-Concept: It includes the adolescents' own perceptions, feelings, and moral judgments. This idea is associated with the values and beliefs that provide meaning and direction to one's life. If a person believes that they are someone who values moral ethics, they will have a good self-concept of moral ethics. However, they were shown to have a weak self-concept regarding morality.

The family Self-Concept: Which include opinions, thoughts, judgment, and an adolescent's perspective on his own family. The family self idea is associated with the presence of a person in the family. If someone enjoys and is proud of their family, feels that they are affective and beloved by them, and gets a lot of support and assistance from them, they will have a positive family self-concept. Instead, a negative family Self-Concept person sees himself as an uncomfortable person in family situations; he despises his own family and never feels happy or satisfied with them.

The goal of evolving Self-Concept

People will hear themselves in relation to the Self-Concept they have since the Self-Concept starts to grow. When an individual hears himself competing with the concept itself, he experiences an unpleasant emotion. This is the most important concept of self. The action will be determined by one's perception of himself.

A person with a positive Self-Concept will be highly appreciative of themselves as well as others, or in other words. He has a higher self-esteem. Self-evaluation is self-respect, which defines the level of his ability and achievement, and he will have a positive Self-Concept based on high self-esteem. Every aspect of his actions could be aimed towards achievement. He always tries to recognize the concept itself. For example, if someone believes that he can successfully do a specific activity, he will try hard to complete it in order to demonstrate that his conviction was correct. Others are unlikely to discourage such individuals since they are self-assured and strong as a result of their innovation. On the other hand, consider someone who has a bad self-image. He will always have a negative judgment of himself, and as a result, he will be afraid of failure and will be hesitant to take on any endeavour in life. For example, if a person believes that he is a "bad person," his attitude towards life as a whole will reflect this. Anything that compliments him in the opposite direction, such as "he is a good individual," will make him miserable.

There are many ways to generate a positive self-concept, such as finding joy in life, developing positive opinions of oneself and others, enhancing the quality of interpersonal relationships, taking initiative, preserving balance in one's life, and altering one's communication style.

Review of Related Literature

A survey of relevant literature is an unavoidable component of any research scheme, because no one can successfully conduct a research without a solid foundation.

In the words of Mouly (1963), "A thorough review of the related literature is an integral part of the conduct of research, helping the researcher in the classification of his/her problem and the avoidance of unnecessary duplication".

In the words of Best (1977), "A familiarity with literature in any problem area helps the student to discover what is already known, what others have attempted to find out, what methods of attack have been promising or disappointing and what problems remain to be solved".

A review of the literature will assist the researcher in establishing a context for his or her study as well as understanding his or her role in the current investigation. It aids in identifying and addressing gaps in prior studies. It allows the investigator to begin his or her investigation with greater confidence and clarity. A review of relevant literature will provide a variety of related research and allow you to understand how they addressed it. It provides the researcher with a fundamental understanding of the available tools and procedures, as well as the numerous ways for doing research, sample methodologies, and data analysis approaches.

Taking into account all of the benefits of reviewing related literature, the researcher carefully examined dissertations, papers, and studies from journals and periodicals, as well as all available resources from the internet, which are summarized in the pages that follow. The investigator had a solid comprehension of the numerous publications and attempted to highlight the topic, study design, sample size, tools employed, statistical techniques used, and main findings in each review.

The current study's goal is to implement a model called the Productive Thinking Model to help secondary school students improve their Self-Concept and Problem-Solving Abilities in Physics. As a result, the investigator investigated the literature on several models or strategies established to improve science education, Problem Solving Abilities, and Self-Concept, which are provided under the headings listed below.

- Studies related to Problem Solving Ability in Physics
- Studies related with Models of Teaching and Self-Concept
- Studies related with Models of Teaching and Problem Solving Ability in Physics

Studies related to Problem Solving Ability in Physics

The investigator analyses articles, theses, and research papers on Problem Solving Ability and presented only those that explored the difficulties students encounter when addressing issues in Physics, as well as models and solutions for improving Problem Solving Ability in Physics. The studies are listed chronologically in descending order.

Sapriyadin et al. (2023) studied the effects of inquiry-based learning on students' use of work and energy materials to solve physics problems and grasp of concepts. The purpose of the study was to determine how students who learnt through inquiry-based learning differed from those who learnt through conventional learning in terms of their concept mastery and problem-solving skills in the area of work and energy, as well as how students' problem-solving skills in the physics topic related to their concept mastery skills. The research methodology employed in this study was quasi-experimental and quantitative in nature, with no equivalent control group. A control class in this study employed conventional learning with learning stages based on the teacher's learning model, and an experimental class that used the Inquiry learning model with learning stages based on the Inquiry learning model syntax. A process of random sampling was used. Tests with physics concept mastery skill instruments, consisting of 10 multiple-choice questions and 5 descriptive questions for problem solving, were part of the data gathering instrument. The results showed that there were notable differences in students' problem-solving skills and idea mastery between those who used inquiry learning and those who used conventional learning. Moreover, the results of the research data analysis show that mastery of the concept and problem-solving skills are related. The results of the study show that students can improve their conceptual knowledge and Problem Solving Abilities by engaging in inquiry-based learning about work and energy materials.

Pelobillo (2022) conducted research on assessment creation for testing student’s context-rich Problem Solving Abilities in Physics. In order to evaluate students' performance in resolving context-rich problems, this study created a 17-item physics Problem Solving ability scale. Eight students were interviewed for this method to find out how they deal with physics challenges. 37 latent traits that characterised their competency were identified by the qualitative analysis. In order to establish psychometrics using the rating scale-graded response model (RSGRM) and to verify psychometric assumptions using Mokken's scale analysis, attributes were surveyed with 370 students. According to MSA analyses, there are 17 legitimate items or sets of outcomes that should be considered when creating assessment tasks that outline the skills required of issue solvers. The assessment results gave insightful details on the students' problem-solving abilities. Additionally, it displayed 3-ordered answer expectancies, which might be a cognitive structure representing the solver's real reasoning. This study found that more research is necessary to fully understand the recommended response.

Qotrunnada (2022) did a study to determine what elements contribute to high school students' difficulty increasing Problem Solving Abilities while studying physics. Using journals obtained through Publish or Perish on the Scopus and Google Scholar databases, 40 journals or publications were examined between 2018 and 2022 as part of a literature study with qualitative analysisThe study's findings indicate that the models and learning media employed must be relevant since they are crucial aspects to examine first when boosting high school student’s Problem Solving Abilities. Additionally, students still find it difficult to distinguish between the physics formulas and equations that will be used in problem solving, and they are limited to writing only what they understand and are expected to solve. Enhancing Problem Solving requires applying relevant learning models, like PBL, PjBL, inquiry, and discovery learning models that academics have used in the literature study. In addition, STEM-based learning has been demonstrated in multiple studies to increase high school students' Problem Solving Ability in physics. Furthermore, pupils require much practice in problem solving.

Distrik et al. (2022) explored the idea of utilising the Concept Attainment Model to enhance online learners' comprehension of physics concepts and problem-solving abilities. The study's main objective was to enhance online learners' comprehension of physics concepts and their ability to solve problems by utilising the Concept Attainment learning model. This research employed a non-equivalent control group pre-test-post-test design in a quasi-experimental manner. The participants were Pringsewu, Lampung, Indonesia's Public Islamic School 1 grade XI students. 35 students in the experimental group (class IPA 3) and 34 students in the control group (class IPA 2) were the samples. The test results for problem-solving skills and physics concept knowledge were grouped, the n-gain was calculated, and the data was then interpreted to perform a descriptive analysis. The results showed that, in terms of physics concept understanding and problem-solving ability, the n-gains of the experimental class fell into the high and moderate categories, respectively, whereas those of the control class fell into the moderate and intermediate categories. Significant variations in conceptual understanding and problem-solving abilities between the experimental and control classrooms were found by the independent sample t-test. This research showed that when it came to improving senior high school students' understanding of physics concepts and problem-solving skills, the concept attainment model in online learning performed better than other traditional learning methods.

Rokmat et al. (2022) examined how the Causalitic-Learning Model (CLM) affected three areas (a) Problem Solving ability; (b) mastery of physics concepts; and (c) the link between CLM and knowledge of physics concepts on Problem Solving Ability. A pre- and post-testing phase, an untreated control group, and a quasi-experimental research methodology were all features of the study. The cluster random sampling technique was used to choose students for the experimental class X-1 (14 men and 16 women) and the control class X-2 (9 men and 21 women). A Problem Solving Ability test was used to obtain the data, which were then analysed using parametric statistics such as two-way ANOVA. The findings show a substantial difference in the experimental and control groups' Problem Solving Abilities in Physics. High gain score associated with experimental group highlights the advantage of Causalitic-Learning model over existing method of teaching in terms of Student's Problem Solving Ability.

Putri et al. (2022) carried out a study to evaluate how well a multimedia-based physics module affected students' ability to solve problems. This module was made with Flip PDF Professional and the ADDIE development methodology. Thirty-four students in Banjarbaru high school's class X MIPA used it. Problem Solving indicators were used to create data collecting tools from student learning outcomes. A mean pre-test score of 4.63 in the extremely bad category, a post-test average score of 52.68 in the sufficient category, and an n-gain of 0.50 in the moderate category all demonstrated an improvement in the students' problem-solving ability. Therefore, it was concluded that the multimodel-based physics module that was developed is beneficial in enhancing students' problem-solving abilities.

Setiawan et al. (2022) did a study on the topic “Utilising Augmented Reality on Online Learning: The Impact for Students”. This study looked into how students’ abilities to solve physics problems online during the COVID-19 epidemic were affected by augmented reality instruction. The randomised Control Group Pre-test-Post-test Design was employed as the design research in this true-experimental investigation. 69 students were participated in this study and is divided into two groups: the experimental and the control. Both the experimental and control groups were found to be normal by considering homogeneous populations based on the preliminary analysis. The findings of the independent t-test showed that using augmented reality in online instruction during the COVID-19 pandemic significantly improved students' problem-solving skills. Incorporating Augmented Reality into the teaching process also provided students with a firsthand, real-world experience with a physics phenomenon, which made it easier for them to visualise the event and solve problems.

Athira and Bindhu (2022) investigated Emotional Competence and Problem Solving Ability in Physics among secondary school students. The study's goal is to determine the gender differences in Emotional Competence and Problem Solving Ability in Physics, as well as the link between the two variables. The study used a survey method with a randomly selected sample of 50 secondary school students. The tools employed were the Emotional Competence Scale and the Physics Problem Solving Ability Test. The study found a significant relationship between Emotional Competence and Problem-solving Abilities in Physics. Furthermore, the study found that students with high Emotional Competence have stronger Problem Solving Ability in Physics.

Tyas et al. (2021) conducted a need analysis study for the development of STEM-PjBL Physics teaching materials. The study's main objectives were to increase students' problem-solving skills and assess teacher and student demands for physics teaching materials in the twenty-first century. The study focused on improving students' problem-solving skills in grade X high school. Surakarta-based grade X students made up the research sample for this study. The study's data came from questionnaires, interviews, and early student evaluations; descriptive data analysis was done. The results of this study indicate that students need more teaching materials, such as STEM-PjBL-based E-modules, which come with accompanying photographs and videos and a model of learning that can help students become more capable at solving problems.

Palloan et al. (2021) seek to investigate the relationship between Self-Concept, Emotional Intelligence and Problem Solving Ability in Physics. The sample size was 150 students. The ability to answer physics issues is tested using a Problem Solving Ability Test. Both multiple regression and basic linear regression were used to evaluate the study data. The results showed that there was a very weak and insignificant positive relationship between Emotional Intelligence and Problem Solving Ability in Physics; a weak and significant positive relationship between Self-

Concept and Emotional Intelligence as well as Problem Solving Ability; and a weak and significant positive relationship between Self-Concept and Problem Solving Ability in Physics.

Kaur (2021) investigated the effects of concept mapping and problem-based learning approaches on ninth-grade students' academic performance, problem-solving abilities, and capacity for self-regulated learning. The 'randomised groups' pre-test-post-test design was employed, which is an actual experimental design. There were 240 students in the study. A purposive sample strategy was used to pick 30 students (15 males and 15 girls) from each of the eight schools. Additionally, 30 students were divided into three groups at random: the Control group (C), the PBL Experimental group (E1), and the Concept mapping Experimental group (E2). Each group consisted of 10 students (5 boys and 5 girls). The study's findings clearly demonstrated that problem-based learning and concept mapping methodologies improve students' ability to retain and comprehend the information presented in terms of content. Both strategies contribute to the development of students' scientific curiosity as well as their abilities to reflect on, organise, and govern the learning process. The Problem Based Learning (PBL) method helps both male and female students tackle scientific problems more effectively and practically.

Bhakti et al. (2020) study attempts to increase student’s Problem Solving Abilities using learning-based video scribe. The primary goal of the study was to determine Problem Solving Abilities in Physics using media-based video scribe learning. This research employed a quasi-experimental design using a Randomised Post-Test Only Control Group Design. Thirty students from the Physics Education program at Indraprasta PGRI University served as samples. The findings indicated that employing learning medium video scribe helped increase Problem Solving Abilities in Physics. The usage of video scribe was proven to have substantial favorable effects on delivering physics teachings. Learning in physics is more efficient while using a video scribe. Students understand abstract physics subject and can engage pupils in learning. These findings are congruent with studies on the improvement of students' Problem Solving abilities in physics learning.

Gebze et al. (2020) did research on improving Problem Solving Ability in Physics Using an Android-Based Mobile Learning Application. This study's main objective was to compare students' problem-solving skills before and after using Android-based learning resources to study physics content (light reflection on concave and convex mirrors). The 27 students of class XI MIPA 2 at MAN 2 Yogyakarta participated in this study. With a pre-experiment research, this study is set up as a pre-test-post-test involving just one group. Problem-solving tests and technical data analysis using descriptive and inferential analysis are two methods of obtaining data. The pre-test and post-test data are from homogenous, normally distributed populations, according to the inferential analysis. The study's conclusions showed that students' problem-solving skills increased at a low to medium N-gain rate.

Annisa et al. (2020) carried out a study to evaluate the efficacy of the comic-based modules andro-web and the improvement in students' problem-solving skills in physics following the use of the online comic based on andro-based modules on the ideal gas. During the second semester of the 2018–19 academic year, thirty students from class XI of IPA 2 State Senior High School Jenggawah served as the sample. The preliminary study, also known as preliminary research, the design phase, also known as the prototype phase, and the assessment phase are the stages of research design. The Andro-based modules webcomic obtained an average score of 81.7% with a valid category based on expert validation results; on the other hand, user validation results produced a score of 93.3% with a very valid category that could be used in test site construction. As a result of this study, XI IPA 2 State Senior High School Jenggawah's comics modules with an androgynous theme can aid students in solving problems during physics class. It was thus suggested that the use of comic-based modules and the internet in teaching materials for the XI science module will improve students' ability to solve physics problems related to ideal gas.

Fiteriani et al. (2020) investigated the effect size of the PjBL learning model combined with the STEM method on boosting student’s creative Problem Solving Ability and meta cognitive skills in learning physics. A non-equivalent control group design was employed in the investigation. Researchers used a purposive sampling strategy because of the characteristics of the population and the sample requirements of the study. The degree of originality in problem-solving abilities, the degree of subject similarity studied, and the fact that all students were taught by the same teacher were among the factors. A test measuring creative Problem Solving ability, a non-test instrument in the form of a questionnaire measuring students' metacognitive abilities, and observation sheets were the research tools used. The results of the data analysis showed that students' creative problem-solving abilities and metacognitive capabilities were impacted by the PjBL learning model's application with the STEM approach.

Smitha and Praveen (2019) conducted a study among higher secondary school students in Kerala state to investigate the impact of selected cognitive variables (logical mathematical intelligence, meta-cognitive awareness in physics) and non-cognitive variables (achievement motivation, social competence) on Problem Solving ability in Physics. The study focused on the importance of non-cognitive characteristics in predicting Problem Solving Abilities in Physics, in addition to cognitive variables. Data were acquired using multiple scales. The subjects were 781 higher secondary school students from various districts of Kerala state. The sample was selected using a random sampling procedure. The results demonstrate that only logical mathematical intelligence varies by gender, while all other variables do not change. The study's findings show that gender has a role in the development of logical and mathematical ability. The results reveal that male students have higher mathematical intelligence than female students.

Ellah et al. (2019) examined the relationship between scientific students' low ability problem-solving skills, working memory, and attention span. A correlation survey research approach was used in the study. Secondary School students studying biology, chemistry, and physics at all public senior secondary schools in the study area during the 2017–2018 school year made up the study population. There were 450 scientific students in the sample, drawn from 24 senior secondary schools in the research locality. The Wechsler Adult Intelligence Scale (WAIS), the Attention Lapses Clicker (ALC), and the Backward Digit Span task were used to gather data.

Multiple regression analysis was used to evaluate the data, and the 0.05 threshold of significance was used to test the null hypothesis. The findings revealed a little percentage difference in the students' scientific problem-solving abilities, which may be explained by working memory and attention span tests. Measures of working memory, attention span, and the combination of working memory and attention span in students did not show any discernible correlation. Among other things, it was proposed that science teachers should alter their students' attention spans by naturally reproducing the same kind of cognitive shift in tasks involving original Problem Solving and thought.

Suryani et al. (2018) carried out a study to evaluate the viability and efficacy of student worksheets based on different representations for enhancing problem-solving skills and conceptual understanding, especially with regard to magnetic materials. Quasi-experimental design with pre-test-post-test control group was the research methodology employed. Using a purposive sampling technique, XII standard high school students from Bandar Lampung made up the study's sample. The student worksheet on feasibility, the observation sheet, the student's answer to the student worksheet, the student activity sheets, the conceptual understanding test, and the problem-solving skill test were the tools used. N-gain analysis, an independent t-test, and percentage-based descriptive analysis were used to analyse the data. The outcomes showed a worksheet for students based on various representations: 1) Practical, as shown by a) the student's favourable reaction (83.75%) to the student worksheet and b) the average score of 87.31 for enforceability in any learning activity, with extremely high standards. 2) Effective, as shown by: a) the active group of students' participation in the study; and b) the notable differences in conceptual understanding and problem-solving abilities between the experimental and control classes through student worksheets based on many representations of the experimental class outperforming the control class, conceptual understanding and problem-solving skills are taught.

Yulindar et al. (2018) investigated the "enhancement of Problem Solving Ability of high school students through learning with real engagement in active Problem Solving (REAPS) Model on the concept of heat transfer". The purpose of this study is to see how the Real Engagement in Active Problem Solving (REAPS) model affects Problem Solving Skills before and after learning about heat transfer. The quantitative research approach was adopted, and the sample size was 35 high school students from Pontianak. Students' Problem Solving Abilities are assessed through a test consisting of three description questions. Expert opinion and field testing were used to validate the validity of the instrument, and the result was a value of 0.84. According to data analysis, students' problem-solving abilities have improved in the medium category, as indicated by their N-Gain score of 0.43. This was due to pupils being less accurate in calculating the results of their answers, as well as having limited time to complete the tasks offered.

Smitha and Praveen (2018) aimed to ascertain the degree of achievement motivation among secondary school students, the level of problem-solving ability among them, the differences in problem-solving ability among them based on gender, location, and institution type, and the noteworthy differences in achievement motivation among them based on gender, location, and institution type. The sample was drawn at random from 130 secondary school students to ensure adequate representation of gender, location, and institution type. The tools employed were the Problem Solving Ability Test and the Achievement Motivation Scale. Percentage analysis and the test of significance for mean difference were the two main methods of analysis. It was found that the problem-solving skills of children in secondary school varied widely. The results showed that 16.92% of the students had low Achievement Motivation, whereas 68.46% had an average Achievement Motivation. Only 14.62% reported strong levels of achievement motivation. There was also no significant difference (at the 0.05 level) in secondary school pupils' Problem Solving Abilities based on gender, location, or institution type. Girls, urban, and government school students reported stronger accomplishment motivation than males, rural, and assisted pupils, according to another important finding.

Simbolon et al. (2017) examined the effect of employing multimode representation in physics learning materials on students' ability to solve problems. This study set out to find out how employing multimode representation in physics learning materials affected students' ability to solve problems. 69 students from Bandung's standard IX served as the study's samples; they were divided into two groups: the experimental and the control. While the control group was taught with textbooks from the school, the experimental group received instruction from the researchers using materials they had prepared. Random sampling was used as the sampling technique. An assessment of Problem Solving skills related to material temperature and heat was used as the research instrument. Rosengrant problem-solving techniques was used for this purpose, it includes four steps such as understanding the question posed, streamlining the issue, characterising its mathematical shape, and describing its physical form. The results showed that employing multimodal physics learning material representations can significantly improve students' capacity for problem-solving.

Sutha and Vanitha (2017) conducted a study to see whether higher secondary school students' achievement in physics and their problem-solving skills are significantly correlated. Simple random selection was used to pick 326 Higher Secondary School Students from the Coimbatore district for the survey. The investigator employed standardised instruments to collect data on Problem Solving Ability and Achievement in Physics. Following that, the obtained scores were analysed using Pearson's Product Moment Correlation, ANOVA, t-test, and percentage analysis. The findings showed that students in higher secondary schools have a modest degree of success and an insufficient level of problem-solving ability. The mean scores of Higher Secondary Students' achievement in Physics and their ability to solve problems were not significantly different based on factors such as gender, school location, father's and mother's educational backgrounds, occupations, or mode of instruction. Additionally, there is no significant correlation between senior secondary school pupils' achievement in physics and their problem-solving skills.

Reddy and Panacharoensawad (2017) conducted an empirical study to assess student’s Problem Solving Abilities in Physics, as well as the elements that make Problem Solving challenging. A questionnaire designed specifically for the purpose was used to collect data from 303 high school students from Chittoor district in Andhra Pradesh. The collected data was evaluated using percentage analysis. The findings showed that students struggled with Problem Solving because they were unable to recall physics equations, did not practise solving physics problems in class, had poor mathematical skills, the teacher lacked motivation and experience, did not have a thorough understanding of physics definitions, laws, and fundamental concepts, and did not have access to enough books or resources on the subject.

Caino et al. (2017) investigated cognitive and non-cognitive aspects influencing complex problem Solving. The primary goal was to identify the influence of certain variables on Problem Solving and to investigate the links between cognitive processes, perseverance, and openness in three dimensions of complicated problem solving. The sample consisted of 235 university students from various specialties, including both men and women. Data was collected using a socio demographic questionnaire, AOSPAN to measure WMC, the Attention Network Test, and two PISA Likert scales. Data was acquired with a computer delivery battery. The study's findings revealed a substantial association between working memory capacity and perseverance; students with high WMC and high Openness or Perseverance performed best across both categories of CPS. The results also revealed a strong main influence of executive attention on knowledge application and strategies.

Chang et al. (2017) conducted a study with the primary goal of analysing student’s collaboration patterns and Problem Solving tactics when addressing a physics problem. Thirty high school students made up the sample, and the study collected data from a number of sources, such as open-ended questionnaires, group discussions, and problem-solving exercises in a collaborative classroom. Data was analysed using the Lag sequential analysis technique. Collaborative simulation helped students focus on the problem space and facilitated the path to Problem Solving. The findings revealed that successful and failed groups differed significantly in terms of collaboration patterns and Problem Solving tactics. The majority of pupils were able to employ the trial and error technique, but they were ultimately unable to solve the problem. Students who employed analytical thinking procedures could readily answer difficulties; however, those who couldn't investigate the Problem Solving process failed to solve the problem.

Siregar (2017) studied the impact of problem-based learning on students' Problem Solving Abilities and self-confidence. The study also examined the relationship between gender and learning. This study's sample consisted of 73 pupils, including 36 in grade VIII-5 and 37 in grade VIII-6. These students' tools included a problem-solving test and a self-confidence scale (66). The study found that problem-based learning improved students' Problem Solving Abilities more than conventional learning. Gender did not have an impact on students' Problem Solving Ability.

Studies related with Models of Teaching and Self-Concept

Sharma and Sharma (2023) examined the relationship between higher secondary school students' academic achievement and their self-concept and problem-solving skills. The study's goal was to investigate the impact of Self-Concept, Problem Solving Ability, and their relationship on students' academic achievement. The study's population consists of students in classes XI and XII who attend upper secondary schools in the Indore district. The sample includes 104 students in Class XI and XII from two distinct C.B.S.E. higher secondary institutions in Indore District. The Self-Concept Rating Scale, established by R. Saraswat, and the Problem Solving Ability

Test (PSAT), designed by L. N. Dubey, were utilised to collect data for this study. The selected student's academic achievements were assessed based on their previous examination results. The data was analysed using a Two way ANOVA. The study's findings show that the interaction of male and female student's Self-Concept and Problem Solving Ability had no effect on academic achievement in higher secondary schools.

Critical Thinking Skills and Student Self-Concept on Student Learning Outcomes by Applying the Inquiry Model was the subject of research by Suryaneli et al. (2021). The survey approach was used to perform the investigation. Ninety students made up the sample for this investigation. Simple random sample with proportionate allocation to each class was the sampling strategy used. Data for this study were gathered by documentation, surveys, observation, and literature review. By using the inquiry model, the results demonstrates how critical thinking abilities and self-concept affect student learning outcomes.

Gathage et al. (2021) examined how secondary school physics students in Kenya's Kitui County perceived themselves after receiving instruction in science through an inquiry-based approach. The Solomon Four Non-Equivalent Control Group Research Design, in particular, was used in this quasi-experimental study design. Four schools' worth of 160 kids made up the sample. According to the study, students who were taught utilising IBSTA and those who were taught using traditional methods differed significantly in their Self-Concept.

Gagan (2020) examined how the small group method affected standard IX students' self-concept, confidence, peer relationships, and academic performance. The primary goal of this study is to compare the mean increase academic achievement scores and peer group relations scores of experimental and control groups of students taught using the small group teaching technique (SGTM) and the traditional method. Also, the experimental and control groups of students taught using SGTM and traditional methods were compared in terms of mean gain Self-Concept and self-confidence ratings. The quasi-experimental, pre-test-post-test control group approach was used to conduct this investigation. The results demonstrate that subjects exposed to small group education had considerably higher mean gain scores on Self-Concept compared to subjects taught using the conventional method. This demonstrates how the small group teaching technique affects the Self-Concept of ninth-grade students. SGTM was proven to be more successful at improving students' Self-Concept.

Rani (2015) carried out a comparison study to examine how students' self-concept and English grammar achievement were affected by the idea attainment and memory models. Three designs were used: control, post-test, and pre-test. Three student groups were involved: one control group, two experimental groups, and one group for each. Purposive sampling was employed in the study. The results of the study show that students who learnt English grammar through the use of the Concept Attainment Model and the Memory Model did better than those who learnt it through the Conventional Method. The study also discovered that students' Self-Concept was much greater in those who were taught English grammar using the Concept Attainment Model and the Memory Model than in those who were taught using the Conventional Method.

Devi (2015) conducted research on the impact of cooperative learning on student's academic progress and Self-Concept. The primary goal of this study is to compare the accomplishment and Self-Concept of students taught using a cooperative learning strategy to those taught using a traditional way of instruction. Using a purposive sample of eighth-graders from the same school, a pre-test post-test control group quasi experimental design was used for the investigation. The study's findings shows that Team Game Tournaments and Students-Team success Divisions under cooperative learning considerably enhanced the scores of students in the experimental group in terms of academic success and Self-Concept.

Stephen and Utibeabasi (2011) carried out a study to find out the impact of self-concept on secondary school physics students' academic achievement. The study was carried out in Nigeria's Akwa Ibom State, in the Uyo LGA. The study included five hundred (500) senior secondary two physics students as a sample. The Self-concept Questionnaire (SQ) and the Physics Achievement Test (PAT), two instruments created by the researchers, were utilised to collect the data for the study. The study's main conclusions demonstrated that pupils with strong self-concept outperformed those with low self-concept in terms of academic achievement. Physics students with high self-concept did not significantly differ in their academic achievement based on their gender.

Kumari and Sushila (2002) examined how well gaming and mastery learning approaches affected students' self-perceptions and academic performance when teaching chemistry. The investigator used pre-test post-test control design and consisted of one hundred and twenty students studying in IX standard. The findings indicate that compared to the group of students taught using the traditional technique, the group of students taught using the gaming and mastery learning model had higher ratings in self-concept and achievement. Additionally, students educated using the mastery learning approach have a higher self-concept than those who only play video games.

Vikram and Gulati (2001) examined the effects of teaching accounting using the Inquiry Training Model, the Mastery Learning Model, and the traditional technique on students' performance, self-concept, adjustment, and cognitive styles. The sample comprised of 60 students in XI Class. The participants were separated into two experimental groups and one control group. The results demonstrated that there was no discernible change in the students' Self-Concept scores between the inquiry training model and the mastery learning model, nor in the students' Self-Concept scores when compared to the control group.

Dabas and Anju (2000) investigated how well students' self-concept, creative ability, and scientific success were affected by the Mastery Learning and Inquiry Training Model. A purposive sample of all of class VII from the same school was utilised in a quasi-experimental pre-test-post-test control group design. The findings showed that the Mastery Learning model greatly improves student’s Self-Concept compared to the Inquiry Training model. Again Mastery Learning Model outperforms traditional teaching methods in improving student’s Self-Concept. Also students Self-Concept is same when compared to inquiry training model and Traditional teaching methods.

Renu and Bala (1997) did a study to determine the impact of the Concept Attainment Model and the Mastery Learning Strategy on students' self-concept, science achievement, and trust-building behaviour in the classroom. pre-test-post-test control group design was used with a sample of 90 students from IXth standard. The results show that both the mastery learning strategy and classroom trust behavior are helpful to improve the Self-Concept of students.

Studies related with models of teaching and Problem Solving ability in Physics

Patel and Mikulkumar (2023) examined the impact of the concept attainment model and the advance organiser model on scientific accomplishment. Experimental design used was two Experimental group Control group Post-test only Design (As a true experimental design). The sample consisted of 102 secondary school students. Purposive sampling technique was utilized. The study's findings demonstrated that CAM instruction was superior to traditional instruction in terms of effectiveness. Comparably, AOM instruction proved to be more successful than conventional instruction. Also the results revealed that AOM and CAM both had an equivalent effect on student’s academic achievement.

Kaur (2023) examined Impact of inquiry training model on scientific success and creativity in relation to scientific curiosity. The equivalent group design for the pre-test and post-test was used. 200 VIII standard students from the Fazilka district make up the sample; 100 students are in the experimental group and 100 students are in the control group. Study result showed that the Inquiry Training Model effectively improves student’s scientific creativity and achievement in science.

Rokmat et al. (2022) examined the effects of the Causalitic-learning Model (CLM) on mastery of physics concepts and Problem Solving Ability. This study employed a quasi-experimental design with pre- and post-testing procedures, as well as an untreated control group. The sample comprised of 60 students. The results revealed a considerable difference in problem-solving skills between the experimental and control groups in physics. CLM and mastering physics concepts both have an effect on PSA, but there is no interaction between the two.

Nainesh (2021) did a study to determine the effectiveness of the inquiry training model in teaching mathematics to standard IX students. The study's main goal was to investigate the impact of an inquiry training model on mathematical achievement. The researcher used an equivalent group post-test experimental design with a representative sample of 160 students from standard 9. The researcher divided these pupils into two equal groups in each schools. While the control group received standard instruction, the experimental group received training using an inquiry-based model. The techniques employed included an inquiry training approach and a mathematics achievement test. The result showed that the inquiry training model is more effective in mathematical achievement than traditional teaching method.

Herayanti, Widodo, Susantini, and Gunawan (2020) created a collaborative blended learning model based on an inquiry tutorial to test its effectiveness. The goal of the study was to determine the usefulness of the created model on Problem Solving Skills in physics. The model included four dimensions: define, design, develop, and disseminate. The model's effectiveness was assessed using a one-shot case study and a pre-post test design. 88 Pre-Service This model involved physics teachers from three classes at a private institution in Mataram, Indonesia. Gain scores were analysed using ANOVA. The research findings suggested that the inquiry-based collaborative blended learning paradigm increased students' Physics Problem Solving skills.

Singh and Kaushik (2020) conducted a quantitative study to assess the impact of inquiry-based learning on chemistry teaching and student achievement. A sample of 80 XI standard students from Jhunjhunu district were recruited, with 40 being rural and 40 being urban. Purposive sampling was used to identify participants. While the control group received common training, the experimental group received instruction based on inquiry. Non-equivalent groups design for the pre-test-post-test was employed. The study found that students who were taught using the inquiry-based method were more likely to support the 5E method compared to those who were taught traditionally. The study found that inquiry-based learning leads to increased knowledge and a broader viewpoint among students. And perform more actively in the classroom than those taught in traditional methods.

Veena (2020) investigated the impact of the Creative Teaching Model Using Robots on IX Standard Students' Creativity and Physics Achievement. The primary goal of this study was to accomplish a specified degree of learning in physics through a creative teaching strategy that utilised direct experience. And to create and test the benefits of a creative teaching paradigm involving robots on creativity and physics achievement. A pre-test-post-test parallel group experimental design was the study methodology employed. The methods used in the study comprised a typical progressive matrix-based intelligence exam, a physics accomplishment test, a nonverbal test of creative thinking, a questionnaire based on socioeconomic status, and a creative teaching model utilising robots. The results of the study show that the Control and Experimental groups' scores on the Physics Learning Achievement Test differed significantly from one another. And the creative teaching methodology developed by the researcher employing robots is more successful for creativity and physics learning.

Bhaskara (2018) conducted a study titled "Comparative study of the effectiveness of Concept Attainment Model over Existing Method of Teaching a unit from physical science between homogenous and heterogeneous groups in higher secondary classes." The study aimed to assess the effectiveness of CAM and standard teaching techniques for teaching physical science to higher secondary pupils. The study utilised a non-equivalent post-test experimental design. The sample comprised of 100 students (40 men and 60 women). The researcher employed parametric statistics to analyse the data. This study found that using a computer-assisted learning (CAM) approach can help students learn and apply theories more successfully than traditional teaching methods.

Maryam et al. (2018) conducted studies on the use of the Conceptual Change Model to rectify mistakes and teach fundamental physics ideas. Determining how well the conceptual change model (CCM) teaches the foundational concepts of electrostatics was the main objective of the research. The study population consisted of female junior high school pupils. This study used the quasi-experimental Solomon four-group design. The conveniently and randomly selected samples were divided into two experimental and two control groups. The tools utilised were tests created by researchers to assess academic achievement in three areas: knowledge, comprehension, and concept application. The hypotheses were tested using central and dispersion measures, the t-test, and two-way ANOVA. The study's findings suggest that Concept Change Model teaching approaches outperform Existing Method of Teaching in terms of learning physics ideas, detecting and correcting misunderstandings.

Turnip et al. (2016) distinguished the problem-solving skills of Physics students taught with the traditional cooperative approach to those taught utilising the inquiry-based just-in-time teaching model. The study aimed to determine if the inquiry-based just-in-time teaching model has an impact on Problem Solving Skills of General Physics students. This is a quasi-experimental study with physical education and physics students at University of Medan. The sample was selected by cluster random sampling. The study found that the inquiry training model has a significant positive impact on physics student's Problem Solving Abilities, compared to the cooperative learning model.

Paliwal (2014) examined how standard IX students' capacity for ambiguity tolerance and inductive reasoning differed between the Inquiry Training Model and the Concept Attainment Model. With pre-tolerance of ambiguity as a covariate, the study looked at how the Inquiry Training Model, Concept Attainment Model, Scientific Attitude, and their interactions effect ambiguity tolerance. The sample for the study consisted of 100 students aged 13-15 years (50 boys and 50 girls) of IX standard studying at private Hindi medium schools in Indore City. The study found that students taught using the Inquiry Training Model outperformed those taught using the Concept Attainment Model in terms of tolerance for ambiguity. Additionally, inductive reasoning using the Inquiry Training Model and the Concept Attainment Model yielded no significant differences.

Amith and Mathur (2013) examined how the Concept Attainment Model affected students' understanding of physics ideas. The data used in this study came from two Mohindergarh (Haryana) schools. This study's main objective was to compare the effects of the standard teaching approach and the concept attainment model on students' achievement in class IX physics concept acquisition. In this study, an experimental research design was adopted. The sample for the study included 228 ninth-grade high school students. The results of the study indicate that there is a significant difference in students' understanding of physics between the traditional approach (TM) and the concept attainment model (CAM).

Khan and Iqbal (2011) compared the Inquiry Training Method to typical lab techniques for teaching ninth-grade biology. The study examined the effect of inquiry lab training on students' scientific process skills. The study included two groups of students: control and experimental. The Scientific Process Skill Scale was given to both student groups. Following the pre-test, the experimental group received 30 days of instruction utilising the inquiry lab approach, whereas the control group received standard lab instruction. The science process skill scale was used as a post-treatment evaluation. The study found that inquiry-based lab instruction is more successful for improving scientific process skills among secondary school biology students.

Saeed (2011) studied the impact of inquiry-based learning on secondary school students chemistry achievement. The study aimed to examine the effectiveness of inquiry-based instruction as a supplementing technique on chemistry academic performance and low IQ. The study used an experimental research design with the Chemistry Achievement Test (CAT) as the research instrument. The study's sample size consisted of 45 senior secondary students. The obtained data was examined using the t-test. The study found that the inquiry method outperformed traditional methods for high achievemment in Chemistry.

Hussaini et al. (2011) conducted a study on Physics teaching approaches, comparing scientific inquiry training to traditional lecture methods. This study aimed to assess how three levels of scientific inquiry training and standard lecture methods affect students' performance and ability to apply physics knowledge in real-life settings. This A pre-test, post-test control group design was used in the research investigation. The sample for the research study included 175 male tenth-grade physics students. Content Alignment Analysis was applied to the data analysis. The study found that guided, unguided, and combined scientific inquiry had a greater impact on students' achievement and ability to apply physics principles in real-world scenarios compared to standard teaching methods. The study indicated that scientific inquiry training increases student achievement in physics.

Praveen (2006) investigated how secondary school students' ability to solve physics problems was affected by their mastery learning method. Pre-test post-test equivalent groups design was the methodology employed in this investigation. Additionally, 74 students from two divisions within the same school make up the sample. The results show that The Mastery Learning Strategy does not significantly improve students' Problem Solving Abilities compared to the Conventional Learning Strategy.

Conclusion

Since the researcher was attempting to use Productive Thinking Model which is not frequently used in instructional settings, Much studies about Productive Thinking Model was not available. So, the investigator done a thorough review through different models of teaching that comes under information processing family to fix the direction of the study. Also, the effect of dependent and independent variable on different models and methods of teaching and their relationships were reviewed. since the studies related to Productive Thinking Model on Problem Solving Ability in Physics is very few in number the investigator reviewed studies that were attempted to study the effectiveness of models of teaching on achievement and other higher order skills.

The Research on several models and techniques within the information processing family demonstrates that they do, in fact, improve retention and achievement. There are remarkably few research examining the impact of specific models on higher order cognitive functions, particularly Physics Problem Solving Ability. Certain research studies (Herayanti et al., 2020; Turnip et al., 2016; Paliwal, 2014) demonstrate that teaching models improve high-level outcomes such as problem solving, inference, inductive reasoning, and deductive reasoning.

Investigator reviewed many studies related to the variables of studies from 2015 on words (for some cases studies before 2015 also reviewed). Altogether, the investigator has presented 56 investigations that were carried out in India and other countries.

In the literature review the investigator found that there were lots of studies related to the effect of models of teaching on Achievement in Physics. But only few studies which is related to the effect of models of teaching on Problem Solving Ability in physics. It gives ways and confidence to conduct research in this area.

Also, through the literature review the investigator has found that there were only few studies which were related to effect of a model of teaching on Self-Concept of students. It points to possibility of deeper studies in this area.

Research shows that Academic Achievement is influenced by the models of teaching. The majority of research investigating the impact of instructional models reveals a stronger correlation with academic achievement. But the studies to investigate the effect of Models of teaching on Problem Solving Ability in physics was less. The review also points out that there aren't many research that use Self-Concept as a dependent variable. As a result, the investigator has a thorough understanding of the variable and has been exposed to its various dimensions. After reviewing relevant research, the investigator was compelled to look into how the Productive Thinking Model affected Problem Solving Abilities and Self-Concept.

Chapter III

METHODOLOGY

- Rationale for the selection of variables
- Variables of the Study
- Objectives of the study
- Hypotheses of the Study
- Method selected for the Study
- Topic selection for the Treatment
- Data collection Tools, Techniques and Other Learning Materials used for the Study
- Data Collection Procedure
- Statistical Techniques Used for Analysis

METHODOLOGY

Research methodology is the way in which the investigator carrying out the research. In order to lead the research to success the methodology adopted should be apt. It includes what data we are going to collect and where from as well as how it is being gathered and analyzed. The relevant selection of methodology leads to sound findings. Research methodology helps the investigator to stick on the track.

Methodology is the procedure of selection of appropriate method, tools and techniques for the study. In order to solve a research problem successfully, various strategies adopted by the investigator for collecting and analyzing data should be relevant to the area of study. The present study entitled as EFFECTIVENESS OF PRODUCTIVE THINKING MODEL ON PROBLEM SOLVING ABILITY IN PHYSICS AND SELF CONCEPT OF STANDARD IX STUDENTS intended to find out the effectiveness of standard IX students. This chapter describes variables selected, objectives and hypotheses, design opted for this study, tools used, samples selected and the statistical techniques used.

Rationale for the selection of variables

Science is a subject which is much more connected with our daily life. We often use scientific phenomenon, laws, and theories by knowingly or unknowingly. So the investigator selected science specifically physics as area of research.

For the selection of independent variable investigator conducted thorough review of literature, and it was found that there are lots of strategies and methods were introduced over existing method of teaching some are successful but some are not. But there were a lot of limitations while implementing those models in various aspects. Most of the methods introduced have practical difficulties regarding time, classroom environment, attitude of students etc. Physics is such a subject which need more activities and space for critical and creative thinking. Instructional strategies which foster creative thinking in physics was very less in number so the investigator selected a model namely Productive Thinking Model. It is a model introduced in the marketing field to improve their outcome. The investigator has done necessary changes and modifications and transformed it in to the educational context. Productive Thinking Model can be included in the information processing family of models of teaching and the investigator fix it as the independent variable.

For the selection of the dependent variable the investigator studied various theories related to Productive Thinking Model and the factors associated with it. It is a model of teaching to solve problems critically and creatively and also it foster self thinking of students. Through literature review the investigator figured out different variables associated with Productive Thinking Model. Since Problem Solving ability is the variable mostly related, with this the investigator selected Problem Solving Ability as one of the dependent variable and Self-Concept as the other.

From the literature review it is evident that there is growing interest to develop different models to enhance the achievement of students. But there are not much models which foster Problem Solving Ability of students. Since Productive Thinking

Model is much more related to Problem Solving the investigator selected Problem Solving Ability in physics as one of the dependent variable. Self-Concept is the other dependent variable because in order to solve a problem effectively it is important to have awareness about once strength and weakness. New ideas are come out only if students are aware of their potentials. Therefore Self-Concept and Problem Solving Ability in Physics are the dependent variables of the study.

Variables of the Study

Variables are the conditions or characteristics that the experimenter manipulates controls or observes. Independent variables are the conditions or characteristics that the experimenter manipulates or controls in order to ascertain the relationship to observed phenomena (Best & Khan, 2012). The dependent variables are the conditions or characteristics that appear, disappear or change as the experimenter introduces, removes, or changes independent variables (Best & Khan, 2012).

The following provides an explanation of the dependent, independent, and control variables that were chosen for the research. The primary objective of this study was to evaluate the effectiveness of the Productive Thinking Model in comparison to the Existing Method of teaching. A deep literature review was carried out for the appropriate selection of the variables. The instructional strategy selected was Productive Thinking Model and Existing Method of Teaching. Two experimental groups and two control groups were selected for this study and hence the study was an experimental one.

The dependent, independent and control group variables are explained in detail below.

Independent Variables

The independent variable selected for the study was Models of Teaching.

Models of Teaching

A model of teaching is a plan or pattern that can be used to shape curriculums (long-term courses of studies), to design instructional materials, and to guide instruction in the classroom and other settings (Joyce & Weil, 1985). Similar to instructional designs, teaching models involve distinct procedures and the creation of specific environments that have the potential to influence students' behaviour. Teaching models assist students in learning a range of concepts, morals, ways of thinking, and self-expression techniques. Show them by example how to learn efficiently. Productive Thinking model is selected as the independent variable for the present study.

Productive Thinking Model. It is a methodical technique to Problem Solving or developing innovative ideas. This model incorporates many strategies that are done at different stages of the process (Hurson, 2007).

In the present study, Productive Thinking Model is a Teaching model in which the physics concept is taught through six stages. Researcher employed the six staged lesson plan to teach the content.

Existing Method of Teaching

The most common approach used in Kerala State's secondary Schools is the process skill oriented Method. The process skill-oriented method, which has been approved by subject matter experts, served as the foundation for the creation of the lesson transcripts.

Dependent variable

This study was trying to find out the effectiveness of Productive Thinking Model over Existing Method of Teaching on Self-Concept and Problem Solving Ability in Physics of Secondary school students of Kerala.

Problem Solving Ability in Physics

Problem Solving Ability is a mental procedure aimed towards obtaining a goal, when no possible solution becomes apparent to the problem solver (Mayer and Wittrock, 2006).

In this study, students' "Problem Solving Ability in Physics" was defined as their capacity to solve a problem using previously covered physics ideas, taking into account the elements of understanding the problem, making sense of the problem, and coming up with a solution.

Self-Concept

The person's belief about themselves, taking into account their characteristics and sense of self (Baumeister, 1999).

In the context of this study, self-concept is defined as optimism, self-acceptance, and self-confidence in one's abilities and potential among IXth std students.

IX Standard Students

IX standard students means, students studying in secondary levels in schools recognized by the Government of Kerala state.

Control Variables

In a research study, control variables are those that must remain constant or restricted. Although this variable is not related to the goal of the study, it should be controlled since it may have an impact on the findings. There is a possibility that, these elements could have an impact on the research outcomes. Therefore, the researcher anticipated certain characteristics of the subjects that would interfere in the experimental setting. ANCOVA was used to statistically control these factors. The students' pre-experimental status in terms of pre-tests was one of the variables that the investigator controlled. verbal group test of intelligence and socio-economic status were also controlled.

Rationale for the selection of control variables

Pre-test scores are used as a control variable by researchers to ensure that the experimental and control groups have the same physics Problem Solving Ability at the start. This initial equality mitigates the impact of pre-existing differences across groups, which might otherwise distort the study's outcomes. Experimental research typically aims to determine the impact of a specific intervention or treatment (here, the Productive Thinking Model). Variations in pre-tests may be misattributed to the intervention rather than the underlying cause if the baseline Problem Solving Abilities of the students is not controlled. The study's internal validity is enhanced by the use of pre-test results as a control variable. The degree to which the outcomes can be consistently ascribed to the independent variable (Productive Thinking Model) as opposed to other variables is known as internal validity. This will aid in determining if any changes in the experimental group were caused by the introduction of the Productive Thinking Model or by other factors.

The investigator employs a verbal group test of intelligence as a control variable to ensure that the experimental and control groups are initially equivalent in terms of general cognitive abilities related to verbal intelligence. This baseline equivalency helps to mitigate the influence of pre-existing IQ differences on Self-Concept and Problem Solving Abilities. A standardised test was used to assess student's verbal intelligence, which included language comprehension, reasoning ability, and verbal fluency. These cognitive skills are significant because they influence how students approach Problem Solving activities and assess their own abilities (Self-Concept). Controlling for verbal intelligence enables researchers to concentrate on the Productive Thinking Model's effects on Self-Concept and Problem Solving Ability rather than overall cognitive abilities. The use of a verbal group test of intelligence as a control variable in this experimental study assures that comparisons between groups are fair and that any observed improvements in Self-Concept and Problem Solving Ability may be more accurately attributed to the Productive Thinking Model.

Income, parental education level, and occupation are all significant Socio-Economic Status determinants that influence student's access to resources, opportunities, and support networks. By controlling for Socio-Economic Status, researchers ensure that any observed differences in Self-Concept and Problem Solving Ability between the experimental and control groups are not due to Socio-Economic Status. This enables neutrality while evaluating the influence of the Productive Thinking Model on various student populations. Internal validity refers to the degree to which observable improvements in the dependent variables (Self-Concept and Problem Solving Ability) can be attributed to the independent variable (Productive Thinking Model) rather than other causes. By controlling for Socio-Economic Status, researchers increase the study's internal validity by ensuring that variations in outcomes are more likely to be caused by the intervention (Productive Thinking Model) rather than socio-economic factors. The use of socio-economic position as a control variable in this experimental investigation ensures that the Productive Thinking Model is carefully and objectively tested. It allows researchers to draw more firm conclusions on the efficacy of the Productive Thinking Model in enhancing Self-Concept and Problem Solving Abilities while controlling for socio-economic factors that would otherwise bias the results.

Objectives of the study

1. To identify the prevailing and innovative Instructional Strategies, Methods and Models adopted by teachers to teach Physics at Secondary School Level.
2. To find out the issues (if any) experienced by the Physics teachers in implementing innovative Instructional Strategies, Methods and Models at

Secondary School Level and to suggest measures (if any) to overcome the constraints in implementing the innovative Instructional Strategies and Models at Secondary School Level.

3. To compare the mean post-test scores of Problem Solving Ability in Physics of experimental and control groups for the Total sample, Boys and Girls.

4. To compare the mean post-test scores of Self-Concept of experimental and control groups for the Total sample, Boys and Girls.

5. To compare the mean gain scores of Problem Solving Ability in Physics of experimental group I and control group II for the Total sample, Boys and Girls.

6. To compare the mean gain scores of Self -Concept of experimental group I and control group II for the Total sample, Boys and Girls.

7. To compare the mean retention scores of Problem Solving Ability in Physics of experimental and controlled groups for the Total sample, Boys and Girls.

8. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability in Physics of pre-tested experimental and control group.

9. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability in Physics of non pre-tested experimental and control group.

10. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of pre-tested experimental and control group.

11. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of non pre-tested experimental and control group.

12. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on retention in Problem Solving Ability in Physics of pre-tested experimental and control group.

13. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on retention in Problem Solving Ability in Physics of non pre-tested experimental and control group.

Hypotheses of the Study

1. There will be no significant difference in mean post-test scores of Problem Solving Ability in Physics of experimental and control groups for the Total sample, Boys and Girls.

2. There will be no significant difference in mean post-test scores of Self-Concept of experimental and control groups for the Total sample, Boys and Girls.

3. There will be no significant difference in the mean gain scores of Problem Solving Ability in Physics of experimental group I and control group II for the Total sample, Boys and Girls.

4. There will be no significant difference in the mean gain scores Self-Concept of experimental group I and control group II for the Total sample, Boys and Girls.

5. There will be no significant difference in the retention scores of Problem Solving Ability in Physics of experimental and control group for the Total sample, Boys and Girls.

6. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability in Physics of pre-tested experimental and control group.

7. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability in Physics of non pre-test experimental and control group.

8. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of pre-tested experimental and control group.

9. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of non pre-tested experimental and control group.

10. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on retention in Problem Solving Ability in Physics of pre-tested experimental and control group.

11. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on retention in Problem Solving Ability in Physics of non pre-tested experimental and control group.

Method selected for the Study

The major aim of the study is to investigate the effectiveness of the Productive Thinking Model on Self-Concept and Problem Solving Ability in Physics among IX standard students. The investigator used experimental method to find the effect of independent variable on dependent variable.

Experimental method

To a researcher, an experimental method is analogous to a blueprint for an architect. With the use of statistical analysis of the data, it gives the researcher the chance to perform the comparison that the experimental hypotheses require in order to create a meaningful interpretation of the findings of the study (Lokesh, 2000).

There are Different types of experimental designs based on factors such as adequacy and complexity. The nature of the experiment, its goal, the variables to be changed, the type of data, the settings we establish for the experiment, the experimenter's skill level, etc. are all taken into consideration when choosing an experimental method. In the present study the investigator intended to investigate the effect of teaching model namely Productive Thinking Model over the Existing Method of Teaching. So the investigator selected Solomon Four Group Design.

Experimental design selected for the study

The aim of the present study is to measure the relative effectiveness of two instructional methods namely, Productive Thinking Model and Existing Method of Teaching for teaching Physics subject and to compare Problem Solving Ability in Physics and Self-Concept of students. Since the study is experimental, the design must be sufficiently controlled and scientific to address any concerns with internal and external validity. Inadequate control of the extraneous variable may have an impact on the study's anticipated outcome. The Solomon Four Group Design will be a preferable choice in light of all these variables and different experimental designs because it can somewhat mitigate risks to internal validity. So the investigator has selected Solomon Four Group Design as the design of this study.

Two control groups (control group I and control group II) and two experimental groups (experimental groups I and II) are included in this design. The Productive Thinking Model was used to instruct Experimental Groups I and II (PTM). The Kerala state syllabus was used to teach the control groups utilising the present method of instruction used in Standard IX. Only one Experimental group and one Control group will receive pre-tests out of the four groups. While post-tests will be given to the four groups.

By using the Solomon Four-Group Design an experimenter can determine whether the pre-test, the treatment, or the combination of the treatment and pre-test was the source of the post-test differences. Because of the thing that it takes four groups to assess the effects of only two levels of a method, this approach is an expensive one. Four groups are needed because there is pre-test received and pre-test non received groups for comparison. The Solomon Four Group Design is a combination of Post-test only and Pre-test Post-test Equivalent Groups Design, offering advantages like no interference from pre-testing effects and greater precision in measuring treatment effects (Kidder, 198 1).

Solomon Four Group Design allows for two simultaneous experiments, incorporating replication advantages. ANCOVA allows for statistical control for pre-test and other variables, preventing post-test differences (Best & Kahn, 2006).

The following is an illustration of the design,

Group		Pre-test		Intervention		Post-test
A	$\longrightarrow$	O_1 O_5	$\longrightarrow$	X_1	$\longrightarrow$	O_2 O_{10}
B	$\longrightarrow$			X_2	$\longrightarrow$	O_4 O_{12}
C	$\longrightarrow$			X_3	$\longrightarrow$	O_6 O_{14}
D	$\longrightarrow$	O_3 O_7	$\longrightarrow$	X_4	$\longrightarrow$	O_8 O_{16}

(Best & Khan, 2017)

Where,

O_1, O_3 and O_5, O_7 are the Pre test Scores of Problem Solving Ability in Physics and Self-Concept respectively

O_2, O_4, O_6, O_8 and O_{10}, O_{12}, O_{14}, O_{16} are the Post test Scores of Problem Solving Ability in Physics and Self-Concept respectively.

$$\left.\begin{array}{l} O_2 - O_1 \\ O_8 - O_3 \end{array}\right\} \text{Gain scores of Problem Solving ability in Physics}$$

$O_{10} - O_5$
$O_{16} - O_7$
Gain scores of Self-Concept

A & B	-	Experimental Groups
C & D	-	Control Groups
X_I	-	Experimental Treatment I (Productive Thinking Model)
X_2	-	Experimental Treatment II (Productive Thinking Model)
X_3 and X_4	-	Control Treatment (Existing Method of Teaching)

Procedure

The following sections provide a description of the method that was used for the study. This section includes details on the study sample, topics chosen, tools, procedures, and other learning materials used, treatment execution, and statistical approaches used for the analysis.

Sample for the study

The study's population consisted of Standard IX student from Kerala state's secondary schools. Since the study is experimental, gathering data from a large sample proved to be challenging. Therefore, two schools, of reasonable Physical distance were selected for treatment. Four groups are selected from two schools, two classes from each school. The investigator selected the two schools which are of greater physical distance so that there will be no contact of students. The investigator has been frequently contacted the school authorities before the experimental phase of the study to ensure the equivalency of the sample. In both the schools the classes are divided on the basis of the previous achievement test records taken from the schools. To make sure the groupings were equivalent, a few further characteristics of these four classes were taken into account during the selection process. The following is a description of these aspects.

Rural-Urban Locality

The two schools were selected from semi-urban areas of Kozhikode district.

Gender

Co-education was offered to both schools. The outcomes of the experiment might change if a school for boys or females was chosen. For this reason, mixed divisions were chosen for the study in order to properly include boys and girls.

The school environment and other factors are made convenient to execute the treatment and the physical distance between the two schools (so that the students of these two schools cannot mingle mutually) were also considered in the selection of the sample. The study was conducted using a Solomen Four Group design, so the investigator tries to establish the equivalence of the experimental and control groups. But in the present study random assignment of subjects was not possible as four classroom groups from two different schools were assigned as experimental and control groups. Anyway random assignment was done while classifying classroom groups to experimental and control groups by considering above mentioned aspects.

Instructional Efficiency

The previous year's terminal exam outcomes were compared to guarantee that the subjects in the two groups (classes) had equal instructional efficiency. Also

Problem Solving Ability in Physics and Self-Concept of students before the actual implementation of Productive Thinking Model was measured using a pre-test on Problem Solving Ability in physics and Self-Concept. Finally, the investigator has re-evaluated student's Problem Solving Ability and Self-Concept after the implementation of Productive Thinking Model.

The ease with which the schools could carry out the experiment and the actual distance between the two schools were taken into account while choosing the sample. Based on their Pre-Experimental Status in terms of their ability to solve physics problems and their level of Self-Concept, Verbal Intelligence, and Socio-Economic Status, the four classroom groups were compared. Tools that were appropriate for this purpose were being used.

Selection of Experimental and control Groups

Two classes were chosen from one school, while the remaining two classes from a different school based on availability and feasibility as the study required two experimental groups and two control groups. Table 2 provides information about the schools chosen for the trial.

Table 2

Details of Schools Selected for the Study

Sl. No.	Name of Schools	Nature of Group
1	Poilkavu HSS, Polkavu	Experimental Group I
2	Poilkavu HSS, Polkavu	Experimental Group II
3	Thiruvangoor HSS, Thiruvangoor	Control Group I
4	Thiruvangoor HSS, Thiruvangoor	Control Group II

Table 3 displays the actual number of students in the Control and Experimental groups at the start of the experiment.

Table 3

Details of Sample Selected for the Study

Sample	Expt group I (PHSS)	Expt Group II (PHSS)	Control Group I (THSS)	Control Group II (THSS)	Total
Boys	30	25	23	28	106
Girls	18	15	17	16	66
Total	48	40	40	44	172

The Experimental Group I and Experimental Group II were taught through Productive Thinking Model in which experimental group I undergoes both pre-test and post-test but there is only post-test to experimental group II and the Control Group I & II, were taught through the Existing Method of Teaching, in which control group I undergoes both pre-test and post-test but control group II undergoes only post-test.

Topic selection for the Treatment

The topics that will be covered in this experiment were chosen from the Physics syllabus that Kerala State's standard IX students follows in the 2021–2022 school year. While selecting the topics for the experiment the investigator had go through; the curriculum, syllabus, textbook and teachers text book and studied it well. Important information about the subjects was also gathered from expert instructors and specialists. By considering various aspects of Productive Thinking Model that we are going to implement, the chapter selected for the treatment was ‘Motion and Laws of Motion'. Additionally, this topic was broken down into smaller sections. The following are the topic and the subunits.

Motion and Laws of motion

1. Unbalanced external force and motion
2. Observations of Galileo
3. Newton's first law of motion
4. Mass and inertia
5. Momentum
6. Newton's second Law of motion
7. Examples of Newton's laws of motion
8. Impulses
9. Newton's third Law of motion
10. Law of conservation of momentum
11. Examples of Law of conservation of momentum
12. Circular motion
13. Centripetal force and centripetal acceleration

Each unit was selected with proper care and thorough examination and found agreeable to Productive Thinking Model. Thirteen Malayalam lesson transcripts, each with a 40-minute time constraint, were generated for the Experimental groups I, II, and Control groups I and II, by utilising the corresponding lesson patterns.

To test the applicability of the draft Lesson Transcript of the Productive Thinking Model, the investigator conducted an experiment with 40 standard IX students. Before the tryout even began, the investigator established a strong rapport with the students. Students were given a clear understanding of the necessity for and goals of the new learning model. The major goals and characteristics of the model, as well as how education is designed to fit this specific model, have also been addressed by the investigator. Concerned teachers in the school were asked to attend the tryout session and their feedback was gathered. The draft lesson transcripts were revised, rewritten, and finished in light of the teachers' recommendations and the students' input.

Data collection Tools, Techniques and Other Learning Materials used for the Study

Unquestionably, the accuracy of the tools and the process of gathering data affect the quality of a study. Various tools and techniques were used at different phases of the data collection to ensure the study's excellence. These comprise the investigator's own tools as well as those created by other writers, all of which are covered in length in this section. The tools and other instructional materials that were used at various stages of the data collection procedure are listed below.

Preliminary Phase

1. Semi-structured Interview Schedule for Secondary school Physics Teachers (Athira & Bindhu, 2021)

Experimental Phase

1. Lesson Transcript for Productive Thinking Model (Athira & Bindhu, 2021)
2. Lesson Transcripts for Existing Method of Teaching (Athira &Bindhu, 2021)

3. Problem Solving Ability Test in Physics (Athira & Bindhu, 2021)
4. Self-Concept Scale (Bindhu & Alphonsa, 2015)
5. Verbal Group Test of Intelligence-VGTI (Kumar, Hameed & Prasanna, 1997)
6. Socio-Economic Status Scale (Bindhu & Vineetha, 2017)

Phase I - Preliminary Phase

In this phase, the investigator conducted an interview on Secondary School Physics Teachers to find out their views on Instructional Strategies, Methods and Models using a Semi-Structured Interview Schedule.

Semi-structured Interview Schedule for Secondary school Physics Teachers (Athira & Bindhu, 2021)

In this study, a sample of Secondary school Physics teachers was interviewed using a semi-structured format to understand the current pedagogical system in Physics. The focus areas were,

- To know the prevailing methods, strategies and models of teaching proposed or tested in teaching Physics at secondary Level.
- The constraints faced by teachers, if any, in executing these methods in Secondary level Physics students.
- Ideas to overcome the constraints, if any, and other measures to be taken.

A semi-structured interview schedule was created to enable respondents to freely share their thoughts on the focus areas in order to collect data on the aforementioned areas. After looking through the available resources, a preliminary draft of the schedule consisting of eight items was made. Experts were consulted for additional feedback and modifications. The schedule has been modified to include five open-ended questions based on their ideas.

Phase 2 - Experimental Phase

This phase comes right before real experimentation in order to create a solid foundation for doing experimental research. Here the researcher intended to find out the effectiveness of Productive Thinking Model on Self-Concept and Problem Solving Ability in Physics among standard IX students. The experiment was conducted using Solomon Four Group design. The two levels of teaching strategies such as Method of Teaching (Existing Method) and Models of Teaching (Productive Thinking Model) was used. Dependent variables are Problem Solving Ability in Physics and Self-concept. Intelligence, Socio-Economic Status and previous knowledge are the control variables of the study.

The researcher chose the samples from the Kozhikode district's Poilkavu Higher Secondary School and Thiruvangoor Higher Secondary School. Both the students and the school administration were willing to assist with the study as needed. According to Piaget's classification, students in the IXth standard were chosen for the experimental group, which falls under the formal operational stage (12–15 years).

The investigator visited the selected schools frequently and collects all the information regarding school environment, classroom structure, student’s previous achievements, teacher’s attitude toward the particular subject Physics etc. And also gathered information regarding teacher’s opinion about student’s attitude towards

Physics subject and their learning strategies. These all data from school authorities and students were helped the investigator to form various groups for experimentation. The physical separation between the two schools (so that the pupils of these two schools cannot mingle mutually) was also taken into consideration during this stage, along with other variables that make the school environment convenient for conducting the experiment.

Experimental stage

Two Experimental Groups and a Control Group had their pre-experimental status in terms of their Problem Solving Ability in Physics is measured prior to the experiment. Using the Productive Thinking Model, experimental treatments were given to experimental groups I and II. Control groups were taught using Existing Method of Teaching. Pre-test on Problem Solving Ability in Physics and Self-Concept were conducted to experimental group I and control group II. After the treatments, post-tests on Problem Solving Ability in Physics and Self-Concept were conducted to all the four groups. Other data for Verbal Intelligence and Socio-Economic Status were collected during this stage.

Lesson Transcript for Productive Thinking Model (Athira & Bindhu, 2021)

The investigator created lesson transcripts using the Productive Thinking Model for the chosen chapters to standard IX students under Kerala state syllabus. There were thirteen subunits in the chapter that was chosen for the treatment. For each learning unit, the two experimental groups and the two control groups had the identical topics chosen and precise goals defined.

Lesson Transcript for productive Thinking Model is created by the investigator for treatment in the Experimental group I and Experimental group II. Since this model incorporates higher order thinking components, the Productive Thinking Model is not a novel idea in the educational field but, it is an essential component of it. Since science offers so much opportunity for analysis, synthesis, and evaluation, our main goal in teaching science is to help students develop these skills. Productive Thinking is the area in science education that strikes a balance between these components so that students can learn something new instead of just memorizing and practising. Here, Productive Thinking Model is developed by Tim Hurson (2007) for practising in management studies. Therefore, the investigator has modified this model by considering the available model and adding the needed components for applying it in the educational field. The six staged Productive Thinking Model Lesson transcript are as follows,

Foundation. The idea behind this stage is that creativity never occurs in a vacuum. In order to achieve this, we must offer a knowledge base from which productivity can be derived. Since motivation, memory, creativity, and critical thinking all play a part in productive thinking, it is important to establish a foundational stage in which teachers manipulate student's prior knowledge to engage them in the material and use student-centered strategies like activities, technology-enhanced instruction, and demonstrations to teach.

Ideation. In this level, ideation fluency is prioritised over the creative part of productive thinking. The following ideas serve as the foundation for ideation.

✓ Quantity comes before quality.

- ✓ Innovation is hindered by functional fixedness.
- ✓ The obstacle preventing creation is criticism.

Students are free to think creatively and from a variety of angles by sticking to the previously mentioned principles. In this situation, a teacher's job is to pose an issue in a way that challenges students, upsetting their balance and encouraging them to come up with solutions. To do this, we must reduce criticism. That is criticism of oneself or criticism from others, as it prevents one from being creative and avoids emphasising memorization, drill, and skill.

Evaluation. The critical thinking component of productive thinking is represented by this phase. It entails assessing creative thought through critical thinking in order to change the idea and make it workable. As critical thinking takes domain criteria into account, it gives the developing ideas value, strength, potential, usefulness, and appropriateness. Peer assessment and presentation are two tactics that can be used in science classroom instruction to assess concepts that are still in their infancy.

Stabilization. The idea is to be stabilised during this phase. Students may have begun to question the stability of the material they were given and the ideas they had created. Two tactics that can be utilised in science classrooms are concept maps and conclusion writing.

Implication. Students are now free to logically infer the generated ideas. At this point, teaching science in the classroom can make use of concept maps and foresight.

Application. In this stage, the model provide enough life opportunities for the students to apply in real life situations.

A Malayalam version of the Model Lesson Transcript on Productive Thinking Model is presented in Appendix

Lesson Transcript for Existing Method of Teaching (Athira & Bindhu, 2021).

The term "Existing Method of teaching" refers to a strategy that is currently using the teachers in secondary schools under Kerala state syllabus. The most common approach used in Kerala State's secondary Schools is the process skill oriented Method. The lesson transcripts were created based on the process skill oriented Method, to highlight their approach to instruction through engaging activities in which students actively participate and produce effective learning outcomes. It takes a child-centered perspective. Process skills are ways of thinking about and engaging with objects and situations that can help understand novel scientific theories and concepts. These abilities enable students to gather data, put their beliefs to the test, and create scientific explanations for the world around them. This is an approach where students actively participate both physically and psychologically. The primary goal of this approach is learning by doing. Since it is generally established that the more senses are activated, the more and longer an individual retains what they have learned, learning by doing is essential to successful learning. Process skill oriented methodology is a well-established fact that learning is active. We forget the things we hear. We might recall what we observe. However, we completely comprehend what we do when we take action. However, one may easily argue that activities include playing, singing, dramatisation, and experiments where the learner's bodily participation is the only need. The issue with this mindset is that pursuits are made just for their own sake. A good learning activity should capable of:

- Assist in the formation of concepts and skill development
- Guarantee everyone's involvement
- Encourage the child's cognitive development.
- Be designed to make learning fun and challenging for the student.
- Should be in tune with the age and nature of the learner.

Aside from this, the substance and the lessons that need to be learned should be adequately represented. The Malayalam version of the lesson transcript is given in Appendix II.

Problem Solving Ability test in Physics (Athira & Bindhu, 2021)

This test is meant to measure the Problem Solving Ability in Physics of the students. The test is constructed by the investigator and the supervising teacher on the topics selected for treatment, as explained earlier the investigator has reviewed various studies and collected many components and dimensions. The investigator concluded that, among all the data gathered, Comprehending the Problem, Clarifying the Problem, and Finding a Solution to the Problem (Praveen, 2006) are the key elements most appropriate for getting ready for the Physics Problem Solving Ability test. The components for the test were described below.

Comprehending the problem. Comprehending the issue emphasizes the first step in becoming familiar with the issue. An in-depth comprehension of the issue is necessary in order to fix it. Understanding entails specific thought processes that assist the problem solver in creating a more detailed problem structure. The following list contains the subcomponents needed to understand the problem.

Sensing the problem. When faced with a circumstance, an individual may choose to react to it or not. He should be able to notice or feel an issue in that circumstance that will throw him in disequilibrium if he wants to react to it. It may take him some time to restore his equilibrium in order to solve that issue.

Defining the problem. One of the most crucial phases in Problem Solving involves defining the problem. We should begin Problem Solving by translating our mental images of the problem into verbal descriptions. Once a problem has been sensed or identified, one should be able to provide a verbal explanation for that problem.

Analysis of the problem into discrete elements. This section of Problem Solving Ability emphasises decomposing an issue into its component elements. To aid in understanding, the problem has been made simpler in this instance by highlighting the pertinent ideas, numbers, people, or objects.

Clarifying the Problem. Clarifying the problem is the second important aspect of Problem Solving ability. The investigator refers to untie the fundamentals of the problem in order to approach it intellectually by providing clarification on the topic. Clarification entails thought processes that take into account potential solutions for the problem that the researcher is trying to solve.

Ability to discriminate between the most relevant and closely related concepts. In this case, the procedure involves categorizing problem-related notions according to their applicability. Here, we're separating and identifying the smaller ideas that the problem involves but that are crucial to its development.

Using analogies for reasoning. Using similarities between related elements or objects that are highlighted in the problem is known as analogy. An ordered system of symmetrical relations based on the identities of structural components is what constitutes an analogy. Analogies emphasise the similarities between a difficult topic and something simpler, paving the way for comparisons to explain it.

Using Inductive or deductive reasoning. Here, certain relationships between crucial terms in the issue are discovered in this component, and the conclusions drawn from them can be applied to a broader setting. Here, two types of thinking are applied as an intellectual exercise to solve problems: general to particular and specific to general

Hypothesizing. Developing hypotheses involves using creative and analytical imagination. A hypothesis is a well-informed estimation or a provisional conjecture that serves as an explanation for a certain circumstance or phenomena. Such kinds of assumptions are essential to the advancement of science. Analogy and induction can be used to formulate hypotheses, and effective hypothesis formulation calls for creativity, in-depth knowledge, and a sincere interest in the topic.

Checking the testability of hypotheses. The testability of a hypothesis is one of its main features. Only when a theory is well-established and compatible with all pertinent data can it be accepted. A strong hypothesis is necessary for a scientific research to be successful because without it, we would not know what to do, what to observe, or what experiment to do

Finding solution to the problem. The third main element of Problem Solving ability is finding solution to the problem. The following list contains this component's subcomponents.

Controlling of variables. One of the key components of Problem Solving is controlling of variables. One of the crucial scientific process skills is this one. In science investigations, it is actually necessary to control some variables in order to observe variable relationships. The ability to determine which factors in an experiment should be controlled and which should be explored is an essential skill for science students.

Prediction of Happening. Another subcomponent that improves the capacity to foresee unknown things based on existing knowledge is prediction of occurring. It may also be thought of as the capacity to extrapolate from known knowledge into novel and unfamiliar circumstances.

Conceiving ideas using diagrammatic representation. Diagrams and illustrations are essential to the learning of science, thus we cannot ignore their importance. Concepts are clarified and the material is given greater meaning through the use of diagrams and illustrations. Using symbols and diagrams to help visualise the concepts involved in an issue is crucial for addressing physics difficulties.

Conceiving a strategy to execute a plan of action to test the hypothesis. This component requires the creation of an experimentation plan. The approach fixation aids the scientist in maximising parameters, eliminating logical mistakes, and figuring out the most effective means of producing precise results

Drawing inference from relevant observed data. This part of the problem-solving ability test makes recommendations for the conclusion that can be made from a given collection of data. This has to do with applying common sense to interpret the collected data in a useful way.

Generalizing. We can draw generalisations when our experiments yield a collection of results that are similar. generalisation is a crucial facet of Problem Solving Ability.

Design of the Problem Solving Ability Test

The basic ideas of physics, such as motion and the laws of motion, served as the foundation for the development of the Problem Solving Ability test. After reviewing the literature, the investigator created a draft Problem Solving Ability Test in Physics for Students in the IX Standard. The 45 multiple-choice questions on the test were created with help from the supervising guide and are based on the ideas of motion and laws of motion. The components recommended by Praveen (2006) served as the basis for the preparation of the Problem Solving Ability Test. To ensure that each prepared item was relevant, the specialists reviewed the preparation process. Multiple choice items were chosen because Ebel & Frisbie (1971) suggested that they are the most commonly utilised test items since they are less susceptible to sampling mistakes and more objective. They are simple to score and analyse, effective, and less ambiguous. The Appendix contains a draft of the Physics Problem Solving Ability

Test. A summary of the components included in the Physics Problem Solving Ability test is provided in Table 4.

Table 4

Summary of the Distribution of Items of the Draft Problem Solving Ability Test in Physics based on Components

Components of Problem Solving ability	Sub components	Question Number	Total
Comprehending the Problem	Sensing the Problem	1,2,3	9
	Defining the Problem	4,5,6	
	Analysis of the Problem into discrete elements	7,8,9	
Clarifying the Problem	Ability to Discriminate between the most relevant and closely related concepts	10,11,12	15
	Using analogies for reasoning	13,14,15	
	Using Inductive / Deductive Reasoning	16,17,18	
	Hypothesizing	19,20,21	
	Checking the testability of hypotheses	22,23,24	
Finding solution to the Problem	Controlling of variables	25,26,27	18
	Prediction of happening	28,29,30	
	Conceiving ideas using diagrammatic representation	31,32,33	
	Conceiving a strategy to execute a plan of action to test the hypothesis	3,35,36	
	Drawing inference from relevant observed data	36,37,38	
	Generalizing	39,40,41	

Table 5 displays the item distribution for the draft Physics Problem Solving Ability Test, which is based on fundamental ideas in motion and laws of motion.

Table 5

Summary of the Distribution of Items of the Draft Problem Solving Ability Test in Physics based on Basic Physics Concepts

Basic concepts	Number of questions
Balanced and Unbalanced forces	4
Newton's Laws of motion	16
Inertia and mass	10
Momentum	7
Impulse	4
Circular Motion	4

45 questions based on motion and laws of motion in physics concept comprised the draft Problem Solving Ability Test in Physics. Students were instructed to select the right response from the four options provided for each question on the test by surrounding the correct option. The possibilities were A, B, C, and D. Every question carries a single mark, and the whole test has a maximum of 45 and a minimum of 0.

Try out of the Problem Solving Ability Test

The 45 multiple-choice test draft was given by the investigator to a representative sample of 100 students in four distinct standard IX classes at a separate school (other than the Experimental and Control groups were selected for treatment). Before the test was given, the subjects were made aware of its aim. The students were given enough copies of the draft test materials and response papers. The test comprised all required instructions, and the investigator provided any extra information that was required. The scoring key was used to assign scores to each of the 100 response sheets. One hundred response sheets were chosen for item analysis.

Item Analysis

For item analysis, the method recommended by Ebel and Frisbie (1991) was used. The response sheets that were chosen were ordered according to decreasing score magnitude. The 27 participants who scored higher (27%) and the 27 subjects who scored lower (27%) were considered to be in the upper and lower groups, respectively. The difficulty index and discriminating power of each item were determined in order to choose the items for the final test.

Difficulty Index. An item's difficulty index was determined by taking the proportion of the group to which the subjects had given the correct response; the greater the index, the easier the question. The formula by Ebel and Frisbie (1991) was used to calculate each item's difficulty index.

$$\text{Difficulty Index } = \frac{U + L}{2N}$$

Where,

U - The number of correct responses in the upper group

L - The number of correct responses in the lower group

N - The number of subjects in each group.

Discriminating Power. According to Ebel and Frisbie (1991), test scores are predicted to be more varied and reliable if higher the average discrimination index for each question on the test. The formula is used to determine each item's discriminating power is,

$$\text{Discriminating Power} = \frac{U - L}{N}$$

Where,

U - The number of correct responses in the upper group

L - The number of correct responses in the lower group

N - The number of subjects in each group.

The difficulty index and discriminating power of each item are given in Table 6.

Table 6

Difficulty Index and Discriminating Power of Items in Problem Solving Ability Test in physics

Item No	U	L	D_i	D_p	Selected Items
1	24	12	0.66	0.44	Selected
2	18	8	0.48	0.37	Selected
3	24	5	0.53	0.70	Selected
4	21	5	0.48	0.52	Selected
5	24	16	0.74	0.62	Selected
6	23	7	0.55	0.48	Selected
7	20	9	0.53	0.70	Selected
8	19	6	0.46	0.55	Selected
9	15	4	0.35	.033	Selected
10	15	5	0.37	0.40	Selected
11	14	9	0.35	0.40	Selected
12	21	6	0.50	0.44	Selected
13	15	7	0.40	0.33	Selected

Item No	U	L	D_i	D_p	Selected Items
14	13	5	0.33	0.30	Selected
15	16	3	0.38	0.40	Selected
16	16	3	0.38	0.40	Selected
17	17	6	0.46	0.48	Selected
18	25	11	0.72	0.62	Selected
19	18	7	0.46	0.40	Selected
20	15	7	0.38	0.33	Selected
21	23	11	0.62	0.44	Selected
22	15	3	0.33	0.44	Selected
23	22	11	0.72	0.62	Selected
24	20	7	0.50	0.48	Selected
25	17	2	0.35	0.55	Selected
26	25	13	0.40	0.44	Selected
27	16	11	0.50	0.18	Rejected
28	18	7	0.46	0.40	Selected
29	12	5	0.31	0.25	Rejected
30	21	10	0.57	0.40	Selected
31	19	8	0.50	0.40	Selected
32	22	12	0.62	0.37	Selected
33	19	6	0.46	0.48	Selected
34	23	11	0.62	0.44	Selected
35	22	13	0.70	0.44	Selected
36	21	8	0.53	0.48	Selected
37	16	3	0.35	0.48	Selected
38	17	8	0.46	0.33	Selected
39	20	15	0.68	0.25	Rejected
40	18	10	0.51	0.30	Selected
41	22	11	0.61	0.47	Selected
42	19	11	0.55	0.30	Selected
43	24	10	0.62	0.51	Selected
44	20	1	0.57	0.33	Selected
45	19	9	0.51	0.37	Selected

U - The number of correct responses in the upper group; L - The number of correct responses in the lower group, D_i - Difficulty Index, D_p – Discriminating power

Appendices provide a draft of the Physics Problem Solving Ability Test (English Version), the Response Sheet, and the Scoring Key.

The researcher made the decision to choose items with discriminating power more than 0.3 and an initial difficulty index ranging from 0.3 to 0.7 from the entire set of draft test items. Additionally, the investigator has taken into account a few items with difficulty index ranging from 0.30 to 0.75. As a result, the investigator used 42 multiple-choice questions that were taken from the draft test to create the final test. The test had an hour allotted for it, and 42 marks was the maximum possible result.

Validity of the Test

The Problem Solving Ability Test's validity was estimated using the Criterion Related Technique. Other than the Experimental and Control groups, students from two class divisions of standard IX from a different school were selected. The obtained response papers were collected and scored. Additionally gathered scores were the marks that the identical sample received on the first Physics terminal test. The two sets of scores' coefficients were then determined using Pearson's Product Moment Correlation. It was discovered that the validity coefficient achieved was 0. 70. It implies that this test is a very reliable way to assess standard IX student’s proficiency in Problem Solving ability in Physics.

Content Validity. As the name suggests, this type of validity is confirmed by assessing each test item's relevance separately and collectively (Freeman, 1976). The investigator sent the test items for expert evaluation in order to ascertain the content validity of the Problem Solving Ability Test. Experts have concluded that the test's content covers key concepts and appropriately addresses the learning objectives. Thus, it was determined that the Physics Problem Solving Ability Test has content validity.

Face Validity. Experts assessed the items on the Problem Solving Ability Test to confirm the test's face validity. Experts suggest that the items in the Problem Solving Ability test may be utilised to assess the Problem Solving Ability in Physics of standard IX students.

Reliability of the Test

Using the test-retest method, the Problem Solving Ability test's reliability was determined. The same sample was given the same test three weeks later, and the data used for validation was gathered from them. Consequently, two sets of scores were generated: the original score and the retest score. The Pearson's Product Moment formula was used to determine the correlation coefficient between the two sets of scores. It was discovered that the correlation coefficient was 0.75.

Split half reliability. Two sets of scores such as first half and second half are generated when the entire item is divided into two equal halves. The two sets of scores' correlation coefficient was calculated using Pearson's Product Moment method. The test's reliability is ensured by the 0.72 coefficient of correlation that was discovered. Therefore the test appears to have appropriate to assess standard IX student's Problem Solving Ability in Physics based on the reliability and validity results.

Self-Concept Scale (Bindhu & Alphonsa, 2016)

The Self-Concept scale created by Bindhu & Alphonsa (2016) was used to measure Self-Concept for the study. The five components of the test include academic self-concept, moral self-concept, social self-concept, and physical self-concept. Table 7 below displays several components and the distribution of items.

Table 7

Component wise distribution of Items

Sl. No.	Components	SI Number of the items
1	Physical Self-Concept	2, 5, 7, 14, 17, 24
2	Mental Self-Concept	1, 3, 4, 9, 18, 19, 20, 23
3	Social Self-concept	6, 8, 13, 16, 10, 21, 39
4	Academic Self-Concept	11, 25, 26, 27, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38

Scoring Procedure

There are five possible answers for each sentence on the self-concept scale: always, mostly, sometimes, rarely, and never. Alternatively, for the positive statements, the five responses have the following scores: 5, 4, 3, 2, 1. the scoring for the negative statements was conducted in the opposite order.

Reliability

The capacity to produce consistent results across a range of measures is known as reliability. The Cronbach's alpha approach was employed by the investigator to determine reliability. The obtained coefficient of correlation was 0.72. This suggests that the scale has acceptable psychometric qualities to measure the Self-Concept of IX Standard students.

Validity

The degree to which a procedure or instrument for gathering data allows one to measure what is meant to be measured is known as its validity. The validity of the Self-Concept scale was confirmed using face validity.

Verbal Group Test of Intelligence - VGTI (Kumar, Hameed, & Prasanna, 1997)

The Verbal Group Test of Intelligence (VGTI) developed by Kumar, Hameed, and Prasanna (1997) was used to test verbal intelligence in the study. The test consists of five subtests, each with twenty multiple-choice items (a total of 100 items). These subtests are divided into five categories: verbal analogy, verbal classification, numerical reasoning, verbal reasoning, and comprehension for students in the 10-15 age range. The test can be finished in not more than an hour. There was a 100 maximum score and a 0 minimum. The subjects' verbal intelligence score is calculated as the sum of their scores on the five subtests.

Validity of the VGTI

Test creators used a criterion-related technique to establish the test's validity. The external criterion was the Kerala University Verbal Group Test of Intelligence (Nair, Pillai, & Amma, 1968). Verbal Analogy, Classification, Numerical Reasoning, Comprehension, and Intelligence-The total obtained validity coefficients were 0.54, 0.54, 0.52, 0.40, 0.46, and 0.65, respectively, and the test constructors stated that it has a high level of content validity.

Reliability of the VGTI

Significant reliability coefficients on verbal analogy, verbal classification, numerical reasoning, verbal reasoning, comprehension, and intelligence-total are 0.66, 0.56, 0.72, 0.63, 0.47, and 0.82, respectively. Test constructors used the Split-half Method to establish the test's reliability, and the Spearman Brown Prophecy formula was used to correct the reliability coefficient.

Socio-Economic Status Scale (Vineetha & Bindhu, 2018)

The variable called Socio-Economic Status (SES) holds great importance in social science teaching and research. A family's socio-economic status refers to where they are in relation to their environment. A good way to describe socio-economic status is as one's ability to access sources of financial, social, cultural, and human capital. The socioeconomic standing of a student is determined by their level of education, employment status, and parental income. The researcher chose four zones, including education, occupation, material possessions, and economic/social position both in India and overseas, based on a review of the literature and the Socio-Economic Status Scale. A score was assigned to each of the choices that were added under each section. The scale has a maximum score of 100. People with a score below 33% are classified as having a low socioeconomic status, those with a score between 33% and 66% as having a middle socioeconomic status, and those with a score above 66% as having a high socioeconomic status. Table 8 shows the Socio-Economic Status Scale's area-by-area scoring.

Table 8

Area-wise scoring procedure of Socio-Economic Status Scale

	Area	Scoring
Education	Professional	7
	Master Degree	6
	University graduate	5
	Semi Professional	4
	Higher secondary	3
	Secondary	2
	Primary	1
	Illiterate	0
Occupation	Central	8
	State	7
	Public undertaking	6
	Owner o a company	5
	Self-mployed	4
	Farmer	3
	Skilled labour	2
	Unskilled labour	1
	Unemployed	0
Material possessions	Four-wheeler	1
	Bike/Scooter	1
	Washing machine	1
	Refrigerator	1
	Credit card	1
	Telephone	1
	Mobile phone	1
	Cable connection	1
	TV	1
	Electricity	1
	Ownership of Other buildings/ shops	3 (if yes)
	Pets/cattle	2

	Area	Scoring
Number of earning members in family	More than 4	10
	Four	8
	Three	5
	Two	3
	One	2
Economic/social position		
Monthly income	Rs.75000 and above	10
	Rs.50000-74999	9
	Rs.35000-49999	8
	Rs.20000-34999	5
	Rs.10000-19999	3
	Below Rs.10000	2
Type of family	Single family	5
	Joint family	3
Trip to foreign countries	Monthly	8
	Once in three months	5
	Once in 6 months	3
	Once in a year	2
	No	0
Type of house	Family tours	2 (if yes)
	Family members working	2 (if yes)
	Abroad	
	Concrete to storey	10
	Concrete one storey	8
	House with tiles roofing	5
	Thatched roof	3
	Rented house	2
	Salaried servant	3 (if yes)
Residential area	Urban	5
	Rural	3

Data Collection Procedure

Before starting the experiment in order to assess the pre-experimental status in terms of Problem Solving Ability in Physics and Self-Concept, a Problem Solving Ability test in Physics and Self-Concept scale were administered to one of the experimental and control groups. The response sheets were then collected. There were two groups involved in the experimental treatment. The productive thinking model was applied to Experimental Group I and Experimental Group II, although no pre-test was given to experimental group II.

Administration of the Post-tests

Following the final phase of the treatments, the Experimental groups I and II, as well as the Control groups, were administered the Post Tests on Problem Solving Ability in Physics and the Self Concept Scale, which had previously been used as Pre-tests to measure the pre-experimental state. The test was given once more to assess the subjects' post-treatment proficiency in Self-Concept and Problem Solving Ability in Physics.

Data on verbal intelligence, Socio-Economic Status, and other control variables were collected from both experimental and control groups.

The major aim of the tests was explained to the students prior to their administration, and the subjects received all essential instructions. The guidelines provided in the manuals were carefully followed when giving the standardised tests, and the subjects were briefed before using the instruments. For a better understanding, the investigator worked through a few instances from each tool on the whiteboard.

For the Control groups as well as the Experimental Groups, a uniform procedure was used. Every test was conducted by the investigator directly.

Scoring and Consolidation of Data

The response sheets that were gathered were scored strictly in accordance with the instructions provided in the corresponding test manuals. The response sheets for the Physics Problem Solving test, the Self-Concept scale, the Verbal Intelligence test, and the general data sheet for socioeconomic status was assessed using the provided scoring keys. Response sheets were only considered, despite the fact that they were completely accurate. As a result, 170 standard IX students were selected as the study's final sample. Following the scoring of the response sheets, the Experimental groups I and II, as well as the Control groups had their individual tool scores calculated and consolidated independently.

Table 9 shows the exact number of students included in the final sample.

Table 9

Final Breakup of the Sample

Sample	Expt group I (PHSS)	Expt Group II (PHSS)	Contrl Group I (THSS)	Contrl Group II (THSS)	Total
Boys	18	15	17	16	66
Girls	28	25	23	28	104
Total	46	40	40	44	170

Statistical Techniques Used for Analysis

The present study demanded following statistical techniques to be used.

Percentage analysis

Percentage analysis was used to determine the most common methods, tactics, and models employed in secondary schools, as well as the constraints associated with applying these methods, strategies, and models. Also measures suggested for teaching physics in secondary school classes.

Basic Descriptive Statistics

Basic descriptive statistics were calculated, including Mean, Median, Mode, Standard Deviation, Skewness, and Kurtosis of each variable, such as the Total and Component wise on Pre-tests and Post-tests of Physics Problem Solving Ability, as well as scores on Self-Concept, Verbal Intelligence, and Socio-Economic Status. Gender-wise calculation was also done. The measured descriptive statistics were used to determine the distribution's nature.

Mean difference Analysis

The significance of difference between means test was used to compare the main variables between the Experimental and Control groups. Garrett's (2004) formula was employed.

$$t = \frac{M_1 - M_2}{\sqrt{\frac{\sigma_1^2}{N} + \frac{\sigma_2^2}{N}}}$$

One-Way ANOVA

For the entire sample of boys and girls, a one-way ANOVA was used to compare the important variables between Experimental Groups I and II and the Control groups. This statistical technique was primarily used to determine whether the Experimental groups I and II and the Control groups differed in Problem Solving Ability in Physics and Self-Concept, as well as gain scores in Problem Solving Ability in Physics and Self-Concept, without controlling for the effects of Covariates such as the students' Pre-Experimental Status in terms of Problem Solving Ability in Physics and Self-Concept, Verbal Intelligence, and Socio-Economic Status. A graphical depiction of the results is used to visually examine the comparisons of the important variables between the four groups.

Single factor Analysis of Covariance

This statistical technique was used to compare the effectiveness of the Productive Thinking Model to the Existing Method of Teaching in terms of Physics Problem Solving Ability and Self-Concept in standard IX students. A statistical technique known as analysis of covariance is used to account for the effect of one or more uncontrolled variables, allowing for a more accurate evaluation of experimental results (Ferguson, 1971). This method is employed when the dependent variable is connected with one or more other variables. In the current investigation, the ANCOVA technique is used to statistically control the effect of the covariates pre-experimental status on Problem Solving Ability in Physics, Verbal Intelligence, and

Socio-Economic Status. ANCOVA can be used to control the effects of any covariate on the dependent variable. Significant F values were subjected to Scheffe's post hoc comparison test.

Chapter IV

ANALYSIS

- Results of Preliminary Survey
- Preliminary Analysis
- Equivalance of the Group
- Major Analysis
- Conclusion

ANALYSIS

To examine the effectiveness of Productive Thinking Model on Self-Concept and Problem Solving Ability in Physics of standard IX students, the collected data has been analysed by the investigator. For the analysis of the present Experimental data, relevant statistical approaches such as the Test of Significance of Difference between Means, single factor ANCOVA employing three Covariates - separately and in combination of three at a time (for pre-tested groups) and Single Factor ANCOVA employing two Covariates - separately and in combination of two at a time (for non pre-tested groups) were used. The formulated hypotheses has been tested by the investigator on the basis of the results of statistical processing,

The statistical analysis was selected and done on the basis of objectives set in this study. The entire analysis procedure done in this study is consolidated in the following manner.

Results of Preliminary Survey

Preliminary Analysis

- Important Statistical Properties
- Equivalence of The Group

Major Analysis

- Mean Difference Analysis
- Analysis of Covariance for Problem Solving Ability in Physics and Self concept

Results of Preliminary Survey

A preliminary survey was undertaken to gather information on the current methods, strategies and models utilised by Secondary School Physics Teachers, as well as their perspectives on different methods of teaching. Innovative and engaging ways can enhance classroom experiences, regardless of whether it is a teacher-centered or chalk-and-talk approach. Using various instructional methods and models, it is possible to effectively reproduce a Physics classroom. In this context, the researcher asked about Innovative Strategies, Methods and Models of teaching to instruct Physics at the secondary schools. A semi-structured interview was done with Secondary School Physics Teachers (N=40) to obtain feedback on the following areas.

- To know the prevailing methods, strategies and models of teaching used or tested in teaching Physics at secondary Level.
- Constraints that teachers may face while adopting these strategies with Secondary level Physics students.
- Suggestions, if any, to overcome the constraints and alternative measures to be taken.

The responses of Secondary School Physics teachers to a semi-structured interview were assessed using percentage analysis. Details are provided in this section.

Prevailing Methods, Strategies and Models of Teaching used for Physics Instruction.

Teachers all over the world use a variety of teacher-centered and student-centered educational approaches and methods. The teaching approaches, strategies, methods and Models of Teaching used in Secondary School Physics Instruction in Kerala are expected to be distributed here. Table 10 displays the percentage of teachers who supported each Strategy, Method, and Teaching Model, in decreasing order of magnitude.

Table 10

Teacher Responses to Commonly Used Teaching Methods, Strategies and Models of Teaching for Secondary School Physics Instruction

Sl. No	Strategies/Method/Models	No. of Teachers Responded (N=40)	Percentage (%)
1	Activity oriented method	36	90%
2	Direct instruction method	36	90%
3	Assignment and project method	30	75%
4	Problem Solving method	19	46%
5	Issue based instruction	19	46%
6	Laboratory method	18	45%
7	Co-operative learning strategy	16	40%
8	Blended learning	14	35%
9	Computer assisted instruction	8	20%
10	Inquiry based Model	4	10%
11	Productive thinking Model	2	5%

From Table, it is clear that 90% of the Physics teachers use Activity oriented method and direct instruction method in Physics Instruction. Assignment and Project method, which allows for differentiated instruction, is used by 75%. Problem Solving method and issue based instruction are suggested by 46% while laboratory method was supported by 45%. Co-operative learning strategy (40%) and Blended learning (35%) were also recommended by teachers while only 20% suggested Computer assisted instruction as an effective model. Inquiry based model (10%) was one of the least preferred model. Productive thinking model (0%) were not preferred by any of the teachers, this might be because of the lack of awareness of such a model in the field of education.

Constraints Faced by Secondary school Physics Teachers in Using Models of teaching.

Teachers often confront constraints when implementing new teaching methods, strategies and Models of Teaching in the classroom. The difficulties they faced for the effective execution of different Methods, Strategies and Models of Teaching are presented in its order in Table 11.

Table 11

Constraints Faced by Secondary School Physics Teachers in Using Innovative Models of teaching

Sl. No.	Types of Constraints Identified	Number of Teachers Responded (N=40)	Percentage (%)
1	Time constraints	33	83
2	Classroom management	28	70
3	Difficulty to complete the portions on time	25	63
4	Assessment challenge	20	50
5	Lack of teacher expertise and training	19	48
6	Resource limitations	12	30
7	Financial constraints	9	23
8	Lack of interest from students	6	15

The table clearly illustrates that, for 83% of instructors, time is the most critical limitation they face when implementing innovative teaching models, as more time is necessary for the successful implementation of new teaching models. Other issues that teachers confront include trouble with class management (70%) and completing portions on time (63%). Teachers also reported difficulty in assessment (50%). Lack of teacher competence and training (19%), resource limitations (30%), financial limits (23%), and a lack of student motivation (15%) are all significant challenges when implementing diverse innovative teaching Methods and Models.

Measures Suggested by Secondary School Physics Teachers' to Overcome the Constraints in Adopting different Methods, Strategies and Models of Teaching

Since the Secondary school Physics Teachers experience certain constraints while implementing Methods, Strategies and Models of Teaching. They put forward some suggestive measures to diminish these difficulties and they are,

- Time span of class should be increased to ensure the successful completion of various teaching models.
- Teachers should receive proper training and seminars to become acquainted with various teaching models and successful implementation tactics, which will help them gain confidence and competency.
- Ensure that the necessary resources, such as technology tools, instructional materials, and support staff, are available to properly implement the new teaching methodologies. Advocate for budgetary allocations and develop ties with organisations that can provide additional resources.
- Align new teaching approaches with the existing curriculum to ensure that students' learning experiences are consistent and cohesive. Teachers should be

encouraged to seamlessly integrate the new models into their lesson plans and teaching strategies.

- Create support structures, such as mentorship programmes, coaching sessions, and shared planning meetings, to assist teachers in implementing the new teaching methodologies. Encourage peers to work together to transmit best practices.

- Recognise the diverse needs and preferences of teachers and students. Allow for freedom while adopting new teaching models, keeping in mind variances in teaching styles, classroom environment, and student populations.

- Conduct research and assessment studies to see if the new teaching methods improve student outcomes.

- When implementing a new teaching model, consider cultural norms, attitudes, and beliefs, especially in diverse or multicultural environments. Ensure that the models are inclusive and respectful to all student's backgrounds and experiences.

Different teaching methods, strategies and models necessitate specific stages, requiring additional time and resources to ensure successful lesson plans. A variety of factors, including teaching skill, student interest, motivation, classroom facilities, parental support, syllabus, and content, contribute to successful teaching models.

The preliminary survey revealed that teachers are eager to try new models of teaching, but experience challenges in implementing them effectively. Based on the responses, the investigator found that we can successfully implement innovative models, strategies and methods of teaching by negotiating the difficulties faced by the teachers.

Also this preliminary survey gives strong base for the investigator to modify Productive Thinking Model used in this study by considering almost all constraints pointed out by the teachers to an extent. It also helps investigator to prepare the lesson transcript effectively.

Preliminary Analysis

Preliminary Analysis was done for the purpose of identifying the important statistical properties of the variables and to ensure the equivalence of Experimental and Control groups with respect to the mean scores of the selected variables such as, Pre-test & Post-test scores of Problem Solving Ability in Physics and Self-Concept, gain scores of Problem Solving Ability in Physics and Self-Concept, Verbal Intelligence and Socio-Economic status. The preliminary analysis constitutes the following heads.

Important Statistical Properties

The major statistical properties like mean, median, mode, standard deviation, skewness and kurtosis were computed for the scores on the Pre-tests of Problem Solving Ability in Physics and Self-Concept, Post-tests of Problem Solving Ability in Physics and Self-Concept, Gain scores of Problem Solving Ability in Physics and Self-Concept, Retention in Problem Solving Ability in Physics, Verbal Intelligence and Socio-Economic status of students. Solomon Four Group design under experimental method is selected for the present study. Hence there will be two experimental groups and two control groups. The statistical property has to find separately for each experimental groups and control groups. The results are shown Table 12, 13, 14 and 15 respectively.

Table 12

Important statistical Properties of the variables for the Experimental Group I (Total sample, Boys and Girls)

Groups	Statistical properties	Problem Solving Ability in Physics (Pre-test)	Problem Solving Ability in Physics (post-test)	Problem Solving Ability in Physics (Gain score)	Self-Concept (pre-test)	Self-Concept (post test)	Self-Concept (gain score)	Verbal Intelligence	Socio-Economic Status
EXPTL GROUP 1 N=46	Mean	18.652	27.673	9.021	48.956	51.000	2.043	50.587	42.891
	Median	19.000	30.000	10.000	48.500	50.000	2.000	51.500	42.500
	Mode	19.000	30.000	10.000	40.000	50.000	3.000	54.000	41.000
	Std	3.114	5.185	3.958	6.889	7.235	1.685	6.513	6.168
	Skew	-.196	-.454	-.943	0.260	.089	-2.427	-.090	-1.38
	Kurt	.822	-1.100	.453	-0.875	-1.054	10.773	-1.251	.605
BOYS N=18	Mean	17.111	26.555	9.444	45.777	47.944	2.166	48.111	42.444
	Median	17.000	27.000	10.000	48.500	46.000	2.000	48.000	42.500
	Mode	18.000	30.000	10.000	42.000	40.000	1.000	42.000	41.000
	Std	2.373	3.853	3.147	5.514	5.396	1.339	5.028	5.158
	Skew	-.237	-.326	-.310	.169	-.037	-.505	.076	-.808
	Kurt	.893	-.973	-.669	-.892	-779	-.892	-1.299	.525
GIRLS N=28	Mean	19.642	28.392	8.750	52.964	51.000	1.960	52.178	43.178
	Median	19.000	30.000	10.000	54.500	51.000	2.000	54.000	43.500
	Mode	19.000	30.000	10.000	58.000	55.000	3.000	59.000	41.000
	Std	3.164	5.839	4.435	7.608	7.050	1.895	6.933	6.815
	Skew	-.666	-.714	-.984	.285	-.308	-2.758	-.487	-.024
	Kurt	2.145	-1.081	.155	-1.078	-863	11.548	.858	.467

Table 13

Important statistical properties of the variable for the experimental group II (Total sample, Boys and Girls)

Groups	Statistical properties	Problem Solving Ability in Physics (Pre-test)	Problem Solving Ability in Physics (post-test)	Problem Solving Ability in physics(gain)	Self-Concept (pre-test)	Self-Concept (post test)	Self-Concept (gain)	Verbal Intelligence	Socio-Economic Status
EXPTL GROUP 2 N=40	Mean	Nil	24.725	Nil	Nil	51.725	Nil	48.775	44.200
	Median	Nil	24.000	Nil	Nil	50.000	Nil	49.000	45.000
	Mode	Nil	20.000	Nil	Nil	48.000	Nil	48.000	48.000
	Std	Nil	4.063	Nil	Nil	7.448	Nil	4.347	4.9778
	Skew	Nil	0.354	Nil	Nil	0.109	Nil	-0.050	0.451
	Kurt	Nil	-1.052	Nil	Nil	-1.093	Nil	0.239	-0.128
BOYS N=18	Mean	Nil	23.600	Nil	Nil	49.600	Nil	47.600	44.266
	Median	Nil	23.000	Nil	Nil	49.000	Nil	48.000	45.000
	Mode	Nil	20.000	Nil	Nil	48.000	Nil	45.000	46.000
	Std	Nil	3.813	Nil	Nil	5.408	Nil	3.135	4.905
	Skew	Nil	0.213	Nil	Nil	0.222	Nil	-0.134	-0.684
	Kurt	Nil	-1.163	Nil	Nil	0.089	Nil	-0.507	0.143
GIRLS N=25	Mean	Nil	25.400	Nil	Nil	53.000	Nil	49.480	44.160
	Median	Nil	24.000	Nil	Nil	55.000	Nil	50.000	44.000
	Mode	Nil	21.000	Nil	Nil	40.000	Nil	48.000	48.000
	Std	Nil	4.133	Nil	Nil	8.281	Nil	4.857	5.120
	Skew	Nil	0.390	Nil	Nil	-.187	Nil	.316	0.362
	Kurt	Nil	-1.345	Nil	Nil	-1.372	Nil	.228	0.033

Table 14

Important statistical properties of the variables for the control group I (Total sample, Boys & Girls)

Group	Statistical properties	Problem Solving Ability in Physics (pre-test)	Problem Solving Ability in Physics (post-test)	Problem Solving Ability in Physics (gain)	Self-Concept (pre-test)	Self-Concept (post-test)	Self-Concept (gain)	Verbal Intelligence	Socio-Economic Status
CNTRL GROUP I N=40	Mean	Nil	20.675	Nil	Nil	49.200	Nil	51.650	45.175
	Median	Nil	20.000	Nil	Nil	49.000	Nil	51.000	46.000
	Mode	Nil	19.000	Nil	Nil	48.000	Nil	50.000	46.000
	Std	Nil	2.432	Nil	Nil	6.4377	Nil	3.230	4.829
	Skew	Nil	1.356	Nil	Nil	0.010	Nil	0.251	-0.459
	Kurt	Nil	1.416	Nil	Nil	-0.161	Nil	0.223	0.228
BOYS N=17	Mean	Nil	19.647	Nil	Nil	48.058	Nil	50.529	46.352
	Median	Nil	20.000	Nil	Nil	48.000	Nil	50.000	46.000
	Mode	Nil	19.000	Nil	Nil	48.000	Nil	50.000	46.000
	Std	Nil	1.169	Nil	Nil	7.676	Nil	3.064	3.920
	Skew	Nil	0.262	Nil	Nil	-0.138	Nil	-0.320	0.187
	Kurt	Nil	-0.554	Nil	Nil	-1.234	Nil	-0.686	-0.271
GIRLS N=23	Mean	Nil	21.434	Nil	Nil	50.043	Nil	52.478	44.304
	Median	Nil	20.000	Nil	Nil	49.000	Nil	52.000	45.000
	Mode	Nil	19.000	Nil	Nil	48.000	Nil	51.000	48.000
	Std	Nil	2.841	Nil	Nil	5.372	Nil	3.160	5.320
	Skew	Nil	.843	Nil	Nil	0.841	Nil	.652	-.440
	Kurt	Nil	0.291	Nil	Nil	.972	Nil	-.025	.935

Table 15

Important statistical properties of the variables for the control group II (Total sample, Boys & Girls)

Group	Statistical properties	Problem Solving Ability in Physics (Pre-test)	Problem Solving Ability in Physics (post-test)	Problem Solving Ability in Physics (gain)	Self-Concept (pre-test)	Self concept (post-test)	Self-Concept (gain)	Verbal Intelligence	Socio-Economic Status
CNTRL GROUP2 N=44	Mean	19.000	20.250	1.386	47.159	49.909	2.931	49.704	40.840
	Median	19.000	20.000	1.000	46.500	50.000	2.500	49.000	41.000
	Mode	18.000	20.000	1.000	46.000	50.000	1.000	59.000	41.000
	Std	3.403	3.942	2.526	6.440	5..909	2.039	6.341	5.264
	Skew	-0.208	-0.028	0.557	-.030	0.114	.907	0.236	-0.202
	Kurt	0.089	-1.105	2.872	-.733	.076	.540	-1.013	0.536
BOYS N=16	Mean	17.875	18.312	.812	46.562	49.0625	2.5000	47.687	40.562
	Median	18.000	18.500	1.000	46.000	48.0000	2.0000	48.000	41.500
	Mode	18.000	15.000	1.000	44.000	45.00[a]	2.00	45.000	35.000
	Std	1.821	2.548	2.072	5.452	4.76751	1.82574	4.422	4.560
	Skew	-.925	0.015	-.998	-.004	.095	1.164	0.048	-0.876
	Kurt	.174	-1.494	1.215	-1.150	-.460	1.205	-0.860	0.301
GIRLS N=28	Mean	19.642	21.357	1.714	47.500	50.678	3.178	50.857	41.000
	Median	19.500	22.000	1.000	47.000	50.000	3.000	50.500	41.000
	Mode	19.000	20.000	1.000	46.000	50.000	1.000	59.000	41.000
	Std	3.927	4.200	2.733	7.015	6.481	2.143	7.027	5.702
	Skew	-0.581	.780	1.7595	-.102	-.033	.795	0.038	-0.059
	Kurt	-0.122	2.701	2.8566	-.753	-.817	.465	-1.345	.540

Equivalance of the Group

The present study was conducted using Solomon Four Group design under the category of experimental research. In an experimental method the experimental and control group equivalence is provided by random assignment of subject to experiment and control treatments. In the present study four intact classrooms from two different schools were selected as experimental and control groups. So it is difficult for random assignment of subjects. Random assignment was done while distinguishing classes to experimental and control groups.

In present study the major barrier is finding sufficient subjects to allocate randomly to four equivalent groups. For this purpose ANCOVA can be used. ANCOVA permits to statistically control for differences on pre-test so that post test differences would not be due to initial differences prior to treatment (Best & Kahn, 2006).

Even though it was not required the investigator thus used ANCOVA for comparing the post test scores, so that the differences on the pre-test and control variables namely, verbal intelligence and socioeconomic status can be statistically controlled, so that differences in post tests would not be caused by initial differences advance to treatment.

Solomon four group design possess two experimental and two control groups. In the present study the four groups are distinguished as experimental group I and experimental group II, control group I and control group II. Among these groups only experimental group I and control group II are received pre-tests, but post-tests to all the four groups.

Moreover, the investigator used the test of significance of difference between means with respect to the factors like pre-test scores on Problem Solving ability in Physics, total Verbal group test of intelligence scores and its components (verbal analogy, verbal classification, numerical reasoning, verbal reasoning and comprehension) also Socio-Economic Status. The t test results are shown in table 16.

Table 16

Data and results of the t-test for the scores on Pre-test of Problem Solving ability in physics, Verbal Intelligence (total and component wise) and Socio-Economic Status between the Experimental group I and control group II

Variables	Groups compared	Mean	Std. Deviation	N	t value	Significance
Problem Solving Ability in Physics (Pre-test)	Experimental group I	18.652	3.114	46	0.506	NS
	Control group II	19.000	3.403	44		
Verbal analogy	Experimental group I	12.000	1.605	46	0.424	NS
	Control group II	12.136	1.440	44		
Verbal Classification	Experimental group I	11.347	1.015	46	.847	NS
	Control group II	11.159	1.098	44		
Numerical reasoning	Experimental group I	10.369	1.040	46	0.658	NS
	Control group II	10.227	1.008	44		

Variables	Groups compared	Mean	Std. Deviation	N	t value	Significance
Verbal reasoning	Experimental group I	6.152	1.646	46	1.041	NS
	Control group II	6.522	1.731	44		
Comprehension	Experimental group I	6.173	1.729	46	.523	NS
	Control group II	6.363	1.671	44		
Verbal intelligence (total)	Experimental group I	50.587	6.513	46	0.651	NS
	Control group II	49.704	6.341	44		
Socioeconomic status	Experimental group I	42.891	6.168	46	1.693	NS
	Control group II	40.840	5.264	44		

From above table, Experimental group I and Control group II students (two groups which received Pre-tests) does not significantly differ in their scores of Pre-test, Verbal Intelligence Total (and it's scores with respect to the components Verbal Analogy, Verbal Classification, Numerical Reasoning, Verbal Reasoning and Comprehension), and Socio-Economic Status. So, it can be concluded that, the Pre-tested groups that is Experimental group I and Control group II are equivalent with respect to the covariates as explained earlier.

Major Analysis

In this study two major statistical techniques were used for analysis of data and hypothesis testing which include Mean difference analysis and Analysis of covariance. Each of these techniques is used for conforming the objectives set for the experiment. Mean difference analysis is used to determine whether the two experimental and control groups differ significantly in their mean scores in pre-tests of Problem Solving Ability in Physics and Self-Concept, post-tests of Problem Solving Ability in Physics and Self-Concept, gain scores on Problem Solving Ability in Physics and Self-Concept and Retention in Problem Solving Ability in Physics, without controlling for control variables or covariates. Once the covariates were controlled, analysis of covariance was utilised to determine whether or not the two Experimental groups and the two Control groups differed in the Problem Solving Ability in Physics, Self-Concept and Retention.

Since the Experimental design selected was Solomon Four-Group Design, the difference between Experimental group and Control group and also the difference between the Pre-test received groups and the Pre-test non received groups can be investigated. Only two groups, Experimental group I and Control group II has received Pre-tests and therefore comparison of pre-tests and Gain scores can be done only for these two groups.

Mean difference analysis

Mean difference Analysis is used to find the difference in Pre-test scores of Problem Solving Ability in Physics and Self-Concept, Post-tests of Problem Solving Ability in Physics and Self-Concept, Gain scores on Problem Solving Ability in Physics and Self-Concept and Retention in Problem Solving Ability in Physics, if any, between the two Experimental and two Control groups before controlling the Covariates. This technique was used to compare the Experimental and Control groups with regard to pre-test score on Problem Solving Ability in Physics (component-wise and Total score), pre-test scores of Self-Concept, post-test score of Problem Solving Ability in Physics (component-wise and Total score), post-test scores of Self-Concept, Gain scores on Problem Solving Ability in Physics and Self-Concept and Retention in Problem Solving Ability in Physics (component wise and Total score) without controlling the effects of the Covariates. Each comparison was done in between the two Experimental groups and two Control groups for the purpose of testing the appropriate hypotheses.

Comparison of Pre-test Scores of Problem Solving Ability in Physics Before Control

Comparisons of Pre-test scores made in between the two Pre-tested groups (Experimental group I and control group II) are discussed in this section. Group comparison as well as sex-wise comparison was made in between the two groups.

Comparison of Mean Pre-test Scores of Problem Solving Ability in Physics between the Experimental Group I and Control Group II for total sample. The test of significance of difference between means was used to determine if the Experimental group I and control group II differed significantly in terms of mean Pre-test scores.

The means and standard deviations of the pre-test scores for Problem Solving Ability in Physics were used to conduct Mean Difference Analysis. The results of the t-test are shown in Table 17.

Table 17

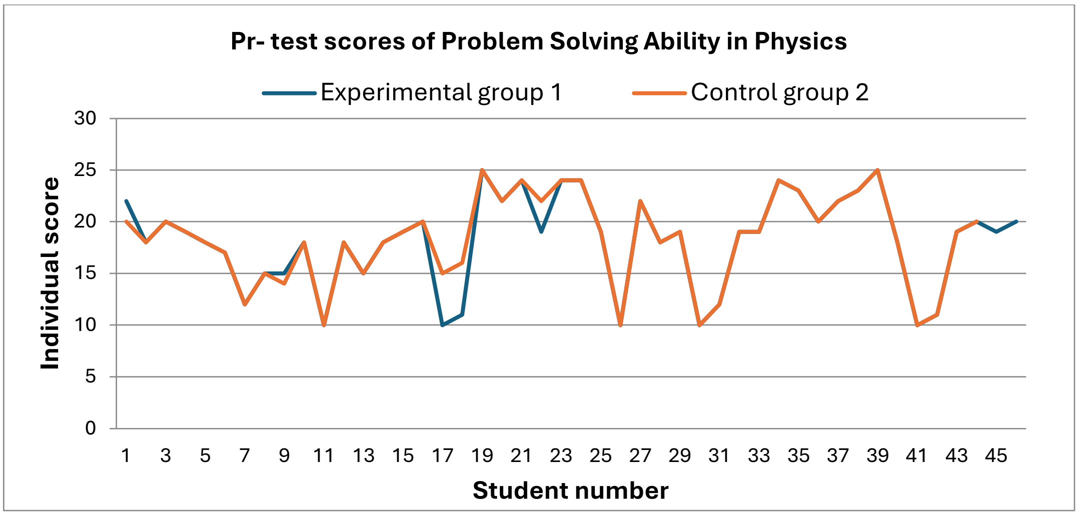
Data and Results of the t-test for the Mean Pre-test Scores of Problem Solving Ability in Physics between the Experimental Group I and Control Group II for the total sample

	Group	N	Mean	Std. Deviation	t value	P value	Significance
Problem Solving Ability in physics (Pre-test)	Experimental group I	46	18.652	3.114	.505	.614	NS
	Control Group II	44	19.000	3.403			

Table 17 shows that the obtained t-value for Pre-test score of Problem Solving Ability in Physics is not significant. From the result it is evident that Experimental group I and control group I1 does not differ in their mean Pre-test score of Problem Solving Ability in Physics. This suggests that the subjects in the Experimental group I and the Control group II were in the same pre-experimental state. Figure 2 presents a graphical analysis and presentation of overall student performance on the Pre-test of Problem Solving Ability in Physics among Experimental group I and Control group II.

Figure 2

Comparison of pre-test scores of Experimental group I and control group II(total)



On the examination of the graphical representation of pre-test scores between the Experimental group I (total) and Control group II (total) points that the individual performance of these two groups is similar to a certain extent. Statistically significant difference was not observed through the Mean Difference Analysis. The graphical observation also aligns with mean difference analysis.

Comparison of Mean Pre-test Scores of Problem Solving Ability in Physics between the Experimental Group I and Control Group II (Boys and Girls). To determine if there is any significant difference in the mean Pre-test scores of Problem Solving Ability in Physics between the Experimental group I and the control group II (boys and girls), a test of significance of difference between means was employed.

The Mean Difference Analysis was performed on the means and standard deviations of the pre-test scores of Problem Solving Ability in Physics. Table 18 shows the data and t-test results.

Table 18

Data and Results of the t-test for the Mean Pre-test Scores of Problem Solving Ability in Physics between the Experimental Group I and Control Group II (Boys and Girls)

Gender		Group	N	Mean	Std. Deviation	T	P value	Level of Significance
Boys	Problem Solving Ability in Physics (pre-test)	Experimental group I	18	17.111	2.373	1.043	.305	NS
		Control group II	16	17.875	1.821			
Girls		Experimental group I	28	19.642	3.164	0.000	1.000	NS
		Control group II	28	19.642	3.927			

From the table, it is evident that the t-value is not significant It shows that the mean pre-test scores of the boys and girls in the Experimental group I and the Control group I1 are identical. They both performed the same in the Pre-test of Problem Solving Ability in Physics. Figure 3 and 4 presents a graphical analysis and presentation of the boys' and girls' pre-test scores of Problem Solving Ability in Physics for the Experimental group I and the Control group II.

Figure 3

Comparison of individual pre-test scores of Experimental group I boys and Control group II boys

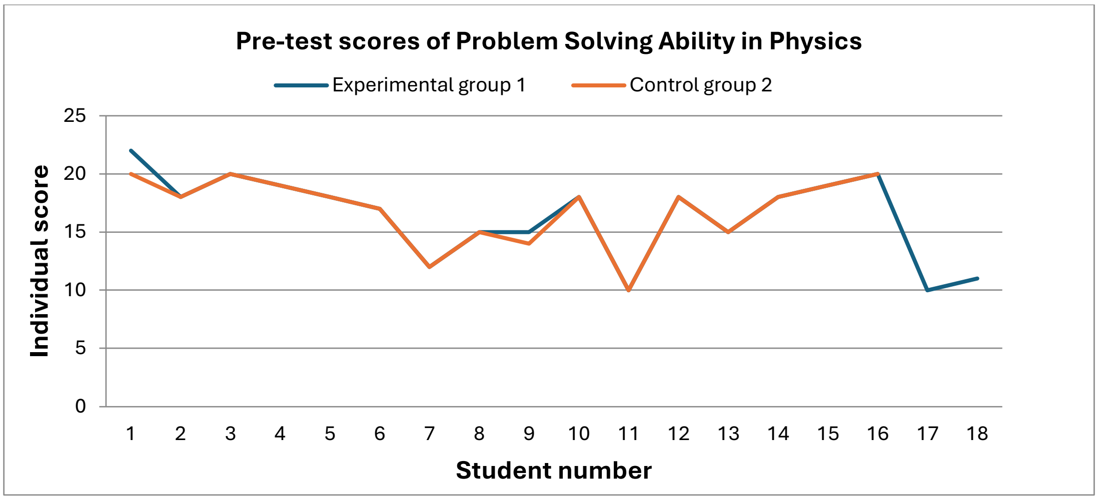
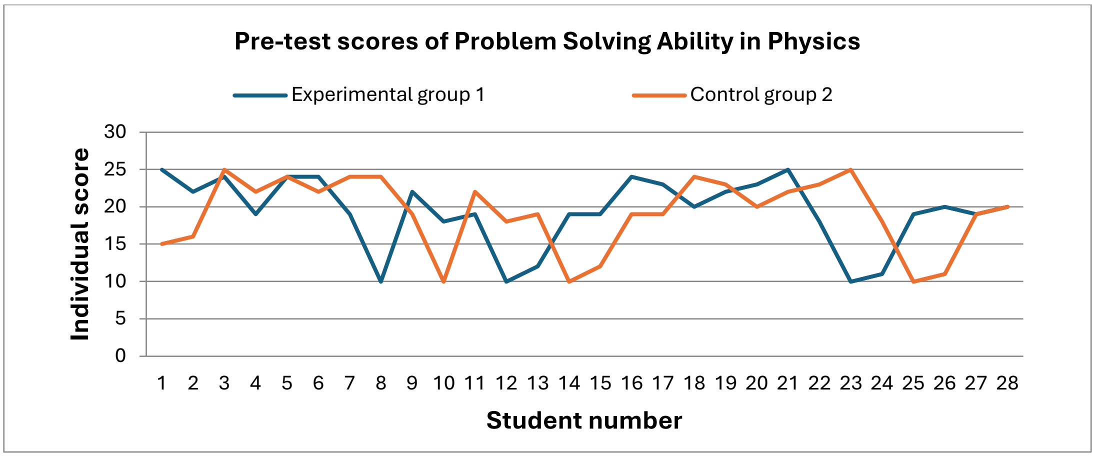


Figure 4

Comparison of individual pre-test scores of Problem Solving Ability in Physics among Experimental group I girls and Control group II girls



On the examination of the graphical representation of pre-test scores of boys and girls between the Experimental group I and Control group I1 points that the individual performance of the Boys and girls of these two groups is similar to a certain extent. Statistically significant difference was not observed through the Mean Difference Analysis. The graphical observation also is an agreement with the mean difference analysis.

Comparison of Pre-test Scores of Self Concept Before Control

Comparisons of Pre-test scores made in between the two Pre-tested groups (Experimental group I and control group II) are discussed in this section. Group comparison as well as sex-wise comparison was made in between the two groups.

Comparison of Mean Pre-test Scores of Self-Concept between the Experimental Group I and Control Group II for total sample. To determine if there are any significant differences in the mean Pre-test scores of Self-Concept between the Experimental group I and the control group II, the Test of significance of the difference between means was employed.

The Mean Difference Analysis was performed on the means and standard deviations of the Self-Concept Pre-test results. Table 19 displays the data and t-test results.

Table 19

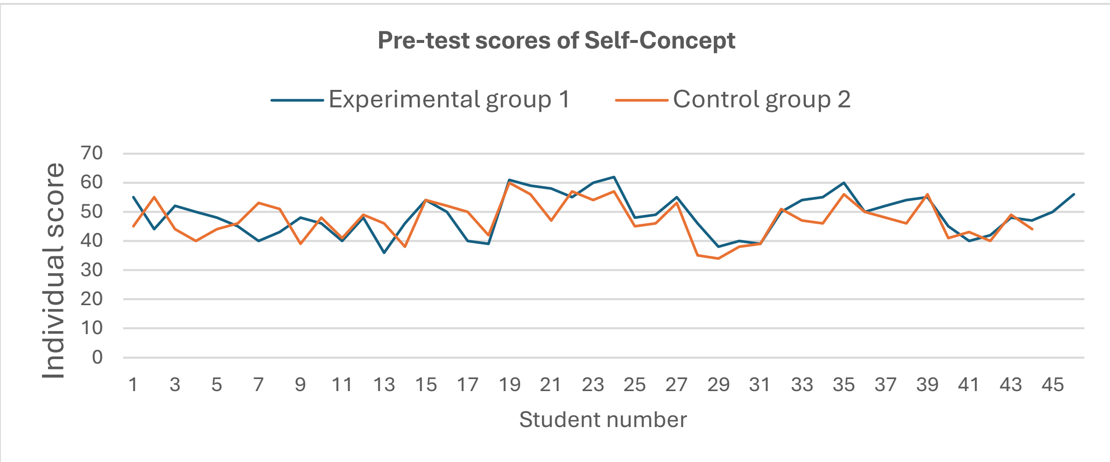
Data and Results of the t-test for the Mean Pre-test Scores of Self-Concept between the Experimental Group I and Control Group II for the total sample

	Group	N	Mean	Std. Deviation	t value	P value	Significance
Self-Concept (pre-test)	Experimental group I	46	48.956	6.889	1.277	0.205	NS
	Control Group II	44	47.159	6.440			

Table shows that the obtained t-value for Pre-test score of self concept is not significant. From the result it is evident that Experimental group I and control group I1 does not differ in their mean Pre-test score of self concept. This suggests that the subjects in the Experimental group I and the Control group II were in the same pre-experimental state in terms of Self-Concept. Figure 5 shows a graphic analysis and presentation of the entire student performance on the self-concept (pre-test) for Experimental group I and Control group II

Figure 5

Comparison of pre-test scores of Self-Concept of Experimental group I and control group II (total)



On the examination of the graphical representation of pre-test scores of Self-Concept between the Experimental group I (total) and Control group II (total) points that the individual performance of these two groups is similar to a certain extent. Statistically significant difference was not observed through the Mean Difference Analysis. The graphical observation also aligns with mean difference analysis.

Comparison of Mean Pre-test Scores of Self-Concept between the Experimental Group I and Control Group II (Boys and Girls). Test of significance of difference between means was used to study whether the Experimental group I and control group II (Boys & Girls) differ significantly in terms of mean Pre-test scores of Self-Concept.

The Mean Difference Analysis was performed on the means and standard deviations of the Pre-test scores of Self-Concept. Table 20 shows the data and t-test results.

Table 20

Data and Results of the t-test for the Mean Pre-test Scores of Self-Concept between the Experimental Group I and Control Group II (Boys and Girls)

		Group	N	Mean	Std. Deviation	t value	Level of Significance
Boys	Self concept (Pre-test)	Experimental group I	18	45.777	5.396	0.250	NS
		Control group II	16	46.562	5.452		
Girls		Experimental group I	28	51.000	7.050	1.133	NS
		Control group II	28	47.500	7.615		

As the table indicates, the obtained t-value is not significant, which shows that there is no difference in the mean pre-test scores for Self-Concept between the boys and girls in the Experimental group I and the Control group II. They both scored the same on the pre-test of Self-Concept.

Comparison of Post-Tests on Problem Solving Ability in Physics Before Control

Difference in Problem Solving Ability Scores in Physics (component wise and total score) was investigated between the two experimental groups and control groups for the comparison of groups. Comparison was done in between each Experimental and each Control group, between Experimental group total and Control group total and also in between the Boys and Girls of Experimental group total and control group total. The control variables were not considered in all these comparisons.

Comparison of Mean Post-test scores of Problem Solving Ability in Physics (Component-wise and Total) Between the Experimental Group I and Control Group I for the total sample. The test of significance of difference between mean was used to determine if there is a significant difference between the mean post-test scores of Problem Solving Ability in Physics (Component-wise and Total) of Experimental group I and the Control group I. The Mean Difference Analysis was performed using the means and standard deviations of the post-test scores of Problem Solving Ability Test in Physics (Component-wise and Total). Table 21 displays the data and t test results.

Table 21

Data and Results of the t-test for the Mean Problem Solving Ability scores in Physics (Component-wise and Total) between the Experimental Group I and Control Group I for the total sample

	Experimental group I			Control group I			t value	Level of significance
	Mean	Sd1	N1	mean	Sd2	N2		
Comprehending the problem	6.587	1.309	46	5.325	.764	40	5.352	0.01
Clarifying the problem	10.637	2.407	46	7.475	1.75	40	6.856	0.01
Finding solution to the problem	10.347	2.223	46	7.825	1.483	40	6.092	0.01
Problem Solving Ability (total)	27.673	5.185	46	20.675	2.432	40	7.617	0.01

Table shows that the obtained t values for total Problem Solving Ability scores and component wise scores in Comprehending the Problem, Clarifying the problem and Finding solution to the problem are significant at 0.01 level.

The results specify that the mean Problem Solving Ability scores of the Experimental group I and Control group I (component wise and total scores) are significantly different. Higher mean Problem Solving Ability score of the Experimental group indicate its superiority over control group.

Comparison of Mean Post-test scores of Problem Solving Ability in Physics (component-wise and total) Between the Experimental Group I and Control Group II for the total sample. Test of significance of difference between mean was used to study whether the Experimental group I and Control group II differ significantly in terms of mean post-test scores of Problem Solving Ability in Physics

(Component-wise and Total). The Mean Difference Analysis was performed on the means and standard deviations of the Problem Solving Ability scores (Component-wise and Total) in Physics. The results are shown in table 22.

Table 22

Data and Results of the t-test for the Mean post-test scores of Problem Solving Ability in Physics (Component-wise and Total) between the Experimental Group I and Control Group II for the total sample

	Experimental group I			Control group II			t value	Level of significance
	Mean	SD1	N1	mean	Sd2	N2		
Comprehending the problem	6.587	1.309	46	4.659	1.199	44	7.273	0.01
Clarifying the problem	10.630	2.407	46	7.318	2.020	44	7.055	0.01
Finding solution to the problem	10.347	2.223	46	8.272	1.703	44	4.954	0.01
Problem Solving Ability (total)	27.673	5.185	46	20.250	3.942	44	7.620	0.01

Table shows that the obtained t values for the total Problem Solving Ability score and component wise scores in Comprehending the Problem, Clarifying the problem and Finding solution to the problem are significant at 0.01 level.

The results specify that the mean Problem Solving Ability scores of the Experimental group I and Control group II (component wise and total scores) are significantly different. Higher mean Problem Solving Ability score of the Experimental group indicate its superiority over control group.

Comparison of Mean post-test scores of Problem Solving Ability in Physics (Component-wise and Total) Between the Experimental Group II and Control Group I. The significance of the difference between means test was used to determine if there is a significant difference between Mean post-test scores of Problem Solving Ability in Physics (Component-wise and Total) of Experimental group II and Control group I. The Mean Difference Analysis was performed on the means and standard deviations of the Problem Solving Ability scores (Component-wise and Total) in Physics. The result of the test is shown in table 23.

Table 23

Data and Results of the t-test for the Mean post-test scores of Problem Solving Ability in Physics (Component-wise and Total) between the Experimental Group II and Control Group I for the total sample

	Experimental group II			Control group I			t value	Level of significance
	Mean	SD1	N1	mean	Sd2	N2		
Comprehending the problem	6.175	1.059	40	5.325	.764	40	4.115	0.01
Clarifying the problem	90425	2.011	40	7.475	1.753	40	4.621	0.01
Finding solution to the problem	9.075	1.845	40	7.825	1.483	40	3.340	0.01
Problem Solving Ability (total)	24.725	4.063	40	20.675	2.432	40	5.408	0.01

Table shows that the obtained t values for Total Problem Solving Ability Scores and component wise scores in Comprehending the Problem, Clarifying the problem and Finding solution to the problem are significant at 0.01 level.

The results specify that the mean post-test scores of Problem Solving Ability scores of the Experimental group II and Control group I (component wise and total scores) are significantly different. Higher mean Problem Solving Ability score of the Experimental group indicate its superiority over control group.

Comparison of Mean post-test scores of Problem Solving Ability in Physics (Component-wise and Total) Between the Experimental Group II and Control Group II for the total sample. Test of significance of difference between mean was used to determine if there is a significant difference between Mean post-test scores of Problem Solving Ability in Physics (Component-wise and Total) of Experimental group II and the Control group II. The Mean Difference Analysis was performed on the means and standard deviations of the Problem Solving Ability scores (Component-wise and Total) in Physics. Results of the test are shown in Table 24.

Table 24

Data and Results of the t-test for the Mean post-test scores of Problem Solving Ability in Physics (Component-wise and Total) Scores between the Experimental Group II and Control Group II for the total sample

	Experimental group II			Control group II			t value	Level of significance
	Mean	SD1	N1	Mean	Sd2	N2		
Comprehending the problem	6.175	1.059	40	4.659	1.199	44	6.113	0.01
Clarifying the problem	9.425	2.011	40	7.318	2.020	44	4.783	0.01
Finding solution to the problem	9.075	1.845	40	8.272	1.703	44	2.072	0.01
Problem Solving Ability(total)	24.725	4.063	40	20.250	3.942	44	5.121	0.01

Table shows that the obtained t values for Total Problem Solving Ability and component wise scores in Comprehending the Problem, Clarifying the problem and Finding solution to the problem are significant at 0.01 level.

The results specify that the mean Problem Solving Ability scores of the Experimental group II and Control group II (component wise and total scores) are significantly different. Higher mean Problem Solving Ability score of the Experimental group indicate its superiority over control group.

Comparison of Mean post-test scores on Problem Solving Ability in Physics (component-wise and Total) between the Experimental Group and Control Group Boys. Test of significance of difference between mean was used to study whether the Experimental group and Control group Boys differ significantly in terms of Mean post-test scores of Problem Solving Ability in Physics (Component-wise and Total). The Mean Difference Analysis was performed on the means and standard deviations of the post-test scores of Problem Solving Ability in Physics (Component-wise and Total). The results are shown in table 25.

Table 25

Data and Results of the t-test for the Mean post-test scores of Problem Solving Ability in Physics (Component-wise and Total) between the Experimental Group and Control Group Boys

	Experimental group Boys			Control group Boys			t value	Level of significance
	Mean	SD1	N1	Mean	Sd2	N2		
Comprehending the problem	6.151	1.034	33	4.515	1.202	33	5.927	0.01
Clarifying the problem	10.030	1.911	33	6.757	1.323	33	8.085	0.01
Finding solution to the problem	9.030	2.228	33	7.787	1.430	33	2.695	0.01
Problem Solving Ability (total)	25.212	4.060	33	19.000	2.046	33	7.849	0.01

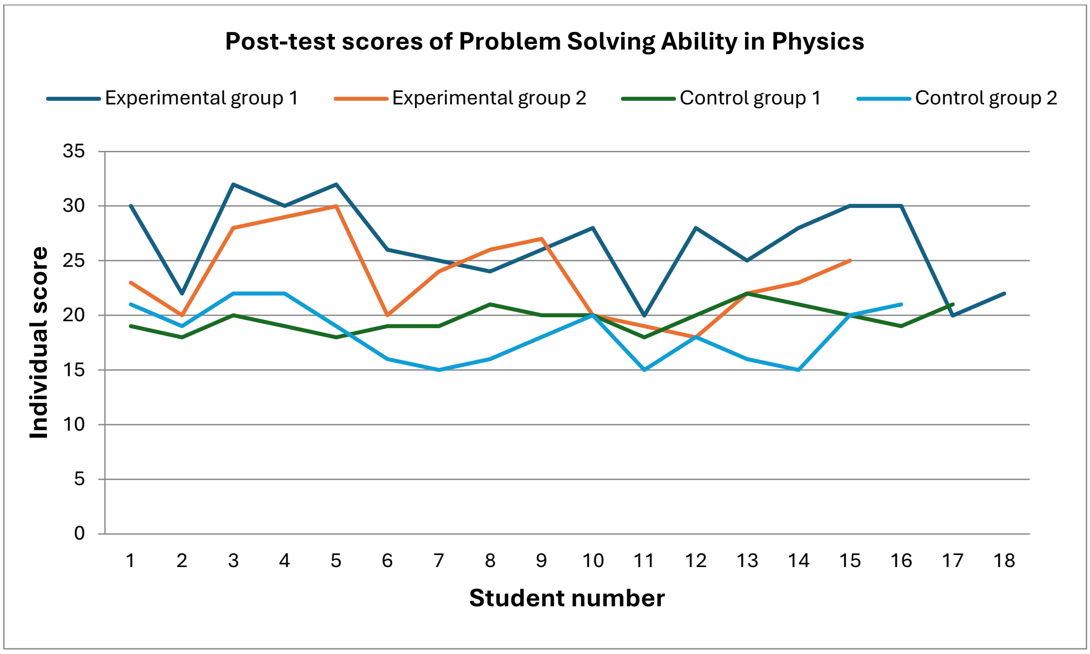
Table shows that the obtained t values for Problem Solving Ability in Physics total score and component wise scores in Comprehending the Problem, Clarifying the problem and Finding solution to the problem are significant at 0.01 levels.

The results specify that the mean Problem Solving Ability scores of the Experimental group boys and Control group boys (component wise and total scores) are significantly different. Higher mean Problem Solving Ability score of the Experimental group Boys indicate its superiority over control group.

The individual performance of experimental and control group Boys on Problem Solving Ability Scores (Total) was graphically analyzed and presented in figure 6.

Figure 6

Comparison of the individual Problem Solving Ability scores (total) of the experimental group boys and control group boys



From the graphical representation of individual Problem Solving Ability scores between the Boys of the Experimental and Control groups, it is evident that the performance of the boys in the two experimental groups is similar to and higher than that of the boys in the control groups. Additionally, a statistically significant difference was discovered by Mean Difference Analysis. The boys in the experimental group performed better than the boys in the control group, and this was a result of the treatment. The Mean Difference Analysis finding is thus validated by the graphical observation.

Comparison of Mean post-test scores of Problem Solving Ability in Physics (Component -wise and Total) Between the Experimental Groups and Control Groups Girls. Test of significance of difference between mean was employed to study whether the Experimental group and Control group Girls differ significantly in terms of Mean Problem Solving Ability in Physics scores Component-wise and Total. The Mean Difference Analysis was performed on the means and standard deviations of the Physics Problem Solving Ability scores (Component-wise and Total). The results are shown in table 26.

Table 26

Data and Results of the t-test for the Mean post-test scores of Problem Solving Ability in Physics (Component-wise and Total) between the Experimental Group and Control Group Girls

	Experimental group Girls			Control group Girls			t value	Level of significance
	Mean	SD1	N1	Mean	Sd2	N2		
Comprehending the problem	**6.547**	**1.294**	**53**	**5.274**	**.850**	**51**	**5.901**	**0.01**
Clarifying the problem	**10.094**	**2.528**	**53**	**7.803**	**2.088**	**51**	**5.026**	**0.01**
Finding solution to the problem	**10.207**	**1.974**	**53**	**8.235**	**1.703**	**51**	**5.444**	**0.01**
Problem Solving ability total	**26.9811**	**5.278**	**53**	**21.392**	**3.617**	**51**	**6.275**	**0.01**

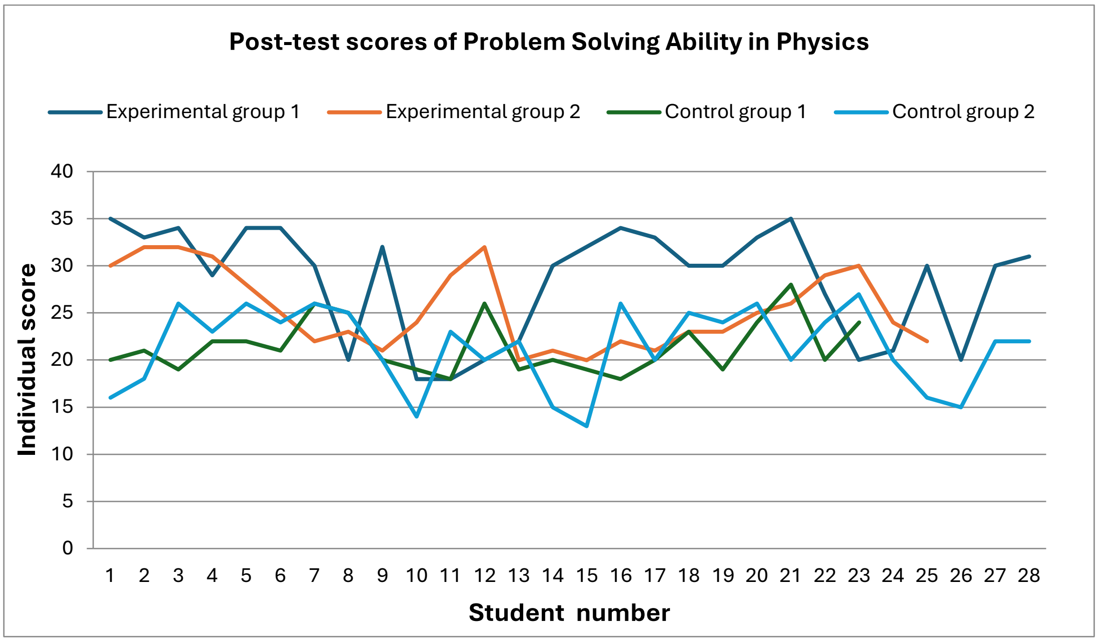
Table shows that the obtained t values for Total Problem Solving Ability score and component wise scores in Comprehending the Problem, Clarifying the problem and Finding solution to the problem are significant at 0.01 levels.

The results specify that the mean Problem Solving Ability scores of the Experimental group girls and Control group girls (component wise and total scores) are significantly different. Higher mean Problem Solving Ability score of the Experimental group indicate its superiority over control group.

The individual performance of experimental and control group girls on Problem Solving ability scores (Total) was graphically analyzed and presented in figure 7.

Figure 7

Comparison of the individual Problem Solving Ability scores (total) of the experimental group Girls and control group Girls



A visual analysis of the graphical representation of individual Problem Solving Ability scores between the girls of the Experimental and Control groups indicates that the performance of the girls in the two experimental groups is comparable to, or better than, that of the girls in the control groups. Also, a statistically significant difference was discovered using Mean Difference Analysis. The experimental girls performed well than the control girls as a result of the effect of Productive Thinking Model. The conclusion of the Mean Difference Analysis is thus validated by the graphical observation.

Comparison of Mean post-test scores of Problem Solving Ability in Physics (Component-wise and Total) Between the Experimental Groups and Control Groups Total. The significance of the mean difference was tested to determine whether there is a significant difference between the overall Mean post-test scores of Problem Solving Ability (Component-wise and overall) of the Experimental and Control groups. The Mean Difference Analysis was performed on the means and standard deviations of the Problem Solving Ability scores (Component-wise and Total) in Physics. The test results are shown in table 27.

Table 27

Data and Results of the t-test for the Mean Post-test scores of Problem Solving Ability in Physics (Component-wise and Total) between the Experimental Groups and Control Groups Total

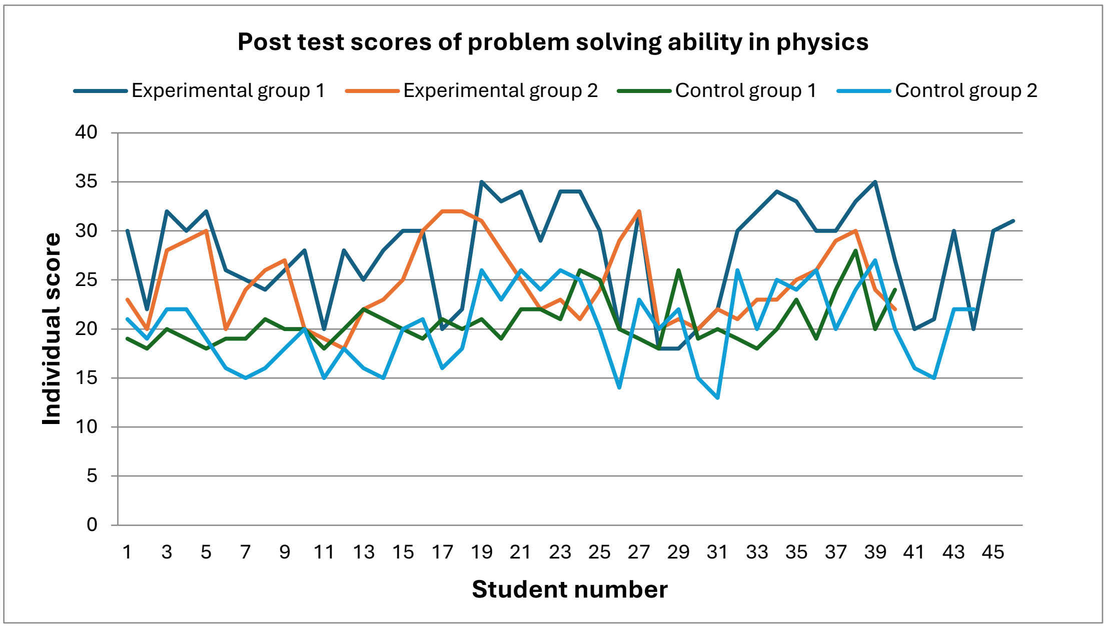
	Experimental groups			Control groups			t value	Level of significance
	Mean	SD1	N1	mean	Sd2	N2		
Comprehending the problem	6.395	1.210	86	4.976	1.063	84	8.112	0.01
Clarifying the problem	10.069	2.299	86	7.392	1.888	84	8.283	0.01
Finding solution to the problem	9.755	2.141	86	8.059	1.608	84	5.829	0.01
Problem Solving ability total	26.302	4.899	86	20.452	3.298	84	9.111	0.01

Table shows that the obtained t values for Total Problem Solving Ability and component wise scores in Comprehending the Problem, Clarifying the problem and Finding solution to the problem are significant at 0.01 level.

The results specify that the mean Problem Solving Ability scores of the Experimental group girls and Control group girls (component wise and total scores) are significantly different. Higher mean Problem Solving Ability in Physics scores of the Experimental group indicate its superiority over control group due to the overall effect of the treatment. A graphical representation of the performance of students in each experimental group and control group are shown in figure 8.

Figure 8

Comparison of the Problem Solving Ability test scores (total) of the two experimental groups and two control groups (total)



From the graphical analysis it is evident that the performance of the students in the two experimental groups is better than that of the control groups. This indicates the advantage of Productive Thinking Model over existing method of teaching.

Discussion. Many studies have similar results, such as the introduction of models of teaching (like, Concept attainment model, causalitic- learning model) have shown benefit up on Problem Solving Ability in Physics of students. Studies conducted by Rokhmat et al. (2021) and Distrik, Setwan and Ertikanto (2022) supports the result obtained by the investigator. This could be because students in the current generation are demanding new teaching strategies or methods that improve their Problem Solving Abilities. Any big effort to establish a new teaching model will be beneficial and a cure for the existing constructivist way of teaching.

Comparison of Post-Tests of Self-Concept Scores Before Control

For the purpose of group comparison, the differences in self-concept scores between the two experimental groups and the control groups were examined. Comparison was done in between each Experimental and each Control group, between Experimental group total and Control group total and also in between the Boys and Girls of Experimental group total and control group total. The control variables were not considered in all these comparisons. Here one way ANOVA is used for the comparison of groups.

Comparison of Self-Concept among experimental and control groups (for the total sample). ANOVA is one method used to investigate whether there are any significant differences between the Experimental and Control groups with respect to the Mean Self-Concept scores for the entire sample. The means and standard deviations of the Self-Concept scores were subjected to do one way ANOVA. Data and results of the test are presented in table 28.

Table 28

Data and Results of one way ANOVA for the comparison of Self-Concept scores among Experimental and control groups (for the total sample)

	N	Mean	SD	F value	P value
Experimental group I	46	51.0000	7.23571	1.131	.338
Experimental group II	40	51.7250	7.44893		
Control group I	40	49.2000	6.43787		
Control group II	44	49.9091	5.73370		

The table shows that the p value is greater than 0.05, indicating that the experimental and control groups' Self-Concept scores do not differ significantly. Hence no further comparison was done among each group separately.

Comparison of Self-Concept scores among experimental and control groups (for boys). ANOVA can be used, to determine whether there are significant differences in Mean Self-Concept scores between the boys in the Experimental and Control groups. The means and standard deviations of the Self-Concept scores were subjected to do one way ANOVA. Data and results of the test are presented in table 29.

Table 29

Data and Results of one way ANOVA for the comparison of Self Concept scores among Experimental and control groups (for boys)

	N	Mean	SD	F value	P value
Experimental group I	18	47.9444	5.51439	.272	.845
Experimental group II	15	49.6000	5.40899		
Control group I	17	48.0588	7.67684		
Control group II	16	48.8125	4.35460		

According to the table, there is no significant difference between the experimental and control groups' boys' Self-Concept scores (p value greater than 0.05). Hence no further comparison was done among each group separately.

Comparison of Self-Concept among experimental and control groups (for girls). ANOVA can be performed to investigate whether there are significant differences in Mean Self-Concept scores between the girls in the Experimental group and the girls in the Control group. The means and standard deviations of the self concept scores were subjected to do one way ANOVA. Data and results of the test are presented in table 30.

Table 30

Data and Results of one way ANOVA for the comparison of Self-Concept scores among Experimental and control groups (for girls)

	N	Mean	SD	F value	P value
Experimental group I	28	52.9643	7.60839	1.268	.290
Experimental group II	25	53.0000	8.28151		
Control group I	23	50.0435	5.37230		
Control group II	28	50.5357	6.37984		

The table shows that the p value is greater than 0.05, indicating that there is not a significant difference between the experimental and control groups' girls' Self-Concept scores. Hence no further comparison was done among each group separately.

Comparison of Gain Scores of Problem Solving Ability in Physics

The pre-tested groups' gain scores that is Experimental Group I and Control Group II were compared and discussed in this section. Gain scores were compared in between the groups as well as in between the Boys and Girls of the two groups.

Comparison of Mean Gain Scores of Problem Solving Ability in Physics between the Experimental Group I and Control Group II. Mean difference analysis (t) was employed to determine whether there were any appreciable differences in Gain scores of Problem Solving Ability in Physics between the Experimental group I and the Control group II. The Mean Difference Analysis was performed on the means and the standard deviations of the gain scores of Problem Solving Ability in Physics. The data and findings of the t-test are presented in Table 31.

Table 31

Data and Results of the t-test for the Mean Gain Scores of Problem Solving Ability in Physics between the Experimental Group I and Control Group I1

	Experimental group II			Control group II			t value	Level of significance
	M1	Sd1	N1	M2	Sd2	N2		
Gain scores	9.021	3.958	46	1.386	2.526	44	10.854	0.01

The derived t-value for the Gain score is determined to be significant at the 0.0 1 level, as the table demonstrates.

From the result it is evident that the mean Gain score of the Experimental group I and Control group II is significantly different. Higher mean Gain score of the Experimental group show its advantage over the Control group and high spot the effect of the model (Productive Thinking Model) before controlling the Covariates.

Comparison of Mean Gain Scores of Problem Solving Ability in Physics between the Experimental Group I and Control Group II Boys. Test of significance of difference between means was used to study whether the Experimental group I boys and Control group II boys differ significantly in terms of Gain scores of Problem Solving Ability in Physics, The Mean Difference Analysis was done using means and standard deviations of the Gain scores of Problem Solving Ability in Physics. Table 32 shows the data and results.

Table 32

Data and Results of the t-test for the Mean Gain Scores of Problem Solving Ability in physics between the Experimental Group I and Control Group I1 Boys

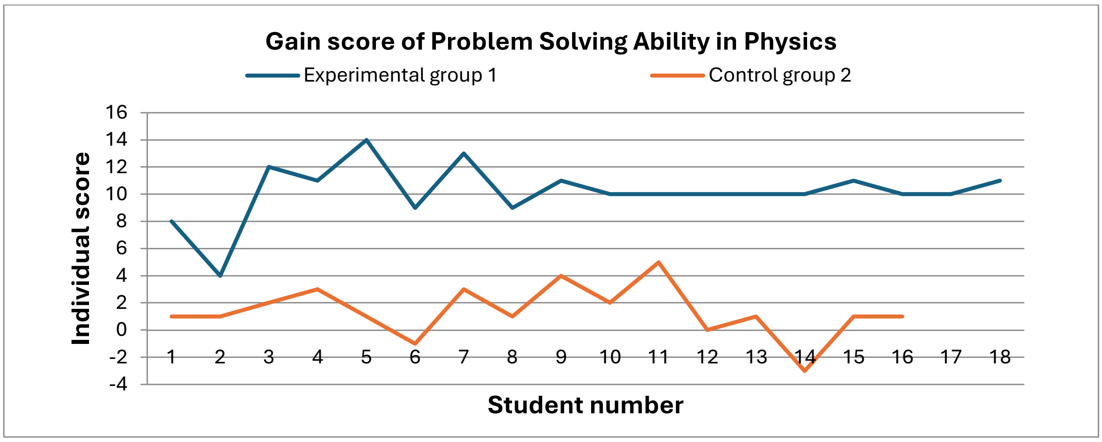
	Experimental group I boys			Control group II boys			t value	Level of significance
	M1	Sd1	N1	M2	Sd2	N2		
Gain scores	9.444	3.147	18	.8125	2.072	16	9.313	0.01

The table demonstrates that the t-value for Gain score is significant at the 0.01 level.

The results show that the mean Gain scores of the Experimental group I boys and the Control group II boys differ significantly. Higher mean Gain score of the Experimental group show its advantage over the Control group and high spot the effect of the Model (Productive Thinking Model) before controlling the Covariates. The performance of the Boys in Experimental and Control groups on Gain score was graphically examined and presented in Figure 9.

Figure 9

Comparison of the individual gain scores of the Experimental group I boys and Control group II boys



The graphical representation of individual Gain scores between Experimental group I and Control group II boys shows that the effect of these two groups are not the same. Mean Difference Analysis again specify statistically significant difference. Performance of Boys in the experimental group is higher than that of Boys in the control group. So the graphical representation supports the result of Mean Difference Analysis.

Comparison of Mean Gain Scores of Problem Solving Ability in Physics between the Experimental Group I and Control Group II Girls. Test of significance of difference between means was employed to study whether the Experimental group I girls and Control group II girls differ significantly in terms of Gain scores of Problem Solving Ability in Physics, the means and standard deviations of the Gain scores of Problem Solving Ability in Physics were used for the Mean Difference Analysis. Data and results of the t-test are presented in Table 33.

Table 33

Data and Results of the t-test for the Mean Gain Scores of Problem Solving Ability in Physics between the Experimental Group I and Control Group II Girls.

	Experimental group II Girls			Control group II Girls			t value	Level of significance
	M1	Sd1	N1	M2	Sd2	N2		
Gain scores	80750	4.435	28	1.714	2.733	28	7.145	0.01

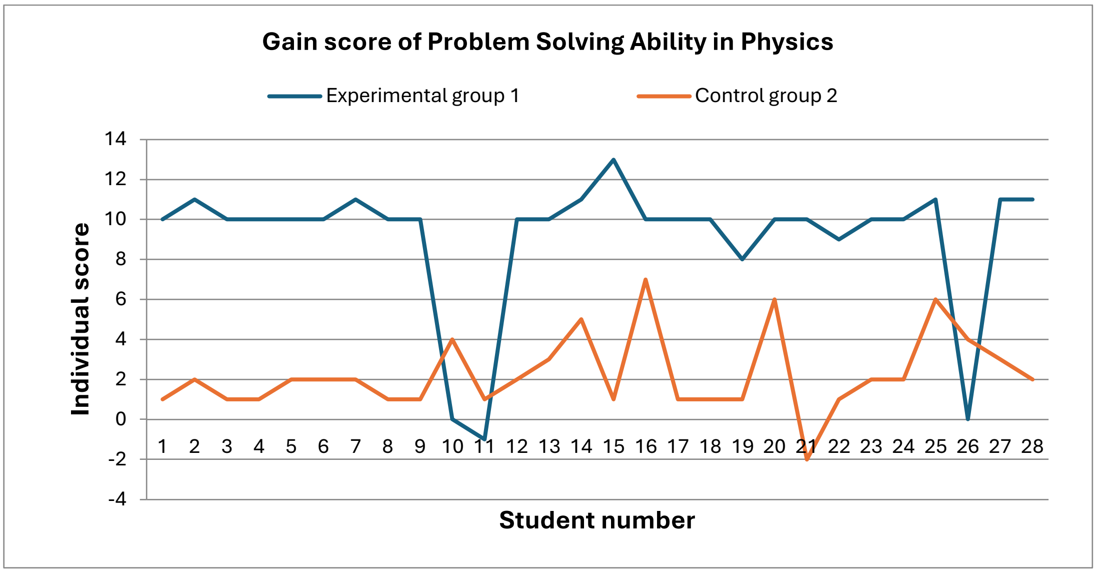
Table shows that the obtained t-value for Gain score is found to be significant at 0.01 level.

From the result it is evident that the mean Gain score of the Experimental group I Girls and Control group I1Girls is significantly different. Higher mean Gain score of the Experimental group show its advantage over the Control group and high spot the effect of treatment (Productive Thinking Model) before controlling the Covariates.

The performance of the Girls in Experimental and Control groups on Gain score was graphically examined and presented in Figure 10.

Figure 10

Comparison of the individual gain scores of the Experimental group I girls and Control group II girls



The graphical representation of individual Gain scores between Experimental group I and Control group II girls shows that, the effect of these two groups are not the same. Mean Difference Analysis again specify statistically significant difference. Performance of girls in the experimental group is higher than that of girls in the control group. So the graphical representation supports the result of Mean Difference Analysis.

Discussion. The high gain scores in Problem Solving Ability in Physics of experimental group over control group were also obtained in studies conducted by (Rokhmat, 2021) & (Idafiteriani, 2020). This also supports the result obtained by the investigator. This might be due to the high demand of students for the introduction of new and innovative method of teaching rather than sticking on same way of teaching and learning.

Comparison of Gain Scores of Self Concept

In this section Gain scores of the Pre-test received groups (Experimental Group I and Control Group II were compared and discussed. Gain scores were compared in between the groups as well as in between the Boys and Girls of the two groups.

Comparison of Mean Gain Scores of self concept between the Experimental Group I and Control Group II. Mean difference analysis (t) was used to study whether the Experimental group I and Control group II differ significantly in terms of Gain scores in self concept. The means and standard deviations of the Gain scores in Self-Concept were subjected to the Mean Difference Analysis. Data and results of the t-test are presented in Table 34.

Table 34

Data and Results of the t-test for the Mean Gain Scores Self-Concept between the Experimental Group I and Control Group I1

	Experimental group I			Control group II			t value	Level of significance
	M1	Sd1	N1	M2	Sd2	N2		
Gain scores	2.931	2.039	46	2.043	1.685	44	2.257	0.05

Table shows that the obtained t-value for Gain score is found to be significant at 0.0 5 level.

From the result it is evident that the mean Gain score of the Experimental group I and Control group II is significantly different at 0.05 levels of significance.

Higher mean Gain score of Self-Concept associated with Experimental group show its advantage over the Control group and high spot the effect of the model (Productive Thinking Model) before controlling the Covariates.

Comparison of Mean Gain Scores of Self-Concept between the Experimental Group I and Control Group II Boys. Test of significance of difference between means was used to study whether the Experimental group I boys and Control group II boys differ significantly in terms of Gain scores of self-Concept. The means and standard deviations of the Gain scores of Self-concept were subjected to the Mean Difference Analysis. Data and results of the t-test are presented in Table 35.

Table 35

Data and Results of the t-test for the Mean Gain Scores of Self-Concept between the Experimental Group I and Control Group II Boys

	Experimental Group I Boys			Control Group II Boys			t value	Level of significance
	M1	Sd1	N1	M2	Sd2	N2		
Gain scores	2.500	1.825	18	2.165	1.339	16	0.612	NS

Table shows that the obtained t-value for Gain score is found to be significant at 0.0 1 level.

From the result it is evident that the mean Gain scores of self concept among Experimental group I boys and Control group II boys is significantly different. Higher mean Gain score of the Experimental group show its advantage over the Control group and high spot the effect of Productive Thinking Model before controlling the Covariates.

Comparison of Mean Gain Scores of self concept between the Experimental Group I and Control Group II Girls. Test of significance of difference between means was employed to study whether the Experimental group I girls and Control group I1 girls differ significantly in terms of Gain scores of Self-Concept. The means and standard deviations of the Gain scores were used to the Mean Difference Analysis. Data and results of the t-test are presented in Table 36.

Table 36

Data and Results of the t-test for the Mean Gain Scores of Self-Concept between the Experimental Group I and Control Group II Girls.

	Experimental group II Girls			Control group II Girls			t value	Level of significance
	M1	SD1	N1	M2	SD2	N2		
Gain scores	3.178	2.143	28	1.964	1.895	28	2.246	0.05

Table shows that the obtained t-value for Gain score of Self-Concept is found to be significant at 0.01 level.

From the result it is evident that the mean Gain score of Self-Concept among Experimental group I Girls and Control group II Girls is significantly different. Higher mean Gain score of the Experimental group show its advantage over the Control group and high spot the effect of treatment (Productive Thinking Model) before controlling the Covariate.

Comparison of Retention Scores in Problem Solving Ability in Physics Before Control

In order to study the difference in Retention in Problem Solving Ability in physics between the groups, the comparison of Retention scores (component wise and total) were done between each experimental and each control group. Again in between the total experimental groups and control groups. Comparison was also done in between the groups with respect to gender.

Comparison of Mean Retention Scores in Problem Solving Ability in Physics (Component-wise and Total) Between the Experimental Group I and Control Group I for the total sample. Here, Test of significance of difference between means was used to know whether the Experimental group I and Control group I significantly differ with respect to mean Retention scores on Problem Solving Ability in Physics (Component-wise and Total).

For doing mean difference analysis the means and standard deviation of the Retention scores (component wise and Total) were utilized. Data and results of the t-test are shown in Table 37.

Table 37

Data and Results of the t-test for the Retention in Problem Solving Ability in Physics (Component wise and Total) Scores between the Experimental Group I and Control Group I for the total sample

Components	Experimental group I			Control group I			t value	Level of significance
	Mean	Sd1	N1	Mean	Sd2	N2		
Comprehending the problem	5.217	.916	46	5.575	.812	40	1.901	NS
Clarifying the problem	8.391	1.949	46	9.100	1.316	40	1.945	NS
Finding solution to the problem	7.978	1.983	46	8.400	1.215	40	1.167	NS
Problem Solving Ability (total)	23.326	3.183	46	22.950	2.263	40	0.622	NS

Table indicates that the obtained t values for all the components are not significant. It shows that the mean Retention scores of the Experimental group I and Control group I (Component-wise and Total) are not significantly different.

Comparison of Mean Retention Scores in Problem Solving Ability in Physics (Component-wise and Total) Between the Experimental Group I and Control Group II for the total sample. Here, Test of significance of difference between means was employed to know whether the Experimental group I and Control group II significantly differ with respect to mean Retention scores in Problem Solving Ability in Physics (Component-wise and Total).

For doing mean difference analysis the means and standard deviation of the Retention scores in Problem Solving Ability (component wise and Total) were utilized. Data and results of the t-test are shown in Table 38.

Table 38

Data and Results of the t-test for the Retention (Component wise and Total) Scores between the Experimental Group I and Control Group II for the total sample

	Experimental group I			Control group II			t value	Level of significance
	Mean	SD1	N1	mean	Sd2	N2		
Comprehending the problem	5.217	.916	46	5.159	.861	44	.311	NS
Clarifying the problem	8.391	1.949	46	8.977	2.017	44	1.402	NS
Finding solution to the problem	7.978	1.983	46	8.954	1.346	44	2.720	0.01
Problem Solving Ability (total)	23.326	3.183	46	21.113	3.272	44	3.249	0.01

Results shows that the t value of the components, finding solution to the problem and Problem Solving ability total are significant at 0.01 levels of significance. Which indicate that the mean Retention scores of the Experimental group I and Control group II (except finding solution to the problem and Problem Solving Ability total) are not significantly different.

Comparison of Mean Retention Scores in Problem Solving Ability in Physics (Component-wise and Total) Between the Experimental Group II and Control Group I for the total sample. Here, Test of significance of difference between means was used to know whether the Experimental group II and Control group I differ significantly with respect to mean Retention scores in Problem Solving Ability in Physics (Component-wise and Total).

For doing mean difference analysis the means and standard deviation of the Retention scores in Problem Solving Ability in Physics (component wise and Total) were utilized. Data and results of the t-test are shown in Table 39

Table 39

Data and Results of the t-test for the Retention (Component wise and Total) Scores between the Experimental Group II and Control Group I

	Experimental group II			Control group I			t value	Level of significance
	Mean	SD1	N1	mean	Sd2	N2		
Comprehending the problem	5.222	.919	40	5.575	.812	40	1.804	NS
Clarifying the problem	8.150	1.747	40	9.100	1.316	40	2.746	0.01
Finding solution to the problem	8.025	1.367	40	8.400	1.215	40	1.296	NS
Problem Solving ability total	21.325	3.540	40	22.950	2.263	40	2.446	0.05

Table indicates that the obtained t values for the components, clarifying the problem and Problem Solving ability total are significant (at 0.05 level). Comprehending the problem and finding solution to the problem are not significant.

Results shows that the mean retention scores of the experimental group II and control group I (Component wise and total except clarifying the problem) does not differ significantly.

Comparison of Mean Retention Scores in Problem Solving Ability in Physics (Component-wise and Total) Between the Experimental Group II and Control Group II for the total sample. Here, Test of significance of difference between means was used to know whether the Experimental group II and Control group II differ significantly with respect to mean Retention scores in Problem Solving Ability in Physics (Component-wise and Total).

For doing mean difference analysis the means and standard deviation of the Retention scores in Problem Solving Ability in Physics (component wise and Total) were utilized. Data and results of the t-test are shown in Table 40.

Table 40

Data and Results of the t-test for the Retention in Problem Solving Ability in Physics (Component wise and Total) Scores between the Experimental Group II and Control Group II for the total sample.

	Experimental group II			Control group II			t value	Level of significance
	Mean	SD1	N1	mean	Sd2	N2		
Comprehending the problem	5.225	.919	40	5.159	.861	44	.339	NS
Clarifying the problem	8.150	1.747	40	8.977	2.017	44	2.00	0.05
Finding solution to the problem	8.025	1.367	40	8.954	1.346	44	3.137	0.01
Problem Solving Ability (total)	21.325	3.540	40	21.113	3.27	44	.284	NS

Table indicate that the obtained t value for clarifying the problem and finding solution to the problem are significant at 0.01 and 0.05 level of significance. While comprehending the problem and Problem Solving ability total are not differ significantly.

Result shows that Problem Solving components (except clarifying the problem and finding solution to the problem) and Problem Solving Ability total scores are not significantly different.

Comparison of Mean Retention Scores in Problem Solving ability in Physics (Component-wise and Total) Between Experimental Group Boys and Control Group Boys. Test of significance of difference between means was employed to know whether the Experimental group boys and Control group boys differ significantly with respect to mean Retention scores in Problem Solving Ability in Physics (Component-wise and Total).

For doing mean difference analysis the means and standard deviation of the Retention scores in Problem Solving Ability in Physics (component wise and Total) were utilized. Data and results of the t-test are shown in Table 41.

Table 41

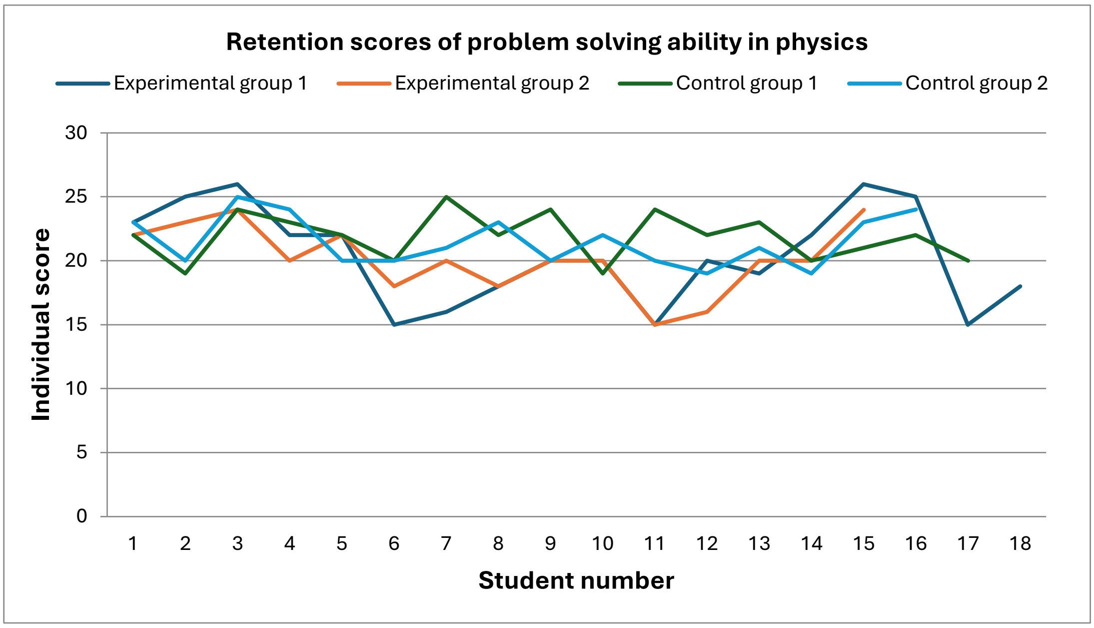
Data and Results of the t-test for the Retention in Problem Solving Ability in Physics (Component wise and Total)Scores between the Experimental Group and Control Group Boys

	Experimental group Boys			Control group Boys			t value	Level of significance
	Mean	SD1	N1	mean	Sd2	N2		
Comprehending the problem	4.969	.809	33	5.424	.830	33	2.252	0.05
Clarifying the problem	7.636	1.673	33	8.424	1.323	33	2.123	0.05
Finding solution to the problem	7.727	1.375	33	8.030	1.103	33	.987	NS
Problem Solving Ability(total)	21.454	2.905	33	21.303	1.976	33	.248	NS

Results shows that the mean Retention scores of the boys in experimental group and control group (Component-wise and Total) except the components comprehending the problem and clarifying the problem does not differ significantly. The effect of the Boys in the Experimental and Control groups on Retention scores was graphically analyzed and shown in Figure 11.

Figure 11

Comparison of the mean Retention scores in Problem Solving Ability in Physics of the Experimental group Boys and Control group Boys



From analyzing the graphical representation of individual Retention scores in Problem Solving Ability in Physics between all the Experimental and Control groups Boys it was clear that the individual performance of the boys of these four groups are almost same. Through the Mean Difference Analysis also statistically more significant difference was not observed. So, the graphical representation stresses the result of Mean Difference Analysis.

Comparison of Mean Retention Scores in Problem Solving Ability in Physics (Component-wise and Total) Between Experimental Group Girls and Control Group Girls. Test of significance of difference between means was employed to know whether the Experimental group Girls and Control group Girls differ significantly with respect to mean Retention scores in Problem Solving Ability in Physics (Component-wise and Total).

For doing mean difference analysis the means and standard deviation of the Retention scores in Problem Solving Ability in Physics (component wise and Total) were utilized. Data and results of the t-test are shown in Table 42.

Table 42

Data and Results of the t-test for the Retention in Problem Solving Ability in Physics (Component wise and Total) Scores between the Experimental Group and Control Group Girls

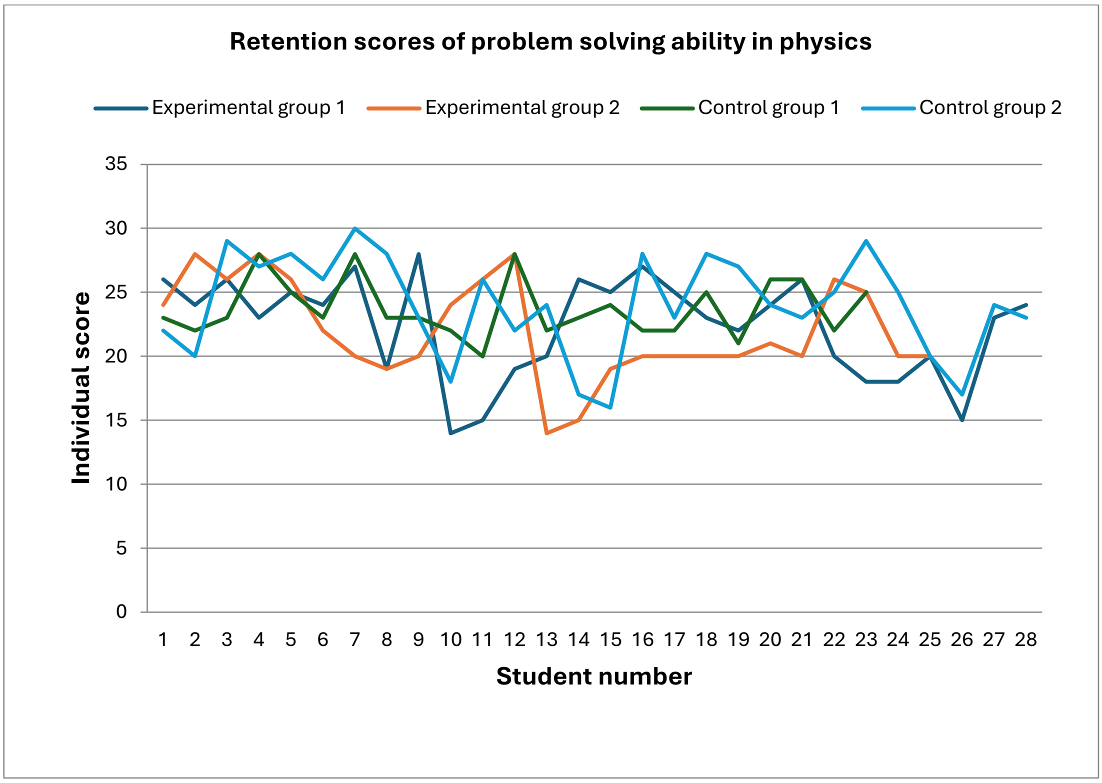
	Experimental group Girls			Control group Girls			t value	Level of significance
	Mean	SD1	N1	mean	Sd2	N2		
Comprehending the problem	5.377	.945	53	5.313	.882	51	.354	NS
Clarifying the problem	8.679	1.858	53	9.431	1.824	51	2.082	0.05
Finding solution to the problem	8.169	1.888	53	9.117	1.259	51	2.999	0.01
Problem Solving Ability (total)	22.981	3.702	53	22.431	3.407	51	.787	NS

Table indicates that the obtained t value for clarifying the problem and finding solution to the problem are significant at 0.01 and 0.05 level of significance. While comprehending the problem and Problem Solving Ability total score are not differ significantly.

Result shows that Problem Solving components (except clarifying the problem and finding solution to the problem) and total are not significantly different. The effect of the Girls in the Experimental and Control groups on Retention scores was graphically analyzed and shown in Figure 12.

Figure 12

Comparison of the mean Retention scores of the Experimental group girls and Control group girls



From analyzing the graphical representation of individual Retention scores in Problem Solving Ability in Physics between the Experimental and Control groups girls it was evident that the individual performance of the Girls of these two groups are same. Through the Mean Difference Analysis also statistically significant difference was not observed for the components of Problem Solving Ability in Physics (except clarifying the problem and finding solution to the problem) and total Problem Solving Ability score in Physics. So, the graphical representation also agree the result of Mean Difference Analysis.

Comparison of Mean Retention Scores in Problem Solving Ability in Physics (Component-wise and Total) Between Experimental Group Total and Control Group Total. Test of significance of difference between means was employed to know whether the Experimental group Total and Control group Total differ significantly with respect to mean Retention scores in Problem Solving Ability in Physics (Component-wise and Total).

For doing mean difference analysis the means and standard deviation of the Retention scores in Problem Solving Ability in Physics (component wise and Total) were utilized. Data and results of the t-test are shown in Table 43.

Table 43

Data and Results of the t-test for the Retention (Component wise and Total) Scores between the Experimental Group Total and Control Group Total

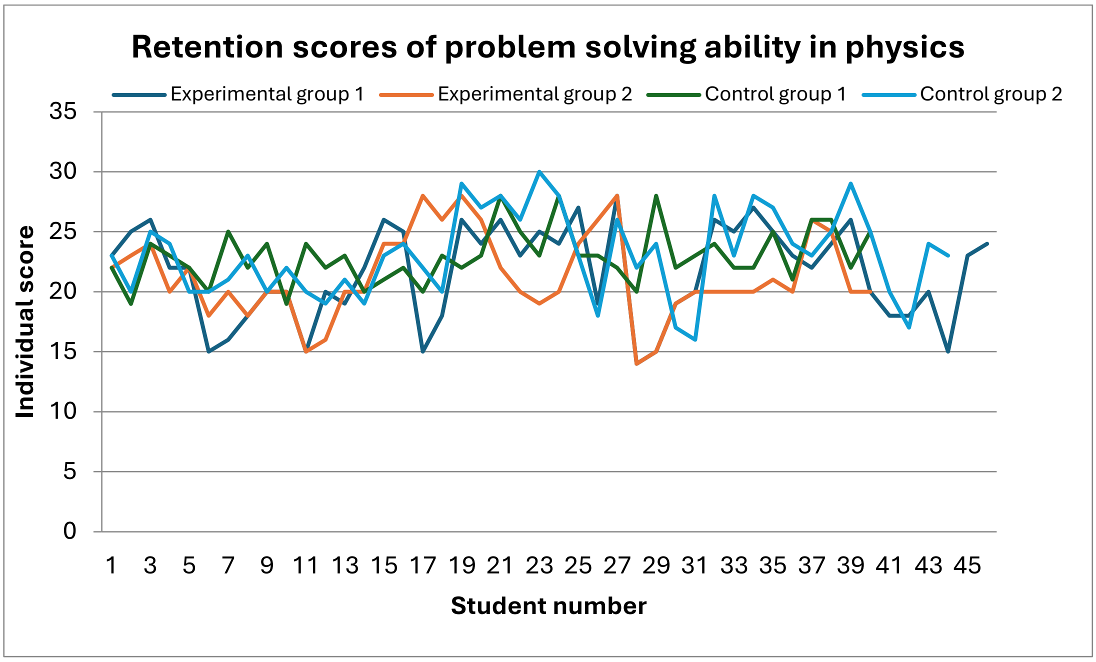
	Experimental group Total			Control group Total			t value	Level of significance
	Mean	SD1	N1	Mean	Sd2	N2		
Comprehending the problem	5.2209	.912	86	5.357	.859	84	1.001	NS
Clarifying the problem	8.279	1.851	86	9.035	1.710	84	2.766	0.01
Finding solution to the problem	8.000	1.714	86	8.690	1.307	84	2.947	0.01
Problem Solving Ability (total)	22.395	3.481	86	21.988	2.967	84	.820	NS

Table indicates that the obtained t value for clarifying the problem and finding solution to the problem are significant at 0.01 and 0.05 level of significance. While comprehending the problem and Problem Solving Ability total score are not differ significantly.

Result shows that Problem Solving components (except clarifying the problem and finding solution to the problem) and total are not significantly different. The effect of the students in the Experimental and Control groups on Retention scores was graphically analyzed and shown in Figure 13.

Figure 13

Comparison of the mean Retention scores in Problem Solving Ability in Physics of the Experimental groups and Control groups



Discussion. Gebze,(2020) and Distrik (2022) in their studies also found the same result that the mean Retention scores in Problem Solving Ability is same for both the experimental and control groups. this might be similar due to the factors like consistent test conditions, similar learning experiences or effective teaching method applied.

Summary and Discussion of Mean Difference Analysis

The comparison of the mean Pre-test scores of Problem Solving Ability in Physics, Problem Solving Ability test scores (component-wise and Total), Gain scores in Problem Solving Ability in Physics and Retention scores (component -wise and Total) between the two Experimental and two Control groups from the Results of the Mean Difference Analysis conducted are consolidated in the following tables.

Table 44

Summary of t-values for Pre-test Scores

SI No:	Groups compared	t value	Level of significance
1	Experimental group I and control group II	.505	NS
2	Experimental group I boys and control group II boys	1.043	NS
3	Experimental group I girls and control group II girls	0.000	NS

From table 44 it is evident that t values obtained are not significant. So it can be understood that the pre-test scores doesn't differentiate the Experimental and Control group which received pre-tests. That means the pre-experimental status of the groups remains same.

Table 45

Summary of t-values for Problem Solving Ability in Physics (Total) Scores

Sl. No.	Group compared	t value	Level of significance
1	Experimental group I and control group I	7.617	0.01
2	Experimental Group I and Control Group I1	7.620	0.01
3	Experimental Group I1 and Control Group I	5.408	0.01
4	Experimental Group II and Control Group II	5.121	0.01
5	Experimental Group Boys and Control Group Boys	7.085	0.01
6	Experimental Group Girls and Control Group Girls	7.255	0.01
7	Experimental Group Total and Control Group Total	9.111	0.01

Here all the t values of Problem Solving Ability in Physics are significant that means Problem Solving Ability scores in Physics differentiate Experimental group and control group. These comparison which gives significant t value reveals the superiority of experimental groups over control groups. Also high mean score associated with the Experimental groups implies the Effect of Productive Thinking Model over Existing Method of Teaching.

In gender wise comparison, Experimental group I Boys and Girls were seen to have superiority over Control group Boys and Girls.

Table 46

Summary of t-values for Gain Scores

SI No:	Groups compared	t value	Level of significance
1	Experimental group I and control group II	10.854	0.01
2	Experimental group I boys and control group II boys	9.313	0.01
3	Experimental group I girls and control group II girls	7.145	0.01

Table underlies that the t values obtained for all the three comparisons are significant at 0.01 levels of significance. Results specify that the experimental and control groups (Pre-tested experimental group I and control group II) can be differentiated by the gain scores. Comparison shows the advantage of Experimental group, since greater mean Gain scores are linked with Experimental group.

In gender wise comparison also, Boys and Girls in the experimental group I were superior over Boys and Girls in control group II.

Table 47

Summary of t-values for Retention in Problem Solving Ability in Physics Total) Scores

Sl. No.	Group compared	t value	Level of significance
1	Experimental Group I and Control Group I	0.622	NS
2	Experimental Group I and Control Group I1	3.249	0.01
3	Experimental Group I1 and Control Group I	2.446	0.05
4	Experimental Group I1 and Control Group 11	.777	NS
5	Experimental Group Boys and Control Group Boys	.248	NS
6	Experimental Group Girls and Control Group Girls	.787	NS
7	Experimental Group Total and Control Group Total	.820	NS

From table 47 it is evident that out of the seven comparisons only two t values are significant. Retention in Problem Solving Ability does not differentiate the control groups and experimental groups.

For a visual analysis of the performance graphical comparison of the scores were also done for the two experimental groups and two control groups on Pre-test scores on Problem Solving Ability in Physics, Post-test scores on Problem Solving Ability in Physics (Total), Gain scores and Retention scores (Total). All the graphical representations support the results of mean difference analysis.

Mean Difference Analysis results on Pre-test scores, Problem Solving Ability in Physics (Component-wise and Total), Gain scores and Retention scores (component-wise and Total) disclose the fact that the two groups such as Experimental groups and Control groups differ significantly in terms of Problem Solving Ability and Gain, even without controlling the covariates in the Experiment. But in their Retention scores there is no significant difference in the Experimental groups and Control groups

Analysis of Covariance for Problem Solving Ability in Physics, Self-Concept and Retention in Problem Solving Ability in Physics

Covariance analysis was used to determine whether the Experimental and Control groups differed significantly in terms of standard IX students' Problem Solving Ability in Physics, Self-Concept, and Retention in Problem Solving Ability after controlling for the effects of three control variables. Since the subjects in the study not randomly assigned to experimental and control groups, ANCOVA was used. ANCOVA allows the investigator to statistically control the differences on the pre-tests and the concerning control variables so that the differences in the post tests would not be due to initial differences prior to Experiment.

For the pre-tested groups such as Experimental group I and Control group II, single factor ANCOVA with three covariates separately and a combination of three at a time was used. And for the non pre-tested groups that is Experimental group II and Control group I, single factor ANCOVA with two covariates separately and a combination of two at a time was used.

The output of Analysis of Covariance again used to understand the relative effectiveness of Productive Thinking model and Existing Method of Teaching on Problem Solving Ability in Physics and Self-Concept after controlling the single as well as combined effect of covariates. The controlled variables were pr-tests, Verbal Intelligence and Socio-Economic status. Then the Effectiveness of productive Thinking Model and Existing Method of Teaching on Problem Solving Ability in Physics and Self-Concept was studied.

Separate Analysis of Covariance were used for Pre-tested groups and non Pre-tested groups. For Problem Solving Ability in Physics, Retention and Self-Concept separate ANCOVA were employed for both these groups. Thus Pre-tested groups 12 ANCOVA (four ANCOVA when Problem Solving Ability treated as dependent Variable and four ANCOVA when Self-Concept treated as dependent Variable),and four ANCOVA when Retention is treated as dependent variable. And non Pre-tested group has 9 ANCOVA (3 ANCOVA when Problem Solving Ability treated as dependent variable and 3 ANCOVA when Self-Concept treated as dependent Variable also 3 ANCOVA when Retention is treated as dependent variable).

The basic assumptions like linearity and homogeneity is to be checked before conducting ANCOVA. Statistical Package for Social Sciences (SPSS) was used to establish the normality of the distribution of the dependent variable scores.

Tests for Basic Assumptions

The essential assumptions of ANCOVA were examined by examining the data acquired, and the results are shown below.

Linear Relationship between the Dependent Variable and the Covariates. Scatter plots were used to analyse the connection between the covariates Verbal Intelligence, Socio-Economic status, and the pre-test and the dependent variables, Problem Solving Ability in Physics and Self-Concept. The Scatter Plots' visual analysis demonstrated that there was little deviation from linearity in the relationship between the dependent variables and the covariate.

Scatter plots of the covariates with relation to dependent variables, Problem Solving Ability in Physics, Self-Concept, and retention in Problem Solving Ability in Physics of the experimental and control groups are represented in Figure 14, 15 and 16 respectively.

Figure 14

Scatter Plots of Problem Solving ability in Physics (Post-test) Scores (Total) with all Covariate

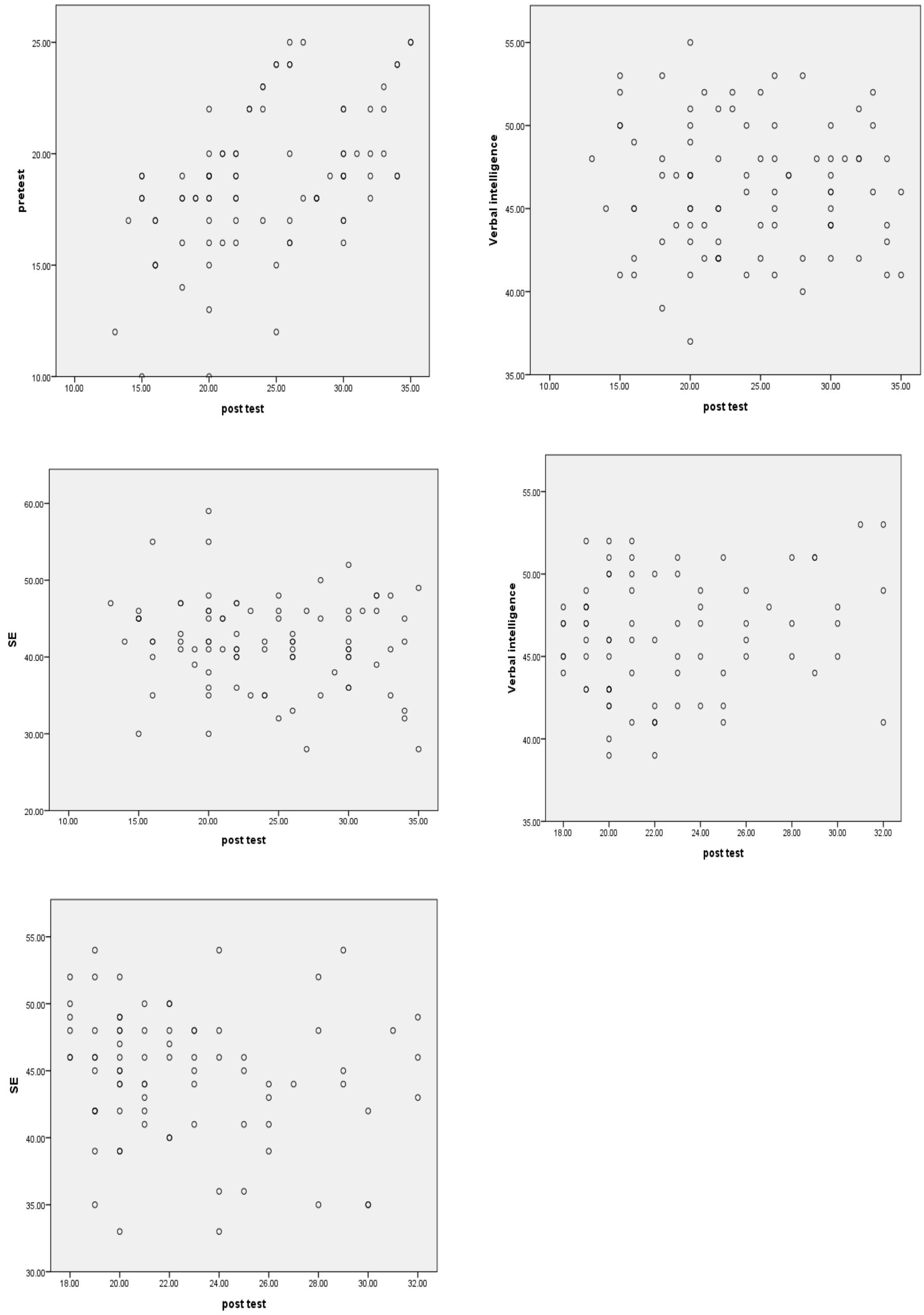


Figure 15

Scatter plots for Self concept scores with all covariates

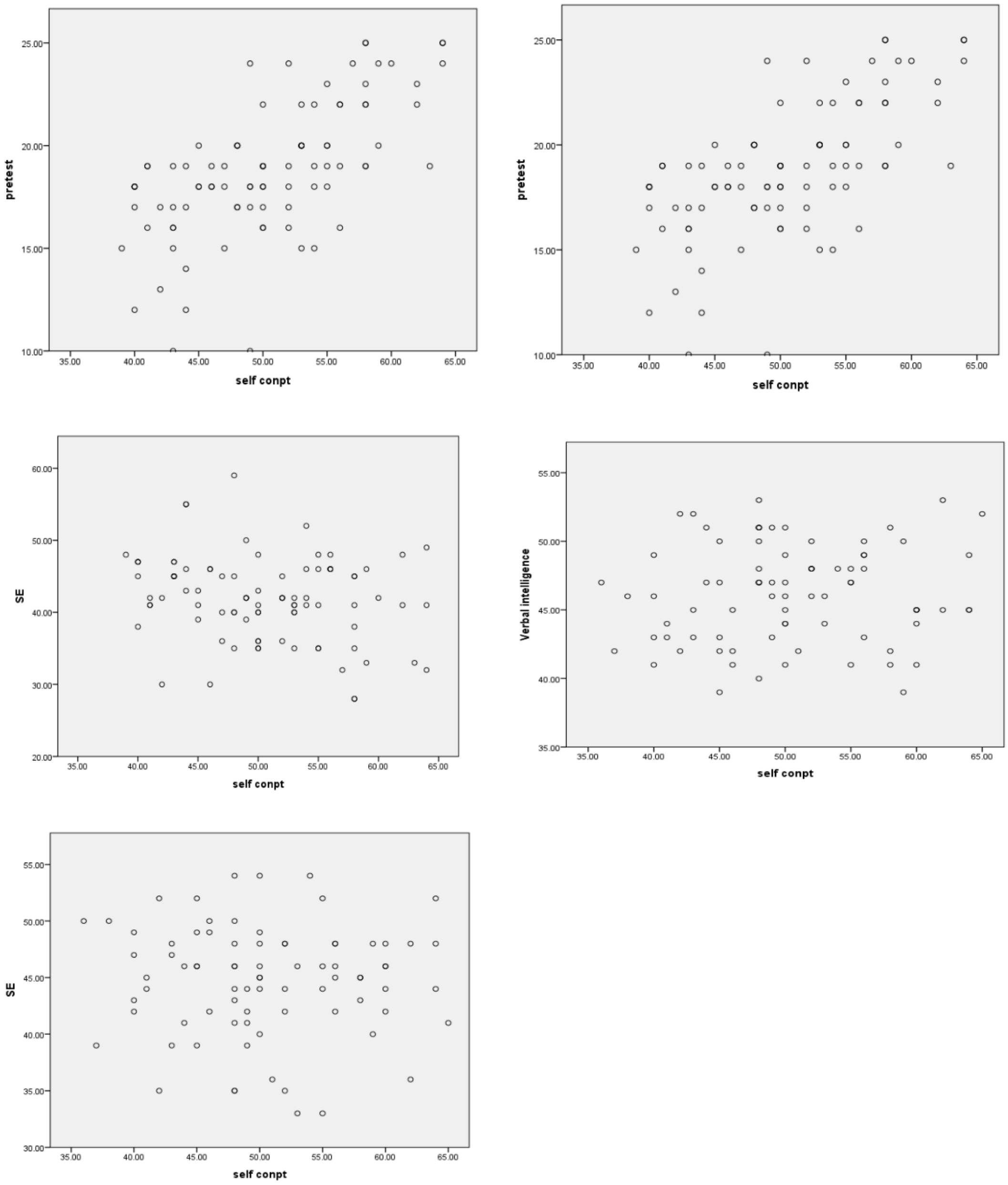
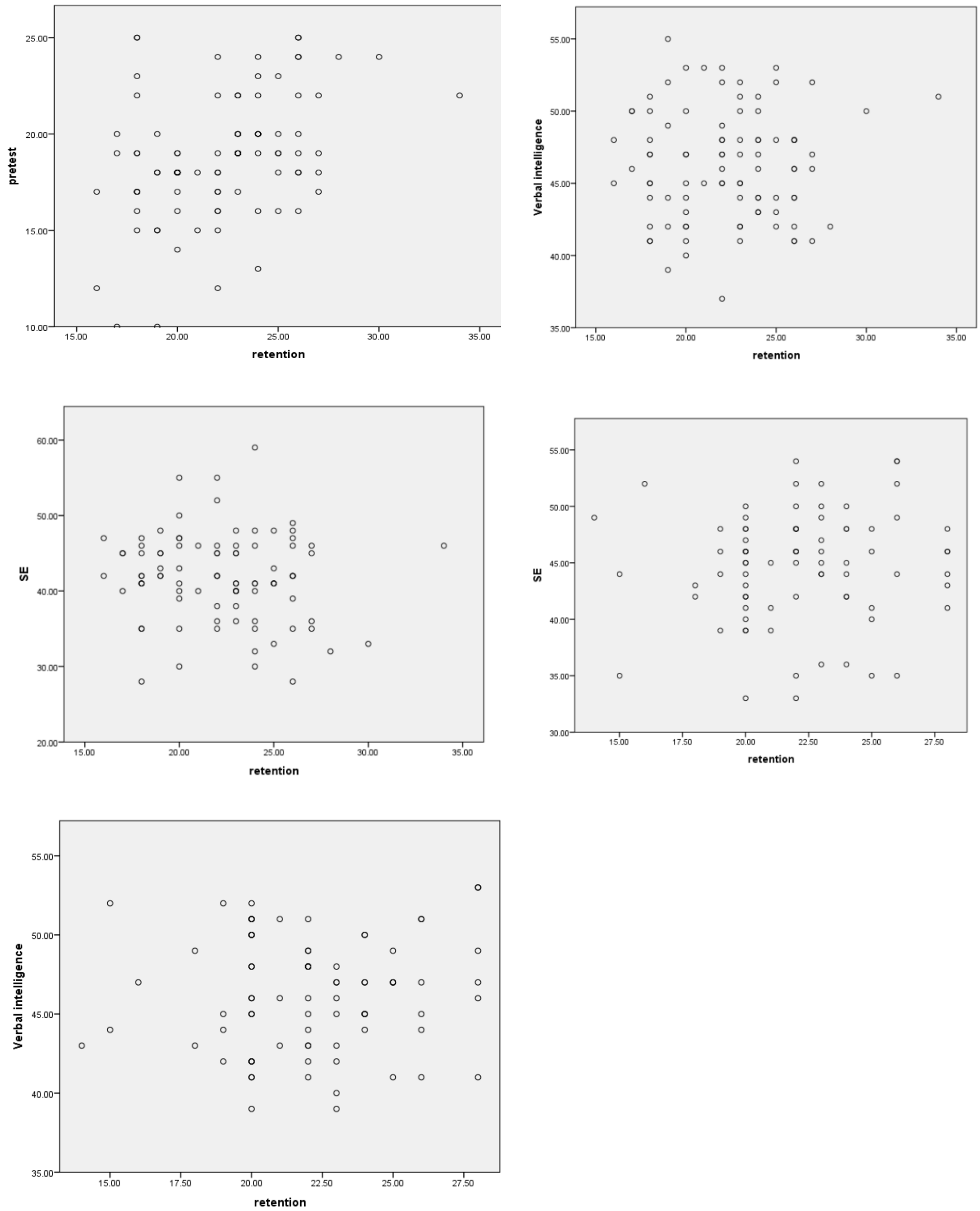


Figure 16

Scatter plots of Retention scores in Problem Solving Ability in Physics (total) for all covariates



Test of Homogeneity of Variance

Separate analysis of variance was used to evaluate if the slopes of regression lines are the same (homogeneity of within class regression) for the level of independent variable (Productive Thinking Model) in order to meet the homogeneity of variance assumptions.

For every ANCOVA for Problem Solving Ability in Physics, Retention and Self-Concept, Pre-test, Socio-Economic Status, and Verbal Intelligence, both individually and in combination, different tests of homogeneity of variance were conducted. It was concluded from all of the homogeneity tests that the within-class regression coefficients for the two levels of the independent variable were homogenous, or the same. In part, the test's result does not disprove pooling within-class regression (Winer, 1977). Consequently, it was determined that the data fit the ANCOVA model.

Analysis of Covariance for Problem Solving Ability in Physics

Single factor ANCOVA was employed to study the difference between Experimental and Control groups in terms of Problem Solving Ability in Physics. Single factor ANCOVA with three Covariate Pre-test score, Verbal Intelligence, and Socio-Economic Status (separately and in combination of three at a time) was used for Pre-tested groups and with two Covariate Verbal Intelligence and Socioeconomic Status (Separately and in combination of two at a time) was used for non pre-tested groups. ANCOVA was employed to examine whether significant difference exists even after controlling the effects of the covariate. By After adjusting for the individual and cumulative effects of the covariate, the researcher could use single factor ANCOVA to further examine the relative efficacy of the Productive Thinking Model and the Existing Method of Teaching on Problem Solving Ability in Physics. Two levels of Instructional Procedures such as Productive Thinking Model and Existing Method of Teaching were incorporated in the ANCOVA as the two levels of Independent variable. The Covariates were Pre-test score (only for Pre-tested groups), Verbal Intelligence and Socio-Economic Status separately and in combination. Problem Solving Ability in Physics was considered as the dependent Variable.

Analysis of Covariance for Problem Solving Ability in Physics for Pre-tested Groups. To test this, the investigator studied whether or not significant difference exists between the Pre-tested Experimental and Control groups with regard to the mean Problem Solving Ability scores. All together 4 ANCOVA was done. Each ANCOVA, controlling each covariate namely, Pre-test score, Verbal Intelligence, Socio-Economic Status and the combined effect of three covariates. The result is shown in below 48.

Table 48

Summary of Single Factor ANCOVA for Problem Solving Ability in Physics for Pre-tested Groups

Source of variation		Pre- test score	Verbal Intelligence	Socio-Economic status	Total effect of 3 covariates
Sum of Squares	Between groups	1351.058	1233.896	1375.734	1419.072
	Within groups	994.524	1877.718	1688.854	922.970
Df	Between groups	1	1	1	1
	Within groups	87	87	87	85
Mean Square	Between groups	1351.058	1233.896	1375.734	1419.072
	Within groups	11.431	21.583	19.412	10.858
Total		55150.00	55150.00	55150.00	55150.00
F		118.189	57.170	70.870	130.688
Sig.		.000**	.000**	.000**	.000**

**- difference is significant at 0.01 level of significance

As per table the obtained F (1,87) is 188.189 for the effect of Productive Thinking Model on Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Problem Solving Ability in Physics is significant among IXth standard students after controlling pre-test scores, F(1,87) = 118.189, p<.01

As per table, the obtained F (1,87) is 57.170 for the effect of Productive Thinking Model on Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of

Productive Thinking Model on Problem Solving Ability in Physics is significant among IXth standard students after controlling Verbal Intelligence, F(1,87) = 57.170, p<.01

As per table, the obtained F (1,87) is70.870 for the effect of Productive Thinking Model on Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Problem Solving Ability in Physics is significant among IXth standard students after controlling Socio-Economic status , F(1,87) = 70.870, p<.01

As per table, the obtained F (1,85) is 130.688 for the effect of Productive Thinking Model on Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Problem Solving Ability in Physics is significant among IXth standard students after controlling the total effect of 3 covariates (pre-test, Verbal Intelligence, socio-Economic status), F(1,85) = 130.688, p<.01

This demonstrates that even after accounting for the linear effects of each covariate, there is still a statistically significant difference between the group criteria means. Thus, when a linear adjustment is made for the effect of variation due to the difference in the Pre-test score, Verbal Intelligence, Socio-Economic Status, and the combined effect of the three covariates on Problem Solving Ability in Physics, the ANCOVA results show that there is a statistically significant difference between the two experimental and control groups. Here we compared pre-test received two groups and it was found significant even after controlling the covariates , since it was two groups compared and significant difference is clearly evident there for there is no relevance of Posthoc comparison.

Analysis of Covariance for Problem Solving Ability in Physics for non Pre-tested Group. All together 3 ANCOVA were done to examine the significant difference between non pre-tested Experimental and Control group with regard to mean Problem Solving Ability scores. One by one, each covariate namely, Verbal Intelligence, Socio-Economic Status and the combined effect of two covariates were controlled in the five ANCOVA. The result is shown in table 49.

Table 49

Summary of Single Factor ANCOVA for Problem Solving Ability in Physics for non Pre-tested Groups

Source of variation		Verbal Intelligence	Socio-Economic status	Total effect of 2 covariates
Sum of Squares	Between groups	309.281	313.071	294.510
	Within groups	853.086	864.074	842.030
Df	Between groups	1	1	1
	Within groups	77	77	76
Mean Square	Between groups	309.281	313.071	294.510
	Within groups	11.079	11.222	11.079
Total		42426.00	42426.00	42426.00
F		27.916	27.899	26.582
Sig.		.000**	.000**	.000**

**- difference is significant at 0.01 level of significance

As per table, the obtained F (1,77) is 27.916 for the effect of Productive Thinking Model on Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Problem Solving Ability in Physics is significant among IX standard students after controlling Verbal intelligence of non pre-tested group, $F(1,77) = 27.916$, $p<.01$

As per table, the obtained F (1,77) is 27.899 for the effect of Productive Thinking Model on Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Problem Solving Ability in Physics is significant among IX standard students after controlling Socio-Economic status of non pre-tested group , $F(1,77) = 27.899$, $p<.01$

As per table, the obtained F (1,76) is 26.582 for the effect of Productive Thinking Model on Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Problem Solving Ability in Physics is significant among IX standard students after controlling the total effect of 2 covariates (Verbal Intelligence & socio economic status), $F(1,85) = 130.688$, $p<.01$

The three F-values for the Instructional Procedure on Physics Problem Solving Ability were discovered to be greater above the 0.01 level of significance . This demonstrated a statistically significant difference between the groups' criteria means even after accounting for each covariate's linear influence. Therefore, the ANCOVA results indicate that there is a significant difference between the non-pre-tested Experimental and control group on Problem Solving Ability in Physics when a linear adjustment is made for the effect of variation due to the difference in Verbal Intelligence, Socio-Economic Status, and the combined effect of two covariates. Here also we compared non pre-tested two groups and it was found significant even after controlling the covariates. Since it was two groups compared and significant difference is clearly evident there is no relevance of Posthoc comparison.

Summary and discussion of analysis of covariance for Problem Solving Ability in Physics. Results of 7 ANCOVA employed to study the effectiveness of Instructional strategies (Productive Thinking Model and Existing Method of Teaching) on Problem Solving Ability in Physics for Pre-tested Group and non Pre-tested Group are summarized and discussed. The table below presents the aggregated F-values obtained for the 7 ANCOVA.

Table 50

Summary of the F-values of ANCOVA for Problem Solving Ability in Physics

SI. No.	Source of variance	Dependent variable	Covariate		F	Sig
1	Instructional Strategy (Productive Thinking Model and Existing Method of Teaching)	Problem Solving Ability in Physics	Pre-test Received Group	Pre-test	118.189	.000**
2				Verbal intelligence	57.170	.000**
3				Socioeconomic status	70.870	.000**
4				Total effect	130.688	.000**
5			Pre-test Non Received Group	Verbal intelligence	27.916	.000**
6				Socioeconomic status	27.899	.000**
7				Total effect	26.582	.000**

Total of seven ANCOVA were done on Problem Solving Ability for Pre-tested and non pre-tested groups. Using Pre-test scores (only for Pre-tested groups) Verbal Intelligence and Socio-Economic Status as Covariates separately and in combination.

This was done to know whether variations in the mean Problem Solving Ability scores of the Experimental and Control group occur or not after treatment.

When the effects of Covariates, Pre-test score, Verbal Intelligence, Socio-Economic Status and combined effect was controlled, F-values were found significant for the Pre-tested group. This confirms that the Pre-tested Experimental and Control groups differ significantly in Problem Solving Ability in Physics

When the effect of Covariates, Verbal Intelligence, Socio-Economic Status and combined effect was controlled, F values were found significant for the non Pre-tested group. This confirms that the non Pre-tested Experimental and Control groups differ significantly in Problem Solving Ability in Physics.

Out of 7 ANCOVA employed to study the difference between Experimental groups and Control groups in Problem Solving Ability in Physics, all the 7 ANCOVA gives significant difference. From these results it can be concluded that strategy in the Experimental group (Productive Thinking Model) was more effective than the Control group (Existing Method of Teaching).

After Covariance Analysis, it was found that the Pre-tested and non pre-tested groups significantly differed in their Problem Solving Ability in Physics. In both cases, Pre-tested and not pre-tested Experimental groups were seen to be Superior over the Control groups. This underlies the advantage of Productive Thinking Model over Existing Method of Teaching with regard to Problem Solving Ability in Physics.

Discussion. Since Productive Thinking Model is new in Teaching Learning process not much studies available with the same covariates selected. So the investigator reviewed other studies which comes under the same family of teaching and the results are used to support the present study. Hence can say that the result is in line with the study conducted by Rekha(1988) ,where she found that Piagetian model of teaching is significantly capable of developing Problem Solving Ability over the traditional method of teaching, even though intelligence and Achievement in the subject are controlled. Praveen (2006) also found the same result with the Mastery of learning strategy with verbal intelligence and socio-Economic status controlled.

Analysis of Covariance for Self-Concept

Single factor ANCOVA was employed to study the difference between Experimental and Control groups in terms of Self-Concept. Single factor ANCOVA with three Covariate Pre-test score, Verbal Intelligence, and Socio-Economic Status (separately and in combination of three at a time) was used for Pre-tested groups and with two Covariate Verbal Intelligence and Socioeconomic Status (Separately and in combination of two at a time) was used for non Pre-tested groups. ANCOVA was employed to examine whether significant difference exists even after controlling the effects of the covariate. By employing single factor ANCOVA, the investigator could further study the relative effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept, after controlling the single and combined effects of the covariate. Two levels of Instructional Procedures such as Productive Thinking Model and Existing Method of Teaching were incorporated in the ANCOVA as the two levels of Independent variable. The Covariates were Pre-test score (only for Pre-test received group), Verbal Intelligence and Socioeconomic Status separately and in combination. Self-Concept was considered as the dependent Variable.

Analysis of Covariance for Self-Concept for Pre-tested groups. Here the investigator studied whether or not significant difference exists between the Pre tested Experimental and Control groups with regard to the mean Self-Concept scores. All together 4 ANCOVA was done. Each ANCOVA, controlling each covariate namely Pre-test score, Verbal Intelligence, Socio-Economic Status and the combined effect of three covariates. The result is shown in table 51.

Table 51

Summary of Single Factor ANCOVA for Self-Concept for Pre-tested Groups

Source of variation		Pre- test score	Verbal Intelligence	Socio-Economic status	Total effect of 3 covariates
Sum of Squares	Between groups	53.502	26.807	63.042	79.065
	Within groups	2179.412	3769.591	3512.230	2091.843
Df	Between groups	1	1	1	1
	Within groups	87	87	87	85
Mean Square	Between groups	53.502	26.807	63.042	79.065
	Within groups	25.051	43.329	40.370	24.610
Total		233016.00	233016.00	233016.00	233016.00
F		2.136	.619	1.562	3.213
Sig.		$.148^{NS}$	$.434^{NS}$	$.215^{NS}$	$.077^{NS}$

NS- difference is not significant at 0.05 level of significance

The four F-values for the instructional procedure on self-concept were obtained below the tabular value for the 0.05 level of significance, as shown in Table. This demonstrates that, once the linear effect of each covariate is taken into account, there is no longer a statistically significant difference between the criteria means of the groups. Therefore, it may be said that between the Experimental and Control groups, there is no statistically significant difference in Self-Concept.

Post-hoc comparison was not done because none of the four F-values from ANCOVA were determined to be significant for treatment groups on Self-Concept

Analysis of Covariance for Self-Concept for non Pre-tested Group. Here the investigator studied whether or not significant difference exists between the non pre-tested Experimental and Control groups with regard to the mean Self-Concept scores. All together 3 ANCOVA were done to examine the significant difference between non pre-tested Experimental and Control group with regard to mean Problem Solving Ability scores. One by one, each covariate namely, Verbal Intelligence, Socio-Economic Status and the combined effect of two covariates were controlled in the three ANCOVA. The result is shown in table 52.

Table 52

Summary of Single Factor ANCOVA for Self concept for non pre-tested Groups

Source of variation		Verbal Intelligence	Socio-Economic status	Total effect of 2 covariates
Sum of Squares	Between groups	116.900	124.927	114.332
	Within groups	3760.118	3780.037	3759.712
Df	Between groups	1	1	1
	Within groups	77	77	76
Mean Square	Between groups	116.900	124.927	114.332
	Within groups	48.833	49.091	49.470
Total		207625.00	207625.00	207625.00
F		2.394	2.545	2.311
Sig.		.126^{NS}	.115^{NS}	.133^{NS}

NS- difference is not significant at 0.05 level of significance

The three F-values for the instructional procedure on Self-Concept were determined to be below the tabular value for the 0.05 level of significance, as shown in Table. This demonstrates that, once the linear effect of each covariate is taken into account, there is no longer a statistically significant difference between the criteria means of the groups. Therefore, it may be said that between the Experimental and Control groups, there is no statistically significant difference in Self-Concept.

Post-hoc comparison was not done because none of the four F-values from ANCOVA were determined to be significant for treatment groups on self-concept

Summary and discussion of analysis of covariance for Self Concept. The findings of seven ANCOVA tests used to compare the impact of instructional methodologies (Productive Thinking Model and Existing Method of Teaching) on the Self-Concept of the pre-tested and non pre-tested groups are compiled and analysed. Table 53 presents the aggregated F-values obtained for the 7 ANCOVA.

Table 53

Summary of the F-values of ANCOVA for Self-Concept

SI. No.	Source of variance	Dependent variable	Covariate		F	Sig
1	Instructional strategy (Productive Thinking Model and Existing Method of teaching)	Self-Concept	pre-test Received Group	Pre-test	2.136	.148^{NS}
2				Verbal intelligence	.619	.434^{NS}
3				Socioeconomic status	1.562	.215^{NS}
4				Total effect	3.213	.077^{NS}
5			Pre-test Non Received Group	Verbal intelligence	2.394	.126^{NS}
6				Socioeconomic status	2.545	.115^{NS}
7				Total effect	2.311	.133^{NS}

Total of seven ANCOVA were done on Self concept for Pre-test received and non received groups. Using Pre-test scores (only for Pre-tested groups) Verbal Intelligence and Socio-Economic Status as Covariates separately and in combination. This was done to know whether variations in the mean Self-Concept scores of the Experimental and Control groups occur or not after treatment.

When the effects of Covariates, Pre-test score, Verbal Intelligence, socio-Economic Status and combined effect was controlled, F-values were found not significant for the Pre-tested group. This confirms that the Pre-tested Experimental and Control groups not differ significantly in Self-Concept.

When the effect of Covariates, Verbal Intelligence, Socioeconomic Status and combined effect was controlled, F values were not found significant for the non pre-tested group. This confirms that the non pre-tested Experimental and Control groups also not differ significantly in Self concept.

Out of 7 ANCOVA employed to study the difference between Experimental groups and Control groups in Self-Concept, all the 7 ANCOVA gives no significant difference. From these results it can be concluded that strategy in the Experimental group (Productive Thinking Model) was not that effective than the Control group (Existing Method of Teaching) in terms of self-Concept of students.

After Covariance Analysis, it was found that the Pre-tested and non pre-tested groups not significantly differed in their Self-Concept in both cases.

Analysis of Covariance for Retention in Problem Solving Ability in Physics

Single factor ANCOVA was used to assess whether there was any difference, if any, in the Experimental and Control groups Retention of Problem Solving Ability in Physics even after the effects of the covariates were taken into account. For the pre-tested groups, a single factor ANCOVA was used with three covariates (Pre-test score, Verbal Intelligence, and Socio-Economic Status - singly and in combination of five at a time); for the non pre-tested group, a single factor ANCOVA was used with two covariates (Verbal Intelligence and Socio-Economic Status - singly and in combination of four at a time).

After adjusting for the individual and cumulative effects of the covariates, the researcher may use single factor ANCOVA to further examine the relative efficacy of the Productive Thinking Model and the Existing Method of Teaching on Retention in Problem Solving Ability in Physics. The next subsection details the procedure of the ANCOVA on Retention for both the pre-tested and non pre-tested groups.

Analysis of Covariance for Retention for pre-tested Group. Total of four ANCOVA were done on Retention for Pre-tested group using Pre-test scores (only for Pre-tesedt groups), Verbal Intelligence and Socio-Economic Status as Covariates separately and in combination. In each of the four ANCOVAs, the pre-test score, verbal intelligence, socioeconomic status, and the cumulative effect of three factors were accounted for. The three ANCOVAs' complete descriptions would be too lengthy, thus they are shown in Table 54.

Table 54

Summary of Single Factor ANCOVA for Retention in Problem Solving Ability in Physics (Total Score) for pre-tested Groups

Source of variation		Pre- test score	Verbal Intelligence	Socio-Economic status	Total effect of 3 covariates
Sum of Squares	Between groups	124.884	111.154	127.968	136.487
	Within groups	748.537	914.817	885.640	732.442
Df	Between groups	1	1	1	1
	Within groups	87	87	87	85
Mean Square	Between groups	124.884	111.154	127.968	136.487
	Within groups	8.604	10.515	10.180	8.617
Total		45560.00	45560.00	45560.00	45560.00
F		14.515	10.571	12.571	15.839
Sig.		.000**	.002**	.001**	.000**

**- difference is significant at 0.01 level of significance

As per table 54 the obtained F (1,87) is 14.515 for the effect of Productive Thinking Model on Retention in Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Retention is significant among IXth standard students after controlling pre-test scores, $F(1,87) = 14.515$, $p<.01$

As per table, the obtained F (1,87) is 10.571 for the effect of Productive Thinking Model on Retention in Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Retention is significant among IXth standard students after controlling Verbal intelligence, $F(1,87) = 10.571$, $p<.01$

As per table, the obtained F (1,87) is12.571 for the effect of Productive Thinking Model on Retention in Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Retention is significant among IXth standard students after controlling Socioeconomic status, $F(1,87) = 12.571$, $p<.01$

As per table, the obtained F (1,85) is 15.839 for the effect of Productive Thinking Model on Retention in Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Retention is significant among IXth standard students after controlling the total effect of 3 covariates (pre-test, Verbal Intelligence, socio-Economic status), $F(1,85) = 15.839$, $p<.01$

The three F-values for the Instructional Procedure on Retention in Problem Solving Ability in Physics were discovered to be greater than the 0.01 level of significance. This demonstrated a statistically significant difference between the groups criteria means even after accounting for each covariate's linear influence. Therefore, ANCOVA results indicate that the Pre-tested Experimental and control group differ significantly when a linear adjustment is made for the effect of variation due to the difference in the Pre-test, Verbal Intelligence, Socio-Economic Status, and the combined effect of 3 covariates on Retention in Problem Solving Ability in Physics. Here again we compared pre-tested two groups and it was found significant even after controlling the covariates, since it was two groups compared and significant difference is clearly evident there is no relevance of Posthoc comparison.

Analysis of Covariance for Retention for non pre-tested Group. Total of three ANCOVA were done on Retention for non pre-tested group using Verbal Intelligence and Socio-Economic Status as Covariates separately and in combination. In each of the three ANCOVAs, the pre-test score, verbal intelligence, socio-Economic status, and the cumulative effect of three factors were accounted. The three ANCOVAs' complete descriptions would be too lengthy, thus they are shown in Table 55.

Table 55

Summary of Single Factor ANCOVA for Retention in Problem Solving Ability in Physics (Total Score) for non pre-tested Groups

Source of variation		Verbal Intelligence	Socio-Economic status	Total effect of 2 covariates
Sum of Squares	Between groups	56.107	49.944	53.156
	Within groups	681.436	686.007	678.875
Df	Between groups	1	1	1
	Within groups	77	77	76
Mean Square	Between groups	56.107	49.944	53.156
	Within groups	8.850	8.909	8.933
Total		39947.00	39947.00	39947.00
F		6.340	5.606	5.951
Sig.		.014*	.020*	.017*

*- difference is significant at 0.05 level of significance

As per table, the obtained F (1,77) is 6.340 for the effect of Productive Thinking Model on Retention in Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Retention is significant among IX standard students after controlling Verbal intelligence, $F(1,77) = 6.340$, $p<.01$

As per table, the obtained F (1,77) is 5.606 for the effect of Productive Thinking Model on Retention in Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Retention is significant among IX standard students after controlling Socio-Economic status, $F(1,77) = 5.606$, $p<.01$

As per table, the obtained F (1,76) is 5.951 for the effect of Productive Thinking Model on Retention in Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Retention is significant among IXth standard students after controlling the total effect of two covariates (Verbal Intelligence & socio economic status), $F(1,76) = 5.951$, $p<.01$

The three F-values for the Instructional Procedure on Retention was discovered to be above the 0.05 level of significance. This demonstrated a statistically significant difference between the groups criteria means even after accounting for each covariate's linear influence. Thus, ANCOVA results indicate that the non-pre-tested Experimental and control group differ significantly in retention in Problem Solving ability in physics when a linear adjustment is made for the effect of variation due to the difference in verbal intelligence, socioeconomic status, and the combined effect of two covariates of the subjects. Here we compared non pre tested two groups and it was found significant even after controlling the covariates, since it was two groups compared and significant difference is clearly evident there is no relevance of Posthoc comparison.

Summary and Discussion of Analysis of Covariance for Retention. This subsection summarises and discusses the findings of the seven ANCOVA tests used to determine the impact of the instructional procedure (Productive Thinking Model and Existing Method of Teaching) on retention (total) in Problem Solving ability in physics for both the pre-tested and non-pre-tested groups.

The 7 ANCOVA are summarized and presented in table 56.

Table 56

Summary of the F-values of ANCOVA for retention

SI. No.	Source of variance	Dependent variable	Covariate		F	Sig
1	Instructional strategy (Productive Thinking Model and existing method of teaching)	Retention	Pre-test Received Group	Pre-test	14.515	0.01
2				Verbal intelligence	10.571	0.01
3				Socioeconomic status	12.571	0.01
4				Total effect	15.839	0.01
5			Pre-test Non Received Group	Verbal intelligence	6.340	0.05
6				Socioeconomic status	5.06	0.05
7				Total effect	5.951	0.05

As Table indicates, 7 ANCOVA were employed for Retention in Problem Solving Ability in Physics for Pre-tested group and non pre-tested group, using Pre-test scores (only for Pre-tested group) Verbal Intelligence, and Socio-Economic Status as Covariates separately and in combination. The purpose of this was to ascertain whether the mean Retention scores of the Experimental and Control groups would differ after treatment.

When the effects of the covariates were eliminated separately and in combination, the F-values for the pre-tested group and the non pre-tested group were found to be significant. Therefore we can conclude that both the pre-tested and non pre-tested experimental and control group differ significantly on Retention.

All seven ANCOVAs used to examine the Retention differences between the Experimental and Control groups produced significant F-values. This demonstrates that, in terms of Retention, the Productive Thinking model treatment given to the experimental group is more successful. The experimental group is superior over the control group.

Following the completion of Covariance Analysis, it was seen that there was a difference in the Experimental and Control groups on Retention in Problem Solving Ability in Physics between the pre-tested and non pre-tested groups. So it can be concluded that the Productive Thinking Model is able to differentiate the Experimental groups which is pre-tested or non pre-tested with regard to Retention.

Conclusion

The chapter on analysis is divided into two parts. The first portion covers the initial examination of the experimental data, which was carried out in order to determine the groups' equivalency and identify significant statistical features.

Next section includes major analysis, where Mean difference analysis and Analysis of Covariance were used. Without adjusting for variables, the mean difference analysis revealed a significant difference in the experimental group's and the control group's Problem Solving Abilities in physics. The experimental groups are also linked to high mean scores.

Further ANCOVA results also shows that the pre-tested and non pre-tested groups significantly differed both in their Problem Solving Ability in Physics and Retention. In both cases, pre-tested and non pre-tested Experimental groups were seen to be Superior over the Control groups. This underlies the advantage of Productive Thinking Model over Existing Method of Teaching with regard to Problem Solving Ability in Physics.

From the results of analysis it is evident that student who taught through Productive thinking model Perform well than that of students who taught through Existing Method of Teaching. It highlights the need for new method or way of teaching other than existing one. Students are always interested to study new things in a new and innovative way that will last forever. Productive Thinking Model is such a Model that brings students to a world of productivity and fruitful thinking where students themselves can link theories and facts in order to solve a problem. It will bring confidence and self efficacy among students.

Chapter V

SUMMARY OF FINDINGS

- Study in retrospect
- Major findings of the study
- Tenability of hypotheses
- Conclusion

SUMMARY OF FINDINGS

The whole idea of a study is what gives it life. This chapter provides a brief overview of the complete procedure such as, variables chosen, the goals, the theories, the techniques and processes, the data collection, the statistical analysis of the data, and the results to have a comprehensive understanding of the current research. The findings are summarized and presented in this chapter.

This session also includes a full discussion of the study's educational implications as well as suggestions for further research.

Study in Retrospect

The purpose of the study was to evaluate the effectiveness of Productive Thinking Model and Self-Concept over Existing Method of Teaching. Also to study the main effect of Productive Thinking Model on Self-Concept and Problem Solving Ability in Physics of IX standard students. To obtain pertinent information on the prevalent instructional strategies, methods, and teaching models used in secondary level physics classes, a preliminary survey on secondary school physics teachers was also carried out.

Restatement of the Problem

The goal of the current investigation was to determine the effectiveness of Productive Thinking Model on Self-Concept and Problem Solving Ability in Physics

The problem of the study is restated as the **"Effectiveness of Productive Thinking Model on Problem Solving Ability in Physics and Self-Concept of IX standard students".**

Variables of the Study

The following are the independent, dependent, and control variables that were chosen for the current study:

Independent Variables

The independent variables selected for the study were:

- Models of Teaching (Productive Thinking Model)
- Method of Teaching (Existing Method of Teaching)

Dependent variables

The following dependent variables were assessed:

- Problem Solving Ability in Physics
- Self-Concept of students

Control variables

The control variables selected for the study are,

- Pre experimental status in terms of Problem Solving Ability in Physics
- Pre experimental status in terms of Self-Concept
- Verbal intelligence
- Socio-Economic status

Objectives of the study

The following are specific objectives that have been developed.

1. To identify the prevailing and innovative Instructional Strategies, Methods and Models adopted by teachers to teach Physics at Secondary School Level.

2. To find out the issues (if any) experienced by the Physics teachers in implementing innovative Instructional Strategies, Methods and Models at Secondary School Level and to suggest measures (if any) to overcome the constraints in implementing the innovative Instructional Strategies and Models at Secondary School Level.

3. To compare the mean post-test scores of Problem Solving Ability in Physics of experimental and control groups for the Total sample, Boys and Girls.

4. To compare the mean post-test scores of Self-Concept of experimental and control groups for the Total sample, Boys and Girls.

5. To compare the mean gain scores of Problem Solving Ability in Physics of experimental group I and control group II for the Total sample, Boys and Girls.

6. To compare the mean gain scores of Self -Concept of experimental group I and control group II for the Total sample, Boys and Girls.

7. To compare the mean retention scores of Problem Solving Ability in Physics of experimental and controlled groups for the Total sample, Boys and Girls.

8. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability in Physics of pre-tested experimental and control group.

9. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability in Physics of non pre-tested experimental and control group.

10. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of pre-tested experimental and control group.

11. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of non pre-tested experimental and control group.

12. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on retention in Problem Solving Ability in Physics of pre-tested experimental and control group.

13. To study the effectiveness of Productive Thinking Model and Existing Method of Teaching on retention in Problem Solving Ability in Physics of non pre-tested experimental and control group.

Hypotheses of the Study

The following hypotheses were intended to be tested by the current investigation.

1. There will be no significant difference in mean post-test scores of Problem Solving Ability in Physics of experimental and control groups for the Total sample, Boys and Girls.

2. There will be no significant difference in mean post-test scores of Self-Concept of experimental and control groups for the Total sample, Boys and Girls.

3. There will be no significant difference in the mean gain scores of Problem Solving Ability in Physics of experimental group I and control group II for the Total sample, Boys and Girls.

4. There will be no significant difference in the mean gain scores Self-Concept of experimental group I and control group II for the Total sample, Boys and Girls.

5. There will be no significant difference in the retention scores of Problem Solving Ability in Physics of experimental and control group for the Total sample, Boys and Girls.

6. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability in Physics of pre-tested experimental and control group.

7. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability in Physics of non pre-tested experimental and control group.

8. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of pre-tested experimental and control group.

9. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of non pre-tested experimental and control group.

10. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on retention in Problem Solving Ability in Physics of pre-tested experimental and control group.

11. There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on retention in Problem Solving Ability in Physics of non pre-tested experimental and control group.

Methodology

The investigation was carried out using an experimental method. There were two phases of the investigation. In the first phase, which was preparatory, the investigator surveyed teachers of physics in secondary schools to collect information on the models, strategies, and instructional methods that are currently in use, as well as any barriers that teachers may have had to overcome to start using these materials to teach physics in secondary schools.

Experimentation was the second phase. Experimental phase was to test the effectiveness of the Productive thinking model on self concept and Problem Solving ability in Physics among IX standard students. Second Phase consists of final experimentation in which the effect of Productive thinking model on retention in Problem Solving Ability in Physics among IX standard students was studied. Productive Thinking Model was used for transacting concepts in Physics in Experimental groups and Existing Method of Teaching was used in control groups. Analysis was done based on the data obtained.

Design of the study

The study was designed using Solomon Four Group design. Experimental group I and II was taught using Productive Thinking Model(PTM) and two control groups using Existing Method of Teaching.

Sample of the study

Students in Kerala state syllabus schools enrolled in standard IX were the population under consideration for the experimental study. Four intact standard IX classrooms with about 40 pupils each made up the study's sample. All together 172 students from four divisions of these two schools. 88students were given experimental treatment (Experimental group I & II) and 84 were given control treatment (Control group I &II).

Selection of topics for Treatment

For the academic year 2021–2022, the recommended text book on Physics for Standard IX in the Kerala State syllabus was used to select the content to be taught to the experimental and control groups. A thorough analysis of the curriculum, syllabus, teachers manual, text book, and other educational resources was done prior. The researcher sought advice from specialists and concerned teachers as well. A single chapter was chosen based on practicality, keeping the syllabus's sequence intact. By consulting Physics teachers and students, investigator found that the chapter "Motion and Laws of Motion" is more related to real life and we can see lots of examples from day today life. After a thorough analysis, the chosen chapter was determined to be compatible with the chosen teaching model for the research.

Tools and Teaching Materials used for the study

The experiment was successfully carried out by the researcher using the following Teaching Materials and Tools. It comprises tools created by the researcher as well as additional tools created by other writers.

1. Semi- Structured Interview Schedule for Secondary school Physics Teachers (Athira & Bindhu, 2021)
2. Lesson Transcript for Productive Thinking Model (Athira & Bindhu, 2021)
3. Lesson Transcripts for Existing Method of Teaching (Athira & Bindhu , 2021)
4. Problem Solving Ability Test in Physics (Athira & Bindhu, 2021)
5. Self-Concept Scale (Bindhu & Alphonsa, 2016)
6. Verbal Group Test of Intelligence – VGTI (Kumar, Hameed, & Prasanna, 1997)
7. Socio – economic status (Bindhu&Vineetha, 2017)

Statistical techniques

1. Preliminary Analysis
2. Percentage analysis
3. Pearson's Product moment Coefficient of correlation
4. The test of significance of difference between means
5. Analysis of Variance (ANOVA)
6. Analysis of Co Variance (ANCOVA)

Major Findings of the study

Mean difference analysis without changing the control variables, is the first step in evaluating whether there is a difference between the two Experimental and the two Control groups in terms of the Pre-test and Post-test on Problem Solving Ability in Physics and Self-Concept, Gain scores in Problem Solving Ability in Physics and Self-Concept and Retention scores in Problem Solving ability in Physics . The outcomes together with an explanation are,

Findings of Preliminary Survey

The study starts with a preliminary analysis to gather responses from Secondary School Physics teachers on existing teaching methods, strategies and models.

Existing methods, Strategies and Models used by Secondary School Physics teachers

The study started with a semi-structured interview with Secondary School Physics teachers. The study found that the majority of teachers were aware of existing strategies and procedures in Physics classes.

Secondary School Physics teachers most commonly employed approaches were found to be activity-oriented, direct instruction, assignment and project-based method. The inquiry-based and productive Thinking Models are the least employed models in schools.

The interview revealed that teachers understand the desired effects of many strategies including logical thinking, reasoning, technology advancement, and knowledge sharing. However, the majority of teachers are unwilling to implement such methodologies in the present classroom environment.

Constrains faced by Secondary school Physics teachers in Implementing Strategies, Methods and Models.

Teachers are aware of multiple methods for providing education, but they confront certain obstacles in executing them. They face the following obstacles:

- Time constraints
- Class room management
- Difficulty to complete the portions on time
- Assessment challenge
- Lack of teacher experts and training
- Resource limitations

Because of the above mentioned obstacles teachers are not willing to implement new and innovative strategies, methods and models in the class rooms.

Measures suggested by Secondary School Physics teachers to overcome the constraints in implementing Innovative Instructional Methods, Strategies and Models

The physics teachers in secondary schools have proposed various solutions to get beyond the limitations they face while putting techniques, strategies, and models of instruction into practice. The following is a list of them:

- The time span of class should be increased to ensure the successful completion of various teaching models.
- Teachers should receive proper training and seminars to become acquainted with various teaching models and successful implementation tactics, which will help them gain confidence and competency.
- Ensure that the necessary resources, such as technology tools, instructional materials, and support staff, are available to properly implement the new teaching methodologies. Advocate for budgetary allocations and develop ties with organisations that can provide additional resources.
- Align new teaching approaches with the existing curriculum to ensure that students' learning experiences are consistent and cohesive. Teachers should be encouraged to seamlessly integrate the new models into their lesson plans and teaching strategies.

Findings of Experimental Phase

Comparison of Pre-test Scores on Problem Solving Ability in Physics Before Control

Result 1. The mean pre-test scores of Problem Solving Ability in Physics between Experimental group I and Control group II does not differ significantly

Mean difference analysis was used to determine whether there is a significant difference in the mean pre-test scores on Problem Solving Ability in Physics between experimental group I and control group II for the total sample.

The findings showed that, for the entire sample, there was no statistically significant difference in the mean pre-test scores for Problem Solving Ability in Physics between Experimental group I and control group II.

The two groups' comparability was further demonstrated by the graphical representation of the mean pre-test scores on Problem Solving Ability in Physics between experimental group I and control group II for the entire sample.

The mean pre-test scores on Problem Solving Ability in Physics for the entire sample had a t value of .50, which is less than the table value of 1.96 at the.05 level of significance. The result indicated that the experimental and control groups do not differ significantly in mean pre-test scores for the total sample.

Problem Solving Ability in Physics(pre-test), Me_{ExpI}=18.652, M_{contII} = 19, t=.50,$p > .05$

Result 2. The mean pre-test scores of Problem Solving Ability in Physics between Experimental group I Boys and Control group II Boys does not differ significantly

Mean difference analysis was used to determine whether there is a significant difference in the mean pre-test scores on Problem Solving Ability in Physics between the boys in the experimental group I and the control group II for the total sample.

The findings showed that, for the total sample, there was no statistically significant difference in the mean pre-test scores for Problem Solving Ability in Physics between the boys in the Experimental group I and the boys in the control group II.

The similarity between the two groups was further demonstrated by the graphical depiction of the mean pre-test scores on Problem Solving Ability in Physics for Boys in Experimental Group I and Control Group II for the total sample.

The mean pre-test scores on Problem Solving Ability in Physics between the boys in Experimental Group I and Control Group II given a t value of 1.043, which is less than the table value of 1.96 at the.05 level of significance. The outcome showed that there is no statistically significant difference in the mean pre-test scores between the experimental and control groups for the entire sample.

Problem Solving Ability in Physics(pre-test), Me_{Exp1}=17.111, M_{cont2} = 17.875, t=.50,$p > .05$

Result 3. The mean pre-test scores of Problem Solving Ability in Physics between Experimental group I Girls and Control group II Girls does not differ significantly

Mean difference analysis was used to determine whether there is a significant difference in the mean pre-test scores on Problem Solving Ability in Physics between the experimental group I and control group II girls for the total sample.

The findings showed that, for the total sample, there was no statistically significant difference in the mean pre-test scores on Problem Solving ability in physics between the Experimental group I Girls and the control group II Girls.

The mean pre-test scores on Problem Solving Ability in Physics for the total sample of girls in the Experimental Group I and Control Group II were further demonstrated by the graph.

The mean pre-test scores for the girls in Experimental group I and control group II on Problem Solving Ability in Physics yielded a t value of 0.000, which is less than the table value of 1.96 at the.05 level of significance. The outcome showed that there is no statistically significant difference in the mean pre-test scores between the girls in the experimental and control groups.

Problem Solving ability in Physics(pre-test), Me_{ExpI}=19.642, M_{contII} = 19.642, t=.000,*p>.05*

Comparison of Pre-test Scores on Self-Concept Before Control

Result 4. The mean pre-test scores of Self-Concept between Experimental group I and Control group II does not differ significantly

Mean difference analysis was used to determine whether there is a significant difference in the mean pre-test scores on Self-Concept between experimental group I and control group II for the total sample.

The findings showed that, for the total sample, there was not a significant difference in the mean pre-test scores on Self-Concept between Experimental group I and control group II.

The t value obtained for the mean pre-test scores on Self-Concept for the total sample is 1.277 which is less than the table value 1.96 at .05 levels of significance. The result indicated that the experimental and control groups do not differ significantly in mean pre-test scores for the total sample.

Self-Concept (pre-test), Me_{ExpI}= 48.956, M_{contII} = 19, t= 47.159,$p > .05$

Result 5. The mean pre-test scores of Problem Solving ability in Physics between Experimental group 1 Boys and Control group 2 Boys does not differ significantly

Mean difference analysis was performed to determine whether there is a significant difference in the mean pre-test scores on Self-Concept between the boys in the experimental group I and the control group II, on the total sample.

The findings showed that, for the total sample, there was no discernible difference in the mean pre-test scores on self-concept between the boys in the Experimental group I and the control group II.

The similarity between the two groups was further demonstrated by the graphical depiction of the mean pre-test scores on Self-Concept for the boys in experimental group I and control group II for the total sample.

The mean pre-test scores on Self-Concept for the boys in both Experimental Group I and Control Group II, had a t value of 0.250, which is less than the table value of 1.96 at the.05 level of significance. The outcome showed that there is no statistically significant difference in the mean pre-test scores for boys in two groups between the experimental and control groups.

Self-Concept (pre-test), Me_{Exp1}=45.777, $M_{cont\ II}$ = 46.562, t=.50,$p > .05$

Result 6. The mean pre-test scores of Problem Solving ability in Physics between Experimental group 1 Boys and Control group 2 Boys does not differ significantly

Mean difference analysis was used to determine whether there is a significant difference in the mean pre-test scores on Self-Concept between the girls in the experimental group I and the control group II, for the total sample.

The findings showed that, for the total sample, there was no significant difference in the mean pre-test scores on self-concept between the girls in the experimental group I and the control group II.

The similarity between the two groups was further demonstrated by the graphical representation of the mean pre-test scores on Self-Concept for girls in experimental group I and control group II for the entire sample.

The t value obtained for the mean pre-test scores on Self-Concept for the Girls in Experimental group I and control group II is 1.133 which is less than the table value 1.96 at .05 levels of significance. The result indicated that the experimental and control groups do not differ significantly in mean pre-test scores for Girls in the two groups.

Self-Concept (pre-test), Me_{Exp1}=51.000, $M_{cont\ II}$ = 46.562, t=47.500,$p>.05$

Comparison of Post Tests on Problem Solving Ability in Physics Before Control

Result 7. Mean Post test scores on Problem Solving Ability in Physics (Component-wise and Total) between the Experimental Group I and Control Group I differ significantly.

Total score. Mean difference analysis was used to determine whether there is a significant difference between the mean post-test scores on Physics Problem Solving Ability between Experimental Group I and Control Group I for the total sample.

The findings showed that, for the total sample, there is a significant difference in the mean post-test scores on Problem Solving ability in physics between Experimental group I and control group I.

The difference between the experimental group I and the control group I on the mean post-test scores for Problem Solving Ability in Physics for the entire sample was further demonstrated by the graph.

The t value obtained for the mean post-test scores on Problem Solving Ability in Physics for the total sample is 7.617 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly in mean post-test scores for the total sample.

Problem Solving Ability in Physics(post-test), Me_{ExpI}=27.673, M_{contI} = 20.675, t=7.617,$p<.01$

Component wise comparison of post-tests on Problem Solving Ability in Physics before control are given below:

Comprehending the problem. The t value obtained for the component Comprehending the problem for the total sample is 5.352 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component comprehending the problem for the total sample

Comprehending the Problem ,$Me_{Exp\ I}$=6.587, $M_{cont\ I}$ = 5.327, t=5.352,$p<.01$

Clarifying the problem. The t value obtained for the component Clarifying the problem for the total sample is 6.856 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component clarifying the problem for the total sample

Clarifying the Problem ,Me_{ExpI}=10.637, $M_{cont\ I}$ = 7.475, t=6.856,$p < .01$

Finding solution to the problem. The t value obtained for the component Finding solution to the problem for the total sample is 6.092 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component Finding solution to the problem for the total sample

Finding solution to the problem ,$Me_{Expm\ I}$=10.347, $M_{cont\ I}$ = 7.825, t=6.092 ,$p < .01$

Result 8. Mean Post test scores on Problem Solving Ability in Physics (Component-wise and total) Between the Experimental Group I and Control Group II differ significantly

Total score. Mean difference analysis was used to determine whether there is a significant difference in the mean post-test scores on Problem Solving Ability in Physics between experimental group I and control group II for the total sample.

The findings showed that, there is significant difference in the mean post-test scores on problem-solving ability in physics between Experimental group I and control group II for the total sample.

The two groups' differences were further demonstrated by the graphical representation of the mean post-test scores on Problem Solving Ability in Physics for the entire sample between experimental group I and control group II.

The mean post-test scores on Physics Problem Solving Ability for the entire sample had a t value of 7.620, which is higher than the table value of 2.58 at the.01 level of significance. The outcome showed a significant difference in the mean post-test scores for the entire sample between the experimental and control groups.

Problem Solving Ability in Physics (post-test), Me_{ExpI}=27.673, M_{contII} = 20.250, t=7.620,$p<.01$

Component wise comparison of post-tests on Problem Solving Ability in Physics before control are given below:

Comprehending the problem. The t value obtained for the component Comprehending the problem for the total sample is 7.273which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component comprehending the problem for the total sample

Comprehending the Problem ,Me_{ExpI}=6.587, M_{contII} = 4.659, t=7.273,$p<.01$

Clarifying the problem. The t value obtained for the component Clarifying the problem for the total sample is 7.055 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component clarifying the problem for the total sample

Clarifying the problem ,Me_{ExpI}=10.630, M_{contII} = 7.318, t=7.055,$p<.01$

Finding solution to the problem. The t value obtained for the component Finding solution to the problem for the total sample is 4.954 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component Finding solution to the problem for the total sample

Finding solution to the Problem ,Me_{ExpI}=10.347, M_{contII}= 8.272, t=4.954 ,*p*<.*01*

Result 9. Mean Post test scores on Problem Solving Ability in Physics (Component-wise and total) Between the Experimental Group II and Control Group I differ significantly

Total score. Mean difference analysis was used to determine whether there is a significant difference in the mean post-test scores on Problem Solving Ability in Physics between experimental group II and control group I for the total sample.

The findings showed that, for the total sample, there is a significant difference in the mean post-test scores on problem-solving ability in physics between Experimental group II and control group I.

The two groups' differences were further demonstrated by the graphical representation of the mean post-test scores on Problem Solving Ability in Physics for the entire sample between experimental group II and control group I.

The mean post-test scores on Physics Problem Solving Ability for the total sample had a t value of 5.408, which is higher than the table value of 2.58 at the.01 level of significance. The results showed a significant difference in the mean post-test scores for the total sample between the experimental group II and the control group I.

Problem Solving Ability in Physics(postest), Me_{ExpII}=24.725, M_{contI} = 20.675, t=5.408,$p<.01$

Component wise comparison of post-tests on Problem Solving Ability in Physics before control are given below:

Comprehending the problem. The t value obtained for the component Comprehending the problem for the total sample is 4.115 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component comprehending the problem for the total sample

Comprehending the Problem ,Me_{ExpII}=6.175, M_{contI} = 5.325, t=7.273,$p<.01$

Clarifying the problem. The t value obtained for the component Clarifying the problem for the total sample is 4.621 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component clarifying the problem for the total sample

Clarifying the problem ,Me_{ExpII}=9.0425, M_{contI}= 7.475, t=4.621 , $p<.01$

Finding solution to the problem. The t value obtained for the component Finding solution to the problem for the total sample is 3.340 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component Finding solution to the problem for the total sample

Finding solution to the problem ,Me_{ExpII}=9.075, M_{contI} = 7.825, t=3.340 , $p<.01$

Result 10. Mean Post test scores on Problem Solving Ability in Physics (Component-wise and total) Between the Experimental Group II and Control Group II differ significantly

Total score. Mean difference analysis was used to determine whether there is a significant difference in the mean post-test scores on Problem Solving Ability in Physics between experimental group II and control group II for the total sample,.

The findings showed that, there is significant difference in the mean post-test scores on problem-solving ability in physics between Experimental group II and control group I for the total sample.

The two groups' differences were further demonstrated by the graphical representation of the mean post-test scores on Problem Solving Ability in Physics for the total sample between experimental group II and control group II.

At the.01 level of significance, the t value for the mean post-test scores on Problem Solving Ability in Physics for the total sample is 5.121, which is higher than the table value of 2.58. The outcome showed a significant difference in the mean post-test scores for the total sample between the experimental group II and the control group II.

Problem Solving Ability in Physics (post-test), Me_{ExpII}=24.725, M_{contII} = 20.250, t=5.121,$p<.01$

Component wise comparison of post-tests on Problem Solving Ability in Physics before control are given below:

Comprehending the problem. The t value obtained for the component Comprehending the problem for the total sample is 6.113 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component comprehending the problem for the total sample

Comprehending the Problem, Me_{ExpII}=6.175, M_{contII} = 4.659, t=6.113,$p<.01$

Clarifying the problem. The t value obtained for the component Clarifying the problem for the total sample is 4.783 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component clarifying the problem for the total sample

Clarifying the the Problem ,Me_{ExpII}=9.425, M_{contII}= 7.318, t=4.783 , $p<.01$

Finding solution to the problem. The t value obtained for the component Finding solution to the problem for the total sample is 2.072 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component Finding solution to the problem for the total sample

Finding solution to the problem ,Me_{ExpII}=9.075, M_{contII} = 8.272, t=2.072 , $p<.01$

Result 11. Mean Post test scores on Problem Solving Ability in Physics (Component-wise and total) Between the Experimental Group and Control Group Boys differ significantly.

Total score. Mean difference analysis was used to determine whether there is a significant difference in the mean post-test scores on Problem Solving Ability in Physics between the experimental groups and the control groups of boys.

The findings showed that the mean post-test scores of Problem Solving Ability in Physics for the experimental group Boys as well as Control group Boys differed significantly.

The mean post-test results for Problem Solving Ability in Physics between the experimental and control groups are shown graphically. It also shows a significant difference in the post-test scores of Problem Solving Ability in Physics in the Experimental and Control Groups.

The t value obtained for the mean post-test scores on Problem Solving Ability in Physics total for Boys is 7.849 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental groups and control groups Boys differ significantly in mean post-test scores.

Problem Solving Ability in Physics (post-test), Me_{Exp}=25.212, M_{cont} = 19.000, t=7.849,$p < .01$

Component wise comparison of post-tests on Problem Solving Ability in Physics before control are given below:

Comprehending the problem. The t value obtained for the component Comprehending the problem for the Boys in the Experimental and Control groups is 5.927 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups Boys differ significantly for the component comprehending the problem .

Comprehending the Problem ,Me_{Exp}=6.175, M_{cont} = 4.515, t=5.927,$p<.01$

Clarifying the problem. The t value obtained for the component Clarifying the problem for the Boys in the Experimental groups and control groups is 8.085 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups Boys differ significantly for the component clarifying the problem.

Clarifying the Problem ,Me_{Exp}=10.030, M_{cont} = 6.757, t=8.085 , $p<.01$

Finding solution to the problem. The t value obtained for the component Finding solution to the problem for the total sample is 2.695 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental groips and control groups Boys differ significantly for the component Finding solution to the problem .

Comprehending the Problem ,Me_{Exp}=9.030, M_{cont} = 7.787, t=2.695 , $p<.01$

Result 12. Mean Post test scores on Problem Solving Ability in Physics (Component-wise and total) Between the Experimental Groups and Control Groups Girls differ significantly.

Mean difference analysis was used to determine whether there is a significant difference in the mean post-test scores on Problem Solving Ability in Physics between the experimental groups and the control groups of girls.

The findings showed that the mean post-test scores of Problem Solving Ability in Physics for the experimental group girls and control group girls differ significantly. The graph displays the average post-test results for Physics Problem Solving Ability for both the experimental and control group girls. The total sample of girls demonstrated the differences between the two groups as well.

The t value obtained for the mean postest scores on Problem Solving Ability in Physics total for Girls is 6.275 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental groups and control groups girls differ significantly in mean post-test scores.

Problem Solving Ability in Physics (post-test), Me_{Exp}=26.9811, M_{cont} = 21.392, t=6.275,$p<.01$

Component wise comparison of post-tests on Problem Solving Ability in Physics before control are given below:

Comprehending the problem. The t value obtained for the component Comprehending the problem for the Girls in the Experimental and Control groups is 5.901 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups Girls differ significantly for the component comprehending the problem.

Comprehending the Problem ,Me_{Exp}=6.547, M_{cont} = 5.274, t=5.901,$p<.01$

Clarifying the problem. The t value obtained for the component clarifying the problem for the Girls in the Experimental groups and control groups is 5.026 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups Girls differ significantly for the component clarifying the problem.

Clarifying the Problem ,Me_{Exp}=10.094, M_{cont} = 7.803, t=5.026 , *p<.01*

Finding solution to the problem. The t value obtained for the component Finding solution to the problem for the Girls in the Experimental and Control groups is5.444 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental groups and control groups Girls differ significantly for the component Finding solution to the problem.

Finding solution to the Problem ,Me_{Exp}=10.207, M_{cont} = 8.235, t=5.444, *p<.01*

Result 13. Mean Post test scores on Problem Solving Ability in Physics (Component-wise and total) Between the Experimental Groups and Control Groups Total differ significantly

Total score. Mean difference analysis was used to determine whether there is a significant difference in the mean post-test scores on Problem Solving Ability in Physics between the experimental and control groups for the total sample.

The findings showed a statistically significant difference in the mean post-test scores for Physics' Problem Solving Ability total score between the experimental and control groups.

The two groups' differences were further demonstrated by the graphical representation of the mean post-test scores on Problem Solving Ability in Physics for the experimental and control groups for the entire sample.

At the.01 level of significance, the t value for the mean post-test scores on Problem Solving Ability in Physics for the total sample is 9.111, which is higher than the table value of 2.58. The outcome showed that there is significant differences in the mean post-test scores between the experimental and control groups for the total sample.

Problem Solving Ability in Physics (post-test), Me_{Exp}=26.302, M_{cont}= 20.452, t=9.111,$p<.01$

Component wise comparison of post-tests on Problem Solving Ability in Physics before control are given below:

Comprehending the problem. The t value obtained for the component Comprehending the problem for the total sample is 8.112 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component comprehending the problem for the total sample

Comprehending the Problem ,Me_{Exp}=6.395, M_{cont} = 4.976, t=8.112,$p<.01$

Clarifying the problem. The t value obtained for the component Clarifying the problem for the total sample is 8.283 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component clarifying the problem for the total sample

Clarifying the Problem ,Me_{Exp}=10.069, M_{cont2} = 7.392, t=8.283 , $p<.01$

Finding solution to the problem. The t value obtained for the component Finding solution to the problem for the total sample is 5.829 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly for the component Finding solution to the problem for the total sample

Finding solution to the Problem ,Me_{Exp}=9.755, M_{cont} = 8.059, t=5.829 , $p<.01$

Comparison of Gain Scores Between the Pre-test Received Groups

Result 14. There is significant difference in the mean Gain scores on Problem Solving Ability in Physics and Retention between Experimental group I and control group II

Mean difference analysis was used to determine whether or not there is a significant difference in the mean gain scores on Problem Solving Ability in Physics between experimental group I and control group II for the total sample without controlling the covariate.

The results show that, for the total sample, there was a significant difference in the mean gain scores on Problem Solving ability in physics between experimental group I and control group II.

The two groups' significant differences were further demonstrated by the graphical representation of the mean gain scores on the Problem Solving Ability in Physics for the total sample.

The t- value obtained for the mean gain scores on Problem Solving Ability in physics for the total sample is 10.854 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly in mean gain scores on Problem Solving in Physics for the total sample.

Problem Solving Ability in Physics, Me_{ExpI}=9.021, M_{contII} = 1.386, t=10.854 ,*p<.01*

Result 15. There is significant difference in the mean Gain scores on Problem Solving Ability in Physics between Experimental group I Boys and control group II Boys.

Mean difference analysis was used to determine whether or not there is a significant difference in the mean gain scores on Problem Solving Ability in Physics between experimental group I Boys and control group II Boys for the total sample without controlling for covariates.

The results reveal that there was a significant difference in the mean gain scores between experimental group I Boys and control group II Boys on Problem Solving Ability in Physics for the total sample.

The graphical representation of the mean gain scores on Problem Solving Ability in Physics for the Boys in the total sample also proved that the two groups differ significantly.

The t- value obtained for the mean gain scores on Problem Solving Ability in Physics for the total sample for Boys in experimental group I and control group II is

9.313 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental group I and control group II differ significantly in mean gain scores on Problem Solving Ability in Physics of Boys.

Problem Solving Ability in Physics, Me_{ExpI}=9.444, M_{conII}= .8125, t=9.313, *p<.01*

Result 16. There is significant difference in the mean Gain scores on Problem Solving Ability in Physics between Experimental group I Girls and control group II Girls.

Mean difference analysis was used to determine whether or not there is significant difference in the mean gain scores on Problem Solving Ability in Physics between experimental group I Girls and control group II Girls for the total sample without controlling for covariates.

The results reveal that there was a significant difference in the mean gain scores between experimental group I Girls and control group II Girls on Problem Solving Ability in Physics for the total sample.

The graphical representation of the mean gain scores on Problem Solving Ability in Physics for the Girls in the total sample also proved that the two groups differ significantly.

The t- value obtained for the mean gain scores on Problem Solving Ability in physics for the total sample for Girls in experimental group I and control group II is 7.145 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental group I and control group II differ significantly in mean gain scores on Problem Solving in Physics of Girls.

Problem Solving Ability in Physics,Me_{ExpI}=8.750, M_{conII}= 1.714, t=7.145, *p<.01*

Comparison of Self Concept Scores Before Control

Result 17. Mean Self-Concept scores between the Experimental Group I and Control Group I does not differ significantly.

Mean difference analysis was used to determine whether or not there exists a significant difference between the Self-Concept scores of experimental group I and control group I for the total sample.

The results showed that there was no significant difference in the mean Self-Concept scores between Experimental group I and Control group I for the total sample.

The t value obtained for the mean Self-Concept scores for the total sample is 1.221 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental and control groups does not differ significantly in mean Self-Concept scores for the total sample.

Self-Concept, Me_{ExpI}=51.000, M_{contI} = 49.200, t=1.221,*p>.05*

Result 18. Mean Self-Concept scores between the Experimental Group I and Control Group II does not differ significantly.

The mean difference analysis was used to determine whether or not there exists a significant difference between the Self-Concept scores between experimental group I and control group II for the total sample.

The results showed that there was no significant difference in mean self-concept scores between Experimental group I and Control group II for the entire sample.

The t value obtained for the mean Self-Concept scores for the total sample is 0.794 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental group I and control group II does not differ significantly in mean Self-Concept scores for the total sample.

Self-Concept, Me_{ExpI}=51.000, M_{contII}= 49.909, t=0.794,$p > .05$

Result 19. Mean Self-Concept scores between the Experimental Group II and Control Group I does not differ significantly.

Mean difference analysis was used to determine whether or not there exists a significant difference between the Self-Concept scores of experimental group II and control group I for the total sample.

The results showed that there was no significant difference in mean Self-Concept scores between Experimental group II and Control group I for the total sample.

The t value obtained for the mean Self concept scores for the total sample is 1.156 which is less than the table value 1.98 at .05 levels of significance. The result indicated that the experimental group II and control group I does not differ significantly in mean Self-Concept scores for the total sample.

Self-Concept, Me_{ExpII}=51.000, M_{contI} = 49.200, t=1.156,*p>.05*

Result 20. Mean Self-Concept scores between the Experimental Group II and Control Group II does not differ significantly.

Mean difference analysis was used to determine whether there is a significant difference in the Self-Concept scores between experimental group II and control group II for the total sample.

The findings showed that, for the total sample, there is no significant difference in the mean Self-Concept scores between Experimental group II and control group II.

The t value obtained for the mean self concept scores for the total sample is 1.044 which is less than the table value 1.98 at .05 levels of significance. The result indicated that the experimental group II and control group II does not differ significantly in mean Self-Concept scores for the total sample.

Self-Concept, Me_{ExpII}=51.000, M_{contII} = 49.909, t=1.044,*p>.05*

Result 21. Mean Self-Concept scores between the Experimental Group Boys and Control Group Boys does not differ significantly.

Mean difference analysis was used to determine whether there is a significant difference in the Self-Concept scores between the boys in the experimental group and the boys in the control group for the total sample.

The findings showed that, for the total sample, there is no significant difference in the mean Self-Concept scores between the boys in the Experimental group and the control group.

The t value obtained for the mean Self-Concept scores for the total sample is 0.04 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental and control groups does not differ significantly in mean Self-Concept scores for the total sample.

Even though there is no significant difference in mean Self-Concept scores between boys in both groups, boys in the experimental groups shows high mean Self-Concept score than control groups. It implies the advantage of Productive Thinking Model over Existing Method of Teaching,

Self-Concept, Me_{Exp}= 48.5, M_{cont} =48.43, t=,0.04$p > .05$

Result 22. Mean Self-Concept scores between the Experimental Group Girls and Control Group Girls does not differ significantly.

Mean difference analysis was used to determine whether there is a significant difference in the Self-Concept scores between the girls in the experimental group and the girls in the control group for the total sample.

The findings showed that, for the total sample, there is no significant difference in the mean Self-Concept scores between the girls in the experimental group and the control group.

The t value obtained for the mean self-Concept scores for girls in the experimental and control group is 1.95 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental and control groups girls does not differ significantly in mean Self-Concept scores.

Even though there is no significant difference in mean self-Concept scores between girls in both groups ,Girls in the experimental groups shows high mean Self-Concept score than control groups. It implies the advantage of Productive Thinking Model over Existing Method of Teaching,

Self-Concept, Me_{Exp}= 52.98, M_{cont}=50.28, t=1.95,$p > .05$

Result 23. Mean Self-Concept scores between the Experimental Group Total and Control Group Total does not differ significantly.

Mean difference analysis was used to determine whether there is a significant difference in the Self-Concept scores between the experimental groups total and control groups total.

The findings showed that, for the total sample, there is no significant difference in the mean Self-Concept scores between the Experimental and control groups.

The t value obtained for the mean Self-Concept scores for the total sample is 1.66 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental and control groups does not differ significantly in mean Self-Concept scores for the total sample.

Even though mean Self-Concept scores in both groups does not differ significantly, the high mean Self-Concept score is associated with the experimental groups. It implies the advantage of Productive Thinking Model over Existing Method of Teaching,

Self-Concept, Me_{Exp}=52.98 ,M_{cont}=50.28, t=1.66,$p>.05$

Comparison of Retention Scores Before Control

Result 24. Mean Retention scores on Problem Solving Ability in Physics (Component-wise and Total) between the Experimental Group I and Control Group I does not differ significantly.

Total score. Mean difference analysis was used to determine whether there is a significant difference in the retention scores for problem-solving ability in physics between experimental group I and control group I for the total sample.

The findings showed that, for the total sample, there is no significant difference in the mean retention scores for Problem Solving Ability in Physics between Experimental group I and control group I.

It was also demonstrated that there is no difference between the experimental group I and the control group I based on the graphical representation of mean retention scores on Problem Solving Ability in Physics for the total sample.

The t value obtained for the mean retention scores on Problem Solving Ability in Physics for the total sample is 0.622 which is less than the table value 1.98 at .05

level of significance. The result indicated that the experimental and control groups does not differ significantly in mean retention scores for the total sample.

Problem Solving Ability in Physics (retention), Me_{ExpI}=23.326, M_{contI} = 22.950, t=0.622,$p>.05$

Component wise comparison of Retention Scores on Problem Solving Ability in Physics before control are given below:

Comprehending the problem. The t value obtained for the component Comprehending the problem for the total sample is 1.901 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental group I and control group I does not differ significantly for the component comprehending the problem for the total sample

Comprehending the Problem ,Me_{ExpI}=5.217, M_{contI} = 5.575, t=1.901,$p>.05$

Clarifying the problem. The t value obtained for the component Clarifying the problem for the total sample is 1.945 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental group I and control group I does not differ significantly for the component clarifying the problem for the total sample

Clarifying the Problem ,Me_{ExpI}=8.391, M_{contI} = 9.100, t=1.945,$p>.05$

Finding solution to the problem. The t value obtained for the component Finding solution to the problem for the total sample is 1.167 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental group I and control group I does not differ significantly for the component Finding solution to the problem for the total sample

Finding solution to the problem ,Me_{ExpI}=7.978, M_{contI} = 8.400, t=1.167,$p>.05$

Result 25. Mean Retention scores on Problem Solving Ability in Physics (Component-wise and Total) between the Experimental Group I and Control Group II differ significantly for the total score and one of the component finding solution to the problem.

Total score. Mean difference analysis was used to used whether there is a statistically significant difference between the retention scores on the Problem Solving Ability in Physics total for the experimental group I and the control group II for the total sample.

The findings showed that, for the total sample, there is a significant difference in the mean retention scores for Problem Solving Ability in Physics between Experimental group I and control group II.

The two groups' differences were further demonstrated by the graphical representation of the mean retention scores on Problem Solving Ability in Physics for the experimental group I and the control group II for the total sample.

The t value obtained for the mean retention scores on Problem Solving Ability in Physics for the total sample is 3.249 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental and control groups differ significantly in mean retention scores for the total sample.

Problem Solving Ability in Physics (retention), Me_{ExpI}=23.326, M_{contII} = 21.113, t=3.249,$p<.01$

Component wise comparison of Retention Scores on Problem Solving Ability in Physics before control are given below:

Comprehending the problem. The t value obtained for the component Comprehending the problem for the total sample is .311 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental group I and control group II does not differ significantly for the component comprehending the problem for the total sample

Comprehending the Problem ,Me_{ExpI}=5.217, M_{contII} = 5.159, t=.311,$p>.05$

Clarifying the problem. The t value obtained for the component Clarifying the problem for the total sample is 1.402 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental group I and control group II does not differ significantly for the component clarifying the problem for the total sample

Clarifying the Problem ,Me_{ExpI}=8.391, M_{contII} = 8.977, t=1.402,$p>.05$

Finding solution to the problem. The t value obtained for the component Finding solution to the problem for the total sample is 2.720 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental group I and control group II differ significantly for the component Finding solution to the problem for the total sample

Finding solution to the problem ,Me_{ExpI}=7.978, M_{contII} = 8.954, t=2.720,$p < .01$

Result 26. Mean Retention scores on Problem Solving Ability in Physics (Component-wise and Total) between the Experimental Group II and Control Group I differ significantly for the total score and one of the component Clarifying the problem.

Total score. Mean difference analysis was conducted to study whether there exists significant difference between the Retention scores on Problem Solving Ability in Physics total between experimental group II and control group I for the total sample.

The results indicated that there exists significant difference in the mean retention scores between Experimental group II and control group I on Problem Solving Ability in Physics total score for the total sample.

The graphical representation of mean retention scores on Problem Solving ability in Physics between experimental group II and control group I for the total sample also proved that the two groups are different.

The t value obtained for the mean retention scores on Problem Solving Ability in Physics for the total sample is 2.446 which is greater than the table value 1.98at .05 level of significance. The result indicated that the experimental group II and control group I differ significantly in mean retention scores (total)for the total sample.

Problem Solving ability in Physics(retention), Me_{ExpII}=21.325, M_{contI} = 22.950, t=2.446,$p < .05$

Component wise comparison of Retention Scores on Problem Solving Ability in Physics before control are given below:

Comprehending the problem. The t value obtained for the component Comprehending the problem for the total sample is 1.802 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental group II and control group I does not differ significantly for the component comprehending the problem for the total sample

Comprehending the Problem, Me_{ExpII}=5.222, M_{contI} = 5.575, t=1.804, $p>.05$

Clarifying the problem. The t value obtained for the component Clarifying the problem for the total sample is 2.746 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental group II and control group I differ significantly for the component clarifying the problem for the total sample

Clarifying the Problem, Me_{ExpII}=8.150, M_{contI} = 9.100, t=2.746, $p<0.01$

Finding solution to the problem. The t value obtained for the component Finding solution to the problem for the total sample is 1.296 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental group II and control group I does not differ significantly for the component Finding solution to the problem for the total sample.

Finding solution to the problem, Me_{ExpII}=8.025, M_{contI} = 8.400, t=1.296, $p>.05$

Result 27. Mean Retention scores on Problem Solving Ability in Physics (Component-wise and Total) between the Experimental Group II and Control Group II does not differ significantly for the total score and one of the component Comprehending the problem.

Total score. Mean difference analysis was used to investigate if there is a statistically significant difference in the retention scores on the Problem Solving Ability in Physics total for experimental group II and control group II for the total sample.

The findings showed that, for the total sample, there is a significant difference in the mean retention scores for Problem Solving Ability in Physics between Experimental group II and control group II.

The two groups are not different, as demonstrated by the graphical representation of mean retention scores on Problem Solving Ability in Physics between experimental group II and control group II for the total sample.

The t value obtained for the mean retention scores on Problem Solving Ability in Physics for the total sample is .284 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental group II and control group II does not differ significantly in mean retention scores (total)for the total sample.

Problem Solving Ability in Physics (retention), Me_{ExpII}=21.325, M_{contII} = 21.113, t=.284,$p > .05$

Component wise comparison of Retention Scores on Problem Solving Ability in Physics before control are given below:

Comprehending the problem. The t value obtained for the component Comprehending the problem for the total sample is .339 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental group II and control group II does not differ significantly for the component comprehending the problem for the total sample

Comprehending the Problem ,Me_{ExpII}=5.222, M_{contII} = 5.159, t=0339,*p>.05*

Clarifying the problem. The t value obtained for the component Clarifying the problem for the total sample is 2.000 which is greater than the table value 1.98 at .05 level of significance. The result indicated that the experimental group II and control group II differ significantly for the component clarifying the problem for the total sample

Clarifying the problem ,Me_{ExpII}=8.150, M_{contII} = 8.977, t=2.00,*p<0.05*

Finding solution to the problem. The t value obtained for the component Finding solution to the problem for the total sample is 3.137 which is greater than the table value 2.58 at ..01 level of significance. The result indicated that the experimental group II and control group II differ significantly for the component Finding solution to the problem for the total sample

Finding solution to the problem ,Me_{ExpII}=8.025, M_{contII} = 8.954, t=3.137,*p<.01*

Result 28. Mean Retention scores on Problem Solving Ability in Physics (Component-wise and Total) between the Experimental Group Boys and Control Group Boys does not differ significantly for the total score and one of the component Finding solution to the problem.

Total score. Mean difference analysis was used to determine whether there is a significant difference in the retention scores (total score) for problem-solving ability in physics between the boys in the experimental group and the boys in the control group for the total sample.

The findings showed that, for the total sample, there is not a significant difference in the mean retention scores (total) for problem-solving ability in physics between the boys in the experimental group and the boys in the control group.

The two groups are identical in terms of overall score, as demonstrated by the graphical representation of mean retention scores on Problem Solving Ability in Physics between experimental group Boys and control group Boys for the total sample.

The t value obtained for the mean retention scores on Problem Solving Ability in Physics for the total sample is .248 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental group boys and control group boys does not differ significantly in mean retention scores (total) for the total sample.

Problem Solving Ability in Physics(retention), Me_{Exp}=21.454, M_{cont} = 21.303, t=.248, $p>.05$

Component wise comparison of Retention Scores on Problem Solving Ability in Physics before control are given below:

Comprehending the problem. The t value obtained for the component Comprehending the problem for the total sample is .2.252 which is greater than the table value 1.98 at .05 level of significance. The result indicated that the experimental groups and control groups Boys differ significantly for the component comprehending the problem.

Comprehending the Problem, Me_{Exp}=4.969, M_{cont} = 5.424, t=0339, $p<.05$

Clarifying the problem. The t value obtained for the component Clarifying the problem for the total sample is 2.123 which is greater than the table value 1.98 at .05 level of significance. The result indicated that the experimental groups and control groups Boys differ significantly for the component clarifying the problem for the total sample

Clarifying the problem ,Me_{Exp}=7.639, M_{conI} = 8.424, t=2.123,$p<0.05$

Finding solution to the problem. The t value obtained for the component Finding solution to the problem for the total sample is .987 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental groups and control groups Boys does not differ significantly for the component Finding solution to the problem.

Finding solution to the problem ,Me_{Exp}=7.727, M_{cont} = 8.030, t=.987,$p>.05$

Result 29. Mean Retention scores on Problem Solving Ability in Physics (Component-wise and Total) between the Experimental Group Girls and Control Group Girls does not differ significantly for the total score and one of the component Comprehending the problem.

Total score. Mean difference analysis was used to determine whether there is a significant difference between the retention scores (total score) on Problem Solving Ability in Physics between the girls in the experimental group and the girls in the control group for the total sample.

The findings showed that, for the total sample, there is no significant difference in the mean retention scores (total) for problem-solving ability in physics between the boys in the experimental group and the boys in the control group.

The two groups are identical in terms of overall score, as demonstrated by the graphical representation of mean retention scores on Problem Solving Ability in Physics between girls in the experimental group and control group for the total sample.

The t value obtained for the mean retention scores on Problem Solving Ability in Physics for the total sample is .787 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental group girls and control group girls does not differ significantly in mean retention scores (total) for the total sample.

Problem Solving Ability in Physics(retention), Me_{Exp}=21.981, M_{cont}= 22.431, t=.787,$p>.05$

Component wise comparison of Retention Scores on Problem Solving Ability in Physics before control are given below:

Comprehending the problem. The t value obtained for the component Comprehending the problem for the total sample is .354which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental groups and control groups girls does not differ significantly for the component comprehending the problem .

Comprehending the Problem ,Me_{Exp}=5.313, M_{cont} = .354, t=0339,$p>.05$

Clarifying the problem. The t value obtained for the component Clarifying the problem for the total sample is 2.082 which is greater than the table value 1.98 at .05 level of significance. The result indicated that the experimental groups and control groups girls differ significantly for the component clarifying the problem for the total sample

Clarifying the problem ,Me_{Exp}=8.679, M_{conI} = 9.431, t=2.082,$p<0.05$

Finding solution to the problem. The t value obtained for the component Finding solution to the problem for the total sample is 8.169 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental groups and control groups girls differ significantly for the component Finding solution to the problem.

Finding solution to the problem ,Me_{Exp}=8.169, M_{cont} = 9.117, t=8.169,$p<.01$

Result 30. Mean Retention scores on Problem Solving Ability in Physics (Component-wise and Total) between the Experimental Group total and Control Group total does not differ significantly for the total score and one of the component Comprehending the problem.

Total score. Mean difference analysis was used to determine whether there is a significant difference in the overall Retention scores on Problem Solving Ability in Physics for the experimental group and the control group.

The findings showed that, for the total sample, there is no significant difference in the mean retention scores for Problem Solving Ability in Physics (total score and the component grasping the problem) between the Experimental group total and the control group total.

The graphical representation of mean retention scores on Problem Solving Ability in Physics between experimental group total and control group total also proved that the two groups are not different.

The t value obtained for the mean retention scores on Problem Solving Ability in Physics (total score) for the total sample is .820 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental group total and control group total does not differ significantly in mean retention scores (total)for the total sample.

Problem Solving Ability in Physics(retention), Me_{Exp}=22.395, M_{cont} = 21.988, t=.820,$p>.05$

Component wise comparison of Retention Scores on Problem Solving Ability in Physics before control are given below:

Comprehending the problem. The t value obtained for the component Comprehending the problem for the total sample is 1.001 which is less than the table value 1.98 at .05 level of significance. The result indicated that the experimental group totaland control group total does not differ significantly for the component comprehending the problem for the total sample

Comprehending the Problem ,Me_{Exp}=5.220, M_{contI} = 5.5.357, t=1.001,$p>.05$

Clarifying the problem. The t value obtained for the component Clarifying the problem for the total sample is 2.766 which is greater than the table value 2.58 at .01 level of significance. The result indicated that the experimental group total and control group total differ significantly for the component clarifying the problem .

Clarifying the problem ,Me_{ExI}=8.279, M_{cont} = 9.035, t=2.766,$p<0.01$

Finding solution to the problem. The t value obtained for the component Finding solution to the problem for the total sample is 2.947 which is greater than the table value 2.58 at ..01 level of significance. The result indicated that the experimental group total and control group total differ significantly for the component Finding solution to the problem for the total sample

Finding solution to the problem, Me_{Exp}=8.000, M_{cont}= 8.690, t=2.947, $p<.01$

Conclusion of the Results of Mean Difference Analysis

The pre-tested groups had significantly different mean Problem Solving Ability score and Gain scores. However, the mean pre-test and retention scores were determined to be not significant. High scores in Problem Solving ability in Physics and gain scores were associated with Experimental Group. That means the experimental group using the Productive Thinking Model scored better than the control group using the Existing Method of Teaching.

There was a significant difference in the average post-test scores for problem Ability in physics for the pre-tested groups as well. But no significant difference was obtained in their retention scores. Experimental group II has high Problem Solving Ability score than the control group I which also high spot the advantage of Productive Thinking Model over Existing Method of Teaching.

Here, the investigator compared all the four groups in terms of pos-test in Problem Solving Ability in Physics. and it was found that in each comparison the experimental groups has got high mean score in Problem Solving Ability in Physics than the control groups which was taught through Existing Method of Teaching. It clearly shows the advantage of experimental groups over control groups as a result of introduction of Productive Thinking Model.

Analysis of Covariance for Problem Solving Ability in Physics

After controlling the covariates (pre-experimental status in terms of problem-solving ability in physics and Self-Concept, verbal intelligence, and socio-economic status), both separately and together for the total sample, ANCOVA was performed to determine the efficacy of the Productive Thinking Model over the Existing Method of Teaching in cases of problem-solving ability in physics, self-concept, and retention. The results are presented here.

Analysis of Covariance for Problem Solving Ability in Physics for Pre-tested Group.

Result 31. There exist significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability of pre-tested experimental and control group when pre-test in Problem Solving Ability in Physics as covariate.

The obtained F (1,87) is 188.189 for the effect of Productive Thinking Model on Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Problem Solving Ability in Physics is significant among IXth standard students after controlling pre-test scores, $F(1,87) = 118.189$, $p<.01$

Thus, when a linear adjustment is made for the effect of variation caused by the difference in the Pre-test score on Problem Solving Ability in Physics, the ANCOVA results show that there is a statistically significant difference between the two experimental and control groups.

Result 32. There exist significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability of pre-tested experimental and control group when Verbal Intelligence as covariate.

The obtained F (1,87) is 57.170 for the effect of Productive Thinking Model on Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Problem Solving Ability in Physics is significant among IXth standard students after controlling Verbal intelligence, $F(1,87) = 57.170, p<.01$.

Thus, when a linear adjustment is made for the influence of variance due to the difference in Verbal intelligence on Problem Solving Ability in Physics, the ANCOVA results show that there is a statistically significant difference between the two experimental and control groups.

Result 33. There exist significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability of pre-tested experimental and control group when Socio-Economic status as covariate.

The obtained F (1,87) is70.870 for the effect of Productive Thinking Model on Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Problem Solving Ability in Physics is significant among IXth standard students after controlling Socio-Economic status , $F(1,87) = 70.870, p<.01$

Thus, when a linear adjustment is made for the influence of variance due to the difference in Socio-Economic status on Problem Solving Ability in Physics, the ANCOVA results show that there is a statistically significant difference between the two experimental and control groups.

Result 34. There exist significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability of pre-tested experimental and control group when pre-test, Verbal intelligence and Socio-Economic status as covariate in combination.

The obtained F (1,85) is 130.688 for the effect of Productive Thinking Model on Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Problem Solving Ability in Physics is significant among IX standard students after controlling the total effect of 3 covariates (pre-test, Verbal Intelligence, socio-Economic status), $F(1,85) = 130.688$, $p<.01$.

Therefore, when a linear adjustment is made for the effect of variation due to the difference in Pre-test scores, verbal intelligence, and socio-economic status as combination on Problem Solving Ability in Physics, the ANCOVA results show that there is a statistically significant difference between the two experimental and control groups.

Analysis of Covariance for Problem Solving ability in Physics for Pre-test Received Group.

Result 35. There exist significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability of non pre-tested experimental and control group when pre-test in Problem Solving Ability in Physics as covariate.

The obtained F (1,77) is 27.916 for the effect of Productive Thinking Model on Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking

Model on Problem Solving Ability in Physics is significant among IX standard students after controlling Verbal intelligence of non pre-tested group, $F(1,77) = 27.916$, $p<.01$

Therefore, the ANCOVA results indicate that there is a statistically significant difference between the two experimental and control groups when a linear adjustment is made for the effect of variation due to the difference in Verbal intelligence of non pre-tested groups.

Result 36. There exist significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability of non pre-tested experimental and control group when Socio-Economic status as covariate.

The obtained $F(1,77)$ is 27.899 for the effect of Productive Thinking Model on Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Problem Solving Ability in Physics is significant among IX standard students after controlling Socioeconomic status of non pre-tested group , $F(1,77) = 27.899$, $p<.01$

Thus, when a linear adjustment is made for the effect of variation caused by the difference in Socio-Economic status of non-pre-tested groups, the ANCOVA results show that there is a statistically significant difference between the two experimental and control groups.

Result 37. There exist significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability of non pre-tested experimental and control group when Verbal Intelligence and Socio-Economic status as covariate in combination

The obtained F (1,76) is 26.582 for the effect of Productive Thinking Model on Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Problem Solving Ability in Physics is significant among IX standard students after controlling the total effect of 2 covariates (Verbal Intelligence & socio-Economic status), $F(1,85) = 130.688$, $p<.01$

Thus, when a linear adjustment is made for the effect of variation caused by the difference in the combination of Verbal Intelligence and Socio-Economic status of pre-tested groups, the ANCOVA results show that there is a statistically significant difference between the two experimental and control groups.

Analysis of Covariance for Self-Concept

Analysis of Covariance for Self-Concept of Pre-tested Groups

Result 38. There exist no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of pre-tested experimental and control group when Pre-test on Problem Solving Ability in Physics as covariate.

F-values for the instructional procedure on Self-Concept were obtained below the tabular value for the 0.05 level of significance. This demonstrates that, once the linear effect of the covariate pre-test is taken into account, there is no longer a statistically significant difference between the criteria means of the groups.

Therefore, when the pre-test in Problem Solving Ability in Physics is taken into account as a covariate, there is no statistically significant difference in Self-Concept between the Experimental and Control groups.

Result 39. There exist no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of pre-tested experimental and control group when Verbal Intelligence as covariate.

F-values for the instructional procedure on Self-Concept were obtained below the tabular value for the 0.05 level of significance. This demonstrates that, once the linear effect of the covariate pre-test is taken into account, there is no longer a statistically significant difference between the criteria means of the groups.

Thus, when verbal intelligence is considered as a covariate, there is no statistically significant difference in Self-Concept between the pre-tested Experimental and Control groups.

Result 40. There exist no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of pre-tested experimental and control group when Socio-Economic status as covariate.

F-values for the instructional procedure on Self-Concept were obtained below the tabular value for the 0.05 level of significance. This demonstrates that, once the linear effect of the covariate pre-test is taken into account, there is no longer a statistically significant difference between the criteria means of the groups.

Consequently, when Socio-Economic status is included as a covariate, there is no statistically significant difference in Self-Concept between the pre-tested Experimental and Control groups.

Result 41. There exist no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of pre-tested experimental and control group when Pre-test, Verbal Intelligence and Socio-Economic status as covariate in combination.

F-values for the instructional procedure on self-concept were obtained below the tabular value for the 0.05 level of significance. This demonstrates that, once the linear effect of the covariate pre-test is taken into account, there is no longer a statistically significant difference between the criteria means of the groups.

Therefore, when pre-test, verbal intelligence, and Socio-0Economic level are combined as covariates, there is no statistically significant difference in Self-Concept between the Experimental and Control groups that underwent pre-testing.

Analysis of covariance for self-Concept of non pre-tested groups

Result 42. There exist no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of non pre-tested experimental and control group when Verbal Intelligence as covariate.

F-values for the instructional procedure on Self-Concept were obtained below the tabular value for the 0.05 level of significance. This demonstrates that, once the linear effect of the covariate pre-test is taken into account, there is no longer a statistically significant difference between the criteria means of the groups.

Thus, when verbal intelligence is considered as a covariate, there is no statistically significant difference in Self-Concept between the non-pre-tested Experimental and Control groups.

Result 43. There exist no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of non pre-tested experimental and control group when Socio-Economic status as covariate.

F-values for the instructional procedure on Self-Concept were obtained below the tabular value for the 0.05 level of significance. This demonstrates that, once the linear effect of the covariate pre-test is taken into account, there is no longer a statistically significant difference between the criteria means of the groups.

Consequently, when Socio-Economic status is included as a covariate, there is no statistically significant difference in Self-Concept between the non-tested Experimental and Control groups.

Result 44. There exist no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of non pre-tested experimental and control group when Pre-test, Verbal Intelligence and Socio-Economic status as covariate in combination.

F-values for the instructional procedure on Self-Concept were obtained below the tabular value for the 0.05 level of significance. This demonstrates that, once the linear effect of the covariate pre-test is taken into account, there is no longer a statistically significant difference between the criteria means of the groups.

Therefore, when the pre-test, verbal intelligence, and Socio-Economic status are included as covariates, there is no statistically significant difference in Self-Concept between the Experimental and Control groups that did not get the pre-test.

Analysis of Covariance for Retention in Problem Solving Ability in Physics

Analysis of covariance for Retention in Problem Solving Ability in Physics for pre-tested groups

Result 45. There exist significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Retention in Problem Solving Ability of pre-tested experimental and control group when pre-test in Problem Solving Ability in Physics as covariate.

The obtained F (1,87) is 10.571 for the effect of Productive Thinking Model on Retention in Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Retention is significant among IXth standard students after controlling Verbal intelligence, $F(1,87) = 10.571$, $p<.01$

Therefore, ANCOVA results indicate that there is a significant difference between the Pre-tested Experimental and control group when the effect of variation caused by the difference in the Pre-test on Retention in Problem Solving Ability in Physics is linearly adjusted for.

Result 46. There exist significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Retention in Problem Solving

Ability of pre-tested experimental and control group when Verbal Intelligence as covariate.

The obtained F (1,87) is 10.571 for the effect of Productive Thinking Model on Retention in Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Retention is significant among IXth standard students after controlling Verbal Intelligence, $F(1,87) = 10.571$, $p<.01$

Therefore, ANCOVA results indicate that there is a significant difference between the pre-tested experimental and control group when a linear adjustment is made for the influence of variation due to the difference in verbal intelligence on retention in Problem Solving ability in physics.

Result 47. There exist significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Retention in Problem Solving Ability of pre-tested experimental and control group when Socio-Economic status as covariate.

The obtained F (1,87) is12.571 for the effect of Productive Thinking Model on Retention in Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Retention is significant among IXth standard students after controlling Socio-Economic status , $F(1,87) = 12.571$, $p<.01$

As a result, ANCOVA results indicate that there is a significant difference between the experimental and control groups' pre-test scores when the influence of variance resulting from differences in socioeconomic status is linearly adjusted for.

Result 48. There exist significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Retention in Problem Solving Ability of pre-tested experimental and control group when Pre-test in Problem Solving Ability in Physics, Verbal Intelligence and Socio-Economic status as covariate in combination.

The obtained F (1,85) is 15.839 for the effect of Productive Thinking Model on Retention in Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Retention is significant among IXth standard students after controlling the total effect of 3 covariates (pre-test, Verbal Intelligence, socio-Economic status), $F(1,85) = 15.839$, $p<.01$

Therefore, ANCOVA results indicate that the Pre-tested Experimental and control group differ significantly when a linear adjustment is made for the effect of variation due to the difference in the Pre-test, Verbal Intelligence, and Socio-Economic status as combination on Retention in Problem Solving Ability in Physics.

Analysis of covariance for Retention in Problem Solving Ability in Physics for non pre-tested groups

Result 49. There exist significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Retention in Problem Solving

Ability of non pre-tested experimental and control group when Verbal Intelligence as covariate.

The obtained F (1,77) is 6.340 for the effect of Productive Thinking Model on Retention in Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Retention is significant among IX^{th} standard students after controlling Verbal Intelligence, $F(1,77) = 6.340$, $p<.01$

Therefore, ANCOVA results indicate that there is a significant difference between the non-pre-tested Experimental and control group when a linear adjustment is made for the influence of variance due to the difference in Verbal Intelligence on Retention in Problem Solving Ability in Physics.

Result 50. There exist significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Retention in Problem Solving Ability of non pre-tested experimental and control group when Socio-Economic status as covariate.

The obtained F (1,77) is 5.606 for the effect of Productive Thinking Model on Retention in Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Retention is significant among IX^{th} standard students after controlling Socio-Economic status , $F(1,77) = 5.606$, $p<.01$

Therefore, ANCOVA results indicate that there is a significant difference between the non-pre-tested Experimental and control group when a linear adjustment is made for the influence of variation due to the difference in the Socio-Economic status on Retention in Problem Solving Ability in Physics.

Result 51. There exist significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Retention in Problem Solving Ability of non pre-tested experimental and control group when Verbal Intelligence and Socio-Economic status as covariate in combination.

The obtained F (1,76) is 5.951 for the effect of Productive Thinking Model on Retention in Problem Solving Ability in Physics was found beyond the table value for 0.01 level of significance. The result of F-test supports that the effect of Productive Thinking Model on Retention is significant among IXth standard students after controlling the total effect of two covariates (Verbal Intelligence & Socio-Economic status), $F(1,76) = 5.951$, $p<.01$

Therefore, ANCOVA results indicate that there is a significant difference between the non pre-tested Experimental and control group when a linear adjustment is made for the effect of variation due to the difference in Verbal Intelligence and Socio-Economic status as a combination on Retention in Problem Solving Ability in Physics.

Conclusion on the Result of ANCOVA

ANCOVA results also shows that the Pre-tested and non pre-tested groups significantly differed both in their Problem Solving Ability in Physics and Retention. In both cases, Pre-tested and non pre-tested Experimental groups were seen to be Superior over the Control groups. This underlies the advantage of Productive

Thinking Model over Existing Method of Teaching with regard to Problem Solving Ability in Physics.

From the results of analysis it is evident that student who taught through Productive Thinking Model Perform well than that of students who taught through Existing Method of Teaching. It highlights the need for new method or way of teaching other than existing one.

Tenability of Hypotheses

This study evaluates the tenability of its hypotheses based on major findings.

Hypothesis 1

There will be no significant difference in mean post-test scores on Problem Solving ability in physics of experimental and control group Total sample, Boys and Girls .

The analysis of data revealed that there is significant difference between the mean post-test scores of experimental and control groups on Problem Solving Ability in Physics for the total sample. Also there exists significant difference exists between the mean post-test scores of experimental and control groups Boys and Girls. So it can be concluded that the experimental and control groups differ significantly in their mean post-test scores on Problem Solving Ability in Physics for the total sample.

The results revealed that experimental group which was taught using Productive Thinking Model was found more effective in enhancing Problem Solving Ability in Physics of IX standard students when compared to control group which was taught using Existing Method of Teaching. So, it can be stated that Productive

Thinking Model is more effective in enhancing Problem Solving Ability in Physics. Thus the null hypothesis formulated is rejected.

Hypothesis 2

There will be no significant difference in the mean gain scores on Problem Solving Ability in physics of experimental group I and control group II for Total sample, Boys and Girls.

The analysis of data revealed that there is significant difference between the mean Gain scores of experimental and control groups on the dependent variable Problem Solving Ability in Physic for the total sample. Significant difference in Gain score exists for Boys and Girls also. So it can be concluded that the experimental and control groups differ significantly between their mean Gain scores Problem Solving Ability in Physics for the total sample.

The results revealed that experimental group which was taught using Productive Thinking Model was found more effective in enhancing Problem Solving Ability in Physics for Ix standard students when compared to control group taught using Existing method of teaching. So it can be stated that Productive Thinking model is more effective in enhancing Problem Solving Ability in Physics. Thus the null hypothesis formulated is rejected

Hypothesis 3

There will be no significant difference in the retention scores on Problem Solving ability in physics of experimental and control group Total sample, Boys and Girls.

The analysis of data revealed that there is no significant difference between the mean Retention scores of experimental and the control group on Retention in Problem Solving Ability in Physics for the total sample and also experimental and control group Boys and Girls. So it can be concluded that the experimental and control groups not differ significantly between their mean scores on Retention in Physics for the total sample. Thus the null hypothesis formulated is accepted.

Hypothesis 4

There will be no significant difference in the Self-Concept scores of experimental and control group for the total sample, Boys and Girls.

The analysis of data revealed that there is no significant difference between the mean Self-Concept scores of experimental and the control group for the total sample and also experimental and control group Boys and Girls. So it can be concluded that the experimental and control groups does not differ significantly between their mean scores on self-Concept for the total sample for the boys and girls also there is no significant difference in self-Concept scores.

So it can be stated that Productive Thinking Model is not much effective in enhancing Self-Concept of students. Thus the null hypothesis formulated is accepted.

Hypothesis 5

There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability of pre-tested experimental and control group.

ANCOVA was used to test this hypothesis. All together four ANCOVA was done for Problem Solving Ability in Physics .the covariates selected were Pre-test, Verbal Intelligence, Socio-Economic status and the combination of the three . Four out of four ANCOVA employed, yielded significant F- values. In all the four comparisons higher mean scores of Problem Solving Ability in Physics associated with the Experimental groups to which Productive Thinking Model was implemented. Thus Productive Thinking model proved its advantage over the existing method of teaching with regard to Problem Solving Ability in Physics. Therefore the hypothesis is rejected.

Hypothesis 6

There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Problem Solving Ability of non pre-tested experimental and control group.

ANCOVA was used to test this hypothesis. All together three ANCOVA was done for Problem Solving Ability in Physics .the covariates selected were, Verbal Intelligence, Socio-Economic status and the combination of the two .three out of three ANCOVA employed, yielded significant F- values. In all the three comparisons higher mean scores of Problem Solving Ability in Physics associated with the Experimental groups to which Productive Thinking Model was implemented. Thus Productive Thinking Model proved its advantage over the Existing Method of Teaching with regard to Problem Solving Ability in Physics. Therefore the hypothesis is rejected.

Hypothesis 7

There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of pre-tested experimental and control group.

ANCOVA was used to test this hypothesis. All together four ANCOVA was done for self concept .the covariates selected were Pre-test, Verbal Intelligence, Socio-Economic status and the combination of the three . Four out of four ANCOVA employed, yielded F- values which are not significant. Thus Productive Thinking Model is not that effective over the Existing Method of Teaching with regard to Self-Concept of students. Therefore the hypothesis is accepted.

Hypothesis 8

There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on Self-Concept of non pre-tested experimental and control group.

ANCOVA was used to test this hypothesis. All together three ANCOVA was done for Self-Concept. the covariates selected were Verbal Intelligence, Socio-Economic status and the combination of the three. Three out of three ANCOVA employed, yielded F- values which are not significant. Thus Productive Thinking Model is not that effective over the Existing Method of Teaching with regard to Self-Concept of students. Therefore the hypothesis is accepted.

Hypothesis 9

There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on retention in Problem Solving Ability and Self-Concept of pre-tested experimental and control group.

ANCOVA was used to test this hypothesis. All together four ANCOVA was done for retention in Problem Solving Ability in Physics .the covariates selected were Pre-test, Verbal Intelligence, Socio-Economic status and the combination of the three . Four out of four ANCOVA employed, yielded significant F- values. In all the four comparisons higher mean scores of retention in Problem Solving Ability in Physics associated with the Experimental groups to which Productive Thinking Model was implemented. Thus, Productive Thinking Model proved its advantage over the Existing Method of Teaching with regard to retention in Problem Solving Ability in Physics. Therefore, the hypothesis is rejected.

Hypothesis 10

There will be no significant difference in the effectiveness of Productive Thinking Model and Existing Method of Teaching on retention in Problem Solving Ability and Self-Concept of non pre-tested experimental and control group.

ANCOVA was used to test this hypothesis. All together three ANCOVA was done for Retention in Problem Solving Ability in Physics. The covariates selected were, Verbal Intelligence, Socio-Economic status and the combination of the two .three out of three ANCOVA employed, yielded significant F- values. In all the three comparisons higher mean scores of Retention in Problem Solving Ability in Physics associated with the Experimental groups to which Productive Thinking Model was implemented. Thus, Productive Thinking Model proved its advantage over the Existing Method of Teaching with regard to Retention in Problem Solving Ability in Physics. Therefore, the hypothesis is rejected.

Conclusion

The investigator made conclusions based on the study's objectives. The study reveals that Productive Thinking Model is more effective than Existing Method of Teaching for developing Problem Solving Ability in Physics of secondary school students. Research sample for experiment were equal in terms of their pre-test scores, Intelligence and Socio-Economic status. Both groups received the identical lessons, but were treated differently. Results shows that the Productive Thinking Model is more effective to inculcate Problem Solving Ability in Physics and it is a very interesting and engaging model of teaching to teach science contents specifically Physics subject.

The present study has revealed the effectiveness of Productive Thinking Model over Existing Method of Teaching, as the high mean scores are linked with the groups to which Productive Thinking Model was executed in terms of Problem Solving Ability in Physics and Self-Concept.

Chapter VI

RECOMMENDATIONS OF THE STUDY

- Educational Implications derived
- Productive Thinking Model
- Suggestions for further research
- Recommendations

RECOMMENDATIONS OF THE STUDY

Educational Implications derived

The primary goal of this study was to compare the effectiveness of the Productive Thinking Model to the Existing Method of Teaching on Students' Self-Concept and Problem-Solving Ability in Physics at the IX Standard. The study's conclusions are used to infer some implications that will help the secondary schools in educational system.

Productive Thinking Model

Form this study, it is evident that the Experimental group I and II taught using Productive Thinking Model is more effective when compared to the Existing Method of Teaching in the two controlled groups. This may be because of the features of the particular model. Productive Thinking Model is a synchronized fusion of analytical and creative thinking. This model also encourages creativity and critical thinking at every step of the Problem Solving process. IX standard students come under secondary school students and they have wide range of thinking capacity which helps easy and fast learning. Particularly in physics classes, a teacher who employs the same approach or method for the entire academic year may cause students to get bored, uninterested, unmotivated, etc.

In contrast to the existing Method of Teaching, the Productive Thinking Model was a ground-breaking breakthrough in the teaching and learning process. Physics can be taught in secondary schools using the Productive Thinking Model.

Productive Thinking Model have its own difference from Existing Method of Teaching. Students taught using Productive Thinking Model was better in Problem Solving Ability and self-Concept than the control group. Students were able to debate the material in their groups using the various phases of the Productive Thinking Model when they were unable to understand the broad explanation given in class. The study's findings indicate that student involvement and communication have increased.

Additionally, the Productive Thinking Model facilitates productive student communication. It is evident that the teacher, the groups of students, and the students themselves were developing their interactions. That mean intra-group, inter-group and teacher student interaction is found great. Apart from the autocratic setting teacher plays entirely a different role here. Teacher build bond with students in different forms like dividing the group, giving direction, giving follow up activities, clarification of doubts and through the process of evaluation.

In addition, this model takes into consideration the intellectual, emotional, social, and psychological benefits of nurturing. As a result of their active participation in the classroom, students develop the self-Concept and Problem Solving Abilities necessary to address today's critical issues.

The study also showed that, while teaching Physics to students in the IX standard, the Productive Thinking Model significantly outperforms the Existing

Method of Teaching, regardless of gender. So, undoubtedly Productive Thinking Model can be used for teaching Physics irrespective of Gender of the students. In addition, Productive Thinking Model is found to be effective for different topics of physics namely 'Motion', 'forces' and 'examples of laws of motion' which indicates that this strategy is applicable to different areas of secondary school physics topics.

In addition to academic success, it encourages students to develop other values that they lack, such as sharing, problem-solving skills, tolerance, helping attitudes, and leadership abilities. Despite the activity-based structure of the current curriculum, teachers can adapt the concepts to make them more applicable to real-world situations.

Productive Thinking Model is a flexible model consisting of 6 different steps. Each steps foster the thinking capacity, idea formulation, stability of thoughts, evaluation of own ideas and decision making power of students. it is also designed to increase students involvement in topics, better interaction with classmates that will help the teacher to attain the objectives easily. The Productive Thinking Model does not mandate a specific method or strategy to be used in a typical classroom setting. And the student can learn at their own pace. This Model creating cooperative and positive attitude towards learning.

Productive Thinking Model involves problem solving, creativity, and critical thinking. When students engage in these activities, they often feel more competent and capable, which enhance their self esteem and self concept. As student practice productive thinking model they become more independent in their learning. This autonomy fosters a sense of ownership and pride in their achievements, contributing positively to their self concept.

Productive Thinking Model helps to motivate and give enough confidence to students. As all the students in the class have equal opportunities to think out of the box and make as many ideas as possible on a topic. It also emphasis student based learning and giving opportunity to students to evaluate the ideas generated to fix the right one and find solution to the problem in hand by themselves. It will help the students to solve problems through creative and Productive way and there by improves their higher level thinking capacity.

Productive Thinking Model is common in marketing field, but it has long ways to go in the field of teaching and learning. Proper implementation and addressing of Productive Thinking Model to the present educational system can do more wonders in each and every aspects of teaching and learning.

Suggestions for further research

The researcher anticipates that this investigation will offer fresh perspectives on experimenting with the as-yet-undiscovered aspects of the variables being examined.

1. A survey can be conducted to study the attitude of teachers towards Productive Thinking Model.

2. A detailed survey study can be conducted to know the constraints facing by the teachers while teaching Physics in IX standard

3. Learning Packages on Productive Thinking Model can be developed and its impact can be studied

4. Effect of Productive Thinking Model over Existing Method of Teaching on Achievement in Physics, Attitude towards Physics and self efficacy in Physics (both cognitive and affective outcomes) can be studied.

5. This study was delimited to one unit in IX standard Physics text book- Motion and Laws of motion. Future investigation can found the effectiveness of Productive Thinking Model on other topics in Physics.

6. This study concentrated to study the effect of Productive Thinking Model on Problem Solving Ability in Physics and self-Concept of students. Other variables like Achievement, scientific creativity, goal orientation, interest, anxiety and creative thinking can be included.

7. There are similar physics topics in higher secondary level such as, fluid dynamics, electro dynamics etc. which need more freedom to students to think out of the box and create their own ideas. A similar study can be conducted in the higher secondary level

8. Preparation of teaching module on Productive Thinking Model for secondary school teachers. their knowledge and suggestions can be incorporated for the improvement of this Model.

9. This particular study can be replicated in different school subjects and standards with another Experimental design.

Recommendations

The present study has found out the relevance of introducing new model of teaching especially to teach contents in Physics subject. Teachers would like to implement new methods and strategies to instruct students and students are always happy to get the advantage of such methods. From the present study the investigator realize that students are interested in Productive thinking model than existing method of teaching since the experimental groups got highest mean scores than control groups. From the initial survey the investigator found out that teachers are willing to use different methods with respect to the content area also they are aware of such methods or strategies. The study can significantly contribute to the improvement of important skills and abilities among secondary school students. The findings of the study can help the academic community in formulating and implementing strategies, methods and models of teaching aiming for the betterment of curricular practices which enhance different abilities such as Problem Solving ability in Physics among secondary school students. The study recommends the following to enhance Problem Solving ability among students and positive attitude among teachers towards new models and methods of teaching.

- Proper empowerment programs to teachers in order to update their knowledge and skills in Pedagogical practices are to be provided.
- Conduct in-service training on important 21st century skills to make teachers aware of different abilities and skills that are to be inculcate among secondary school students like, Problem Solving ability, self concept etc.

- Every year, school must organize awareness programs on different method and strategies of teaching newly introduced in the field of teaching and learning.
- Promote journal and article reading among teachers in order to make teachers aware of new method of teaching and acquisition of new skills and abilities needed to survive in this changed society.
- Teachers might receive incentives for taking additional courses to improve their pedagogical techniques and skills, leading to increased professional productivity.

REFERENCES

Alam, M. (2017). Study of Effectiveness of Concept Attainment Model of Teaching on Achievement in Science Among Secondary School Students. *International Journal of Advanced Research*, *5*(9), 93–97. https://doi.org/10.21474/ijar01/5305

Alexander, N. (2022). Productive Thinking and the Problem of Creativity of Personality. Collection of Research Papers Problems of Modern Psychology, 56. https://doi.org/10.32626/2227-6246.2022-56

Ambarini, R., Faridi, A., Sukarno, S., & Yuliasri, I. (2023). Tadaluring Microteaching Learning Model: A practical and applicable key to improve teacher students' qualified teaching achievements. *International Journal of Research in Education and Science*, *9*(2), 546–570. https://doi.org/10.46328/ ijres.3102

Annisa, S. A., Lesmono, A. D., & Yushardi, Y. (2020). Comic-Based module development Andro-Web to improve problem solving ability in physics in high school students. *Berkala Ilmiah Pendidikan Fisika,* *8*(1), 40. https://doi.org/10.20527/bipf.v8i1.7641

Athira & Bindhu (2022). Emotional competence and Problem Solving Ability in Physics among secondary school students. *CTEF Annual conference Proceedings*.

Baumeister, R. F. (1998). The self. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), Handbook of social psychology (4th ed., pp. 680–740). New York: McGraw-Hill.

Baumeister, R. F. (1999). The nature and structure of the self: An overview. In R. Baumeister (Ed.), *The self in social psychology* (pp. 1-20). Philadelphia, PA: Psychology Press (Taylor & Francis).

Best, J. W, & Kahn, J.V. (2006). Research in Education (9thed.). New Delhi: Prentice Hall of India Private. Ltd.

Best, J. W. (1977). *Research in education*. Englewood Cliffs, N.J. : Prentice-Hall

Best, J. W. (1977). *Research in education*. Englewood Cliffs, N.J. : Prentice-Hall

Best, J. W., & Kahn, J. V. (2012). Research in education. New Delhi: Prentice Hall of India Private Limited.

Bhakti, B.Y., Astuti, D. A. I., Rahmavati, Y. E. (2020) Improving Students' Problem Solving Ability Through Learning Based Videoscribe. *JIPF (JURNAL ILMU PENDIDIKAN FISIKA)*, 5(2),2477-5959

Bindhu & Alphonsa. (2016). Influence of Self-Concept on Aspiration of Tribal secondary school students. (Un published M.Ed Dissertation, Calicut university, Kerala)

Bloom, B. S. (1956). Taxonomy of educational objectives: The classification of educational objectives, Handbook I: Cognitive Domain. New York: Longmans, Green.

Brady, L. (1985). Models and Methods of Teaching. Prentice-Hall of Australia.

Bransford, J. D., & Stein, B. S. (1984) The ideal problem solver: A guide for improving thinking, learning and creativity (2nded.). New York: W.H. Freeman

Bruner, J. S., & Goodman, C. C.: (1947). "Value and need as organizing factors in perception". The Journal of Abnormal and Social Psychology, 42(1), 33-44.

Burns, R. (1897) To a louse. In, The complete poetical works of Robert Burns. New York: Houghton Mifflin.

Caino, P. C. G., Musso, M. F., Mustafic, M., Greiff, S., & Cascallar E. C. (2017). Cognitive and non cognitive factors: Relationships and effects on complex problem solving. Paper presented at the ICPS conference, Austria. Retrieved from https://www.researchgate.net/publication/315756267. doi:10.13140/RG .2.2.10569.54880

Campbell, L. P. (1995). P.A.C.E - A student problem solving procedure that works. Education, 116 (2), 272-274.

Cervone, D., & Pervin, A. (2011). *Personality: theory and research* (15th ed.). Wiley publishers.

Chang, C., Chang, M., Chiu, B., Liu, C., Chiang, S. F., Wen, C., Hwang, F., Wu, Y., Chao, P., Lai, C., Wu, S., Chang, C., & Chen, W. (2017). An analysis of student collaborative problem solving activities mediated by collaborative simulations. Computers & Education, 114, 222–235. https://doi.org/10.1016/j.compedu.2017.07.008

Chaudhary & Pariksha (2002). A comparative study of the effectiveness of gaming and mastery learning models on students self concept and achievement in teaching of Chemistry (Doctoral dissertation, Maharshi Dayanand University). Retrieved from http://hdl.handle.net/10603/112527

Cooley, C.H.(1912). Human Nature and The Social Order, Scibners, New York. p. 89.

Cuddon, J. A. (2013). *A Dictionary of Literary Terms and Literary Theory*. John Wiley & Sons.

Cunningham, J. B., & MacGregor, J. N. (2013). Productive and re-productive thinking in solving insight problems. The Journal of Creative Behavior, 48(1), 44–63. https://doi.org/10.1002/jocb.40

Dabas, R and K,A. (2000). Effectiveness of Mastery Learning and Inquiry Training Model on pupils Self-concept, creative abilities and achievement in Science (Doctoral dissertation, Maharshi Dayanada university). Retrieved from http:/hdl.handle.net/10603/113024

Davidson, J.E., Deuser, R., & Sternberg, R.J. (1994). The role of metacognition in problem solving, In J. Metcafe., & A.P Shimanura (Eds.), Metacognition: Knowing about Knowing, (pp.207- 226). Cambridge, MA: MIT Press.

Dececco J. P. and Crawford W. R. (1997) , the Psychology of Learning and Instruction, New Delhi , Prentice Hall of India Pvt. , Ltd.

Dewey, J. (1933). How We Think. A Restatement of the Relation of Reflective Thinking to the educative Process (Revised Ed.). Boston: D. C. Health.

Distrik, I. W., Setiawan, W., & Ertikanto, C. (2022b). Building physics concept understanding and problem-solving ability in online learning through concept attainment model. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni, 11*(1), 141–150. https://doi.org/10.24042/jipfalbiruni.v11i1.11775

Duckwoth, K., (1964). Quotations. Retrieved from en.wikipedia.org/wiki/ kevin_Duckworth.

Duncker, K. (1945). On problem solving. (L. S. Lees, Trans). Psychological Monographs, 58 (5). i-113. doi:10.1037/h0093599. Retrieved from http://psychnet.apa.org.

Dunn, R. & Dunn, K. (1990). Learning syles/teaching styles: Should they be matched. Educational leadership.

Ebel, L. & Frisbie, A. (1991). Essentials of educational measurement. U.S.A: Prentice-Hall Inc

Eggen et al (1979, Strategies for teachers , Information Processing Models in Class room, New Jersey , Prentice Hall Of Inc.

Ellah, B., Achor, E. E., &Enemarie, V. (2019). Problem-Solving Skills as Correlates of Attention Span and Working Memory of Low Ability Level Students in Senior Secondary Schools. Journal of Education and eLearning Research, 6(3), 135-141.

Eragamreddy, N. (2013). Teaching creative thinking skills. International Journal of English Language & Translation Studies, 1(2). 91-105.

Erdemir,N. (2009). Determining student's attitude towords Physics through Problem-Solving strategy. Asia-Pacific forum on Science teaching and learning, 10(2), p-1

Ferguson, G.A. (1971). Statistical analysis in psychology and education (3rd ed.). Tokyo: McGraw Hill.

Fischer, B., & Fischer, L. (1979). Styles in teaching & learning. Educational Leadership, 36, 245-254.

Fiteriani, I., Diani, R., Hamidah, A., & Anwar, C. (2021). Project-based learning through STEM approach: Is it effective to improve students' creative problem-solving ability and metacognitive skills in physics learning? *Journal of Physics Conference Series, 1796*(1), 012058. https://doi.org/10.1088/1742-6596/1796/1/012058

Fitts, W.H. (1971). The Self Concept and Self Actualization (1st Ed.). Los Angels:Western Psychological services

Freud, S. (1990). *New introductory lectures on psycho-analysis*. WW Norton.

Gagne, R. M. (1965). The conditions of learning. New York: Holt, Rinechart & Winston.

Gathage, J. K., Embeywa, H., & Koech, P. (2021). The effect of inquiry-based science teaching approach on selfconcept of secondary school physics students in kitui county, Kenya. *African Journal of Education and Practice, 7*(2)

Gebze, D. A., Jumadi, N., & Perwati, S. (2020). Improving problem-solving ability in physics through android-based mobile learning application. *Journal of Physics Conference Series*, 1440(1), 012022. https://doi.org/10.1088/1742-6596/1440/1/012022

Gecas, V. (1991). The self-concept as a basis for a theory of motivation. In J. Howard & P. Callero (Eds.), The self-society dynamic: Cognition, emotion, and Goswami. (Ed.), *Handbook of Childhood Cognitive Development*

Calhoun, G., Kurfiss, J., & Warren, P. (1976). A Comparison of Self-Concept and Self-Esteem of Black and White Boys. *The Clearing House*, *50*(3), 131–133. http://www.jstor.org/stable/30184847

GoI (2005). *National Curriculum Framework 2005*. National Council of Educational Research and Training, Government of India, New Delhi.

GoI (2020). *National Education Policy 2020*. Ministry of Human Resource Development, Government of India, New Delhi.

GoK (2007). *Kerala Curriculum Framework 2007*. State Council of Educational Research and Framework, Government of Kerala, Thiruvananthapuram.

Hayes, J.R. (1989). The complete problem solver (2nded). Hillsdale, NJ: Erlbaum.

Hunt, D. E. (1970). Matching models in education. Toronto: Ontario Institute for Studies in Education.

Hurlock, E.B.(1979). Personality Development . Megraw-Hill Kogakusha, New York p. 93-95.

Hurson, T. (2007) Think Better : An innovators Guide to Productive Thinking. New York: McGraw-Hill. ISBN 0071494936.

Hussain, A., Muhammad, A. & Shakoor, A. (2011). Physics Teaching Methods: Scientific Inquiry v/s Traditional Lecture. *International Journal of Humanities and Social Science*, 1(19), 269-276.

James, W. (1890/1983). The principles of psychology. Newyork, NY:Holt, Rinehart&Winston (original work published in 1890)

Jersild, A.T. (1963).The Psychology of Adolescence, The Macmillan Comp, New York. p. 98.

Jonassen, D. H. (1997). Instructional design model for well structured and ill structured problem solving learning outcomes. Educational Technology: Research and Development, 45(1), 65 – 95.

Jonassen, D. H. (1999). Designing constructivist learning environments. In C. M. Reigeluth (Ed.), Instructional design theories and models: A new paradigm of instructional theory (Vol.2, pp. 215-239). Mahwah, NJ: Lawrence Erlbaum Associates.

Jonassen, D. H. (2000). Toward a design theory of problem solving. Educational Technology: Research and Development. 48(4), 63 –85.

Jonassen, D. H. (2003). Designing research based instruction for story problems. Educational Psychology Review, 15 (3), 267 – 296.

Jonassen, D. H. (2003). Learning to solve problems: An instructional design guide. San Francisco: Willey and Sons, Inc.

Joyce, B., & Marsha, W. (1980). *Models of teaching*. Prentice-Hall of India Private Limited, M-97, Connaught Circus, New Delhi.

Joyce, B., & Weil, M. (1972). *Conceptual complexity, teaching style and models of teaching (By National Council for the Social Studies).* https://files.eric.ed.gov/fulltext/ED073965.pdf

Joyce, B., Marsha, W. and Calhoum, E. (2000). "Models of Teaching", Belmouth USA.

Joyce, B., Weil, M & Showers, B. (1992). Models of teaching, New Delhi: Prentice Hall of India.

Joyce, R. B., Weil, M., & Showers, B. (1992). Models of Teaching (4th ed.). Allyn and Bacon, the University of Michigan.

Kaur, J. (2021). *Impact of problem based learning and concept mapping strategies in science on achievement problem solving ability and self regulated learning skills among ninth class students* (Doctoral dissertation, Panjab University). Retrieved from (2021) . http://hdl.handle.net/10603/331168

Khan, M., & Iqbal, M. Z. (2011). Effect of inquiry lab teaching method on the development of scientific skills through the teaching of Biology in Pakistan. Language in India, 11(1). https://web.p.ebscohost.com/abstract

Kuhn, D. (2010). What is scientific thinking and how does it develop? In U. Goswami. (Ed.), Handbook of Childhood Cognitive Development (Blackwell). Teachers College Columbia University.

Kumar, P. S., & Reshma, P. T. (2006). Effctiveness of peer tutoring and existing method of teaching on achievement and retention in biology of standard VIII pupils (Doctoral dissertation, University of Calicut University, Kerala). Retrieved from http://hdl.handle.net/10603/31073

Kumar, S.P.K., Hameed, A. & Prasanna, A. (1997). Verbal group test of intelligence. Calicut: Department of Education, University of Calicut.

Lali (2020). Effect of jurisprudential inquiry model on self-concept, emotional intelligence and meta cognition of adolescent students in coastal area. (Doctoral dissertation, University of Kerala). Retrieved from http://hdl.handle.net/10603/456826

Lecky, P. (1945). Self-consistency : A theory of personality. Long Island, N. Y, Island press.

Marzano,r.j .(1995).Question Standardized tests measure cognitive skills answer .educational leadership,45-8:66- 73.

Mayer, R. E. & Wittrock, M. C. (2006). Problem solving. In P.A. Alexander & P.H. Winne (Eds.), Handbook of Educational Psychology. Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers, 287-303.

Mayer, R. E. (1992). Thinking, problem solving, cognition (2nded.). New York: W.H. Freeman and Company.

Mayer, R. E. (1992). Thinking, problem solving, cognition (2nded.). New York: W.H. Freeman and Company.

Mayer, R. E. (1998). Cognitive, metacognitive, and motivational aspects of problem solving. Instructional Science, 26, 49–63.

Mayer, R. E., & Wittrock, M. C. (2006). Problem solving. Handbook of Educational Psychology, 2, 287-303

Meacham, J. A., & Emont, N. C. 1989). The interpersonal basis of everyday problem solving. In J. D. Sinnott (Eds.), Everyday problem solving: Theory and applications. (pp.7–23). New York, NY: Praeger Publishers.

Mead, G.(1934). Mind, Self and Society, Univ of Chicago Press, Chicago, p. 34.

Mir, N. D. T. H., & Tandon, N. D. J. K. (2022). Effectiveness of Jurisprudential Inquiry Model of Teaching for Enhancing Achievement in Social Science and Social Tolerance among High School Students. *International Journal of Advanced Research in Science Communication and Technology*, 443–448. https://doi.org/10.48175/ijarsct-3585

Mishra, S.K. (2016) Self-Concept- A persons concept of self- Influence, International journal of recent research Aspects ISSN: 2349-7688, Special issues: Conscientious and Un impeachable Technologies 2016, pp. 8-13

Mouly, J. G. (1963). *The Science of Educational Research*. American Book Company, University of California.

Newell, A., & Simon, H. A. (1972). Human problem solving. Englewood Cliffs, NJ: Prentice-Hall.

Olaniyan, A. O., & Omosewo, E. O. (2015). Effects of a Target-Task Problem-Solving model on senior secondary school students' performance in physics. *Science Education International*, 25(4), 522–538. http://files.eric.ed.gov/fulltext/EJ1086539.pdf.

Oyserman, D., Elmore, K., & Smith, G. (2012). Self, self- concept, and identity. In M. R. Leary & J. P. Tangney (Eds.), Handbook of self and identity (2nd ed., pp. 69–104). New York: Guilford Press.

Paliwal, A. (2014), Comparison of Inquiry Training Model and Concept Attainment Model interms of Tolerance of Ambiguity and Inductive Reasoning among IX Class Students of M.P. Board (unpublished doctoral dissertation), Devi Ahilya Vishwavidyalaya, Indore.

Palloan, P., Usman, U., & Hakim, A. (2021). The influence between Self-Concept and emotional intelligence on the ability of physics problem solving. *Jurnal Pendidikan Fisika Indonesia*, 17(1), 31–39. https://doi.org/10.15294/jpfi.v17i1.26111

Passi,B.K., Singh, L.C., & Sansanwal, D.N. (1991). "Models of teaching : Report of the three –phased study of CAM and ITM. Independent study", NCERT

Pelobillo, G. (2022). Assessment development in measuring students' context-rich problem-solving ability in physics. *International Journal of Instruction*, 15(4), 855–870. https://doi.org/10.29333/iji.2022.15446a

Pinto, R. K. & Clare A. C. (2018). Effect of Autonomous Learner Model on Self-Esteem of Secondary school students with different levels of achievement. I-*Manager's Journal on School Educational Technology, 13*. https://files.eric.ed.gov/fulltext/EJ1269398.pdf

PISA-Programme for International Student Assessment. (2003). Learning for tomorrow's world- First results from PISA 2003. Paris: Organization for Economic Co-operation and Development.

Polya , G. (1981). Mathematics discovery: An understanding, learning and teaching problem solving (combined edition). New York: John Wiley & Son.

Polya, G. (1957). How to Solve It. New York: Double Day & Co, Inc.

Prakash, V. & Bindhu, C.M. (2020). Influence of Big five Factors of Personality on Psychological Resilience and Role Conflict Management among Higher secondary school students of kerala (Doctoral dissertation, Kannur University, Kerala).

Praveen, M. (2006). Effect of Mastery Learning Strategy on Problem Solving Ability in Physics of Secondary School Students (Unpublished Doctoral Dissertation). University of Calicut, Calicut.

Purkey, W. W. & Schmidt, J. J. (1987). The inviting relationship: n expanded perspective for professional counseling. Englewood Cliffs, NJ: Prentice Hall.

Putri, S. A., M, A. S., & Haryandi, S. (2023). The effectiveness of Multimodel-Based physics modules on students' Problem-Solving ability. *Jurnal Ilmiah Pendidikan Fisika*, *7*(1), 173. https://doi.org/10.20527/jipf.v7i1.6863

Qotrunnada, N. A. (2022). Analysis of the difficulties of high school students in improving problem solving ability in physics learning. *International Journal of Current Educational Research, 1*(1), 84–101. https://doi.org/10.53621/ijocer.v1i1.141

Rani, S. (2015). A Comparative Study of Effectiveness of Concept Attainment Model and Memory Model on Students Achievement in English Grammar and Self-concept, (Doctoral dissertation, Chaudary Devi Lal University). Retrieved from (2015)

Rawat, H. (2011). Teaching of science. Delhi: Chawla Offset Printers.

Reddy, M.V.B., & Panacharoensawad, B. (2017). Students Problem-Solving Difficulties and Implications in Physics: An Empirical Study on Influencing Factors. *Journal of Education and Practice*, *8*(14). Retrieved from www.iiste.org.

Rekha, K. (1988). A study of the effectiveness of the piagetian model of teaching for the development of Problem Solving Ability in secondary school students. M Ed Thesis. University of Calicut.

Rokhmat, J., Hikmawati, N., Kosim, N., Wahyudi, N., & Sari, Y. (2022). The influence of causalitic-learning model on problem-solving ability in terms of students' mastery of physics concepts. *Journal of Physics Conference Series, 2165*(1), 012051. https://doi.org/10.1088/1742-6596/2165/1/012051

Romiszowski, A.J. (1981), Designing Instructional Systems: decision making in course planning and curriculum design, London: Kogan Page.

Sadler-Smith, E. (2015). Wallas' four stage model of the creative process: More than meets the eye? Creativity Research Journal, 27(4),342-352. doi:10.1080/ 10400419.2015.1087277.

Saleh, S. (2014). Malaysian Students' Motivation towards Physics Learning. European Journal of Science and Mathematics Education, 2, 223-232.

Sapriyadin, D., Sutopo, S., & Wisodo, H. (2023). Influence of inquiry learning on concept mastery ability and physics problem solving ability of students on work and energy material. *Journal Penelitian Pendidikan IPA, 9*(2), 734–744. https://doi.org/10.29303/jppipa.v9i2.3253

Setiawan, B., Rachmadtullah, R., Nulhakim, L., Wahyudiana, E., & Iasha, V. (2022). The utilization of augmented reality on online learning: The impact for students' physics problem-solving ability. *AIP Conference Proceedings.* https://doi.org/10.1063/5.0103173

Sheldon, K. M., Ryan, R. M., Rawsthorne, L. J., & Ilardi, B. (1997). Trait self and true self: Cross-role variation in the Big-Five personality traits and its relations with psychological authenticity and subjective well-being. *Journal of Personality and Social Psychology, 73*, 1380–1393.

Simbolon, M., Sinaga, P., & Utari, S. (2017). Effect of Application of Physics Learning material Using Multimode representation to Improve Problem Solving Ability. *Advances in Social Science, Education and Humanities Research (ASSEHR), 57*.

Singh, J. & Kaushik, V. (2020). The study of the effectiveness of the inquiry based learning method in chemistry teaching learning process. *Turkish Journal of Computer and Mathematics Education (TURCOMAT), 11*(3), 867-875.

Siregar, N. (2017). Problem solving ability of students mathematics in problem based learning. *Journal of Educational Science and Technology (EST)*, 185–189. https://doi.org/10.26858/est.v3i3.4475

Siswanto, J., Susantini, E., & Jatmiko, B. (2018). Practicality and Effectiveness of the IBMR Teaching Model to Improve Physics Problem Solving Skills. *Journal of Baltic Science Education, 17*(3), 381–394. https://doi.org/10.33225/jbse/18.17.381

Smith, M. U. (1991). Toward a unified theory of problem solving. Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Smitha, R., & Praveen, M. G. (2018). Problem Solving Ability and Achievement Motivation among Secondary School Students. *Indian Journal of Applied Research, 8* (10), 66-68. doi:10.15373/2249555X.

Smitha, R., & Praveen, M. G. (2019). The interaction effect of Gender, locale and type of management of the school on the problem solving ability of the higher secondary school students. *IOSR Journal of Research & Method in Education, 9* (1), 27-32. DOI: 10.9790/7388-0901012732.

Smitha, R., and Manoj Praveen, G., (2018). Problem Solving Ability and Achievement Motivation among Secondary School Students. *Indian Journal of Applied Research, 8*(10). Retrieved from https://www.researchgate.net/publication/ 331960742_Problem_Solving_Ability_And_Achievement_Motiva tion_Among_Secondary_School_Students

Sternberg, R. J. (1984). A contextualist view of the nature of intelligence. *International Journal of Psychology, 19*(1-4), Retrieved from http://doi.org/ 10.1080/00207598408247535.

Sternberg, R. J., & Frensch, P. A. (1991) Complex problem solving: Principles and mechanisms. Hillsdale NJ Lawrence Erlbaum Associates.

Stets, J. E., & Burke, P. J. (2003). A sociological approach to self and identity. In M. R. Leary & J. P. Tangney (Eds.), Handbook of self and identity (pp. 128–152). New York: Guilford Press. action (pp. 171–188). Cambridge: Cambridge University Press.

Suryaneli, S., Sudjarwo, S., & MSinaga, R. (2021). Critical thinking skills and student self concept on student learning outcomes by applying the inquiry model. *International Journal of Multicultural and Multireligious Understanding, 8*(8), 12. https://doi.org/10.18415/ijmmu.v8i8.2790

Suryani, Y., Distrik, I. W., & Suyatna, A. (2018b). The Practicality and Effectiveness of Student Worksheet Based Multiple Representation to Improve Conceptual Understanding and Students' Problem-Solving Ability of Physics. *International Journal of Research-GRANTHAALAYAH, 6*(4), 166–173. https://doi.org/10.29121/granthaalayah.v6.i4.2018.1639

Sutha, N., & Vanitha, J. (2017). A Study on Problem Solving Ability and Achievement in Physics of Higher Secondary Students in Coimbatore District. *International Journal of Research – GRANTHAALAYAH, 5*(6).

Taneja, R. (1989). Dictionary of Education. Anmol Publication Murare New Dehli, India. p. 155. (2) (PDF) Difficulties Encountered By Science Teachers During Teaching Concepts Of Science. Available from: https://www.researchgate.net/publication/3126234

Thorndike, E. L. (1898). Animal intelligence; An experimental study of the associative processes in animals. Psychological Monographs: General and Applied, 2 (4), 1-109 http://dx.doi.org/10.1037/h0092987.

Titus & Bincy. (2016). Effectivenes of synectics model and Gaming strategy on Achievement and creativity in mathematics among Secondary school students. (Doctoral dissertation, Mahathma Gandhi university). Retrieved from. http://hdl.handle.net.10603/195032

Turnip, B., Wahyuni, I. & Tanjung, Y.I. (2016). The Effect of Inquiry Training Learning Model Based on Just in Time Teaching for Problem Solving Skill. *Journal of Education and Practice, 7*(15), 177-181. https://files.eric.ed.gov/fulltext/EJ1103095.pdf

Tyas, L., Harjana, H., & Wahyuningsih, D. (2021). Need analysis for the development of STEM-PJBL Physics teaching materials to improve students' problem solving ability in the 21st century. *International Journal of English Literature and Social Sciences, 6*(1), 402–406. https://doi.org/10.22161/ijels.61.51

Varshney, A. K. (2017). Comparative study of effect of inquiry training model and conventional method of teaching on achievement in science of secondary school students. https://www.semanticscholar.org/paper/Comparative-Study-of-Effect-of-Inquiry-Training-and-Varshney/79d2ff5edcfe477a177e0b5dab4a6e9c85724042

Wallas, G. (1926). The art of thought. London: Jonathan Cape.

Wood, P. K. (1983). Inquiring systems and problem structure: Implications for cognitive development. Human Development, 26(5), 249 -265

Yulindar, A., Setiawan, A., & Liliawati, W. (2018). Enhancement of problem solving ability of high school students through learning with real engagement in active problem solving (REAPS) model on the concept of heat transfer. *Journal of Physics Conference Series, 1013*, 012052. https://doi.org/10.1088/1742-6596/1013/1/012052

APPENDICES

Appendix I

DEPARTMENT OF EDUCATION

UNIVERSITY OF CALICUT

SEMI STRUCTURED INTERVIEW SCHEDULE FOR SECONDARY SCHOOL PHYSICS TEACHERS

Dr. Bindhu C.M.	**Athira V**
Professor & Head	Research Scholar
Department of Education	Department of Education

Name of the Teacher :.. Gender : ....

Name of the Institution :................................... Type of the Institution : ....

Educational Qualification :.................................... Year of Experience : ....

1. Do you adopt any specific strategy to teach Physics at Secondary Level?

   ____

2. Suggest some of the strategy , methods and Models that you have attempted to teach Physics at Secondary level.

   ____

   ____

3. Have you ever experienced any constraints while adopting the Strategies, Methods and Models you suggested?

   ____

   If yes, what are the constraints you faced?

   ____

   ____

4. Give you suggestions to overcome the constraints in implementing the different strategies, Methods and Models

   ____

   ____

   ____

Appendix II

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

LESSON TRANSCRIPT BASED ON PRODUCTIVE THINKING MODEL (Malayalam Version)

Dr. C.M. Bindhu	**Athira. V**
Professor & Head	Research Scholar
Department of Education	Department of Education

LESSON TRANSCRIPT NO. 1

Name of the Teacher	:	Athira. V			
Name of School	:	Poyilkkavu HSS			
Class	:	IX Std.			
Unit	:	ചലനവും ചലന നിയമങ്ങളും	Time	:	1 hr
Topic	:	സന്തുലിതബലവും അസന്തുലിത ബലവും	Date	:	

Objectives

- നിത്യജീവിതത്തിൽ വ്യത്യസ്ത ബലങ്ങൾ പ്രയോഗിക്കപ്പെടുന്ന സന്ദർഭങ്ങൾ തിരിച്ചറിയൽ
- സന്തുലിതബലവും അസന്തുലിതബലം എന്നീ ആശയങ്ങൾ മനസ്സിലാക്കൽ
- സന്തുലിതബലവും അസന്തുലിതബലവും അളക്കുന്നത് കണ്ടെത്തൽ
- സന്തുലിതബലവും അസന്തുലിതബലവും തരംതിരിക്കൽ

Resources

- Videos, Demonstration

Presentation

1) Foundation അദ്ധ്യാപിക രണ്ട് വ്യത്യസ്ത സന്ദർഭങ്ങൾ കുട്ടികൾക്കു മുൻപിൽ ഒരു Demonstration ൽ കൂടെ അവതരിപ്പിക്കുന്നു.	ഈ രണ്ടു സന്ദർഭങ്ങളെക്കുറിച്ചും ഓരോ കുട്ടികളും തന്റെ മുന്നറിവുകൾ ഓർത്തെടുത്ത്

<table>
<tr>
<td>(i) രണ്ടു കുട്ടികൾ ഒരു വലിയ കല്ല് ഒരേ വശത്ത്നിന്നും തള്ളുമ്പോൾ കല്ല് ചെറുതായി നീങ്ങുന്നു. വേറൊരു കുട്ടി മറുവശത്ത്നിന്നും തള്ളുമ്പോൾ കല്ലിന്റെ അനക്കം കുറയുന്നു.
(ii) ഒരു കല്ലിന്റെ രണ്ടുവശത്തുനിന്നും കുട്ടികൾ നീക്കുമ്പോൾ കല്ല് നീങ്ങുന്നില്ല.</td>
<td>ഉത്തരം കണ്ടെത്താൻ ശ്രമിക്കുന്നു. കാരണം അറിയാനുള്ള ജിജ്ഞാസ അവരിൽ ഉളവാകുന്നു.</td>
</tr>
<tr>
<td>

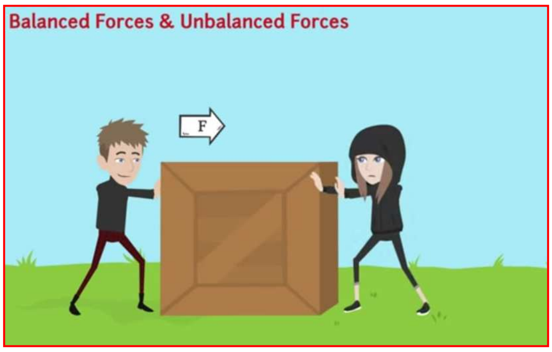
2) Ideation

രണ്ട് വീഡിയോകൾ പ്രദർശിപ്പിക്കുന്നു.

Video 1

ഒരു വടംവലി മത്സരത്തിൽ ഓരോ വശത്തുനിന്നും ആളുകൾ പ്രയോഗിക്കുന്ന ബലം ആനിമേഷനിലൂടെ കാണിക്കുന്നു. വടത്തിന്റെ ചലനവും കാണിക്കുന്നു.

Video 2



ഒരു വലിയ മേശ രണ്ട് വശത്തുനിന്നും വ്യത്യസ്ത ബലം പ്രയോഗിച്ച് തള്ളുന്നത് കാണിക്കുന്നു. മേശയുടെ ചലനം കാണിക്കുന്നു.

</td>
<td>കുട്ടികളിൽ ഇതുമായി ബന്ധപ്പെട്ട് വിവിധ idea കൾ ഉണ്ടാവുന്നു. അവർ ചർച്ച ചെയ്ത് അവയെല്ലാം സയൻസ് ഡയറിയിൽ കുറിക്കുന്നു. ഇതിനായി കുട്ടികൾ അവരുടെ മുന്നറിവുകൾ പ്രയോജനപ്പെടുത്തുന്നു.</td>
</tr>
</table>

കുട്ടികളെ വ്യത്യസ്ത ഗ്രൂപ്പുകളായി തിരിച്ച് ഈ സന്ദർഭങ്ങൾ നിരീക്ഷിച്ച് എന്തായിരിക്കും കാരണം എന്ന് ചർച്ച ചെയ്ത് അനുമാനങ്ങൾ രേഖപ്പെടുത്താൻ ആവശ്യപ്പെടുന്നു.	
3) Evaluation അദ്ധ്യാപിക ഒരു demonstration ൽ കൂടി മുൻപ് കാണിച്ച വീഡിയോ ക്ലാസ്സിൽ ചെയ്തുകാണിക്കുന്നു. കാണിക്കുന്നതിനിടയിലൂടെ ചോദ്യങ്ങൾ കുട്ടികളോടു ചോദിക്കുകയും അവയുടെ ഉത്തരം demonstrationൽ കൂടി വ്യക്തമാക്കുകയും ചെയ്യുന്നു.	ഓരോ ഗ്രൂപ്പിലുള്ള കുട്ടികളും താൻ രേഖപ്പെടുത്തിയ അനുമാനങ്ങൾ വിശകലനം ചെയ്ത് immature ideaകൾ ഒഴിവാക്കി സ്വയം വിലയിരുത്തി പാകമായ അനുമാനങ്ങൾ മാത്രം സ്വീകരിക്കുകയും രേഖപ്പെടുത്തുകയും ചെയ്യുന്നു. അതിനായി അവർ ഗ്രൂപ്പിൽ പരസ്പരം ചർച്ച ചെയ്യുന്നു. ടീച്ചറുടെ വിശകലനത്തിൽനിന്നും അവരുടെ സംശയങ്ങൾ ധുരീകരിക്കാൻ ശ്രമിക്കുന്നു.
4) Stabilization ഓരോ ഗ്രൂപ്പും തന്റെ നിഗമനങ്ങൾ അവതരിപ്പിക്കുന്നു. തെറ്റുകൾ ടീച്ചർ തിരുത്തുന്നു.	കുട്ടികൾ താൻ കണ്ടെത്തിയ ആശയങ്ങൾ സ്ഥിരപ്പെടുത്തുന്നു. അതായത്, ഇവിടെ demonstration, videos & ടീച്ചർ ക്ലാസ്സിന്റെ തുടക്കത്തിൽ ഉന്നയിച്ച ചോദ്യങ്ങൾ എന്നിവയുടെ ഉത്തരം "സന്തുലിതബലം വസ്തുവിനെ ചലിപ്പിക്കുന്നില്ല, വസ്തു ചലിക്കാൻ അസന്തുലിത ബലം വേണം" എന്ന

	ആശയത്തിൽ എത്തിച്ചേരുന്നു.
5) Implication Video 1 & 2 വിശകലനത്തോടുകൂടി കുട്ടികൾക്കു മുന്നിൽ അവതരിപ്പിക്കുന്നു. or അതേ സന്ദർഭം ക്ലാസ്സിൽ പരീക്ഷണത്തിലൂടെ കാണിച്ച് വിവരിക്കുന്നു (കുട്ടികളെതന്നെ വിളിച്ച് ചെയ്യിപ്പിക്കുന്നു.)	കണ്ടെത്തിയ ആശയങ്ങൾ കുട്ടികൾ ക്രോഡീകരിക്കുന്നു. ശേഷം സന്തുലിതബലം, അസന്തുലിതബലം എന്നീ ആശയങ്ങളും അതിനെ സ്വാധീനിക്കുന്ന ഘടകങ്ങളും കൃത്യമായി organize ചെയ്ത് സയൻസ് ഡയറിയിൽ രേഖപ്പെടുത്തുന്നു.
6) Application ടീച്ചർ താഴെ പറയുന്ന നിത്യജീവിതത്തിലെ ചില സന്ദർഭങ്ങളിൽ കുട്ടി എന്താണ് നിരീക്ഷിക്കുന്നത് എന്ന് സയൻസ് ഡയറിയിൽ രേഖപ്പെടുത്താൻ ആവശ്യപ്പെ ടുന്നു. • കുറേ ആളുകൾ ചേർന്ന് ഭാരമുള്ള ഉരുളൻ കല്ലുകൾ ഒരു ലോറിയിൽ നിന്നും ഇറക്കുന്നു. ഈ സന്ദർഭം അസന്തുലിത ബാഹ്യബലം എന്ന ആശയവുമായി ബന്ധപ്പെടുത്തി വിശകലനം ചെയ്യുക.	

Home Assignment
നിത്യജീവിതത്തിൽ സന്തുലിതവും അസന്തുലിതവുമായ ബാഹ്യബലങ്ങൾ പ്രയോഗിക്കുന്ന സന്ദർഭങ്ങൾ പട്ടികപ്പെടുത്തുക.

LESSON TRANSCRIPT NO. 2

Name of the Teacher	:	Athira. V			
Name of School	:	Poyilkkavu HSS			
Class	:	IX Std.			
Unit	:	ചലനവും ചലനനിയമങ്ങളും	Time	:	1 hr
Topic	:	ഗലീലിയോയുടെ നിരീക്ഷണങ്ങൾ	Date	:	

Objectives

- അസന്തുലിതബലം എങ്ങനെ അളന്ന തിട്ടപ്പെടുത്താം എന്ന കണ്ടെത്തൽ.
- അസന്തുലിതബലം ബലത്തിന്റെ പ്രത്യേകതകൾ തിരിച്ചറിയൽ
- എല്ലാ അസന്തുലിതബലങ്ങളും ചലനമുണ്ടാക്കുന്നില്ല എന്ന തിരിച്ചറിയാൻ
- ആന്തരികബലവും ബാഹ്യബലവും എന്താണെന്ന് തിരിച്ചറിയൽ.

Resources

- Demonstration, Experiment

Presentation

1) Foundation മുൻപു പഠിച്ച കാര്യങ്ങളെ ആസ്പതമാക്കി രണ്ട് സന്ദർഭങ്ങൾ ഒരു ചോദ്യരൂപേണ (സംശയരൂപേണ), അദ്ധ്യാപിക കുട്ടികൾക്കു മുൻപിൽ അവതരിപ്പിക്കുന്നു. 1. ഒരാൾ ഒരു ലോറിയിൽ കേറിനിന്ന് തള്ളാൻ ശ്രമിക്കുകയാണെങ്കിൽ ലോറി നീങ്ങുന്നില്ല. എന്നാൽ പുറത്തുനിന്നു തള്ളുമ്പോൾ ലോറി നീങ്ങുന്നു. 2. ഒരു കുട്ടി കസേരയിൽ ഇരുന്നുകൊണ്ട് കസേര മുകളിലോട്ടുയർത്താൻ ശ്രമിക്കുമ്പോൾ കസേര പൊങ്ങുന്നില്ല എന്നാൽ കസേരയിൽ നിന്ന് എഴുന്നേറ്റ് ഉയർത്തുമ്പോൾ കസേര ഉയരുന്നു.	ഈ രണ്ടു സന്ദർഭങ്ങളെക്കുറിച്ചും ഓരോ കുട്ടികളും തന്റെ മുന്നറിവുകൾ ഓർത്തെടുത്ത് ഉത്തരം കണ്ടെത്താൻ ശ്രമിക്കുന്നു. കാരണം അറിയാനുള്ള ആഗ്രഹം അവരിൽ ഉണ്ടാകുന്നു.
2) Ideation അദ്ധ്യാപിക ഒരു പരീക്ഷണക്രമം വീഡിയോയിൽ കാണിക്കുന്നു.	കുട്ടികൾ ഈ സന്ദർഭവുമായി ബന്ധപ്പെട്ട് വ്യത്യസ്ത അഭിപ്രായങ്ങൾ

(ശബ്ദം add ചെയ്ത് explain ചെയ്യുന്നതോടൊപ്പം പരീക്ഷണം കാണിക്കുന്നു) കുട്ടികളെ വിവിധ ഗ്രൂപ്പുകളാക്കി തിരിച്ച് ടീച്ചർ ഈ പരീക്ഷണവുമായി ബന്ധപ്പെട്ട് ചോദ്യങ്ങൾ ഉന്നയിക്കുന്നു. പരീക്ഷണവും ഒപ്പമുള്ള വിവരണവും വ്യക്തമായി നിരീക്ഷിച്ച് എന്തായിരിക്കും കാരണങ്ങൾ എന്ന് ചർച്ച ചെയ്ത് അനുമാനങ്ങൾ രേഖപ്പെടുത്താൻ ആവശ്യപ്പെടുന്നു.	ഉണ്ടാവുന്നു. ഗ്രൂപ്പായി ചർച്ച ചെയ്ത് അവനെയെല്ലാം പട്ടികപ്പെടുത്തുന്നു. ഇതിനായി മുന്നറിവുകൾ പ്രയോജനപ്പെടുത്തുന്നു.
3) Evaluation അദ്ധ്യാപിക മുൻപ് കാണിച്ച വീഡിയോ ഒരു demonstrationൽ കൂടി ക്ലാസ്റൂമിൽ ചെയ്തുകാണിക്കുന്നു. കാണിക്കുന്നതിനിടയിലൂടെ മുൻപ് ഉന്നയിച്ച ചോദ്യങ്ങൾ ഒന്നുകൂടി കുട്ടികളോടു ചോദിക്കുകയും അവയുടെ ഉത്തരങ്ങൾ demonstrationൽ കൂടി വ്യക്തമാക്കുകയും ചെയ്യുന്നു.	ഓരോ ഗ്രൂപ്പിലുമുള്ള കുട്ടികളും താൻ രേഖപ്പെടുത്തിയ അനുമാനങ്ങൾ വിശകലനം ചെയ്ത് അർത്ഥമില്ലാത്ത അനുമാനങ്ങൾ ഒഴിവാക്കി സ്വയം വിലയിരുത്തി യോജിച്ച ആശയങ്ങൾ മാത്രം തിരഞ്ഞെടുത്ത് രേഖപ്പെടുത്തുന്നു. അതിനായി അവർ ഗ്രൂപ്പിൽ പരസ്പരം ചർച്ച ചെയ്യുന്നു. ടീച്ചറുടെ വിശദീകരണത്തിൽനിന്നും, തന്റെ സംശയങ്ങൾ ധുരീകരിക്കാൻ ശ്രമിക്കുന്നു.
4) Stabilization ഓരോ ഗ്രൂപ്പും തന്റെ നിഗമനങ്ങൾ അവതരിപ്പി ക്കുന്നു. തെറ്റുകൾ ടീച്ചർ തിരുത്തുന്നു.	കുട്ടികൾ താൻ കണ്ടെത്തിയ ആശയം സ്ഥിരപ്പെടുത്തുന്നു. അതായത്, ഇവിടെ demonstration, video & ടീച്ചറുടെ explanation എന്നിവയിലൂടെ ഗലീലിയോയുടെ നിരീക്ഷണങ്ങളും, ന്യൂട്ടന്റെ ചലനിയമങ്ങൾക്ക് അവയ്ക്കുള്ള

	പങ്കം കുട്ടികൾ തിരിച്ചറിയുന്നു.
5) Implications ഗലീലിയോട്ടും പരീക്ഷണത്തിലൂടെ ക്ലാസ്സിന്റെ തുടക്കത്തിൽ ഉന്നയിച്ച ചോദ്യങ്ങൾക്കുള്ള ഉത്തരം ടീച്ചർ വിശദീകരിക്കുന്നു.	കണ്ടെത്തിയ ആശയങ്ങൾ കുട്ടികൾ ക്രോഡീകരിക്കുന്നു. ശേഷം ആന്തരികബലം, ബാഹ്യബലം എന്നീ ആശയങ്ങളും, ഗലീലിയോയുടെ നിരീക്ഷണങ്ങൾ ന്യൂട്ടന്റെ നിയമങ്ങളെ എങ്ങനെ സ്വാധീനിക്കുന്നു. എന്നും കൃത്യമായി organize ചെയ്ത് സയൻസ് ഡയറിയിൽ രേഖപ്പെടുത്തുന്നു.
6) Application ടീച്ചർ താഴെ പറയുന്ന സന്ദർഭങ്ങളിൽ കുട്ടി എന്താണ് നിരീക്ഷിക്കുന്നത് എന്നും ഇതിന്റെ കാരണെ ന്തെന്നും സയൻസ് ഡയറിയിൽ രേഖപ്പെടുത്താൻ ആവ ശ്യപ്പെടുന്നു. • ഒരു ബോൾ മിനുസമുള്ള പ്രതലത്തിലൂടെയും പരുപരുത്ത പ്രതലത്തിലൂടെയും ഒരേ സമയം ഉരുട്ടുന്നു. ബോളിന്റെ ചലനം നിരീക്ഷിക്കുക.	

LESSON TRANSCRIPT NO. 3

Name of the Teacher	:	Athira. V			
Name of School	:	Poyilkkavu HSS			
Class	:	IX Std.			
Unit	:	ചലനവും ചലനനിയമങ്ങളും	Time	:	1 hr
Topic	:	ന്യൂട്ടന്റെ ഒന്നാം ചലനിയമവും ജഡത്വവും	Date	:	

Objectives

- ന്യൂട്ടന്റെ ഒന്നാം ചലനനിയമം എന്താണെന്ന് മനസ്സിലാക്കൽ.
- നിത്യജീവിതത്തിൽ ന്യൂട്ടന്റെ ഒന്നാം ചലനനിയമം അനുഭവപ്പെടുന്ന സന്ദർഭങ്ങൾ തിരിച്ചറിയൽ.
- ജഡത്വം എന്ന ആശയം തിരിച്ചറിയൽ.
- ജഡത്വത്തെ സ്വാധീനിക്കുന്ന ഘടകങ്ങൾ തിരിച്ചറിയൽ.

Resources

- Demonstration, Experiment, Videos

Presentation

1) Foundation അദ്ധ്യാപിക രണ്ട് വ്യത്യസ്ത സന്ദർഭങ്ങൾ സംശയരൂപേണ കുട്ടികൾക്കു മുൻപിൽ അവതരിപ്പിക്കുന്നു. i) ഒരാൾ കുറേ ദൂരം ഓടിയ ശേഷം ലോങ് ജമ്പ് ചാടിയപ്പോൾ കുറേ ദൂരത്തിൽ ചാടി എന്നാൽ ഓടാതെ നിന്ന് സ്ഥലത്തുനിന്നു ചാടിയപ്പോൾ കുറച്ച് ദൂരം മാത്രം ചാടി. ii) ചൂടിപ്പായയിലുള്ള മണ്ണ് നിലത്തുവെച്ച് തട്ടിയപ്പോൾ മുഴുവനായി പോയില്ല എന്നാൽ ചുടിപ്പായ	ഈ രണ്ടു സന്ദർഭങ്ങളെക്കുറിച്ചും ഓരോ കുട്ടികളും തന്റെ മുന്നറിവുകൾ ഓർത്തെടുത്ത് ഉത്തരം കണ്ടെത്താൻ ശ്രമിക്കുന്നു. കാരണം അറിയാനുള്ള ജിജ്ഞാസ അവരിൽ ഉളവാക്കുന്നു.

<table>
<tr>
<td>

കുത്തനെ വച്ച് തട്ടിയപ്പോൾ മണ്ണ് മുഴുവനായി പോയി വൃത്തിയായികിട്ടി.

</td>
<td></td>
</tr>
<tr>
<td>

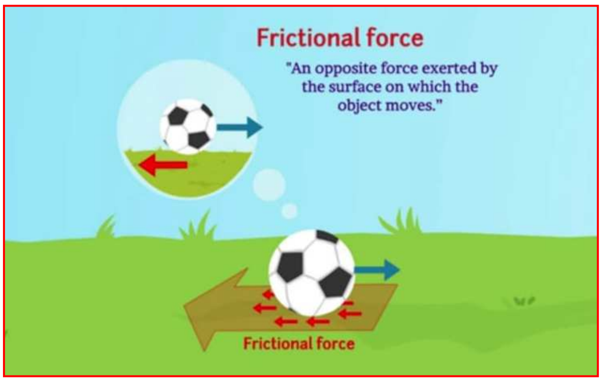
2) Ideation

രണ്ട് വീഡിയോകൾ പ്രദർശിപ്പിക്കുന്നു

Video 1

നിർത്തിയിട്ട ഒരു ബസ്സ് പെട്ടന്ന് ഓടിക്കുമ്പോൾ ബസ്സിലെ യാത്രക്കാരുടെ ചലനം കാണിക്കുന്ന വീഡിയോ.

Video 2



ഒരു എനിമേഷനിൽക്കൂടി ഒരു ഉരുണ്ട ബോൾ മിനുസമുള്ള പ്രതലത്തിലൂടെ ഉരുളുന്നതും ഒരു കല്ല് ചലനദിശയിൽ വെച്ച് ബോള് അതിൽ തട്ടി നിശ്ചലമാവുകയും ചെയ്യുന്നു.

കുട്ടികളെ വിവിധ ഗ്രൂപ്പുകളാക്കി തിരിച്ച് ഈ സന്ദർഭങ്ങൾ നിരീക്ഷിച്ച് എന്തായിരിക്കും കാരണം

</td>
<td>

കുട്ടികളിൽ ഇതുമായി ബന്ധപ്പെട്ട് വിവിധ ഐഡിയകൾ ഉണ്ടാവുന്നു. അവർ ചർച്ച ചെയ്ത് അവയെല്ലാം സയൻസ് ഡയറിയിൽ കുറിക്കുന്നു. ഇതിനായി കുട്ടികൾ തന്റെ മുന്നറിവുകൾ പ്രയോജനപ്പെടുത്തുന്നു.

</td>
</tr>
</table>

എന്ന് ചർച്ച ചെയ്ത് അനുമാനങ്ങൾ രേഖപ്പെടുത്താൻ ആവശ്യപ്പെടുന്നു.	
3) Evaluation അദ്ധ്യാപിക ഒരു മിനുസമുള്ള പേപ്പറിൽ ബോട്ടിൽ വെച്ച് പേപ്പർ ഒരു വശത്തേക്ക് പെട്ടെന്നു വലിച്ചെടുക്കുന്ന പരീക്ഷണം ചെയ്ത് കാണിച്ച് അത് മുൻപ് കാണിച്ച വീഡിയോയുമായി ബന്ധപ്പെടുത്തുന്നു. ഇടയിൽ ചോദ്യങ്ങൾ കുട്ടികളോടു ചോദിക്കുകയും അവയുടെ ഉത്തരം demonstrationൽ കൂടി വ്യക്തമാക്കുകയും ചെയ്യുന്നു.	ഓരോ ഗ്രൂപ്പിലുള്ള കുട്ടികളും താൻ രേഖപ്പെടുത്തിയ അനുമാനങ്ങൾ വിശകലനം ചെയ്ത് immature ideaകൾ ഒഴിവാക്കി സ്വയം വിലയിരുത്തി പാകമായ അനുമാനങ്ങൾ മാത്രം സ്വീകരിക്കുകയും രേഖപ്പെടുത്തുകയും ചെയ്യുന്നു. അതിനായി അവർ ഗ്രൂപ്പിൽ പരസ്പരം ചർച്ച ചെയ്യുന്നു. ടീച്ചറുടെ explanationsൽ നിന്നും തന്റെ സംശയങ്ങൾ ധുരീകരിക്കാൻ ശ്രമിക്കുന്നു.
4) Stabilization ഓരോ ഗ്രൂപ്പുകളും തന്റെ നിഗമനങ്ങൾ അവതരിപ്പിക്കുന്നു. തെറ്റുകൾ ടീച്ചർ തിരുത്തുന്നു.	കുട്ടികൾ താൻ കണ്ടെത്തിയ ആശയം സ്ഥിരപ്പെടുത്തുന്നു. അതായത്, ഇവിടെ demonstration, video & ടീച്ചർ ക്ലാസ്സിന്റെ തുടക്കത്തിൽ ഉന്നയിച്ച് ചോദ്യങ്ങൾ എന്നിവയുടെ ഉത്തരം ന്യൂട്ടന്റെ ഒന്നാം ചലനനിയമം ആണ് എന്ന് ആശയത്തിൽ എത്തിച്ചേരുന്നു.
5) Implications Video 1 & Video 2 explanation ഒാട്ടുകൂടി കുട്ടികൾക്കു മുന്നിൽ അവതരിപ്പിക്കുന്നു.	കണ്ടെത്തിയ ആശയങ്ങൾ കുട്ടികൾ ക്രോഡീകരിക്കുന്നു. ശേഷം ന്യൂട്ടന്റെ ഒന്നാം ചലനനിയമവും, ജഡത്വം

OR Same സന്ദർഭം ക്ലാസ്സിൽ പരീക്ഷണത്തിലൂടെ കാണിച്ച് വിവരിക്കുന്നു. (കുട്ടിയെതന്നെ വിളിച്ച് ചെയ്യിപ്പിക്കുന്നു)	എന്ന ആശയവും അതിനെ സ്വാധീനിക്കുന്ന ഘടകങ്ങൾ എന്നിവ കൃത്യമായി organize ചെയ്ത് സയൻസ് ഡയറിയിൽ രേഖപ്പെടുത്തുന്നു.
6) Application ടീച്ചർ താഴെ പറയുന്ന നിത്യജീവിതത്തിലെ ചില സന്ദർഭങ്ങളിൽ കുട്ടി എന്താണ് നിരീക്ഷിക്കുന്നത് എന്ന് സയൻസ് ഡയറിയിൽ രേഖപ്പെടുത്താൻ ആവശ്യപ്പെടുന്നു. • മാവിൽനിന്നും മാങ്ങ ഞെട്ടറ്റു വീഴുന്നു. • ഓടി കൊണ്ടിരിക്കുന്ന ബസ്സിൽനിന്നും ഇറങ്ങുന്ന ആൾ കുറച്ചുദൂരം ഓടിയശേഷം നിൽക്കുന്നു.	

Home Assignment
ന്യൂട്ടന്റെ ഒന്നാം ചലനനിയമവുമായി ബന്ധപ്പെട്ട സാഹചര്യങ്ങൾ നിത്യജീവിതത്തിൽ നിന്നും കണ്ടെത്തി വിശദീകരണസഹജം സയൻസ് ഡയറിയിൽ രേഖപ്പെടുത്തുക.

LESSON TRANSCRIPT NO. 4

Name of the Teacher	:	Athira. V			
Name of School	:	Poyilkkavu HSS			
Class	:	IX Std.			
Unit	:	ചലനവും ചലനനിയമങ്ങളും	Time	:	1 hr
Topic	:	ജഡത്വത്തിന്റെ ഉദാഹരണങ്ങൾ	Date	:	

Objectives

- ജഡത്വം എന്ന ആശയം കൂടുതൽ ആഴത്തിൽ മനസ്സിലാക്കൽ
- ജഡത്വം അനുഭവപ്പെടുന്ന നിത്യജീവിതത്തിലെ സന്ദർഭങ്ങൾ തിരിച്ചറിയൽ
- ജഡത്വത്തെ സ്വാധീനിക്കുന്ന ഘടകങ്ങൾ തിരിച്ചറിയൽ.

Resources

- Videos, Demonstration, Story

Presentation

1) Foundation അദ്ധ്യാപിക ഒരു കഥ രൂപേണ ഒരു പ്രശ്നം കുട്ടികൾക്കു മുമ്പിൽ അവതരിപ്പിക്കുന്നു. Story Line- ഞാൻ ഇന്നു രാവിലെ സ്കൂളിൽ വരാനായി നേരത്തെ തന്നെ ഇറങ്ങി. ഞാൻ സാധാരണ വരാറുള്ള ബസ്സ് സ്റ്റാന്റിൽ നിർത്തിയിട്ടിരിക്കുന്നതു കണ്ട് എനിക്ക് ആസ്വാസമായി. ഞാൻ നേരത്തെ തന്നെയാണ് സ്റ്റാന്റിൽ എത്തിയത്, ബസ്സ് ഇതുവരെ എടുത്തിട്ടില്ല. ഞാൻ സന്തോഷത്തോടെ ബസ്സിൽ കയറി ഇരുന്നു. ഒരു 5 മിനുട്ടോളം ഇരുന്നപ്പോൾ എന്തോ തർക്കം പുറത്തു കേട്ടു. പെട്ടെന്ന് ദേഷ്യത്തോടെ ഡ്രൈവർ ബസ്സിൽ ചാടി കയറി സ്പീഡിൽ ബസ് സ്റ്റാർട്ട് ചെയ്തും എന്റെ ശരീരത്തിന്റെ മുകൾ ഭാഗം ബേക്കിലോട്ട് നീങ്ങി പുറകിലുള്ള	കുട്ടികൾ ടീച്ചർക്ക് ഉണ്ടായ ഈ പ്രശ്നത്തിന്റെ കാരണം എന്തെന്നറിയാൻ തന്റെ മുന്നറിവുകൾ ഓർത്തെടുക്കുന്നു. എന്തായിരിക്കാം കാരണം എന്നറിയാനുള്ള ജിജ്ഞാസ അവരിൽ ഉളവാകുന്നു.

കമ്പിയിൽ തല തട്ടി നല്ലപോലെ വേദനയോടെ ഞാൻ കരയാൻ തുടങ്ങി. ആളുകൾ വന്ന് വെള്ളമൊക്കെ തന്ന് ആശ്വസിപ്പിച്ചു. കുറച്ചുകഴിഞ്ഞപ്പോൾ ശരിയായി. ഇവിടെ എനിക്ക് ഇങ്ങനെ ഒരു അനുഭവം ഉണ്ടാവാൻ എന്തായിരിക്കും കാരണം?	
2) Ideation രണ്ട് പരീക്ഷണങ്ങൾ കുട്ടികളെക്കൊണ്ട് തന്നെ ചെയ്യിപ്പിക്കുന്നു. Expt. 1: മിനുസമുള്ള ഒരു മേശപ്പുറത്ത് 10 ഓളം ഒരു രൂപ കോയിൻസ് അട്ടിയായി വെക്കുന്നു. ശേഷം ഒരു കുട്ടിയെകൊണ്ട് മറ്റൊരു കോയിൻ ഉപയോഗിച്ച് അട്ടിയായി വെച്ച കോയിനുക ളുടെ ഏറ്റവും അടിയിലെ കോയിൻ തട്ടിത്തെ റിപ്പിക്കുന്നു. Expt. 2: ഒരു കുട്ടിയെ വിളിച്ച് ഭാരം കുറഞ്ഞ ഒരു ബോളും ഭാരം കൂടിയ മറ്റൊരു സ്റ്റീൽ ബോളും തറയിൽ ഒരുമിച്ച് ഉരുട്ടി വിടാൻ പറയുന്നു. ശേഷം അതിന്റെ ചലനവും അത് നിശ്ചലമാകാനെടുത്ത സമയവും നിരീക്ഷിക്കാൻ ആവശ്യപ്പെടുന്നു. കുട്ടികളെ ഗ്രൂപ്പുകളായി തിരിച്ച് മുകളിൽ കാണിച്ച പരീക്ഷ ണങ്ങൾ നിരീക്ഷിക്കുവാനും ഇവിടെ സംഭവിച്ച കാര്യങ്ങ ളുടെ കാരണം എന്തായിരിക്കും എന്ന് ചിന്തിച്ച് സയൻസ് ഡയറിയിൽ രേഖപ്പെടുത്താനും ആവശ്യപ്പെടുന്നു.	കുട്ടികളിൽ ഇതുമായി ബന്ധപ്പെട്ട് വിവിധ ഐഡിയകൾ ഉണ്ടാവുന്നു. അവർ ചർച്ച ചെയ്ത് എല്ലാ ideaകളും സയൻസ് ഡയറിയിൽ കുറിക്കുന്നു. ഇതിനായി കുട്ടികൾ അവരുടെ മുന്നറിവുകൾ പ്രയോജനപ്പെടുത്തുന്നു.

3) Evaluation അദ്ധ്യാപിക മുൻപ് കാണിച്ച പരീക്ഷണം ആവർത്തിക്കുകയും അതിനിടയിൽ കുട്ടികളോട് ചോദ്യങ്ങൾ ചോദിക്കുകയും അവയുടെ ഉത്തരം വ്യക്തമാക്കുകയും ചെയ്യുന്നു.	ഓരോ ഗ്രൂപ്പിലുള്ള കുട്ടികളും അവർ രേഖപ്പെടുത്തിയ അനുമാനങ്ങൾ വിശകലനം ചെയ്ത് കൃത്യമായ അനുമാനങ്ങൾ മാത്രം സ്വീകരിക്കുകയും രേഖപ്പെടുത്തുകയും ചെയ്യുന്നു. അതിനായി അവർ ഗ്രൂപ്പിൽ പരസ്പരം ചർച്ച ചെയ്യുന്നു. ടീച്ചറുടെ വിശദീകണത്തിൽ നിന്നും അവരുടെ സംശയങ്ങൾ ധൂരീകരിക്കാൻ ശ്രമിക്കുന്നു.
4) Stabilization ഓരോ ഗ്രൂപ്പുകളും തന്റെ നിഗമനങ്ങൾ അവതരിപ്പിക്കുന്നു. തെറ്റുകൾ ടീച്ചർ തിരുത്തുന്നു.	കുട്ടികൾ അവർ കണ്ടെത്തിയ ആശയങ്ങൾ സ്ഥിരപ്പെടുത്തുന്നു. അതായത് ഇവിടെ, Expt, story എന്നിവയുടെ ഉത്തരം ജഡത്വം എന്ന ആശയം ആണ് എന്ന് മനസ്സിലാക്കുന്നു.
5) Implications ടീച്ചർ ഒന്ന്, രണ്ട് ഉദാഹരണങ്ങൾ കൂടി അവതരിപ്പിച്ച് ജഡത്വം എന്ന് ആശയം വിവരിക്കുന്നു.	കണ്ടെത്തിയ ആശയങ്ങൾ കുട്ടികൾ ക്രോഡീകരിക്കുന്നു. ശേഷം ജഡത്വം എന്ന ആശയവും സ്വാധീനിക്കുന്ന ഘടകങ്ങളും നിത്യജീവിതത്തിൽ അനുഭവപ്പെടുന്ന സന്ദർഭങ്ങൾ എന്നിവ കൃത്യമായി organize ചെയ്ത് സയൻസ് ഡയറിയിൽ രേഖപ്പെടുത്തുന്നു.

6) Application നിത്യജീവിതത്തിൽ ജഡത്വം എന്ന ആശയം പ്രയോജനപ്പെടുത്തുന്ന സന്ദർഭങ്ങൾ കണ്ടെത്തി പട്ടികപ്പെടുത്താൻ ടീച്ചർ കുട്ടികളോട് ആവശ്യപ്പെടുന്നു.	

Home Assignment

LESSON TRANSCRIPT NO. 5

Name of the Teacher	:	Athira. V			
Name of School	:	Poyilkkavu HSS			
Class	:	IX Std.			
Unit	:	ചലനവും ചലനനിയമങ്ങളും	Time	:	1 hr
Topic	:	ആക്കം	Date	:	

Objectives

- ആക്കം എന്ന ആശയം എന്താണ് എന്ന് തിരിച്ചറിയുന്നതിന്.
- നിത്യജീവിതത്തിൽ ആക്കം അനുഭവപ്പെടുന്ന സന്ദർഭങ്ങൾ തിരിച്ചറിയുന്നതിന്.
- ആക്കം അളക്കുന്നത് മനസ്സിലാക്കുന്നതിന്
- ആക്കത്തെ സ്വാധീനിക്കുന്ന ഘടകങ്ങൾ മനസ്സിലാക്കുന്നതിന്.

Resources

- Videos, Demonstration

Presentation

1) Foundation അദ്ധ്യാപിക നിത്യജീവിതത്തിലെ സന്ദർഭം സംശയരൂപേണ കുട്ടികൾക്കു മുമ്പിൽ അവതരിപ്പിക്കുന്നു. ഒരു ട്രാഫിക് സിഗ്നലിൽ നിറയെ വണ്ടികൾ നിർത്തിയിട്ടിരിക്കുന്നു. അപ്പോൾ ഹെവിലോഡു മായി വന്ന ഒരു ലോറി സ്പീഡിൽ വന്ന് നിർത്താൻ നോക്കിയപ്പോൾ മുൻപിലുള്ള വണ്ടിയിൽ തട്ടി അപകടമുണ്ടായി. അതേ സമയം ഒരു കാർ ഇതുപോലെ വന്ന് നിർത്താൻ ശ്രമിച്ചപ്പോൾ ഇങ്ങനെ അപകടം ഉണ്ടായില്ല.	ഈ സന്ദർഭത്തെക്കുറിച്ച് ഓരോ കുട്ടിയും തന്റെ മുന്നറിവുകൾ ഓർത്തെടുത്ത് ഉത്തരം കണ്ടെത്താൻ ശ്രമിക്കുന്നു. കാരണം അറിയാനുള്ള ആഗ്രഹം അവരിൽ ഉളവാകുന്നു.
2) Ideation ഒരു പരീക്ഷണം ചെയ്ത് കാണിക്കുന്നു.	കുട്ടികൾ നിരീക്ഷിച്ച കാര്യങ്ങളെ

Expt. (i): രണ്ട് വ്യത്യസ്ത മാസുള്ള ബോളുകൾ നിലത്ത് തയ്യാറാക്കിയ ഒരു മണൽ മെത്തയിലേക്ക് ഒരേ സ്പീഡിൽ മുകളിൽ നിന്ന് താഴോട്ടിടുന്നു. മണലിൽ ഉണ്ടായ ആഘാതം നിരീക്ഷിക്കുന്നു. Expt. (ii): ഒരേ മാസുള്ള ബോളുകൾ വ്യത്യസ്ത ഉയരത്തിൽ നിന്നും മണൽമെത്തയിലേക്ക് ഇടുന്നു. ആഘാതം നിരീക്ഷിപ്പിക്കുന്നു. കുട്ടികളെ വിവിധ ഗ്രൂപ്പുകളായി തിരിച്ച് ഈ സന്ദർഭങ്ങൾ നിരീക്ഷിച്ച് എന്തായിരിക്കും കാരണം എന്ന് ചർച്ച ചെയ്ത് രേഖപ്പെടുത്താൻ ആവശ്യപ്പെടുന്നു.	അടിസ്ഥാനപ്പെടുത്തി ചർച്ച ചെയ്ത് വിവിധ അനുമാനങ്ങൾ രേഖപ്പെടുത്തുന്നു. ഇതിനായി കുട്ടികൾ അവരുടെ മുന്നറിവുകൾ പ്രയോജനപ്പെടുത്തുന്നു.
3) Evaluation അദ്ധ്യാപിക demonstrationൽ കൂടി മുൻപ് കാണിച്ച പരീക്ഷണം ഒന്നുകൂടി വിവരണത്തിലൂടെ ചെയ്ത് കാണിക്കുന്നു. ഇതിനിടയിലൂടെ കുട്ടികളിൽനിന്ന് ആശയങ്ങളും വിശദീകരണങ്ങളും പുറത്തുവരാനായി ചോദ്യങ്ങൾ ചോദിക്കുന്നു	ഓരോ ഗ്രൂപ്പിലുള്ള കുട്ടികളും അവർ രേഖപ്പെടുത്തിയ അനുമാനങ്ങൾ വിശകലനം ചെയ്ത് പാകമായ അനുമാനങ്ങൾ മാത്രം സ്വീകരിക്കുകയും രേഖപ്പെടുത്തുകയും ചെയ്യുന്നു. അതിനായി അവർ ഗ്രൂപ്പിൽ പരസ്പരം ചർച്ച ചെയ്യുന്നു. ടീച്ചറുടെ വിശദീകണത്തിൽ നിന്നും അവരുടെ സംശയങ്ങൾ ധൂരീകരിക്കാൻ ശ്രമിക്കുന്നു.
4) Stabilization ഓരോ ഗ്രൂപ്പുകളും തന്റെ നിഗമനങ്ങൾ അവതരിപ്പിക്കുന്നു. തെറ്റുകൾ ടീച്ചർ തിരുത്തുന്നു.	കുട്ടികൾ അവർ കണ്ടെത്തിയ വിവരങ്ങൾ സ്ഥിരപ്പെടുത്തുന്നു. അതായത് തുടക്കത്തിൽ ചോദിച്ച ചോദ്യം, പരീക്ഷണം എന്നിവയുടെ ഉത്തരം ആക്കം എന്ന ആശയം ആണെന്നും അത് മാസ്സിന്റെയും പ്രവേഗത്തിന്റെയും

	ഗുണിതമാണെന്നും തിരിച്ചറിയുന്നു.
5) Implications കാര്യങ്ങൾ മനസ്സിലാക്കിയ ശേഷം ഒന്നുകൂടി കുട്ടികളെക്കൊണ്ടുതന്നെ പരീക്ഷണം ചെയ്യിപ്പിക്കുന്നു.	കണ്ടെത്തിയ ആശയങ്ങൾ കുട്ടികൾ ക്രോഡീകരിക്കുന്നു. ശേഷം ചലിക്കുന്ന വസ്തുക്കളുടെ സവിശേഷ ഗുണമായ ആക്കം തിരിച്ചറിയുകയും അത് അളന്ന് തിട്ടപ്പെടുത്തുന്നതെങ്ങനെ എന്ന് മനസ്സിലാക്കി organize ചെയ്ത് സയൻസ് ഡയറിയിൽ രേഖപ്പെടുത്തുന്നു.
6) Application താഴെ പറയുന്ന നിത്യജീവിതത്തിലെ ചില സന്ദർഭങ്ങളിൽ കുട്ടി എന്താണ് നിരീക്ഷിക്കുന്നതെന്ന് സയൻസ് ഡയറിയിൽ രേഖപ്പെടുത്താൻ ആവശ്യപ്പെടുന്നു. • കുട്ടികൾ മൈതാനത്തിൽ ഓടിക്കളിക്കുമ്പോൾ നല്ല വണ്ണമുള്ള ആളിന് വേഗം ഓട്ടം നിർത്താനും അതുപോലെ ഓടിതുടങ്ങാനും പ്രയാസം അനുഭവപ്പെടുന്നു. എന്തായിരിക്കും ഇതിനു കാരണം?	

Home Assignment

Appendix III

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

LESSON TRANSCRIPT BASED ON PRODUCTIVE THINKING MODEL
(English Version)

Dr. C.M. Bindhu	**Athira. V**
Professor & Head	Research Scholar
Department of Education	Department of Education

LESSON TRANSCRIPT NO. 1

Name of the Teacher	:	Athira. V			
Name of School	:	Poyilkkavu HSS			
Class	:	IX Std.			
Unit	:	Motion and Laws of Motion	Time	:	1 hr
Topic	:	Equilibrium force and unbalanced force	Date	:	

Objectives

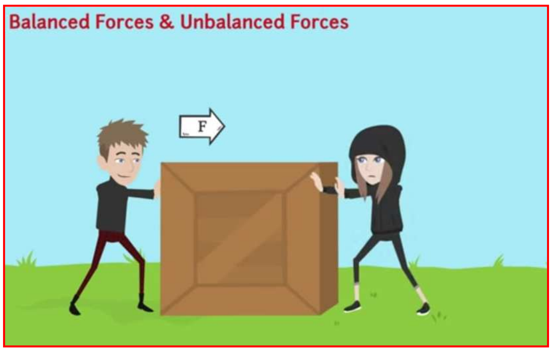
- Identifying situations where different forces are applied in everyday life
- Understanding the concept of balanced force and unbalanced force
- Finding the measurement of balanced and unbalanced forces
- Classification of balanced force and unbalanced force

Resources

- Videos, Demonstration

Presentation

1) **Foundation** The teacher presents two different scenarios in front of the students in a demonstration.	Each student remembers his previous knowledge about these two cases and tries to find the

(i) When two students push a large stone from the same side, the stone moves slightly. When another child pushes from the other side, the motion of the stone slows down. (ii) Children are moved from both sides of a stone Now the stone does not move.	answer. Curiosity arises in them to know the reason.
2) Ideation Two videos are displayed. Video 1  Animation shows the force exerted by people on each side in a tug-of-war match. Also shows the movement of the rod. Video 2  A large table runt is shown pushing from side to side with varying force. Shows table movement.	Students have different ideas about this. They discuss and record them all in the science diary. For this, children use their prior knowledge.

Divide the children into different groups and ask them to observe these situations and discuss what could be the cause and make inferences.	
3) Evaluation The teacher shows the video shown earlier in a demonstration to the class. Questions are asked to the children through demonstration and their answers are clarified through demonstration.	The student in each group analyze the hypotheses recorded by him and exclude immature ideas and self-evaluate and accept and record only mature hypotheses. For that they discuss among themselves in the group. They try to clear their doubts from the teacher's analysis.
4) Stabilization Each group presents its conclusions. The teacher corrects the mistakes.	Student consolidate the ideas they have discovered. That is, here the answer to the demonstration, videos & questions asked by the teacher at the beginning of the class comes down to the concept "Balanced force does not move the object, unbalanced force is required to move the object".

5) Implication Video 1 & 2 are presented to students and asked to analyse their ideas. or The same scenario is shown and explained in the class through an experiment (calling on the children themselves.)	Students consolidate the ideas discovered. After that, the concepts of balanced force and unbalanced force and the factors affecting it are organized and recorded in the science diary.
6) Application The teacher asks the child to record in the science diary what he observes in some of the following daily life situations. • A number of people unload heavy pebbles from a lorry. Analyze this context in relation to the concept of unbalanced external force.	

Home Assignment List the situations where balanced and unbalanced external forces are applied in everyday life.

LESSON TRANSCRIPT NO. 2

Name of the Teacher	:	Athira. V			
Name of School	:	Poyilkkavu HSS			
Class	:	IX Std.			
Unit	:	Motion and Laws of Motion	Time	:	1 hr
Topic	:	Galileo's observations	Date	:	

Objectives

- Finding out how to measure unbalanced forces.
- Identifying characteristics of unbalanced forces
- Recognize that not all unbalanced forces cause motion
- Identifying internal and external forces.

Resources

- Demonstration, Experiment

Presentation

1) **Foundation** Keeping in mind, what has been learned previously, two cases are presented to the children in a question form (samsayarupena). 1. If a person tries to push a lorry, the lorry does not move. But when pushed from outside, the lorry moves. 2. When a child sits on a chair and tries to lift the chair, the chair does not rise, but when he gets up from the chair and lifts it, the chair rises.	Each student remembers his previous knowledge about these two cases and tries to find the answer.
2) **Ideation** The teacher demonstrates an experiment in the video.	Students have different opinions regarding this

(Experiment shown with adding sound and explaining) The teacher divides the children into different groups and asks questions related to this experiment. The experiment and the accompanying description are clearly observed and asked to discuss what the causes might be and to make hypotheses.	context. Discuss as a group and list them all. Advance knowledge is used for this.
3) **Evaluation** The teacher shows the video shown earlier in a demonstration in the classroom. During the demonstration, the questions raised earlier are asked to the children again and their answers are clarified through the demonstration.	The students in each group analyze the hypotheses recorded by him, discard the meaningless hypotheses and select only the ideas that are compatible with self-evaluation. For that they discuss among themselves in the group. From the teacher's explanation, students tries to clear their doubts.
4) **Stabilization** Each group presents its conclusions. The teacher corrects the mistakes.	Students confirm the idea they have found. That is, here, through demonstration, video & teacher's explanation, students recognize Galileo's observations and the role of Newton's motions.
5) **Implications** The teacher explains the answers to the questions raised at the beginning of the class with Galileo's experiment.	Students codify the ideas discovered. Then the concepts of internal force and external force, and

	how Galileo's observations influenced Newton's laws. Ideas are organized and recorded in science diary.
6) Application The teacher asks the child to record in the science diary what he observes and the reason for it in the following cases. • A ball rolls along a smooth surface and a rough surface at the same time. Observe the movement of the ball.	

LESSON TRANSCRIPT NO. 3

Name of the Teacher	:	Athira. V			
Name of School	:	Poyilkkavu HSS			
Class	:	IX Std.			
Unit	:	Motion and Laws of Motion	Time	:	1 hr
Topic	:	Newton's first law of motion and inertia	Date	:	

Objectives

- Understanding the concept of Newton's first law of motion.
- Identifying situations where Newton's first law of motion is experienced in everyday life.
- Identifying the concept of inertia.
- Identifying factors influencing inertia.

Resources

- Demonstration, Experiment, Videos

Presentation

1) Foundation The teacher presents two different scenarios like an issue. i) A person jumps a long distance after running a long jump, but jumps only a short distance when he jumps from a standing position without running. ii) The soil in the carpet did not come off completely when it was tapped on the ground	Each student remembers his previous knowledge about these two cases and tries to find the answer. It makes them curious to know the reason.

<table>
<tr><td>but when the carpet was tapped upright the soil was completely removed and cleaned.</td><td></td></tr>
<tr><td>

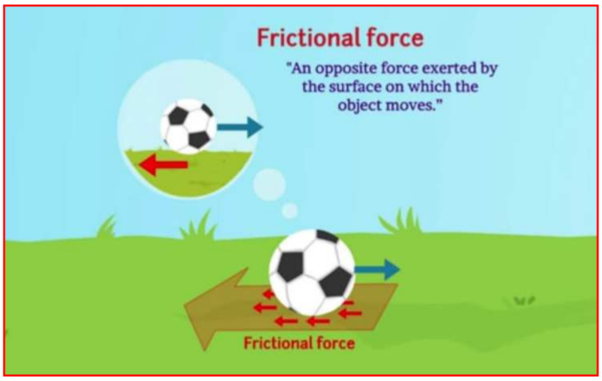
2) Ideation

Two videos are displayed

Video 1

A video showing the movement of passengers on a bus as it suddenly drives away from a stopped bus.

Video 2



Another animation shows a spherical ball rolling along a smooth surface and a stone in the direction of motion causing the ball to hit it and come to rest.

Divide the children into different groups and ask them to observe these situations and discuss what could be the reason and make inferences.

</td><td>Students have different ideas about this. They discuss and record them all in the science diary. For this, children use their prior knowledge.</td></tr>
</table>

3) **Evaluation** The teacher demonstrates the experiment of putting a smooth paper in a table and a bottle on it. Suddenly pulling the paper to one side and present this situation in relation to the video shown earlier. In between, teacher asks questions to the students and their answers are clarified through demonstration.	The students in each group analyze the hypotheses recorded by them and exclude immature ideas and self-evaluate and accept and record only mature hypotheses. For that they discuss among themselves in the group. They tries to clear their doubts from the teacher's explanations.
4) **Stabilization** Each group presents their conclusions. The teacher corrects the mistakes.	Students confirm the idea they have found. That is, here the demonstration, video & the answer to the questions asked by the teacher at the beginning of the class come to the idea that Newton's first law of motion is the answer.
5) **Implications** Video 1 & 2 are played with explanation OR Same context is demonstrated and described through experiment in the class. (Asks the students to do experiment by themselves)	Students consolidate the ideas discovered. Then Newton's first law of motion, the concept of inertia and the factors influencing it are accurately organized and

	recorded in the science diary.
6) Application The teacher asks the child to record in the science diary what he observes in some of the following daily life situations. • The mango is shocked by the flour. • A person gets off a running bus and stops after running for some distance.	

Home Assignment Find situations related to Newton's first law of motion from everyday life and record them in the science diary.

LESSON TRANSCRIPT NO. 4

Name of the Teacher	:	Athira. V			
Name of School	:	Poyilkkavu HSS			
Class	:	IX Std.			
Unit	:	Motion and Laws of Motion	Time	:	1 hr
Topic	:	Examples of inertia	Date	:	

Objectives

- Deeper understanding of the concept of inertia
- Identifying situations in everyday life where inertia is felt
- Identifying factors influencing inertia.

Resources

- Videos, Demonstration, Story

Presentation

1) **Foundation** The teacher presents a problem to the children in the form of a story. **Story Line-** I left early this morning to come to school. I was relieved by seeing the usual bus I prefer to travel. I reached the stand early and the bus has not taken yet. I happily boarded and seated the bus. After sitting for about 5 minutes, I heard some argument. Suddenly, the driver jumped on the bus in anger and started the bus at speed, my upper body moved backwards and hit my head on the back rail and I started crying in pain. People came and gave me water and comforted me. After a while it was alright. What could be the reason for such an experience here?	Students recall their previous knowledge to find out what caused the problem that the teacher had. They become curious to know what could be the reason.

2) **Ideation** Two experiments are performed by children themselves. **Expt. 1:** About 10 one-rupee coins are placed in a pile on a smooth table. A child then knocks over the bottommost coin of the stack of coins with another coin. Expt. 2: A child is called and asked to roll a light ball and another heavy steel ball together on the floor. It is then asked to observe its movement and the time it takes to come to rest. Divide the children into groups and ask them to observe the experiments shown above and write down the inference in their science diary.	Students have different ideas about this. They discuss and record all the ideas in the science diary. For this, students use their prior knowledge.
3) **Evaluation** The teacher repeats the experiment shown earlier and in between asks questions to the students and explains their answers.	Students in each group analyze the inferences they have recorded and accept and record only the correct inferences. For that they discuss among themselves in the group. They try to clear their doubts from the teacher's explanation.
4) **Stabilization** Each group presents its conclusions. The teacher corrects the mistakes.	Students consolidate the ideas they have discovered. Students understood that the reason behind the story and the experiment were the concept of inertia.

5) Implications The teacher explains the concept of inertia by presenting two or more examples.	Students consolidate the ideas discovered. Then the concept of inertia and the influencing factors and situations experienced in daily life are accurately organized and recorded in the science diary.
6) Application The teacher asks the children to find and list instances where the concept of inertia is used in everyday life.	

Home Assignment Find examples of inertia of motion and inertia of rest and classify it in table.

LESSON TRANSCRIPT NO. 5

Name of the Teacher	:	Athira. V			
Name of School	:	Poyilkkavu HSS			
Class	:	IX Std.			
Unit	:	Motion and Laws of Motion	Time	:	1 hr
Topic	:	Momentum	Date	:	

Objectives

- To identify the concept of momentum.
- To identify instances of momentum in everyday life.
- To understand the measurement of momentum
- To understand the factors influencing momentum.

Resources

- Videos, Demonstration

Presentation

1) Foundation The teacher presents the context of everyday life to students like a problem. A traffic signal is full of cars. Then a lorry with a heavy load came at speed and when it tried to stop, it hit the car in front and there happens an accident. At the same time, when a car came and tried to stop, there was no such accident.	Each student remembers his prior knowledge about the context and tries to find the answer. A curiosity arises in them to know the reason.
2) Ideation An experiment shows. Expt. (i): Two balls of different masses are dropped downwards at the same speed onto a sand mattress prepared on the	Students discuss and make various inferences based on what they

ground. Observing the impact on the sand. Expt. (ii): Balls of the same mass are dropped from different heights into the sand bed. Monitoring the impact. Divide the children into different groups and ask them to observe these instances and discuss and record what could be the reason.	observe. For this, students use their prior knowledge.
3) **Evaluation** While showing demonstration, the teacher again explains the experiment shown earlier. Through this, teacher asks questions to elicit ideas and explanations from the students themselves.	Student in each group analyze the inferences they have recorded and accept and record only mature inferences. For that they discuss among themselves in the group. They try to clear their doubts from the teacher's explanation.
4) **Stabilization** Each group presents its conclusions. The teacher corrects the mistakes.	Students consolidate the information they find. That is, the answer to the question and experiment at the beginning is the concept of momentum, which is the product of mass and velocity.
5) **Implications** After understanding the concept teacher asks the students to do the experiment again.	Students consolidate the ideas discovered. After that realising that momentum is a specific property of moving objects, and understanding

	how to measure it, organize it and record it in a science diary.
6) Application Students are asked to record what he observed in the following situations in the science diary. • While some children are playing in the ground, a fat boy felt it difficult to run impulsively and stopped running. What will be the reason behind it?	

Home Assignment Conduct a simple experiment to understand the concept of momentum and write down inferences in the science diary.

Appendix IV

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

LESSON PLAN BASED ON EXISTING METHOD OF TEACHING (Malayalam Version)

Dr. C.M. Bindhu	**Athira. V**
Professor & Head	Research Scholar
Department of Education	Department of Education

LESSON PLAN NO. 1

PRELIMINARY DETAILS

Name of the Teacher	: Athira V.	Standard	: IX
School	: Thiruvangoor HSS	Strength	: 35
Subject	: Physics	Duration	: 40 Mins
Unit	: സന്തുലിതബലം	Date	:
Topic	ചലനവും ചലന നിയമങ്ങളും		

തീം : സന്തുലിതബലം

പഠന നേട്ടങ്ങൾ:

സന്തുലിതബലം എന്ന ആശയം തിരിച്ചറിയുന്നു.

ആശയങ്ങൾ:

സന്തുലിതബലം

വസ്തുതകൾ:

എല്ലാ ബലങ്ങളും ചലനത്തിലേക്ക് നയിക്കുന്നില്ല
ബലങ്ങൾ തുല്യവും എതിർദിശയിലുമാവുമ്പോൾ സ്ഥാനാന്തരം ഉണ്ടാകുന്നില്ല.

പ്രക്രിയശേഷികൾ:

പരീക്ഷണം, നിരീക്ഷണം, നിഗമന രൂപീകരണം

മൂല്യങ്ങൾ മനോഭാവങ്ങൾ:

സഹകരണ മനോഭാവം, ശാസ്ത്രാവബോധം

Appendix

മുന്നറിവുകൾ:

ബലത്തെ കുറിച്ചുള്ള മുന്നറിവുകൾ

പഠനസാമഗ്രികൾ:

- കുട്ടികൾ Water Slide ലൂടെ നീങ്ങുന്ന വീഡിയോ
- പാഠപുസ്തകത്തിലെ ചിത്രം 3.1, 3.2, 3.3, 3.4

പ്രതീക്ഷിത ഉത്പന്നങ്ങൾ:

സന്തുലിതബലം നിർവ്വചിച്ചെഴുതിയ സയൻസ് ഡയറി

പ്രക്രിയ	വിലയിരുത്തൽ
INTRODUCTORY ACTIVITY Good Morning നിങ്ങളിലെത്ര പേർ Amusement പാർക്കുകളിൽ പോയിട്ടുണ്ട്. എല്ലാവർക്കും പാർക്കിൽ പോവാനും ride കളിൽ കേറാനും Water Slide ൽ കയറാനും ഇഷ്ടമാണ്. നമുക്കൊരു ചെറിയ വീഡിയോ കണ്ട് നോക്കാം കുട്ടികൾ Water Slide ൽ തെന്നി നീങ്ങുന്ന വീഡിയോ പ്രദർശിപ്പിക്കുന്നു. ഇവിടെ ഉയരത്തിൽ നിന്നും വരുന്ന കുട്ടികൾ വീണ്ടും ഉയർന്നു പോകുന്നതിന്റെ കാരണം എന്താണ്? എല്ലാ വിധ ചലനങ്ങൾക്കും ബലം ആവശ്യമാണോ? നമുക്ക് ഒരന്വേഷണം നടത്താം.	വീഡിയോ നിരീക്ഷിക്കുന്നു. കുട്ടികൾ ഒരു ബലമുള്ളതുകൊണ്ടാണെന്ന് അഭിപ്രായപ്പെട്ടു
പ്രവർത്തനം -1 രണ്ട് കുട്ടികൾ ഒരേ വശത്തു നിന്ന് ഒരേ ബലത്തോടെ മേശ തള്ളുന്നു. പിന്നീട് രണ്ടുപേരും എതിർ ദിശയിൽ നിന്നു മേശ തള്ളുവാൻ ആവശ്യപ്പെടുന്നു.	കുട്ടികൾ ഉത്സാഹത്തോടെ മേശ തള്ളുന്നു. റബാഹും നിഹാലും പെട്ടെന്ന് തന്നെ ഞങ്ങൾ ചെയ്യാമെന്ന് പറഞ്ഞു.
ചർച്ചാസൂചകം 1) ഒരു വസ്തുവിൽ അനുഭവപ്പെടുന്ന പരിണിത ബലം പൂജ്യമാക്കുന്ന സന്ദർഭങ്ങളിൽ നിശ്ചലമായിരിക്കുന്ന വസ്തു നീങ്ങുന്നുണ്ടോ? 2) ഇത്തരം ബലങ്ങൾ പ്രയോഗിക്കുന്നതിലൂടെ ചലിച്ചുകൊണ്ടിരിക്കുന്ന വസ്തുവിനെ	ഇല്ല എന്നഭിപ്രായപ്പെട്ടു

നിശ്ചലമാക്കാൻ സാധിക്കുമോ? ക്രോഡീകരണം 1) ഇല്ല 2) ഇല്ല സന്തുലിതബലം നിർവചിച്ച ചാർട്ട് പ്രദർശിപ്പിക്കുന്നു. ഒരു വസ്തുവിൽ അനുഭവപ്പെടുന്ന ആകെ ബലം അഥവാ പരിണത ബലം പൂജ്യമെങ്കിൽ പ്രയോഗിക്കപ്പെട്ട ബലങ്ങളെ സന്തുലിത ബലങ്ങൾ എന്നു പറയുന്നു. ഇത്തരം ബലങ്ങൾക്ക് നിശ്ചലാവസ്ഥയിലുള്ള വസ്തുക്കളെ ചലപ്പിക്കാനോ ചലിക്കുന്ന വസ്തുക്കളെ നിശ്ചലമാക്കാനോ കഴിയില്ല. തുടർപ്രവർത്തനം സന്തുലിത ബലങ്ങൾക്ക് കൂടുതൽ ഉദാഹരണങ്ങൾ കണ്ടെത്തി സയൻസ് ഡയറിയിൽ രേഖപ്പെടുത്തുക	

Appendix

LESSON PLAN NO. 2

PRELIMINARY DETAILS

Name of the Teacher	: Athira V.	Standard	: IX
School	: Thiruvangoor HSS	Duration	: 45 Mins
Subject	: Physics	Date	: 13/09/2023
Unit	: ചലനവും ചലനനിയമങ്ങളും		
Topic	: അസന്തുലിത ബാഹ്യബലവും ചലനവും		

തീം: **അസന്തുലിത ബാഹ്യബലവും ചലനവും**

പഠനനേട്ടങ്ങൾ:

- അസന്തുലിത ബലം എന്ന ആശയം തിരിച്ചറിയാൻ സാധിക്കുന്നു
- അസന്തുലിത ബലം വസ്തുക്കളിൽ പ്രയോഗിക്കുമ്പോൾ ഉണ്ടാവുന്ന പരിണിത ഫലങ്ങൾ വിശദീകരിക്കാൻ സാധിക്കുന്നു.

ആശയങ്ങൾ

അസന്തുലിത ബലം

വസ്തുതകൾ

- വാഹനങ്ങളുടെ ടയർ ചളിയിൽ താഴ്ന്ന് പോകുന്നു
- പുറകിൽ നിന്നും തള്ളുമ്പോൾ വണ്ടി നീങ്ങുന്നു

പ്രക്രിയാശേഷി

നിരീക്ഷണം, നിഗമനം

മൂല്യങ്ങൾ മനോഭാവങ്ങൾ

ശാസ്ത്രാവബോധം, സഹകരണ മനോഭാവം

പഠന സാമഗ്രികൾ

പാഠപുസ്തകത്തിലെ ചിത്രം 3.1, 3.2, 3.3, 3.4, 3.5, 3.7

മുന്നറിവുകൾ

- ബലത്തെക്കുറിച്ചുള്ള മുന്നറിവ്
- സന്തുലിത ബലത്തെക്കുറിച്ചുള്ള മുന്നറിവ്

പ്രതീക്ഷിത ഉത്പന്നങ്ങൾ

- നിരീക്ഷണങ്ങൾ രേഖപ്പെടുത്തിയ സയൻസ് ഡയറി
- അസന്തുലിത ബലം നിർവ്വചിച്ചെഴുതിയ സയൻസ് ഡയറി
- അസന്തുലിത ബലത്തിന്റെ പരിണിത ഫലങ്ങൾ വിവരിച്ചെഴുതിയ സയൻസ് ഡയറി.

പ്രക്രിയ	വിലയിരുത്തൽ
INTRODUCTORY ACTIVITY Good Morning all, കഴിഞ്ഞ ക്ലാസിൽ നമ്മൾ സന്തുലിത ബലമെന്താണെന്ന് പഠിച്ചല്ലോ?സന്തുലിതബലത്തിൽ ആകെ ബലം അഥവാ പരിണിത ബലം പൂജ്യമാണെന്നും പഠിച്ചു. എന്നാൽ പരിണിത ബലം പൂജ്യമല്ലാത്ത സന്ദർഭങ്ങളല്ലോ? അവിടെ അനുഭവപ്പെടുന്ന ബലമെന്തായിരിക്കും.	കഴിഞ്ഞ ക്ലാസിലെ ഭാഗങ്ങൾ ഓർത്തെടുത്തു.
പ്രവർത്തനം-1 പാഠപുസ്തകത്തിലെ പട്ടിക 3.1വിശകലനം ചെയ്യാൻ ആവശ്യപ്പെടുന്നു. ശേഷം ചർച്ചാ സൂചകം പൂർത്തിയാക്കാൻ ആവശ്യപ്പെടുന്നു.	
ചർച്ചാസൂചകം 1) പരിണിതബലം പൂജ്യമല്ലാത്ത സന്ദർഭങ്ങൾ ഏതെല്ലാം? 2) ഇത്തരം സന്ദർഭങ്ങളിൽ വസ്തുക്കൾക്ക് ചലനം സംഭവിക്കുന്നുണ്ടോ?	ഉത്തരം പറയുന്നു
ക്രോഡീകരണം 1) ചിത്രം 3.1, 3.3, 3.5 2) ഉണ്ട് ഒരു വസ്തുവിൽ അനുഭവപ്പെടുന്ന ആകെ ബലം അഥവാ പരിണത ബലം പൂജ്യമല്ലെങ്കിൽ, പ്രായോഗിക്കപ്പെട്ട ബലങ്ങളെ അസന്തുലിത ബലങ്ങൾ എന്നുപറയുന്നു	കുട്ടികൾ ആവർത്തിക്കുന്നു.
പ്രവർത്തനം-2 പാഠപുസ്തകത്തിലെ പ്രവർത്തനം (ചിത്രം 3.6) വിശദീകകരിക്കുന്നു. വീഡിയോ പ്രദർശിപ്പിക്കുന്നു. ഒരു മേശയുടെ രണ്ടറ്റങ്ങളിൽ ഓരോ കപ്പി ഘടിപ്പിച്ച് ഒരു മരക്കട്ടയുടെ രണ്ടഗ്രത്തും കെട്ടിയ ചരടുകൾ കപ്പികളിലൂടെ കടത്തി അവയുടെ അഗ്രങ്ങളിൽ സമാനമായ തട്ടുകൾ തൂക്കിയിടുക തട്ടുകളിൽ ഭാരം വയ്ക്കുന്നതിനനുസരിച്ച് മരക്കട്ടയുടെ ചലനത്തെയും അതിൽ അനുബവപ്പെടുന്ന ബലത്തെയും സംബന്ധിച്ച് നിരീക്ഷിച്ച ചർച്ചാ സൂചകം പൂർത്തിയാക്കാൻ	

ആവശ്യപ്പെടുന്നു. **ചർച്ചാസൂചകം** തട്ടുകളിൽ തുല്യ ഭാരം വയ്ക്കുമ്പോൾ മരക്കട്ടയിൽ അനുഭവപ്പെടുന്ന ബലം സന്തുലിതമോ അസന്തുലിതമോ? മേൽപ്പറഞ്ഞ സന്ദർഭങ്ങളിൽ മരക്കട്ടക്ക് ചലനം സംഭവിക്കുമോ? മരക്കട്ടയിൽ ബന്ധിച്ചിരിക്കുന്ന ഏതെങ്കിലും ഒരു തട്ടിലെ ഭാരം വർധിപ്പിക്കുക ഇപ്പോൾ ബലം സന്തുലിതമോ അസന്തുലിതമോ? മരക്കട്ടക്ക് ചലനമുണ്ടാകുമോ? ക്രമേണ തട്ടിലെ ഭാരം വർധിപ്പിച്ചാൽ കട്ടയുടെ ചലനവേഗത്തിന് എന്ത് മാറ്റമാണുണ്ടാവുക? കുറഞ്ഞ ഭാരമുള്ള തട്ടിൽ ഭാരം ക്രമേണ വർധിപ്പിച്ച് കൊണ്ട് മരക്കട്ടയുടെ ഇപ്പോഴുള്ള ചലനദിശ മാറ്റാൻ കഴിയുമോ? **ക്രോഡീകരണം** 1) സന്തുലിതബലം 2) ഇല്ല 3) അസന്തുലിതം മരക്കട്ടയ്ക്ക് ചലനമുണ്ടാവുന്നു 4) കൂടുന്നു 5) അതെ ഒരു വസ്തുവിൽ അസന്തുലിതബലം പ്രയോഗിക്കുമ്പോൾ നിശ്ചലാവസ്ഥയിലുള്ള വസ്തുവിന് ചലനം സംഭവിക്കുകയും ചലനാവസ്ഥയിലുള്ള വസ്തുവിന്റെ ചലനദിശയ്ക്കോ വേഗത്തിനോ മാറ്റം വരുകയും ചെയ്യുന്നു.	സന്തുലിത ബലം ഇല്ല അസന്തുലിത ബലം, മരക്കട്ട ചലിക്കുന്നു കൂടുന്നു അതെ കുട്ടികൾ ആവർത്തിക്കുന്നു
Concluding Activity ഒരു വാഹനത്തിനുള്ളിൽ നിന്ന് കൊണ്ട് വാഹനം തള്ളുന്ന ചിത്രം (ച്ത്രം 3.7) പ്രദർശിപ്പിക്കുന്നു. ഒരു കസേരയിൽ ഇരുന്ന് കൊണ്ട് മുകളിലേക്ക് ബലം പ്രയോഗിച്ച് കസേര ഉയർത്താൻ ആവശ്യപ്പെടുന്നു. ചർച്ചാ സൂചകം • വാഹനത്തിനുള്ളിൽ നിന്ന് കൊണ്ട് ആ വാഹനത്തെ തള്ളി നീക്കാൻ ശ്രമിച്ചാൽ	മർവ്വയും സൽമാനും കസേര ഉയർത്താൻ ശ്രമിക്കുന്നു.

ഫലമെന്തായിരിക്കും? • ഒരു കസേരയിൽ ഇരുന്ന് മുകളിലേക്ക് ബലം പ്രയോഗിച്ചാൽ അതിനെ ഉയർത്തുക സാധ്യമാണോ? **ക്രോഡീകരണം** • വാഹനം ചലിക്കുന്നില്ല • അല്ല	വാഹനം ചലിക്കുന്നില്ല അല്ല എന്നഭിപ്രായപ്പെട്ടു.
അന്തരിക ബലങ്ങൾക്ക് വസ്തുവിനെ ചലിപ്പിക്കാൻ കഴിയില്ല. ഒരു വസ്തു ചലിക്കണമെങ്കിൽ അസന്തുലിത ബാഹ്യബലം പ്രയോഗിക്കണം **തുടർപ്രവർത്തനം** സന്തുലിതബലത്തിനും അസന്തുലിത ബലത്തിനും കൂടുതൽ ഉദാഹരണങ്ങൾ കണ്ടെത്തി സയൻസ് ഡയറിയിൽ കുറിക്കുക. **Reflection and remedies** • കുട്ടികൾ നല്ല രീതിയിൽ സഹകരിച്ചു • Voice Modulation നന്നായിരുന്നു	

Appendix

LESSON PLAN NO. 3

PRELIMINARY DETAILS

Name of the Teacher	: Athira V.	Standard	: IX
School	: Thiruvangoor HSS	Duration	: 45 Mins
Subject	: Physics	Date	: 11/09/2023
Unit	: ചലനവും ചലന നിയമങ്ങളും		
Topic	: ഗലീലിയോയുടെ നിരീക്ഷണങ്ങൾ		

തീം: **ഗലീലിയോയുടെ നിരീക്ഷണങ്ങൾ**

പഠനനേട്ടങ്ങൾ:

- ഗലീലിയോയുടെ നിരീക്ഷണങ്ങൾ മനസ്സിലാക്കുന്നു.
- അസന്തുലിത ബാഹ്യബലം നേർരേഖാ സമചലനത്തിൽ തുടരുന്നതിന് ആവശ്യമില്ലെന്ന് മനസ്സിലാക്കുന്നു

ആശയങ്ങൾ:

- ഒരു വസ്തുവിന് മിനുസമുള്ള ചരിഞ്ഞ പ്രതലത്തിലൂടെ എളുപ്പത്തിൽ ചലിക്കാൻ സാധിക്കുന്നു.
- എല്ലാ ബലങ്ങൾക്കും ചലനം സാധ്യമല്ല.

പ്രക്രിയാശേഷി:

നിരീക്ഷണം, നിഗമനം, വിശകലനം

മൂല്യങ്ങൾ, മനോഭാവങ്ങൾ

ശാസ്ത്രീയ മനോഭാവം, സഹകരണ മനോഭാവം

പഠനസാമഗ്രികൾ:

കസേര, ICT on Slope experiment

മുന്നറിവുകൾ:

എല്ലാ ബലത്തിനും ചലനം സാധ്യമല്ലെന്ന് കുട്ടികൾക്കറിയാം

പ്രതീക്ഷിത ഉത്പന്നം

പൂർത്തീകരിച്ച ചർച്ചാ സൂചകം

പ്രക്രിയ	വിലയിരുത്തൽ
INTRODUCTORY ACTIVITY Good Morning all നിങ്ങളാരെങ്കിലും റോഡിൽ നിന്ന് പോയ വണ്ടി തള്ളാൻ സഹായിച്ചിട്ടുണ്ടോ? നിങ്ങളെന്താണ് അവിടെ ചെയ്യാറുള്ളത്. അതെ, നിങ്ങൾ നിങ്ങൾ വണ്ടി മുന്നോട്ട് തള്ളുമല്ലോ? എല്ലാവരും ഈ ചിത്രത്തിലേക്ക് നോക്കു. ഒരു വാഹനത്തിൽ നിന്ന് കൊണ്ട് ആ വാഹനത്തെ തള്ളി നീക്കാൻ ശ്രമിക്കുകയാണല്ലോ? വാഹനം ചലിക്കുന്നുണ്ടോ? ഇല്ലല്ലോ? ഇനി വാഹനത്തിന് പുറത്ത് നിന്നാണ് തള്ളുന്നതെങ്കിലോ? OK, നമുക്ക് ഇന്നത്തെ ക്ലാസിൽ ഇതിനെ പറ്റി കൂടുതലായി ചർച്ച ചെയ്യാം.	നിഹാൻ അവന്റെ വണ്ടി തള്ളിയ അനുഭവം പറഞ്ഞു
പ്രവർത്തനം-1 ഒരു കുട്ടിയോട് കസേരയിലിരുന്ന്കൊണ്ട് കാലിൽ ബലം കൊടുക്കാതെ ആ കസേര ഉയർത്താനാവശ്യപ്പെടുന്നു. **ചർച്ചാസൂചകം** 1. കസേര ഉയർത്താൻ സാധിക്കുന്നുണ്ടോ. 2. ഇവിടെ ഏത് ബലമാണ് ഉപയോഗിച്ചത്. 3. കാൽ ബലം കൊടുത്തപ്പോൾ കസേര ഉയർത്താൻ സാധിക്കുന്നുണ്ടോ. 4. ഇവിടെ ഏത് ബലമാണ് ഉപയോഗിച്ചത്. **ക്രോഡീകരണം** 1. ഇല്ല 2. ആന്തരികബലം 3. ഉണ്ട് 4. ബാഹ്യബലം "ബാഹ്യബലങ്ങൾക്ക് മാത്രമേ ചലനം സാധ്യമാവുകയുള്ളൂ"	

Appendix

പ്രവർത്തനം -2 മിനുസമുള്ള രണ്ട് പ്രതലങ്ങളെ ചിത്രത്തിൽ കാണുന്നതുപോലെ തുല്യ ചെരിവു വരുന്ന രീതിയിൽ ക്രമീകരിക്കുക. ഒരു നിശ്ചിത ഉയരത്തിൽ നിന്ന് A എന്ന പ്രതലത്തിലൂടെ ഒരു ബോൾ ഉരുട്ടി വിടുക **ചർച്ചാസൂചകം** 1. ബോളിനെന്താണ് സംഭവിക്കുന്നത്? 2. ഈ പ്രതലത്തിന്റെ ചരിവ് കുറച്ചാലോ എന്തായിരിക്കും നിരീക്ഷണ ഫലം? 3. എന്താണ് കാരണം?	ഫിദാൽ ബോൾ ഉരുട്ടി വിടുന്നത് എല്ലാവരും ശ്രദ്ധിച്ചു
ക്രോഡീകരണം 1. B യിലെ അതേ ഉയരത്തിലെത്തുന്നു. 2. B യിലെ അതേ ഉയരത്തിലെത്തുന്നു. 3. Slope കുറക്കുന്നതിനനുസരിച്ച് സഞ്ചരിച്ച ദൂരം കൂടുന്നു.	B യിലെ അതേ ഉയരത്തിലെത്തി B യിലെ അതേ ഉയരത്തിലെത്തി Slope കൂടുന്നു
Concluding Activity A യുടെ ചരിവ് പൂജ്യം ആക്കുന്നു **ചർച്ചാ സൂചകം** 1. ബോൾ അനന്തമായി നീങ്ങുന്നുണ്ടോ? 2. ഇതിനാധാരമായ ബലമേതാണ്? 3. ഈ ബലം ഇല്ലെങ്കിലോ? 4. ഇതേത് തരം ചലനമാണ്? **ക്രോഡീകരണം** 1. ഇല്ല 2. ഘർഷണ ബലം 3. ബോൾ അനന്തമായി നീങ്ങുന്നു 4. സമചലനം	

"ചലിച്ചുകൊണ്ടിരിക്കുന്ന ഒരു വസ്തുവിന് നേർരേഖാ സമചലനത്തിൽ തുടരുന്നതിന് അസന്തുലിത ബാഹ്യ ബലം ആവശ്യമില്ല" തുടർപ്രവർത്തനം നേർരേഖാ സമചലനത്തിന് കൂടുതൽ ഉദാഹരണങ്ങൾ കണ്ടെത്തുക Reflection & Remedies 1. കുട്ടികൾ പ്രവർത്തനങ്ങളെല്ലാം നല്ല രീതിയിൽ ചെയ്തു 2. ശബ്ദം ഉണ്ടായിരുന്നു.	കുട്ടികൾ എല്ലാവരും ആവർത്തിക്കുന്നു

Appendix

LESSON PLAN NO. 4

PRELIMINARY DETAILS

Name of the Teacher	: Athira V.	Standard	: IX
School	: Thiruvangoor HSS	Duration	: 45 Mins
Subject	: Physics	Date	: 13/09/2023
Unit	: ചലനവും ചലന നിയമങ്ങളും		
Topic	ന്യൂട്ടന്റെ ഒന്നാം ചലനനിയമം		

പഠനനേട്ടങ്ങൾ:

- ന്യൂട്ടന്റെ ഒന്നാം ചലനനിയമം മനസ്സിലാക്കുന്നു.
- ഒന്നാം ചലനന നിയമത്തിന് ഉദാഹരണങ്ങൾ മനസ്സിലാക്കുന്നു

ആശയങ്ങൾ:

ന്യൂട്ടന്റെ ഒന്നാം ചലന നിയമം

വസ്തുതകൾ:

ഒരു വസ്തുവിന് അതിന്റെ നിശ്ചലാവസ്ഥയ്ക്കോ ചലനാവസ്ഥയ്ക്കോ മാറ്റം വരുത്തുന്നതിന് അസന്തുലിത ബാഹ്യബലം ആവശ്യമാണ്.

പ്രക്രിയാശേഷി:

പരീക്ഷണം, നിരീക്ഷണം, ആശയവിനിമയം

മൂല്യങ്ങൾ, മനോഭാവങ്ങൾ

ശാസ്ത്രീയ മനോഭാവം, ജിജ്ഞാസ

പഠനസാമഗ്രികൾ:

Book

Ball

Toy Car

മുന്നറിവുകൾ:

ഗലീലിയോയുടെ നിരീക്ഷണത്തെ കുറിച്ചറിയാം

പ്രതീക്ഷിത ഉത്പന്നം

പൂർത്തീകരിച്ച സയൻസ് ഡയറി

പ്രക്രിയ	വിലയിരുത്തൽ
INTRODUCTORY ACTIVITY Good Morning all നിങ്ങൾക്ക് വാഹനങ്ങളിൽ യാത്ര ചെയ്യാൻ ഇഷ്ടമല്ലേ? ഏത് വാഹനത്തിൽ യാത്ര ചെയ്യാനാണ് ഇഷ്ടം? കാർ, ബൈക്ക്, എല്ലാം ഇഷ്ടമാണല്ലോ? വാഹനങ്ങൾ ഓടിക്കൊണ്ടിരിക്കുമ്പോൾ, അവ നിർത്താൻ നമ്മൾ എന്ത് ചെയ്യണം? അതെ ബ്രേക്ക് പിടിക്കണം. എന്തിനാണ് നാം ബ്രേക്ക് പിടിച്ച് അവയെ നിർത്തേണ്ടി വരുന്നത്? വാഹനങ്ങൾ കൂടുതൽ വേഗതയിൽ ചലിക്കാൻ നാം accelerator പ്രയോഗിക്കണമല്ലേ. നമുക്ക് ഇതിന്റെ കാരണമന്വേഷിക്കാം.	കുട്ടികൾ നന്നായി പ്രതികരിച്ചു
പ്രവർത്തനം-1 രണ്ട് കുട്ടികളെ വിളിക്കുന്നു. മേശ തള്ളുന്ന പ്രവർത്തനം ചെയ്യുന്നു. **ചർച്ചാ സൂചകം** 1) മേശ ആദ്യം ഏത് അവസ്ഥയിലായിരുന്നു? 2) രണ്ടു പേരും ഏതിർ ദിശയിൽ നിന്ന് തുല്യ ബലം പ്രയോഗിച്ചപ്പോൾ മേശ നീങ്ങിയോ 3) രണ്ട് പരും ഒരേ ദിശയിൽ നിന്ന് ബലം പ്രയോഗിച്ചപ്പോഴോ? 4) ഏത് തരം ബലമാണ് പ്രയോഗിക്കപ്പെട്ടത്? **ക്രോഡീകരണം** 1) നിശ്ചലാവസ്ഥയിൽ 2) ഇല്ല 3) മേശ നീങ്ങുന്നു 4) അസന്തുലിത ബാഹ്യബലം	കുട്ടികൾ ചർച്ച ചെയ്ത് ചർച്ചാ സൂചകം പൂർത്തീയാക്കുന്നു.
പ്രവർത്തനം - 2 ഒരു കുട്ടി ബോൾ തള്ളി ഉരുട്ടുന്ന പ്രവർത്തനം ചെയ്യുന്നു.	കുട്ടികൾ പ്രവർത്തനം നിരീക്ഷിച്ച് ചർച്ചാ സൂചകം പൂർത്തിയാക്കുന്നു.

Appendix

ചർച്ചാ സൂചകം 1) ബോൾ ഉരുണ്ട് നീങ്ങാൻ കാരണ മെന്താണ്? 2) ബോൾ ആദ്യം ഏതവസ്ഥയിലാ യിരുന്നു? 3) കുട്ടി ബലം പ്രയോഗിച്ചില്ലായിരു ന്നെങ്കിൽ ബോൾ നിശ്ചലാവസ്ഥയിൽ തന്നെ തുടരില്ലേ? **ക്രോഡീകരണം.** 1) കുട്ടി ബലം പ്രയോഗിച്ച 2) നിശ്ചലാവസ്ഥയിൽ 3) തുടരും	
Concluding Activity ഒരു ടോയ്ക്കാർ നേർരേഖയിലൂടെ ഒരേ വേഗതയിൽ ചലിപ്പിക്കുന്നു.	
ചർച്ചാസൂചകം: 1) കാർ ഏതവസ്ഥയിലായിരുന്നു? 2) കാർ നിശ്ചലമാവാൻ കാരണമെന്താണ്? 3) ഘർഷണ ബലം ഇല്ലായിരുന്നെങ്കിൽ കാർ അന്തമായി ചലനം തുടരില്ലേ? ക്രോഡീകരണം 1) ചലനാവസ്ഥ 2) ഘർഷണബലം 3) അതെ	ചലിക്കുന്നു ഘർഷണബലം
"അസന്തുലിതമായൊരു ബാഹ്യബലം പ്രയോഗിക്കുന്നത് വരെ ഏതൊരു വസ്തുവും അതിന്റെ നിശ്ചലാവസ്ഥയിലോ നേർരേഖാ സമചലനാവസ്ഥയിലോ തുടരുന്നതാണ് ഒന്നാം ചലന നിയമം"	

തുടർപ്രവർത്തനം: ന്യൂട്ടന്റെ ഒന്നാം ചലന നിയമത്തിന് ഉദാഹരണങ്ങൾ കണ്ടെത്തി സയൻസ് ഡയറിയിൽ കുറിക്കുക. Reflections and Remedies	

Appendix

LESSON PLAN NO. 5

PRELIMINARY DETAILS

Name of the Teacher	: Athira V.	Standard	: IX
School	: Thiruvangoor HSS	Duration	: 45 Mins
Subject	: Physics	Date	: 13/09/2023
Unit	: ജഡത്വം		
Topic	: ചലനവും ചലനനിയമങ്ങളും		

തീം: ജഡത്വം

പഠനനേട്ടങ്ങൾ:

- ജഡത്വം എന്ന ആശയം തിരിച്ചറിയുന്നു.
- ജഡത്വത്തിന് നിത്യ ജീവിതത്തിലെ സന്ദർഭങ്ങൾ തിരിച്ചറിയുന്നു.

വസ്തുതകൾ:

ഓരോ വസ്തുവും അതിന്റെ ഇപ്പോഴുള്ള അവസ്ഥയിൽ തുടരാനുള്ള പ്രവണത കാണിക്കുന്നു.

ആശയങ്ങൾ

ജഡത്വം, നിശ്ചല ജഡത്വം

പ്രക്രിയാശേഷി

പരീക്ഷണം, നിരീക്ഷണം, നിഗമനം

മൂല്യങ്ങൾ, മനോഭാവങ്ങൾ

സഹകരണ മനോഭാവം, ശാസ്ത്രാവബോധം

പഠനസാമഗ്രികൾ:

വെള്ളം നിറച്ച ബോട്ടിൽ, കട്ടിയുള്ള പേപ്പർ, മിനുസമുള്ള പേപ്പർ, ബീക്കർ, പേപ്പർ, നാണയം

മുന്നറിവുകൾ:

- ഒന്നാം ചലന നിയമത്തെക്കുറിച്ചുള്ള അറിവ്
- നിശ്ചലാവസ്ഥ, ചലനാവസ്ഥ എന്നിവയെ കുറിച്ചുള്ള അറിവ്

പ്രതീക്ഷിത ഉത്പന്നങ്ങൾ

നിശ്ചല ജഡത്വം നിർവ്വചിച്ചെഴുതിയ സയൻസ് ഡയറി

പ്രക്രിയ	വിലയിരുത്തൽ
INTRODUCTORY ACTIVITY Good Morning, നിങ്ങൾ വീട്ടിലെ കാർപെറ്റ് ശ്രദ്ധിച്ചിട്ടുണ്ടോ? അത് വൃത്തിയാക്കുമ്പോൾ കാർപെറ്റ് കുടയുമ്പോൾ അവയിൽ നിന്നും പൊടികൾ വേർതിരിയുന്നത് ശ്രദ്ധിച്ചിട്ടുണ്ടാവുമല്ലോ? എന്തുകൊണ്ടാണ് ഇങ്ങനെ കാർപെറ്റ് ചലിപ്പിക്കുമ്പോൾ അതിൽ പറ്റിയിരിക്കുന്ന പൊടിപടലങ്ങൾ മാറുന്നത് എന്ന് ചിന്തിച്ചിട്ടുണ്ടോ?നമുക്ക് നോക്കാം.	
പ്രവർത്തനം-1 പാഠപുസ്തകത്തിലെ പ്രവർത്തനം ചെയ്യുന്നു. ബോട്ടിലിൽ വെള്ളം നിറച്ച് അത് കട്ടിയുള്ളതും പരുപരുത്തതുമായ പേപ്പറിന് മുകളിൽ വെച്ച് ഒരു വശത്തേക്ക് വലിക്കുന്നു.	
ചർച്ചാസൂചകം 1) എന്തു നിരീക്ഷിക്കുന്നു? 2) പേപ്പർ വലിക്കുന്നതിനു മുൻപ് ബോട്ടിൽ നിശ്ചലാവസ്ഥയിലായിരുന്നില്ലേ? 3) പേപ്പർ വലിക്കുമ്പോൾ ബോട്ടിലിന്റെ മുകൾ ഭാഗം നിശ്ചലാവസ്ഥയിൽ തന്നെ തുടരുന്ന പ്രവണത കാണിക്കുന്നില്ലേ? 4) ബോട്ടിലിന്റെ താഴ്ഭാഗം ചലനാവസ്ഥ പ്രാപിക്കുന്നത് പേപ്പറും ബോട്ടിലിന്റെ തമ്മിലുള്ള ഘർഷണബലം കൊണ്ടായിരിക്കുമല്ലോ?	
ക്രോഡീകരണം 1) ബോട്ടിൽ പുറകിലേക്ക് വീഴുന്നു 2) അതെ 3) അതെ 4) അതെ	
പ്രവർത്തനം-2 മിനുസമുള്ള പേപ്പർ ഉപയോഗിച്ച് പരീക്ഷണം ആവർത്തിക്കുന്നു	

ചർച്ചാസൂചകം 1) എന്താണ് നിരീക്ഷിക്കുന്നത്? 2) ബോട്ടിൽ ആദ്യം ഏത് അവസ്ഥയിലായിരുന്നു? 3) പേപ്പർ വലിച്ചിട്ടും ബോട്ടിൽ പേപ്പറിനൊപ്പം ചലനത്തിലായോ? **ക്രോഡീകരണം** 1) ബോട്ടിൽ നിശ്ചലാവസ്ഥയിൽ തന്നെ തുടരുന്നു 2) നിശ്ചലാവസ്ഥയിൽ 3) ഇല്ല	
Concluding Activity ഒരു ബീക്കറിൽ മുകളിൽ പേപ്പർ കഷ്ണം വയ്ക്കുന്നു. അതിനു മുകളിൽ ഒരു നാണയം വെക്കുന്നു. പേപ്പർ പെട്ടെന്ന് വലിക്കുന്ന പ്രവർത്തനം ചെയ്യുന്നു **ചർച്ചാ സൂചകം** 1) നാണയം ആദ്യം ഏതവസ്ഥയിലാ യിരുന്നു? 2) എന്താണ് നിരീക്ഷിക്കുന്നത് 3) പേപ്പറിനൊപ്പം നാണയം ചലനാ വസ്ഥയിലാവുന്നുണ്ടോ? **ക്രോഡീകരണം** 1) നിശ്ചലാവസ്ഥയിൽ 2) നാണയ ബീക്കറിൽ വീഴുന്നു 3) ഇല്ല	
“നിശ്ചലാവസ്ഥയിലുള്ള ഒരു വസ്തുവിന് അതിന്റെ നിശ്ചലാവസ്ഥയിൽ ത്തന്നെ തുടരുന്നതിനുള്ള പ്രവണതയെ അഥവാ നിശ്ചലാവസ്ഥക്ക് മാറ്റം വരുത്താനുള്ള കഴിവില്ലായ്മയെ നിശ്ചല ജഡത്വം എന്നു പറയുന്നു.” തുടർപ്രവർത്തനം നിശ്ചല ജഡത്വത്തിന് കൂടുതൽ ഉദാഹരണം എഴുതുക	

LESSON PLAN NO. 6

PRELIMINARY DETAILS

Name of the Teacher	: Athira V.	Standard	: IX
School	: Tiravangoor HSS	Duration	: 45 Mins
Subject	: Physics	Date	: 20/06/2021
Unit	: ചലനവും ചലന നിയമങ്ങളും		
Topic	ആക്കം		

തീം: ആക്കം

പഠന നേട്ടങ്ങൾ

- ആക്കം എന്ന ആശയം തിരിച്ചറിയാൻ സാധിക്കുന്നു.
- ആക്കം കണക്കാക്കുന്നതിനുള്ള സമവാക്യം മനസ്സിലാക്കാൻ സാധിക്കുന്നു.
- ആക്കത്തിന്റെ യൂണിറ്റ് കണ്ടെത്താൻ സാധിക്കുന്നു.

വസ്തുതകൾ

- ചില വസ്തുക്കൾ ഭിത്തിയിലേക്ക് എറിയുമ്പോൾ ഭിത്തിയിൽ തട്ടി തിരിച്ചു പോകുന്നു.
- മണലിലേക്ക് ഭാരമുള്ള വസ്തുക്കൾ വിഴുമ്പോൾ അവിടെ കുഴികൾ രൂപപ്പെടുന്നു.

ആശയങ്ങൾ

ആക്കം

പ്രക്രിയാശേഷി:

നിരീക്ഷണം, നിഗമനം

മൂല്യങ്ങൾ, മനോഭാവങ്ങൾ

ശാസ്ത്രാവബോധം, സഹകരണ മനോഭാവം

പഠനസാമഗ്രികൾ

അമ്യൂസ് മെന്റ് പാർക്കിലെ റൈഡിന്റെ ചിത്രം, ബോൾ, പാത്രം മണൽ

മുന്നറിവുകൾ:

പ്രവേഗത്തെക്കുറിച്ചുള്ള മുന്നറിവ്

മാസിന്റെയും പ്രവേഗത്തിന്റെയും യൂണിറ്റിനക്കുറിച്ചുള്ള മുന്നറിവ്

പ്രതീക്ഷിത ഉത്പന്നങ്ങൾ

ആക്കം നിർവ്വചിച്ചെഴുതിയ സയൻസ് ഡയറി

Appendix

പ്രക്രിയ	വിലയിരുത്തൽ
INTRODUCTORY ACTIVITY ഗുഡ് മോർണിംഗ്, നമ്മുടെ സ്കൂളും കെട്ടിടങ്ങളും നല്ല ഉയരമുള്ളതാണല്ലോ? ഉയരം കൂടിയ കെട്ടിടത്തിൽ നിന്നും വീഴുമ്പോൾ അപകടം സംഭരിക്കുമെന്ന് നിങ്ങൾക്കറിയയാമല്ലോ? എന്ത് കൊണ്ടായിരിക്കും ഉയരം കൂടുമ്പോൾ ആഘാതവും അപകടവും കൂടുന്നതെന്ന് നിങ്ങൾ ചിന്തിച്ചിട്ടുണ്ടോ? **പ്രവർത്തനം - 1** സമാന ആകൃതിയും വലുപ്പവുമുള്ള രണ്ട് ഒഴിഞ്ഞ ഐസ്ക്രീം ബോളുകളെടുത്ത് ഒന്നിൽ മണൽ നിറച്ചുള്ള പരീക്ഷണം ചെയ്യുന്നു. **ചർച്ചാ സൂചകം:** 1) തുല്യവേഗത്തിൽ എത്തിയിട്ടും ഇവയിൽ എതു ബോട്ടാണ് മണലിൽ കൂടുതൽ താഴ്ച ഉണ്ടാക്കിയത്? 2) എന്തു കൊണ്ടായിരിക്കും? **ക്രോഡീകരണം:** 1) മണൽ നിറച്ചത് 2) മാസ് കൂടിയതിനാൽ **പ്രവർത്തനം- 2** ഒരേ ബോൾ തന്നെ വ്യത്യസ്ത ഉയരങ്ങളിൽ നിന്നു താഴേക്ക് ഇട്ടുകൊണ്ട് പരീക്ഷണം ആവർത്തിക്കുന്നു. **ചർച്ചാസൂചകം:** 1) ഉയരം കൂടിയതിനാൽ മണലിൽ പതിക്കുന്ന ബോളിന്റെ പ്രവേഗത്തിന് എന്തു മാറ്റമാണുണ്ടായത്? 2) പ്രവേഗം കൂടുന്നതിനനുസരിച്ച് മണലിലുണ്ടാക്കിയ ആഘാതത്തിന് എന്തു മാറ്റമാണ് നിരീക്ഷിക്കുന്നത്?	

ക്രോഡീകരണം: 1) കൂടുന്നു 2) കൂടുന്നു ചലിച്ചുകൊണ്ടിരിക്കുന്ന വസ്തുക്കളുടെ സവിശേഷ ഗുണമാണ് ആക്കം. ഇത് അളക്കുന്നത് വസ്തുവിന്റെ മാസിന്റെയും പ്രവേഗത്തിന്റെയും ഗുണിതമായാണ്. **Concluding Activity:** ആക്കത്തിന്റെ സമവാക്യം എഴുതിയ വർക്ക്ഷീറ്റ് ചർച്ചയിലൂടെ പൂർത്തീകരിച്ച് കൊണ്ട് ആക്കത്തിന്റെ യൂണിറ്റ് കണ്ടെത്തുന്നു. **ചർച്ചാ സൂചകം:** ആക്കം = മാസ് x പ്രവേഗം ആക്കത്തിന്റെ യൂണിറ്റ് = മാസിന്റെ യൂണിറ്റ് x പ്രവേഗത്തിന്റെ യൂണിറ്റ് = --------------------- x ------------------------- ക്രോഡീകരണം = ----------------------------- ആക്കത്തിന്റെ യൂണിറ്റ് = Kg x m/s = Kgm/s തുടർപ്രവർത്തനം: ആക്കവുമായി ബന്ധപ്പെട്ട് നിത്യ ജീവിതത്തിൽ നിന്നും സന്ദർഭങ്ങൾ കണ്ടെത്തി സയൻസ് ഡയറിയിൽ കുറിക്കുക. Reflection & Remedies:	

Appendix V

DEPARTMENT OF EDUCATION
UNIVERSITY OF CALICUT

LESSON PLAN BASED ON EXISTING METHOD OF TEACHING (English Version)

Dr. C.M. Bindhu	**Athira. V**
Professor & Head	Research Scholar
Department of Education	Department of Education

LESSON PLAN NO. 1

PRELIMINARY DETAILS

Name of the Teacher	: Athira V.	Standard	: IX
School	: Thiruvangoor HSS	Strength	: 35
Subject	: Physics	Duration	: 40 Mins
Unit	: Balanced force	Date	:
Topic	Motion and Laws of Motion		

Theme: Balanced Force

Learning Outcomes:

Identify the concept of Balanced force

Concepts

Balanced force

Facts

Not all forces lead to motion

There is no displacement occurs when the forces are equal and opposite

Process Skills

Experimentation, observation and drawing conclusions

Values, Attitudes

Cooperation, scientific awareness

Prerequisites

Knowledge about the concept - Force

Learning Aids

- Video of children moving through the Water Slide
- Figure 3.1, 3.2, 3.3, 3.4 in the textbook

Learning Outcome

Science diary where balanced force is defined

Process	Evaluation
INTRODUCTORY ACTIVITY Good Morning, How many of you have gone to Amusement Parks? Everyone loves to go to the park, go on the rides and go on the water slide. Let's watch a short video showing the cages sliding down the Water Slide. What is the reason why children who come from height here go high again? Do all movements require force? Let's do an investigation.	Watching the video. It was suggested that this happens because students have a strength
Activity - 1 Two students push the table with the same force from the same side. Then both of them are asked to push the table from the opposite direction.	Students enthusiastically push the table. Rabah and Nihal immediately said we would.
Discussion Points 1) Does an object at rest move when the resultant force on an object is zero? 2) Can a moving object be brought to rest by applying such forces? **Consolidation** 1) No 2) No	They said, No.

Displays the chart where the balanced force is defined. If the total force or resultant force on an object is zero, the forces applied are called balanced forces. Such forces cannot move objects at rest or bring objects in motion to rest. **Follow up:** Find more examples of balanced forces and record them in your science diary	

LESSON PLAN NO. 2

PRELIMINARY DETAILS

Name of the Teacher	: Athira V.	Standard	: IX
School	: Thiruvangoor HSS	Duration	: 45 Mins
Subject	: Physics	Date	: 13/09/2023
Unit	: Motion and Laws of Motion		
Topic	: Unbalanced external force and motion		

Theme: Unbalanced external force and motion

Learning Outcomes:

- Understand the concept of unbalanced force
- To explain the resultant effects when an unbalanced force is applied to objects.

Concepts

Unbalanced force

Facts

- Tires of vehicles get low in mud
- The carriage moves when pushed from behind

Process Skills

Observation and conclusion

Values and attitudes

Scientific awareness and cooperative attitude

Learning Aids

Figure 3.1, 3.2, 3.3, 3.4, 3.5, 3.7 in the textbook

Prerequisites

- Previous knowledge about force
- Knowledge of balanced force

Appendix

Learning Outcome

- Science diary, which is recorded with observations
- Science diary, where unbalanced force is defined
- A science diary describing the effects of unbalanced forces.

Process	Evaluation
INTRODUCTORY ACTIVITY Good Morning all, In the last class, we learned what is balanced force? We also learned that in balanced force, the total force or resultant force is zero. But what about cases where the resultant force is not zero? What will be the force felt there?	Remembered concepts learned in the last class.
Activity-1 Ask to analyze Table 3.1 in the textbook. Then ask to complete the discussion points.	
Discussion Points 1) **In which cases the resultant force is not zero?** 2) **Do objects move in such cases?**	Answering
Consolidation 1) Figure 3.1, 3.3, 3.5 2) There is If the total force or resultant force on an object is not zero, the forces applied are called unbalanced forces.	Students repeats.
Activity-2 The activity in the textbook (Figure 3.6) is explained by displaying a video. A pulley is attached to each end of a table and strings tied to both ends of a wooden block are passed through the pulleys and similar pegs are hung from their ends. As weights are placed on the pegs they are	

asked to complete the discussion points. **Discussion Points** Is the force felt on the log balanced or unbalanced when equal weights are placed on the log? In the above cases, does the wooden box move? Increase the weight on any of the rafters attached to the wooden block. Is the force balanced or unbalanced? Can wooden block move? If the weight on the log is gradually increased, what will be the change in the velocity of the block? Can the current direction of motion of the log be reversed gradually by increasing the weight on the light weight log? **Consolidation** 1) Balanced force 2) No 3) Unbalanced wood has motion 4) increases 5) Yes When an unbalanced force is applied to an object, the object at rest moves and the direction or speed of the object in motion changes.	Equilibrium force No Unbalanced force, the log moves Increasing Yes Students repeats
Concluding Activity Figure 3.7 shows a vehicle being pushed from inside a vehicle. Teacher asked to sit on a chair and ask to lift the chair by applying upward force. **Discussion Points** • What would be the effect of trying to push the vehicle from inside the vehicle?	Marva and Salman try to lift the chair. Vehicle does not move

• Is it possible to lift a chair by sitting on it and applying upward force? **Consolidation** • Vehicle does not move • No	It was thought no.
Internal forces cannot move an object. For an object to move, an unbalanced external force must be applied **Follow Up** Find more examples of balanced and unbalanced forces and record them in your science diary. **Reflection and Remedies** • Students cooperated well • Voice Modulation was good	

LESSON PLAN NO. 3

PRELIMINARY DETAILS

Name of the Teacher	: Athira V.	Standard	: IX
School	: Thiruvangoor HSS	Duration	: 45 Mins
Subject	: Physics	Date	: 11/09/2023
Unit	: Motion and Laws of Motion		
Topic	: Galileo's observations		

Theme: Galileo's Observations

Learning Outcomes:

- Understanding Galileo's observations.
- Understanding the concept that an unbalanced external force is not necessary to maintain straight line motion.

Concepts

- An object can easily move along a smooth inclined surface.
- Not all forces can cause motion.

Process Skills

Observation, conclusion and analysis

Values and attitudes

Scientific attitude, Cooperation

Learning Aids

Chair, ICT on Slope experiment

Prerequisites

Children know that not all force can cause motion

Appendix

Learning Outcomes

Completed discussion points

Process	Evaluation
INTRODUCTORY ACTIVITY Good Morning all Have any of you helped push a car off the road? What are you doing there? Yes, you push the car forward, don't you? Everyone look at this picture. Here someone is trying to push the vehicle away from a vehicle? Does the vehicle move? No? What if it is pushed from outside the vehicle? OK, let's discuss this in detailed in today's class.	Nihan recounted the experience of pushing his car
Activity-1 A student is asked to sit on a chair and lift the chair without applying force to the legs. **Discussion index** 1. Can the chair be raised? 2. What force is used here? 3. Is it possible to lift the chair when the force is applied to the leg? 4. Which force is used here? **Consolidation** 1. No 2. Internal force 3. There is 4. External force “Motion is only possible by external forces”	

Activity -2 Arrange the two smooth surfaces so that they are equally inclined as shown in the figure. A ball is rolled from a given height through a surface A **Discussion Points** 1. What happens to the ball? 2. What would be the observed effect if the slope of this surface were reduced? 3. What is the reason?	Fidal was rolling the ball and everyone observing it.
Consolidation 1. reaches the same height as at B. 2. reaches the same height as at B. 3. The distance traveled increases as the slope decreases.	Reached the same height as in B Slope increases to reach the same height as at B
Concluding Activity Makes the slope of A to zero **Discussion Points** 1. Does the ball move infinitely? 2. What is the underlying force? 3. What if this force does not exist? 4. What type of motion is this? **Consolidation** 1. No 2. Frictional force 3. Ball moves infinitely 4. Uniform motion	

"An object in motion does not require an unbalanced external force to remain in straight line motion" **Follow Up.** Find more examples of straight line motion **Reflection & Remedies** 1. Students did all the activities well 2. There was noise.	All students repeat

LESSON PLAN NO. 4

PRELIMINARY DETAILS

Name of the Teacher	: Athira V.	Standard	: IX
School	: Thiruvangoor HSS	Duration	: 45 Mins
Subject	: Physics	Date	: 13/09/2023
Unit	: Motion and Laws of Motion		
Topic	Newton's first law of motion		

Learning Outcomes:

- Understanding Newton's first law of motion.
- Understanding examples of the first law of motion

Concepts

Newton's first law of motion

Facts

An object requires an unbalanced external force to change its state of rest or state of motion.

Process Skills

Experiment, observe and communicate

Values and attitudes

Scientific attitude, curiosity

Learning Aids

Book

Ball

Toy Car

Appendix

Prerequisites:

Know about Galileo's observation

Learning Outcomes

The Completed Science Diary

<table>
<tr><th>Process</th><th>Evaluation</th></tr>
<tr><td>INTRODUCTORY ACTIVITY

Good Morning all

Don't you like traveling in vehicles? Which vehicle do you prefer to travel in? Car, bike? everything is fine? When the vehicles are moving, what should we do to stop them? Yes, brake. Why do we have to put the brakes on and stop them? Shouldn't we apply accelerator to make vehicles move faster? Let's find out why.</td><td>The students responded well</td></tr>
<tr><td>Activity-1

Inorder to do the work of pushing the table, teacher call students.

Discussion Points

1) In what condition was the table initially?

2) Did the table move when both students applied equal force from either direction?

3) When the force is exerted on both ends from the same direction?

4) What type of force was applied?

Consolidation

1) At rest

2) No

3) The table moves

4) Unbalanced external force</td><td>Students discuss and complete the discussion prompt.</td></tr>
</table>

Activity – 2 A student pushes and rolls a ball. **Discussion Points** 1) What causes the ball to roll? 2) What was the initial position of ball? 3) Wouldn't the ball remain at rest if the child had not applied the force? **Consolidation** 1) The child used force 2) At rest 3) will continue	Students observe the activity and complete the discussion points.
Concluding Activity A toycar moves along a straight line with constant speed.	
Discussion Points: 1) What condition was the car in? 2) What causes the car to stop? 3) If there was no frictional force, wouldn't the car continue to move endlessly? **Consolidation** 1) State of motion 2) Frictional force 3) Yes	Moving Frictional force
"The first law of motion states that any object will remain in its state of rest or state of motion until an unbalanced external force is applied on it"	

Follow-up: Find examples of Newton's first law of motion and record them in your science diary. **Reflections and Remedies**	

LESSON PLAN NO. 5

PRELIMINARY DETAILS

Name of the Teacher	: Athira V.	Standard	: IX
School	: Thiruvangoor HSS	Duration	: 45 Mins
Subject	: Physics	Date	: 13/09/2023
Unit	: Inertia		
Topic	: Motion and Laws of Motion		

Theme: Inertia

Learning Outcomes:

- Recognizes the concept of inertia.
- Identifies situations in everyday life for inertia.

Facts

Every object shows a tendency to remain in its present state.

Concepts

Inertia, static inertia

Process Skill

Experiment, observation and conclusion

Values and attitudes

Cooperation, scientific awareness

Learning Aids

Bottle filled with water, thick paper, smooth paper, beaker, paper, coin

Prerequisites

- Knowledge of first law of motion
- Knowledge of state of rest and state of motion

Learning Outcome

The science diary that defined static inertia

Appendix

Process	Evaluation
INTRODUCTORY ACTIVITY Good Morning, Have you noticed the carpet at home? Have you ever noticed that dust separates from carpets when you sweep them while cleaning them? Have you ever wondered why the dust on the carpet changes when you move it? Let's see.	
Activity-1 Doing the activity in the textbook. The bottle is filled with water and placed on top of a thick, rough paper and pulled to one side.	
Discussion Points 1) What is observed? 2) Wasn't the bottle stationary before pulling the paper? 3) Doesn't the top of the bottle tend to remain stationary when the paper is pulled? 4) The bottom of the bottle is moving because of the frictional force between the paper and the bottle?	
Consolidation 1) The bottle falls backwards 2) Yes 3) Yes 4) Yes	
Activity-2 The experiment is repeated with smooth paper **Discussion Points** 1) What is observed? 2) In what condition was the bottle	

initially? 3) Is the bottle being in motion along with the paper? **Consolidation** 1) The bottle remains at rest 2) At rest 3) No	
Concluding Activity A piece of paper is placed on top of a beaker. A coin is placed on top of it. The paper does a quick pulling action **Discussion Points** 1) In what condition was the coin initially? 2) What is observed 3) Can the coin move along with the paper? **Consolidation** 1) At rest 2) The coin falls into the beaker 3) No	
"The tendency of an object at rest to remain in its state of rest, or the inability to change its state of rest, is called static inertia." **Follow Up** Write one more example for static inertia	

LESSON PLAN NO. 6

PRELIMINARY DETAILS

Name of the Teacher	: Athira V.	Standard	: IX
School	: Tiravangoor HSS	Duration	: 45 Mins
Subject	: Physics	Date	: 20/06/2021
Unit	: Motion and Laws of Motion		
Topic	: Momentum		

Theme: Momentum

Learning outcomes

- Understand the concept of momentum.
- Able to understand the equation for calculating momentum.
- It is possible to find the unit of momentum.

Facts

- When some objects are thrown against a wall, they bounce off the wall.
- Pits are formed when heavy objects crawl into the sand.

Concepts

Momentum

Process Skills

Observation and conclusion

Values and attitudes

Scientific awareness and cooperative attitude

Learning Aids

Picture of amusement park ride, ball and bowl of sand

Prerequisites

Previous knowledge of speed

Knowledge of units of mass and velocity

Learning Outcome

Science diary where momentum is defined

Process	Evaluation
INTRODUCTORY ACTIVITY Good morning, is our school buildings are of good height? Did you know that falling from a tall building can be dangerous? Have you ever wondered why trauma and danger increase with height? **Activity – 1** An experiment is carried out by taking two empty ice cream balls of similar shape and size and filling one with sand. **Discussion Points:** 1) Which of the following balls made a greater depth in the sand even though it falls with same speed? 2) Why? **Consolidation** 1) Filled with sand 2) Due to increased mass **Activity- 2** The experiment is repeated by dropping the same ball from different heights. **Discussion Points** 1) What is the change in the velocity of the ball hitting the sand due to the increase in height? 2) What change is observed for the impact on the sand as the velocity increases?	

Consolidation 1) increases 2) increases Momentum is a specific property of objects in motion. It is measured as the product of the object's mass and velocity. **Concluding Activity:** The unit of momentum is found by completing the written equation of momentum by discussing the worksheet. **Discussion Points:** Momentum = mass x velocity Unit of momentum = unit of mass x unit of velocity = -------------------- x -------------------------- **Consolidation** Unit of momentum = Kg x m/s = Kgm/s **Follow-up:** Find instances from everyday life related to momentum and record them in your science diary. **Reflection & Remedies:**	

Appendix VI

CALICUT UNIVERSITY
DEPARTMENT OF EDUCATION
2021

PROBLEM SOLVING ABILITY TEST IN PHYSICS
(Malayalam - Draft)

Dr. Bindhu CM
Professor

Athira V
Research Scholar

നിർദ്ദേശങ്ങൾ

1. ഈ ബുക്ക്‌ലറ്റിൽ 14 ഭാഗങ്ങൾ (Part 1 to part 14) 8 പേജുകളിലായി ഉണ്ട്. ഓരോ ഭാഗങ്ങളിലും 1 മുതൽ 3 വരെ ചോദ്യങ്ങളുണ്ട്.
2. ഓരോ ചോദ്യത്തിനും 1 മാർക്ക് ആണ്.
3. എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരം എഴുതുക. ഉത്തരക്കടലാസിൽ ഉത്തരം മാർക്ക് ചെയ്യുമ്പോൾ ശരിയായ ഉത്തരത്തിനു നേരെ വട്ടം വരക്കുക. ഉദാ:- നിങ്ങളുടെ ഉത്തരം B ആണെങ്കിൽ താഴെ കൊടുത്തതുപോലെ മാർക്ക് ചെയ്യുക.

   A B C D
4. നിങ്ങൾ തന്നിരിക്കുന്ന ഉത്തരങ്ങൾ ഗവേഷണ ആവശ്യങ്ങൾക്ക് മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ.
5. ചോദ്യപേപ്പറിൽ ഒന്നുംതന്നെ എഴുതാൻ പാടില്ല.

PART 1

ദൈനംദിന ജീവിതത്തിലെ ചില സന്ദർഭങ്ങളാണ് താഴെയുള്ള ചോദ്യങ്ങളിൽ പ്രതിപാദിച്ചിരിക്കുന്നത്. ഓരോ സന്ദർഭത്തോടും അനുബന്ധിച്ച് A, B, C, D എന്നിങ്ങനെ കൊടുത്തിരിക്കുന്ന നാലു വസ്തുതകളിൽ ഏറ്റവും അസ്വാഭാവികമെന്നു തോന്നുന്ന നമ്പറിനു ചുറ്റും വട്ടംവരച്ച് മാർക്ക് ചെയ്യുക.

1) രണ്ടു കുട്ടികൾ ചേർന്ന് ഒരു മേശ ഒരേ ദിശയിലേക്ക് ബലം പ്രയോഗിച്ച് തള്ളുന്നു. തള്ളുമ്പോൾ ഉണ്ടായ സാഹചര്യങ്ങളാണ് താഴെ കൊടുത്തിരിക്കുന്നത്. ഇതിൽ ഏതാണ് നിങ്ങളെ ആശ്ചര്യപ്പെടുത്തുന്നത്?

   A. മേശ തള്ളുമ്പോൾ ബുദ്ധിമുട്ട് അനുഭവപ്പെടുന്നു.

   B. മേശ വളരെ വേഗത്തിൽ ബുദ്ധിമുട്ടില്ലാതെ ഒരേ ദിശയിലേക്ക് നീങ്ങുന്നു.

   C. മേശ നീങ്ങുമ്പോൾ തറയിൽ പോറൽ ഉണ്ടാകുന്നു.

   D. മേശയുടെ സ്ഥാനത്തിന് കാര്യമായ മാറ്റം സംഭവിക്കുന്നില്ല.

2) മേശപ്പുറത്തുള്ള അമ്മുവിന്റെ പേപ്പറിനുമുകളിൽ അപ്പു വെള്ളം നിറച്ച വാട്ടർ ബോട്ടിൽ വെച്ചു. അമ്മു ബോട്ടിൽ മാറ്റാതെ പേപ്പർ ഒരു വശത്തേക്ക് വേഗത്തിൽ വലിക്കുന്നു. അപ്പോൾ ഉണ്ടായ സാഹചര്യങ്ങൾ താഴെ കൊടുത്തിരിക്കുന്നു. ഇതിൽ ഏതു സാഹചര്യമാണ് സാധാരണ നാം പ്രതീക്ഷിക്കുന്നതിൽനിന്നും വ്യത്യസ്തമായി അനുഭവപ്പെടുന്നത്?

   A. പേപ്പറിന്റെ വക്കിൽ ചുളിവുണ്ടാകുന്നു.

B. ബോട്ടിലിന്റെ മുകൾഭാഗം പിറകോട്ടു ചായുകയും, പൂർവ്വസ്ഥിതി തുടരുകയും ചെയ്യുന്നു.

C. ബോട്ടിലിൽനിന്നും പകുതിവെള്ളം പേപ്പറിലേക്ക് ചിന്തുന്നു.

D. പേപ്പർ എടുക്കാൻ ബുദ്ധിമുട്ടനുഭവപ്പെടുന്നു.

3) ചന്ദു തോണിയിൽനിന്നും ഇറങ്ങാനായി തോണിയുടെ അറ്റത്തുനിന്ന് കരയിലേക്ക് ചാടുന്നു; ചാടുമ്പോൾ ഉണ്ടായ സന്ദർഭങ്ങളാണ് താഴെ കൊടുത്തിരിക്കുന്നത്. ഇവിടെ നിങ്ങളുടെ ശ്രദ്ധ പിടിച്ചുപറ്റിയ സന്ദർഭം ഏതാണ്?

A. ചന്ദു പെട്ടെന്ന് കരയിലേക്ക് എത്തുന്നു.

B. വെള്ളം ചവിട്ടാതെ ചന്ദു കരയിലേക്കെത്തുന്നു.

C. ചന്ദു മുന്നോട്ടു ചാടിയപ്പോൾ തോണി പുറകോട്ടു നീങ്ങുന്നു.

D. കരയിലേക്ക് ചാടുമ്പോൾ കൂടുതൽ ബലം അനുഭവപ്പെടുന്നു.

PART 2

ദൈനംദിന ജീവിതത്തിലെ ചില സന്ദർഭങ്ങളാണ് താഴെയുള്ള ചോദ്യങ്ങളിൽ പ്രതിപാദിച്ചിരിക്കുന്നത്. ഓരോ സന്ദർഭത്തിലും ഒരു കാതലായ പ്രശ്നം അടങ്ങിയിട്ടുണ്ട്. ഓരോ സന്ദർഭത്തോടും അനുബന്ധിച്ച് കൊടുത്തിരിക്കുന്ന നാലു പ്രസ്താവനകളിൽ ഏതാണ് പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത് എന്ന് നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് മാർക്ക് ചെയ്യുക.

4) നിങ്ങൾ സ്ഥിരമായി ബസ്സിൽ യാത്ര ചെയ്യാറില്ലേ. ബസ്സ് പെട്ടെന്ന് ബ്രേക്ക് ചവിട്ടുമ്പോൾ നിങ്ങൾ മുൻപോട്ട് വീണു പോവാറില്ലെ? താഴെ പറയുന്നവയിൽ ഏത് പ്രസ്ഥാവനയാണ് ഇവിടുത്തെ പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത്?

A. ചലനാവസ്ഥയിലുള്ള വസ്തു ചലനാവസ്ഥ തുടരാനുള്ള പ്രവണത കാണിക്കുന്നു.

B. ബസ്സ് അമിത വേഗതയിൽ ഓടുമ്പോൾ ബാലൻസ് ബുദ്ധിമുട്ടാണ്.

C. ബസ്സിൽ ആവശ്യത്തിലധികം തിരക്കുള്ളതിനാൽ

D. നിശ്ചലാവസ്ഥയിലുള്ള ബസ്സ് പെട്ടെന്ന് ചലിച്ചതിനാൽ.

5) രാജേഷും രമേഷും സുഹൃത്ത്ക്കളായിരുന്നു. അവർ ഒരുമിച്ച് ലോങ്ങ്-ജമ്പ് പരിശീലിക്കാറുണ്ടായിരുന്നു. രണ്ടുപേരും ഒരു മത്സരത്തിൽ പങ്കെടുത്തപ്പോൾ രാജേഷ് കുറേ ദൂരം ഓടിവന്ന് ലോങ്ങ്-ജമ്പ് ചാടുകയും, എന്നാൽ രമേഷ് പെട്ടെന്ന് ഓടിവന്ന് ചാടുകയും ചെയ്തു. മത്സരശേഷം രാജേഷ് നല്ല മാർജിനിൽ വിജയം കൈവരിച്ചു. എന്നാൽ രമേഷ് വളരെ പിന്നിലായിരുന്നു. താഴെ പറയുന്നവയിൽ ഏത് പ്രസ്ഥാവനയാണ് ഇതിലെ പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത്?

A. രമേഷിന് രാജേഷിനെക്കാൾ നീളം കുറവായതിനാൽ ചാടാൻ ബുദ്ധിമുട്ടനുഭവപ്പെട്ടു.

B. രാജേഷ് കൂടുതൽ ദൂരം ഓടി ചലന ജഡത്വം പ്രയോജനപ്പെടുത്തിയതിനാൽ

C. രാജേഷ് രമേഷിനേക്കാൾ കൂടുതൽ സമയം പരിശീലിച്ചതിനാൽ.

D. രാജേഷിന് പരിചയമുള്ള കളിസ്ഥലമായതിനാൽ ചാടാൻ വളരെ എളുപ്പമായിരുന്നു.

6) ചുരങ്ങളിലൂടെ ലോഡ് കയറ്റിയ വാഹനങ്ങൾ ഓടിക്കുമ്പോൾ പലപ്പോഴും അപകടം സംഭവിക്കാറുണ്ട്. താഴെ പറയുന്നവയിൽ ഏതു പ്രസ്താവനയാണ് ഇതിലെ പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത്?

A. ലോഡ് നിറച്ച വാഹനങ്ങൾക്ക് മാസ് കൂടുതലാണ് തന്മൂലം ജഡത്വം കൂടുതലായിരിക്കും.

B. ഭാരം കൂടിയ വാഹനങ്ങൾ വേഗത കുറയ്ക്കാതെ വളവു തിരിക്കാൻ ശ്രമിക്കുന്നതുകൊണ്ട്.

C. ഉയരം കൂടുമ്പോൾ വാഹനങ്ങളുടെ വേഗത കുറയ്ക്കാൻ ബുദ്ധിമുട്ടാണ്.

D. ലോഡ് കയറ്റിയ വാഹനങ്ങൾ ബാലൻസ് ചെയ്യാൻ ബുദ്ധിമുട്ടാണ്.

PART 3

ദൈനംദിന ജീവിതത്തിലെ ചില സന്ദർഭങ്ങളാണ് താഴെയുള്ള ചോദ്യങ്ങളിൽ പ്രതിപാദിക്കുന്നത്. ഓരോ സന്ദർഭത്തിലും ഒരു ശാസ്ത്രപ്രശ്നം അടങ്ങിയിരിക്കുന്നു. ഈ പ്രശ്നത്തിലെ പ്രധാന ഘടകങ്ങൾ ഏതാണെന്ന് കണ്ടുപിടിക്കുകയാണ് നിങ്ങൾ ചെയ്യേണ്ടത്. പ്രധാന ഘടകങ്ങളുടെ ശരിയായ കൂട്ടം കണ്ടെത്തി അതിന്റെ നമ്പറിനുചുറ്റും വട്ടം വരക്കുക.

7) ഉണ്ണിയും കുട്ടനും വ്യത്യസ്ത ഭാരമുള്ള കുട്ടികൾ ആയിരുന്നു. സമാന വലുപ്പവും ആകൃതിയുമുള്ള രണ്ട് ഒഴിഞ്ഞ ഐസ്ക്രീം ബോളുകളെടുത്ത് അവയിൽ ഒന്നിൽ മണൽ നിറച്ച് അത് ഉണ്ണിയും നിറക്കാത്ത കാലിബോൾ കുട്ടനും എടുത്ത് തൊട്ടടുത്തുള്ള കടപ്പുറത്ത് പോയി ഒരു പാറയുടെ മുകളിൽ കയറി, താഴെ മണലിലേക്ക് രണ്ടുപേരും ഒരേ സമയം ബോളുകൾ താഴേക്ക് വലിച്ചെറിയുന്നു. മണ്ണുനിറച്ച ബോൾ മണലിൽ കൂടുതൽ ആഘാതം ഉണ്ടാക്കി. താഴെ പറയുന്നവയിൽ ഏതൊക്കെ ഘടകങ്ങളാണ് ഈ സംഭവത്തെ സ്വാധീനിച്ചത്?

i. കുട്ടികളുടെ ഭാരം

ii. ബോളുകളുടെ വ്യത്യസ്ത ഭാരം

iii. ബോളുകൾ താഴേക്ക് എറിഞ്ഞപ്പോൾ അവയ്ക്ക് ലഭിച്ച് ആദ്യപ്രവേഗം

iv. ബോൾ നിർമ്മിച്ചിരിക്കുന്ന പദാർത്ഥം

A. i & ii

B. i, ii & iii

C. ii & iii

D. iv മാത്രം

8) അച്ചു തന്റെ വീടിന്റെ മുറ്റത്ത് കോൺക്രീറ്റ് പാകിയ നിരപ്പായ പ്രതലത്തിൽ പമ്പരം കറങ്ങിക്കൊണ്ടിരിക്കുമ്പോൾ ഒരു പൂച്ച വന്ന് കറങ്ങുന്നതിനിടയിലൂടെ ചാടിയപ്പോൾ പമ്പരം തെറിച്ചുപോയി. ഈ സന്ദർഭത്തിലെ പ്രധാന ഘടകങ്ങലുടെ കൂട്ടം ഏതെല്ലാമാണ്.

A. പ്രവേഗം, ത്വരണം, അഭികേന്ദ്രത്വരണം

B. അഭികേന്ദ്രബലം, അഭികേന്ദ്രത്വരണം

C. പമ്പരം, വേഗത, പ്രവേഗം, ത്വരണം

D. പൂച്ചയുടെ വേഗത, ബലം, ത്വരണം

9) രാമുവും രാജുവും ക്രിക്കറ്റ് കളി പരിശീലിക്കുകയായിരുന്നു. നല്ല ഫീൽഡർമാരായ രണ്ടുപേരും വേഗത്തിൽ വന്ന ബോൾ പിടിക്കാൻ ശ്രമിച്ചപ്പോൾ രാജുവിന്റെ കൈ വേദനയായി പരിശീലനം നിർത്തേണ്ടിവന്നു. പക്ഷേ ഇതേ സമയം രാമു വളരെ വിദഗ്ദമായി ബോൾ പിടിക്കുമ്പോൾ കൈ പുറകോട്ടു വലിച്ചു. അതിനാൽ വേദന അനുഭവപ്പെട്ടില്ല. ഇതുമായി ബന്ധപ്പെട്ട പ്രധാന ഘടകങ്ങൾ ഏതെല്ലാമാണ്?

A. സമയം, ക്രിക്കറ്റ്, വേഗത

B. ബലം, സമയം, ആവേഗം

C. ആക്കവ്യത്യാസം, ബലം, സമയം

D. വേഗത, പ്രവേഗം, മാസ്സ്

PART 4

താഴെ കൊടുത്തിരിക്കുന്ന സന്ദർഭങ്ങളിലെല്ലാം പ്രസക്തമായതും പരസ്പരം ബന്ധപ്പെട്ടതുമായ രണ്ട് ശാസ്ത്ര ആശയങ്ങൾ അടങ്ങിയിട്ടുണ്ട്. തന്നിരിക്കുന്ന സന്ദർഭങ്ങൾ ശ്രദ്ധയോടെ വായിച്ച് പ്രസക്തമായ ആശയങ്ങളുടെ ജോഡി കണ്ടെത്തി ഉത്തരത്തിനുചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക.

10) ഉത്സവപ്പറമ്പിൽ പെട്ടെന്നുള്ള വെടിപ്രയോഗത്തിന്റെ ഭാഗമായി ആന മതംപൊട്ടി ചീറി പായാൻ തുടങ്ങി. ആന ഒരാളെ ഉന്നംവെച്ച് ഓടിയപ്പോൾ അയാൾ വളഞ്ഞ് പുളഞ്ഞ് ഓടിയതിനാൽ ആനക്ക് അയാളെ ആക്രമിക്കാൻ സാധിച്ചില്ല. ഈ സന്ദർഭത്തിൽ ഏറ്റവും പ്രസക്തമായതും ബന്ധപ്പെട്ടതുമായ ആശയങ്ങളുടെ ജോഡി ഏത്?

A. മാസ്സും, പ്രവേഗവും

B. ദൂരവും മാസ്സും

C. ജഡത്വവും ദൂരവും

D. മാസ്സും ജഡത്വവും

11) അമ്മു മുത്തശ്ശന്റെ കൂടെ ഗ്ലാസ്സ് വാങ്ങിക്കാൻ കടയിൽ പോയി അവിടെ ഗ്ലാസ് പാത്രങ്ങൾ അടുക്കിവെച്ച പാക്കറ്റുകളിൽ സ്പോഞ്ച്, വൈക്കോൽ മുതലായവ നിറച്ച്വെച്ചിരിക്കുന്നത് അവളെ അത്ഭുതപ്പെടുത്തി. അവൾ മുത്തശ്ശനോട് കാരണം. തിരക്കി, പാത്രങ്ങൾ കൂട്ടിമുട്ടി പൊട്ടുന്നത് ഒഴിവാക്കാൻവേണ്ടി ആണെന്ന് മുത്തശ്ശൻ പറഞ്ഞു. ഈ സന്ദർഭത്തിൽ ഏറ്റവും പ്രസക്തമായതും പരസ്പരം ബന്ധപ്പെട്ടതുമായ ആശയങ്ങളുടെ ജോഡി ഏത്?

A. സമയവും ബലവും

B. മാസ്സും ബലവും

C. സമയവും മാസ്സും

D. മാസ്സും ജഡത്വവും

12) ക്ലാസ്സ്റൂമിൽ ഒരു പരീക്ഷണം ചെയ്യുന്നതിന്റെ ഭാഗമായി കുട്ടികൾ ഒരു സ്ട്രോയിലൂടെ നീളമുള്ള ഒരു ചരട് കടത്തി ക്ലാസ്മുറിയുടെ രണ്ടു ജനാലകളിലായി കെട്ടിവെയ്ക്കുന്നു. ഊതി വീർപ്പിച്ച ഒരു ബലൂൺ, സ്ട്രോയിൽ ഒട്ടിച്ചുവെക്കുന്നു. ബലൂണിലെ കാറ്റഴിച്ചുവിട്ടപ്പോൾ കാറ്റ് പുറത്തേക്ക് പോയതിന്റെ എതിർദിശയിലേക്ക് ബലൂൺ ശക്തിയായി ചലിച്ചു. ഇവിടെ ഏറ്റവും പ്രസക്തമായതും തമ്മിൽ ബന്ധപ്പെട്ടതുമായ ആശയങ്ങളുടെ ജോഡി ഏതാണ്?

A. ആഘാതവും പ്രവർത്തനവും

B. പ്രവർത്തനവും പ്രതിപ്രവർത്തനവും

C. ആവേശവും ആഘാതവും

D. ചലനവും ആഘാതവും

PART 5

താഴെ കൊടുത്തിരിക്കുന്ന ശാസ്ത്രീയ പ്രതിഭാസങ്ങൾക്ക് സമാനമായ അവസ്ഥ കണ്ടെത്തി അടയാളപ്പെടുത്തുക

13) ഒരു വസ്തുവിന് സ്വയം അതിന്റെ നിശ്ചലാവസ്ഥയ്ക്കോ, ചലനാവസ്ഥയ്ക്കോ മാറ്റം വരുത്താനുള്ള കഴിവില്ലായ്മയെ ജഡത്വം എന്ന് പറയുന്നു. ഈ പ്രതിഭാസത്തിന് സമാനമായ അവസ്ഥ താഴെ പറയുന്നവയിൽ ഏതാണ്?

A. ജലോപരിതലത്തിലുള്ള തോണിയിൽനിന്ന് ഒരാൾ കരയിലേക്ക് ചാടുന്നു.

B. ഓടിവരുന്ന അത്‌ലറ്റിന് ഫിനിഷിങ് ലൈനിൽ എത്തിയാലുടൻ ഓട്ടം അവസാനിപ്പിക്കാൻ കഴിയില്ല.

C. ഓടികൊണ്ടിരിക്കുന്ന ബസ്സിലെ യാത്രക്കാർക്ക് പുറത്തുള്ള മരങ്ങൾ ചലിക്കുന്നതായി തോന്നുന്നു

D. വളരെ വേഗത്തിൽ ഓടുന്ന ആൾ വേഗത കുറഞ്ഞ് ഓടുന്ന ആളെക്കാൾ നേരത്തെ ഫിനിഷിങ് പോയിന്റിൽ എത്തുന്നു.

14) ആക്കവ്യത്യാസം സ്ഥിരമായിരുന്നാൽ വസ്തുവിൻ അനുഭവപ്പെടുന്ന ബലം അത് പ്രയോഗിക്കാനെടുക്കുന്ന സമയത്തിന് വിപരീതനുപാതത്തിലായിരിക്കും. ഈ തത്വത്തിന് സമാനമായ അവസ്ഥ താഴെ പറയുന്നതിൽ ഏതാണ്?

A. ഒരു അഭ്യാസി കൈകൊണ്ട് വളരെ വേഗത്തിൽ വീശി കട്ടപ്പമുള്ള ഇഷ്ടികകൾ തകർക്കുന്നു.

B. രണ്ടു കുട്ടികൾ ചേർന്ന് ഇഷ്ടിക വലിച്ച് കൊണ്ടുപോയി മുകളിൽനിന്ന് താഴേക്ക് എറിയുന്നു.

C. ഒരു മരംവെട്ടുകാരൻ കോടാലി ഉപയോഗിച്ച് മരം വെട്ടുന്നു.

D. ഒരാൾ മഴു ഉപയോഗിച്ച് കല്ല് പൊട്ടിക്കാൻ ശ്രമിക്കുന്നു.

15) 'ഏതൊരു പ്രവർത്തിനും തുല്ല്യവും വിപരീതവുമായ ഒരു പ്രതിപ്രവർത്തനം ഉണ്ടായിരിക്കും.' ഇതാണ് ന്യൂട്ടന്റെ മൂന്നാം ചലനനിയമം. ഈ നിയമത്തിന് സമാനമായ അവസ്ഥ താഴെ പറയുന്നവയിൽ ഏതാണ്?

A. കുട്ടികൾ ചങ്ങാടത്തിലൂടെ കൈകൊണ്ടു തുഴഞ്ഞ് നീങ്ങുന്നു.

B. ചങ്ങാടത്തിന്റെ കെട്ടഴിഞ്ഞ് ചങ്ങാട്ടം ഉലയുന്നു.

C. ചങ്ങാടത്തിൽ ഒന്നിലധികം കുട്ടികൾ കയറുന്നു.

D. ചങ്ങാടത്തിന്റെ അറ്റം കയർകെട്ടി വലിക്കുന്നു.

PART 6

താഴെ കൊടുത്തിരിക്കുന്ന ഓരോ ചോദ്യത്തിലും ശാസ്ത്രീയമായി തെളിയക്കപ്പെട്ടിട്ടുള്ള ഒന്നിലേറെ പ്രസ്താവനകൾ അടങ്ങിയിരിക്കുന്നു. ആ പ്രസ്തവനകളെ മാത്രം അടിസ്ഥാനമാക്കിയാൽ ഏത് അനുമാനത്തിൽ എത്തിച്ചേരാനാകുമെന്ന് നിർണ്ണയിച്ച് ശരിയായ അനുമാനത്തിനുനെരെയുള്ള നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് അയാളപ്പെടുത്തുക.

16) താഴെ കൊടുത്ത മൂന്ന പ്രസ്താവനകൾ ശ്രദ്ധിക്കുക

(i) ഒരു കുട്ടി തോണിയിൽനിന്നും കരയിലേക്ക് ചാടുമ്പോൾ തോണി പുഴയിലേക്കുതന്നെ നീങ്ങുന്നു.

(ii) തോക്ക് നിറയൊഴിക്കുമ്പോൾ വെടിയുണ്ട മുന്നോട്ട് പായുകയും തോക്ക് പിന്നോട്ട് തെറിക്കുകയും ചെയ്യുന്നു.

(iii) റോക്കറ്റിന്റെ അറകളിൽ നിന്ന് ഉന്നത മർദ്ദത്തിലുള്ള വാതകം പുറത്തേക്ക് പോകുന്നതിന്റെ ഭാഗമായി റോക്കറ്റ് മുന്നോട്ടുകുതിക്കുന്നു.

ഈ പ്രസ്ഥാവനകളെ മാത്രം അടിസ്ഥാനപ്പെടുത്തി നമുക്ക് എന്ത് അനുമാനത്തിലെത്താം.

A. ഒരു പ്രവർത്തനത്തിന് തുല്ല്യമായ പ്രതിപ്രവർത്തനം ഉണ്ടാകും.

B. ഒരു പ്രവർത്തനത്തിന് എതിർ ദിശയിൽ പ്രതിപ്രവർത്തനം ഉണ്ടാകും.

C. ഒരു പ്രവർത്തനത്തിന് പ്രതിപ്രവർത്തനം ഉണ്ടാകും.

D. ഓരോ പ്രവർത്തനത്തിനോടും ഒരു ദിശ ബന്ധപ്പെട്ടിരിക്കുന്നു.

17) താഴെ കൊടുത്ത മൂന്ന വാചകങ്ങൾ ശ്രദ്ധിക്കുക

(i) ഭാരം കയറ്റിയ വാഹനങ്ങൾ വേഗത കുറയ്ക്കാതെ വളവു തിരിയുന്നത് അപകടത്തിന് ഇടയാക്കുന്നു.

(ii) ടാർ നിറച്ച ഒരു വീപ്പ ഉരുട്ടി നീക്കുന്നത് ഒഴിഞ്ഞ ടാർ വീപ്പ ഉരുട്ടുന്നതിനേക്കാൾ കൂടുതൽ പ്രയാസകരമാണ്.

(iii) രണ്ട് വ്യത്യസ്ത ഭാരമുള്ള കല്ലുകൽ ഒരേ സമയം ഉരുട്ടുമ്പോൾ ഭാരം കുറഞ്ഞ കല്ല് ഉരുണ്ടു കൊണ്ടെയിരിക്കുന്ന ഭാരം കൂടിയ കല്ല് പെട്ടെന്ന് നിശ്ചലാവസ്ഥയിലാവുന്നു.

ഈ വാചകങ്ങളെ മാത്രം അടിസ്ഥാനപ്പെടുത്തി നമുക്ക് എന്ത് അനുമാനത്തിലെത്താം.

A. ഒരു വസ്തുവിന്റെ മാസ് കൂടുമ്പോൾ ജഡത്വം കുറയുന്നു.

B. ഒരു വസ്തുവിന്റെ മാസും ജഡത്വവും തമ്മിൽ ബന്ധമില്ല.

C. ഒരു വസ്തുവിന്റെ മാസ് കൂടുമ്പോൾ ജഡത്വം കൂടുന്നു.

D. ഒരു വസ്തുവിന്റെ മാസ് എത്ര കൂടിയാലും ജഡത്വം തുല്ല്യമായിരിക്കും.

18) താഴെ കൊടുത്ത മൂന്ന് പ്രസ്താവനകൾ ശ്രദ്ധിക്കുക

(i) മാവിന്റെ കൊമ്പ് കുലുക്കുമ്പോൾ അതു ചലിക്കാൻ തുടങ്ങുന്ന അവസരത്തിൽ മാങ്ങ അടർന്നു വീഴുന്നു.

(ii) ഓടിക്കൊണ്ടിരിക്കുന്ന ബസ്സിൽ നിന്നും ഇറങ്ങുന്ന ആൾ അല്പദൂരം കൂടി മുന്നോട്ട് ഓടേണ്ടിവരുന്നു.

(iii) ഓട്ടമത്സരത്തിനുശേഷം അത്‌ലറ്റ് ഫിനിഷിങ് പോയിന്റ് കഴിഞ്ഞിട്ടും കുറച്ചുദൂരംകൂടി ഓടുന്നു.

ഈ പ്രസ്താവനകളെ മാത്രം അടിസ്ഥാനപ്പെടുത്തി നമുക്ക് എന്ന് അനുമാനത്തിലെത്താം.

A. ഒരു വസ്തുവിന് സ്വയം അതിന്റെ നിശ്ചലാവസ്ഥയ്ക്കോ ചലനാവസ്ഥയ്ക്കോ മാറ്റം വരുത്താനുള്ള കഴിവില്ല.

B. ഘർഷണം കൂടിയേ പ്രതലത്തിൽ വസ്തുവിന്റെ ചലനത്തിന്റെ വേഗത കുറയുന്നു

C. മാസ് കൂടുതലുള്ള വസ്തുക്കളുടെ ആക്കം വർദ്ധിക്കുന്നു.

D. ഒരേ ദിശയിൽ ചലിക്കുന്ന വസ്തുക്കൾ ഒരു നിശ്ചിത സമയംവരെ ചലിച്ചുകൊണ്ടിരിക്കേണ്ടിയിരിക്കുന്നു.

PART 7

താഴെ തന്നിരിക്കുന്ന സന്ദർഭങ്ങളിലെല്ലാം ഒരു ശാസ്ത്രപ്രശ്നം അടങ്ങിയിട്ടുണ്ട്. ഈ പ്രശ്നത്തെ മനസ്സിലാക്കിയതിനുശേഷം അതിന് ഒരു യുക്തിസഹമായ ന്യായീകരണം തരുന്ന പ്രസ്ഥാവനക്കുചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക.

19) ലോങ്-ജമ്പ് ചാടുന്ന ഒരു അത്‌ലറ്റ് ഒരിടത്തുനിന്ന് ചാടുന്നതിനു പകരം ദൂരെനിന്നും കുതിച്ച് ഓടിവന്ന് ചാടുന്നു. എന്തായിരിക്കും ഇതിനു കാരണം.

A. അത്‌ലറ്റ് ഓടുന്ന ദൂരവും ലോങ്ങ്ജമ്പ് ചെയ്ത ഫിനിഷിങ്ങ് പോയിന്റും തമ്മിൽ ബന്ധമുണ്ടാകും

B. അത്‌ലറ്റ് ഓടിയടുക്കുന്ന വേഗതയും അത്‌ലറ്റിനു ലഭിക്കുന്ന പേശീബലവും തമ്മിൽ ബന്ധമുണ്ടാകും.

C. അത്‌ലറ്റ് ഓടിയെടുക്കുന്ന വേഗതയും അത്‌ലറ്റിനു ലഭിക്കുന്ന പേശീബലവും തമ്മിൽ ബന്ധമുണ്ടാകും

D. ഓടുന്ന ആൾക്ക് നന്നായി ബാലൻസ് ചെയ്ത് ലോങ്ജമ്പ് ചാടാൻ സാധിക്കുന്നുണ്ടാകും.

20) ഓടികൊണ്ടിരിക്കുന്ന ഒരു ബസ്സിൽനിന്നും പുറത്തേക്ക് ഒരാൾ ഇറങ്ങുകയാണ്, വീഴാതിരിക്കുന്നതിനുവേണ്ടി അയാൾ ബസ്സിന്റെ ദിശയിൽ അൽപ്പം ദൂരം മുന്നോട്ട് ഓടി പിന്നീട് പ്രയാസമില്ലാതെ നടന്നുപോവുകയും ചെയ്തു. ബസ്സിൽനിന്ന് ഇറങ്ങിയ ആൾ മുന്നോട്ട് അൽപ്പദൂരം ഓടിയതിനു കാരണമെന്ത്?

A. ചലനാവസ്ഥയിൽ തുടരുന്ന സ്വന്തം ശരീരത്തിന്റെ ചലനജഡത്വം ക്രമേണ കുറയ്ക്കുന്നതിനു വേണ്ടിയാവാം.

B. നിശ്ചലാവസ്ഥയിൽ തുടരുന്ന സ്വന്തം ശരീരത്തിന്റെ നിശ്ചല ജഡത്വം ക്രമേണ കുറയ്ക്കുന്നതിനു വേണ്ടിയാവാം.

C. നിശ്ചലാവസ്ഥയിലുള്ള ആളിന്റെ പ്രവേഗം ബസ്സിനൊപ്പം ആക്കുന്നതിനു വേണ്ടിയാവാം.

D. യാത്രക്കാരന്റെ ശരീരം തറയെ അപേക്ഷിച്ച് നിശ്ചലാവസ്ഥയിലായതിനാൽ ഓടുന്നതിന് സ്ഥിരത കൈവരിക്കാൻ ഉപകരിച്ചേക്കാം.

21) ഭാരമുള്ള വസ്തുക്കൾ വളരെ വേഗത്തിൽ എറിഞ്ഞ് അതു പിടിക്കുമ്പോൾ കൈ അൽപ്പം പുറകോട്ടു നീക്കുന്നു. ഇങ്ങനെ കൈ നീക്കാൻ കാരണമെന്ത്?

A. ആക്ക വ്യത്യാസത്തിനുള്ള സമയംകൂട്ടി ആഘാതം കുറയ്ക്കാൻ വേണ്ടായാവാം.

B. കയ്യിന്റെ പ്രവേഗം വസ്തുവിനൊപ്പം ആക്കാൻ വേണ്ടിയാവാം.

C. കയ്യും വസ്തുവും തമ്മിലുള്ള സമ്പർക്കം കുറച്ച് ആഘാതം കുറയ്ക്കാൻ വേണ്ടിയാവാം

D. ആക്ക വ്യത്യാസ നിരക്ക് കൂട്ടി ആഘാതം കുറയ്ക്കാൻ വേണ്ടിയാവാം.

PART 8

താഴെ കൊടുത്തിരിക്കുന്ന ഓരോ ചോദ്യത്തിലും അവതരിപ്പിച്ചിരിക്കുന്ന ശാസ്ത്രപ്രശ്നത്തിന് ന്യായീകരണമായേക്കാവുന്ന പ്രസ്താവനകളാണ് A, B, C, D എന്നിങ്ങനെ കൊടുത്തിരിക്കുന്നത്. ഇവയിൽ ഏറ്റവും യുക്തി സഹമായതും ഒരു ലഘുപരീക്ഷണം കൊണ്ട് തെളിയിക്കാനാവുന്നതുമായ അനുമാനം (പരികൽപന) അടയാളപ്പെടുത്തുക.

22) കുട്ടികൾ മൈതാനത്തിൽ ഓടി കളിക്കുമ്പോൾ നല്ല വണ്ണമുള്ള ആളിന് വേഗം ഓട്ടം നിർത്താനും അതുപോലെ ഓടിതുടങ്ങാനും പ്രയാസം അനുഭവപ്പെടുന്നു. ഇതിനുകാരണം മനസ്സിലാക്കുന്നതിന് മാസും ജഡത്വവും തമ്മിൽ ബന്ധമുണ്ടോ എന്ന് കണ്ടുപിടിക്കേണ്ടതുണ്ട്. ഇതിന് താഴെ പറയുന്നവയിൽ ഏത് അനുമാനമാണ് ഒരു ലഘുപരീക്ഷണം നടത്തി തെളിയക്കാനാവുന്നത്?

A. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങൾ മിനുസമുള്ള തറയിൽകൂടി ഒരേ വേഗതയിൽ ഉരുട്ടിവിട്ടാൽ മാസ് കൂടുതലുള്ള ഗോളം കൂടുതൽ സമയം ഉരുളും.

B. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങളിൽ മാസ് കൂടിയതിന്റെ ഭൂഗുരുത്വകേന്ദ്രം മദ്ധ്യത്തിലായിരിക്കും.

C. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങൾ ശൂന്യാകാശത്തിൽ ഉരുട്ടിനോക്കിയാൽ മാസ് കൂടുതലുള്ള ഗോളം കൂടുതൽ സമയം ഉരുളും.

D. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങൾക്ക് പാലായന പ്രവേഗം കൊടുത്താൽ എല്ലാ ഗോളങ്ങളും ശൂന്യാകാശത്ത് എത്തിച്ചേരും.

23) 8-ാം ക്ലാസ്സിലെ കുട്ടികൾക്ക് ഒരു അദ്ധ്യാപകൻ വർത്തുളചലനം വിശദീകരിച്ചു കൊടുത്തപ്പോൾ അവർ മുന്നോട്ടുവച്ച യുക്തിസഹമായ പ്രസ്താവനകളാണ് താഴെ കൊടുത്തിരിക്കുന്നത്. ഇവയിൽ ഏതാണ് ഒരു ലഘു പരീക്ഷണത്താൽ തെളിയിക്കാവുന്നത്?

A. ഭൂമിക്കു ചുറ്റും ഗ്രഹങ്ങൾ കറങ്ങുമ്പോൾ അഭികേന്ദ്രബലം നഷ്ടമായാൽ ഗ്രഹങ്ങൾ വർത്തുള ചലനത്തിന്റെ തൊടുവരയിൽ കൂടി തെറച്ച് പുറത്തേക്ക് പോകുന്നു.

B. ഒരു ചരടിൽ അറ്റത്ത് കല്ല്കെട്ടി കറക്കുമ്പോൾ അഭികേന്ദ്രബലവും അഭികേന്ദ്ര ത്വരണവും കേന്ദ്രത്തിലേക്ക് അനുഭവപ്പെടുന്നു. പെട്ടെന്ന് ചരടുവിടുമ്പോൾ കല്ല് പുറത്തേക്ക് തെറിച്ചപോവുന്നു.

C. ഓടികൊണ്ടിരിക്കുന്ന കാറിന്റെ ചക്രത്തിലേക്ക് ഓരു ഉരുളൻ കല്ല് എറിയുമ്പോൾ വർത്തുളചലനം നഷ്ടപ്പെട്ട് കാർ മറയുന്നു.

D. ശൂന്യാകാശത്ത് നിന്ന് ഒരു ജയന്റ് വീൽ കറക്കുമ്പോൾ വൃത്തകേന്ദ്രത്തിലേക്ക് അഭികേന്ദ്രബലവും, അഭികേന്ദ്രത്വരണവും അനുഭവപ്പെടുന്നു.

24) പ്രവേഗവും ആക്കവും നേർ അനുപാതത്തിലാണ്. അതായത് പ്രവേഗം കൂടുമ്പോൾ ആക്കവും കൂടുന്നു. ഇതു മനസ്സിലാക്കുന്നതിന് താഴെ പറയുന്നവയിൽ ഏത് അനുമാനമാണ് ഒരു ലഘു പരീക്ഷണം നടത്തി തെളിയിക്കാനാവുന്നത്.

A. ഒരേ മാസുള്ള രണ്ട് ബോളുകൾ വ്യത്യസ്ത ഉയരത്തിൽ നിന്നും ഒരു മണൽമെത്തയിലേക്ക് ഇടുമ്പോൾ കൂടുതൽ ഉയരത്തിൽ നിന്നും ഇടുമ്പോൾ കൂടുതൽ ആഘാതം ഉണ്ടാക്കുന്നു.

B. ഓരേ മാസുള്ള രണ്ടു ബോളുകൾ വ്യത്യസ്ത ആദ്യപ്രവേഗത്തോടെ ശൂന്യാകാശത്തുനിന്ന് താഴെക്കിടുമ്പോൾ രണ്ടും ഒരേ സമയത്ത് താഴെയെത്തുന്നു.

C. ഒരേ മാസുള്ള ഗോളങ്ങൽക്ക് വ്യത്യസ്ത പാലായനപ്രവേഗം കൊടുത്താൽ എല്ലാ ഗോളങ്ങളും ഒരേ സമയം ശൂന്യാകാശത്തെത്തും.

D. ഒരേ മാസുള്ള രണ്ടു വ്യക്തികൾ വ്യത്യസ്ത ഉയരത്തിൽനിന്നും പുഴയിലേക്ക് ചാടുമ്പോൾ കൂടുതൽ ഉയരെനിന്നും ചാടിയ ആൾ കൂടുതൽ താഴെക്ക് എത്തുന്നു.

PART 9

ഒരു ശാസ്ത്ര പ്രക്രിയയെ സ്വാധീനിക്കുന്ന ഘടകങ്ങൾ ഒന്നിലേറെ ഉണ്ടാവുമല്ലോ. നിർണ്ണായകമായ ഇത്തരം ഘടകങ്ങളിൽ സ്വാധീനം മനസ്സിലാക്കി ശരിയായ ഉത്തരം അടയാളപ്പെടുത്തുക.

25) ചലിച്ചുകൊണ്ടിരിക്കുന്ന വസ്തുക്കളുടെ സവിശേഷഗുണമാണ് ആക്കം. ഇത് മാസിന്റെയും പ്രവേഗത്തിന്റെയും ഗുണിതമാണ്. ഇവ തമ്മിലുള്ള ബന്ധം മനസ്സിലാക്കാൻ സമാന ആകൃതിയുള്ള രണ്ടു വ്യത്യസ്ത ഭാരമുള്ള ഇരുമ്പുഗോളങ്ങളെടുക്കുന്നു. ഒരു പരന്ന പാത്രത്തിൽ നനഞ്ഞ മണൽ നിറച്ചശേഷം ഗോളങ്ങൾ ഒരേ ഉയരത്തിൽനിന്നും മണലിലേക്കിടുന്നു. ഈ പരീക്ഷണത്തിൽ സ്ഥിരമായി നാം നിലനിർത്തുന്ന ഘടകങ്ങൾ ഏതൊക്കെയാണ്?

A. വസ്തുവിന്റെ ഭാരം, ആകൃതി, പരീക്ഷണത്തിന്റെ സമയം

B. പരീക്ഷണം നടത്തുന്ന പ്രതലം, വസ്തുക്കളുടെ ആദ്യപ്രവേഗം വസ്തുവിന്റെ ആകൃതി

C. വസ്തുവിന്റെ ഭാരം, വസ്തുവിന്റെ ആകൃതി, ആദ്യപ്രവേഗം.

D. വസ്തുക്കൾ താഴെക്കിടക്കുന്ന സമയം, പരീക്ഷണം നടത്തുന്ന പ്രതലം, വസ്തുവിന്റെ ഭാരം.

26) ഒരു വസ്തുവിന് അസന്തുലിതമായ ബാഹ്യബലം കൊടുക്കുന്നതുവരെ അതിന്റെ ചലനാവസ്ഥ തുടരാനുള്ള പ്രവണതയാണ് ചലനജഡത്വം. ഇതു കാണിക്കുന്ന പരീക്ഷണത്തിൽ ഒരു വലിയ പാറക്കഷണവും, ഒരു ബോളും ഒരുമിച്ച് നിരപ്പായ പ്രതലത്തിലൂടെ ഉരുട്ടുന്നു. ഇവിടെ ബോൾ ചലിച്ചുകൊണ്ടേയിരിക്കുന്നു. പാറക്കഷണം അൽപ്പദൂരം ചലിച്ചശേഷം നിശ്ചലാവസ്ഥ കൈവരിക്കുന്നു. ഈ പരീക്ഷണത്തിൽ സ്ഥിരമായ നിലനിർത്തുന്ന ഘടകങ്ങൾ ഏതെല്ലാമാണ്.

A. വസ്തുവിന്റെ മാസ്, വേഗത

B. വസ്തു നിർമ്മിച്ച പദാർത്ഥം, മാസ്

C. വസ്തുവിന്റെ വേഗത, ഉരുട്ടുന്ന പ്രതലം

D. വസ്തുവിന്റെ ആകൃതി, ഭാരം

27) അധ്യാപിക ന്യൂട്ടന്റെ മൂന്നാം ചലനനിയമം പഠിപ്പിക്കുമ്പോൾ അത് കൂടുതൽ വ്യക്തമായി കുട്ടികളിലെത്തുന്നതിനായി ഒരു പരീക്ഷണം ചെയ്യുന്നു. ഇതിനായി ഒരു ബലൂണിൽ വായു നിറച്ച് ഒരു വശത്തുനിന്ന് എതിർവശത്തേക്ക് പറത്താൻ ശ്രമിക്കുന്നു. ഈ പരീക്ഷണത്തിൽ സ്ഥിരമായി നിലനിർത്തേണ്ട ഘടകങ്ങൾ ഏതെല്ലാം?

A) ബലൂണിന്റെ കളർ, നിറയ്ക്കുന്ന വായുവിന്റെ അളവ്.

B) ബലൂണിന്റെ വലുപ്പം, ബലൂണിന്റെ കളർ.

C) ബലൂണിൽ നിറയ്ക്കുന്ന വായുവിന്റെ അളവ്, ബലൂൺ പറപ്പിക്കുന്ന ദിശ

D) ബലൂണിന്റെ വലുപ്പം, ബലൂൺ പറന്നുപോകുന്ന ദിശ.

28) അനുവും കൂട്ടുകാരും ക്ലാസ്സിൽ വർത്തുള ചലനത്തെക്കുറിച്ച് പഠിച്ചതിന്റെ ഭാഗമായി ഒരു ഓല പമ്പരം ഉണ്ടാക്കിനോക്കി. കാറ്റത്ത് അവർ വേഗത്തിൽ ഓടുന്നതിനനുസരിച്ച് പമ്പരം വേഗത്തിൽ കറങ്ങാൻ തുടങ്ങി. കറങ്ങിക്കൊണ്ടിരിക്കുന്ന വർത്തുള പാതയിൽ തൊട്ടപ്പോൾ കറക്കം നിലക്കുന്നു. ഈ പരീക്ഷണത്തിൽ സ്ഥിരമായി നിലനിർത്തേണ്ട ഘടകങ്ങൾ ഏതെല്ലാമാണ്?

A. ഓലപമ്പരം കറക്കുന്ന കാറ്റിന്റെ ലഭ്യത.

B. ത്വരണം

C. അഭികേന്ദ്രത്വരണം, അഭികേന്ദ്രപ്രവേഗം

D. വേഗത, പ്രവേഗം

PART 10

താഴെ കൊടുത്തിരിക്കുന്ന സന്ദർഭങ്ങൾ സങ്കൽപ്പിച്ച് ഉണ്ടാക്കേണ്ടവയാണ് നമുക്കറിയാവുന്ന ശാസ്ത്ര സത്യങ്ങളുടെയും തത്വങ്ങളുടെയും വെളിച്ചത്തിൽ, ശരിയെന്ന് നമുക്ക് ഉറപ്പിക്കാവുന്ന ഉത്തരം നമ്പറിനു ചുറ്റും വട്ടംവരച്ച് അടയാളപ്പെടുത്തുക.

29) ജഡത്വം എന്ന ആശയം മനസ്സിലാക്കുന്നതിനായി ഒരു പരീക്ഷണം ചെയ്യുന്നു. ഇതിനായി ഒരു കാർഡ്ബോഡിനു മുകളിൽ കുറച്ച് നാണയങ്ങൾ ഒന്നിനുമുകളിൽ ഒന്നായി അടുക്കിവയ്ക്കുന്നു. ഇത് വെള്ളം നിറച്ച് ഒരു ഗ്ലാസ്സിനുമുകളിൽ വയ്ക്കുന്നു. ശേഷം കാർഡ്ബോഡ് മെല്ലെ വലിക്കുന്നു. ഈ പരീക്ഷണത്തിൽ നാണയങ്ങൾക്ക് പകരം ഭാരം കുറഞ്ഞ ചെറിയ മരക്കഷണങ്ങൾ വച്ചാൽ എന്ത് സംഭവിക്കും?

A. മരക്കഷണങ്ങൾ കൃത്യമായി ഗ്ലാസ്സിലെ വെള്ളത്തിൽ വീഴുന്നു.

B. മരക്കഷണങ്ങൾ പുറത്തേക്ക് തെറിച്ചുവീഴുന്നു.

C. ഗ്ലാസ് പൊട്ടിപ്പോകുന്നു.

D. മരക്കഷണങ്ങളിൽ ചിലത് പുറത്തേക്കും ചിലത് ഗ്ലാസ്സിലേക്കും വീഴുന്നു.

30) കുട്ടികൾ ചങ്ങാടമുണ്ടാക്കി അതിൽ പുഴയിലൂടെ സഞ്ചരിക്കുകയായിരുന്നു. ആറോളം കുട്ടികൾ ചങ്ങാടം തുഴയുന്നുണ്ടായിരുന്നു. അവർ സഞ്ചരിക്കുന്ന ദിശയിലേക്ക് അനുകൂലമായ ഒഴുക്ക് ഉണ്ടായിരുന്നതിനാൽ ചങ്ങാടത്തിന്റെ വേഗത കൂടിവന്നു. പെട്ടെന്ന് ചങ്ങാടം നിർത്താൻ കുട്ടികൾക്ക് തോന്നി. താഴെ പറയുന്നവയിൽ ഏതുകാര്യം ചെയ്യുന്നതാണ് ചങ്ങാടം വേഗം കുറഞ്ഞ് നിൽക്കുന്നതിന് ഏറ്റവും ഫലപ്രദം?

A. 6 പേരും തുഴകൾ വെള്ളത്തിൽ വിലങ്ങനെവച്ച് ചങ്ങാടത്തിന്റെ മുന്നോട്ടുള്ള ഗതി പ്രതിരോധിക്കുന്നു.

B. 6 പേരും എതിർദിശയിലേക്ക് തുഴയുന്നു.

C. മുന്നിലുള്ള മൂന്നുപേർ തുഴ വെള്ളത്തിൽ വിലങ്ങനെവച്ച് ചങ്ങാടത്തിന്റെ മുന്നോട്ടുള്ള ഗതി പ്രതിരോധിക്കുകയും പിറകിലുള്ള മൂന്നുപേർ എതിർദിശയിലേക്ക് തുഴയുകയും ചെയ്യുന്നു.

D. മുന്നിലുള്ള മൂന്നുപേർ എതിർദിശയിലേക്ക് തുഴയുകയും, പിറകിലുള്ള രണ്ടുപേർ തുഴകൾ വിലങ്ങനെ വച്ച് ചങ്ങാടത്തിന്റെ മുന്നോട്ടുള്ള ഗതി പ്രതിരോധിക്കുകയും ചെയ്യുന്നു.

31) മാസും ജഡത്വവും തമ്മിൽ ബന്ധപ്പെട്ടിരിക്കുന്നു എന്ന് നമുക്കറിയാം. ഇവ തമ്മിലുള്ള ബന്ധം എല്ലായിടത്തും ഒരുപോലെയാണോ എന്നും ഏതെങ്കിലും ഘടകങ്ങൾ ഇതിനെ ബാധിക്കുന്നുണ്ടോ എന്നും അറിയുന്നതിനായി വ്യത്യസ്ത മാസുള്ള കല്ലുകൾ ഒരു 15 നില ഫ്ളാറ്റിന്റെ മുകളിൽനിന്നും താഴക്കെറിയുന്നു. താഴെ പറയുന്നവയിൽ ഏതായിരിക്കും സംഭവിക്കുക?

A. രണ്ടു കല്ലുകളും ഒരുമിച്ച് താഴേക്ക് പതിക്കുന്നു.

B. മാസ് കൂടിയ കല്ല് പെട്ടെന്ന് താഴേക്ക് പതിക്കുന്നു.

C. മാസ് കൂടിയ കല്ല് കൂടുതൽ സമയം എടുത്ത് താഴേക്ക് പതിക്കുന്നു.

D. മാസ് കുറഞ്ഞ കല്ല് കൂടുതൽ സമയം എടുത്ത് താഴേക്ക് പതിക്കുന്നു.

32) ചലിക്കുന്ന വസ്തുക്കളുടെ സവിശേഷ ഗുണമാണ് ആക്കം. ഇതു മനസ്സിലാക്കുന്നതിനുള്ള പരീക്ഷണത്തിൽ രണ്ട് വ്യത്യസ്ത മാസുള്ള പാറക്കഷണങ്ങൾ ഒരേ ഉയരത്തിൽനിന്നും താഴെ മണ്ണിലേക്കിടുന്നു. പാറക്കഷണങ്ങൾ മണ്ണിൽ ഉണ്ടാക്കിയ ആഘാതം നോക്കുന്നു. മാസ്കൂടിയ പാറക്കഷണം കൂടുതൽ ആഘാതം ഉണ്ടാക്കുന്നു. ഇവിടെ വ്യത്യസ്ത മാസുള്ള പാറക്കഷണങ്ങൾക്കുപകരം ഒരേ മാസും ഒരേ ഉയരത്തിൽനിന്നും താഴേക്ക് ഇടുന്നതിനുപകരം വ്യത്യസ്ത ഉയരത്തിൽനിന്നും ഇടുകയും ചെയ്താൽ എന്തു സംഭവിക്കും?

A. രണ്ടു പാറക്കഷണങ്ങളും മണ്ണിൽ ഉണ്ടാക്കുന്ന ആഘാതം തുല്യമായിരിക്കും.

B. കൂടുതൽ ഉയരത്തിൽനിന്നും താഴേക്കിട്ട പാറക്കഷണം കൂടുതൽ ആഘാതം ഉണ്ടാക്കുന്നു.

C. കുറഞ്ഞ ഉയരത്തിൽനിന്നും താഴേക്കിട്ട പാറക്കഷണം കൂടുതൽ ആഘാതം ഉണ്ടാക്കുന്നു.

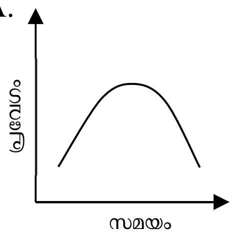
D. മാസ് തുല്യമാക്കിയപ്പോൾ ഉണ്ടാക്കിയ ആഘാതത്തിന് വ്യത്യാസം സംഭവിച്ചിട്ടില്ല.

PART 11

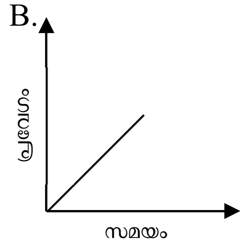
ഓരോ ചോദ്യത്തിനും തനിരിക്കുന്ന ചിത്രങ്ങളെ അപഗ്രഥിച്ച് ചോദ്യത്തിനുള്ള ഉത്തരങ്ങൾ അടയാളപ്പെടുത്തുക.

33) താഴെകൊടുത്തിരിക്കുന്ന ഗ്രാഫുകളിൽ ഏതാണ് സമചലനം സൂചിപ്പിക്കുന്നത്?

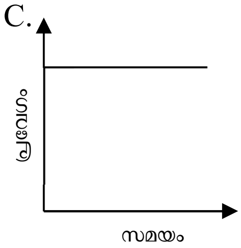
A.



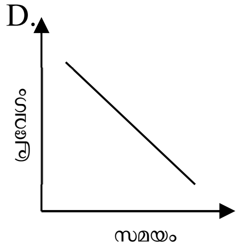
B.



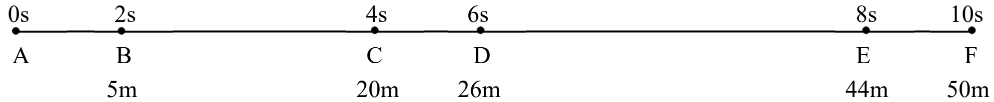
C.

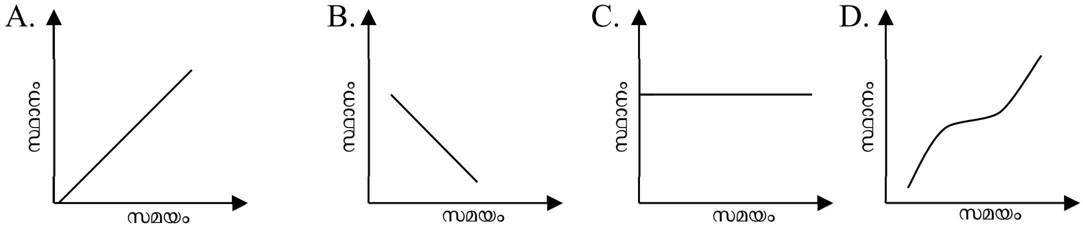


D.

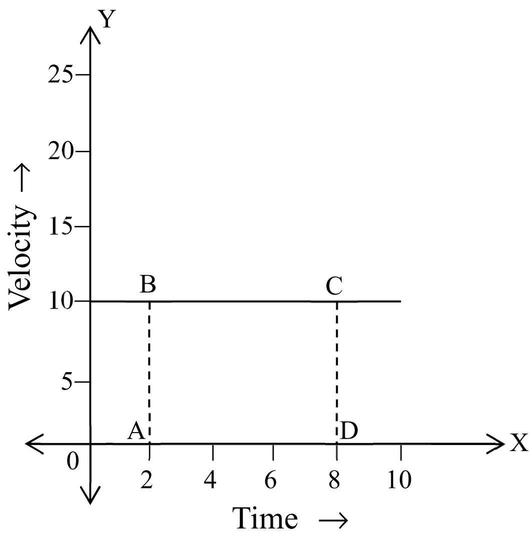


34) താഴെ കൊടുത്തിരിക്കുന്ന ചിത്രത്തിന്റെ അടിസ്ഥാനത്തിൽ ശരിയായ സമയ-സ്ഥാന ഗ്രാഫ് ഏതാണ്?





35) താഴെ തന്നിരിക്കുന്ന ഗ്രാഫ് അപഗ്രഥിച്ച് ശരിയായ പട്ടിക ഏതാണെന്ന് കണ്ടെത്തുക.



A

സമയം	0	2	4	6	8	10
പ്രവേഗം	10	10	10	10	10	10

B

സമയം	0	2	4	6	8	10
പ്രവഗം	4	4	4	4	4	4

C

സമയം	0	2	4	6	8	10
പ്രവേഗം	0	0	0	0	0	0

D

സമയം	0	2	4	6	8	10
പ്രവേഗം	8	8	8	8	8	8

PART 12

താഴെ കൊടുത്തിരിക്കുന്ന ഓരോ ചോദ്യത്തിലും ഒരു ശാസ്ത്ര പ്രസ്താവന കൊടുത്തിട്ടുണ്ട് ഈ പ്രസ്താവന ശരിയാണോ എന്ന് പരിശോധിച്ചറിയാൻ ഏറ്റവും അനിയോജ്യമായ പരീക്ഷണക്രമം തിരഞ്ഞെടുത്ത് നമ്പറിനുചുറ്റും വട്ടം വരച്ചടയാളപ്പെടുത്തുക.

36) ചലിച്ചുകൊണ്ടിരിക്കുന്ന വസ്തുക്കളുടെ സവിശേഷഗുണമാണ് ആക്കം. ഇത് അളക്കുന്നത് വസ്തുവിന്റെ മാസിന്റെയും പ്രവേഗത്തിന്റേയും ഗുണിതമായാണ്. ഈ പ്രസ്താവന

ശരിയാണോ എന്നറിയാൻ താഴെ പറയുന്നതിൽ ഏതു പരീക്ഷണക്രമമാണ് കൂടുതൽ അനുയോജ്യം?

A. ഒരു പരന്ന പാത്രത്തിൽ നനഞ്ഞ മണൽ നിറച്ച ശേഷം വ്യത്യസ്ത ഭാരമുള്ള ബോളുകൾ തുല്ല്യ വേഗതയിൽ മണലിലേക്കിടുക. മണലിന്റെ താഴ്ച നോക്കുക.

B. വ്യത്യസ്ത മാസുള്ള ഇരുമ്പുഗോളങ്ങൾ ഒരു കൽ ഭിത്തിമേൽ എറിഞ്ഞ് ഗോളം തെറിച്ചുവീഴുന്ന ദൂരം അളക്കുന്നത്.

C. പ്രവേഗത്തിന്റേയും മാസിന്റെയും ഗ്രാഫ് വരയ്ക്കുന്നത്.

D. വ്യത്യസ്ത മാസുള്ള ഇരുമ്പുഗോളങ്ങൾ ഒരു മൺ കൂനമേൽ വീഴ്ത്തി അങ്ങനെ ഉണ്ടാവുന്ന കുഴിയുടെ താഴ്ച അളക്കുന്നത്.

37) അസന്തുലിതമായ ഒരു ബാഹ്യബലം പ്രയോഗിക്കുന്നതുവരെ ഓരോ വസ്തുവും അതിന്റെ നിശ്ചലാവസ്ഥയിലോ, നേർരേഖാ സമചലനത്തിലോ തുടരുന്നതാണ്. ഈ നിയമം ശരിയാണോ എന്നറിയാൻ താഴെ പറയുന്നതിൽ ഏതു പരീക്ഷണ ക്രമമാണ് കൂടുതൽ അനുയോജ്യം?

A. ഒരു ഗ്ലാസ്സ് കാർഡ്ബോർഡിന്റെ പരുപരുത്ത പ്രതലത്തിൽ വെക്കുന്നു. ഹാർഡ്ബോർഡ് വേഗത്തിൽ ഒരു വശത്തേക്ക് ചലിക്കുന്നു.

B. വെള്ളം നിറച്ച ഒരു ഗ്ലാസ്സ് കാർഡ്ബോർഡിന്റെ പരുപരുത്ത പ്രതലത്തിൽ വച്ച്. കാർഡ്ബോർഡ് വലിക്കുന്നു.

C. ഒരു കാർപ്പറ്റ് നിറയെ മണ്ണ് വിതറിയശേഷം അത് കുത്തനെവച്ച് വടികൊണ്ട് തട്ടുന്നു.

D. കാരംസ് കോയിനുകൾ അട്ടിയായിവച്ച് അടിയിലെ കോയിൻ സ്ട്രൈക്കർ ഉപയോഗിച്ച് തെറിപ്പിക്കുന്നു.

38) ഒരു വസ്തുവിന്റെ ജഡത്വം അതിന്റെ മാസിനെ ആശ്രയിച്ചിരിക്കുന്നു. മാസ് കൂടുന്നതിനനുസരിച്ച് ജഡത്വം കൂടുന്നു. ഈ പ്രസ്ഥാവന ശരിയാണോ എന്നറിയാൻ താഴെ പറയുന്നവയിൽ ഏതു പരീക്ഷണക്രമമാണ് കൂടുതൽ അനുയോജ്യം?

A. ക്രിക്കറ്റ് ബാറ്റ് ഉപയോഗിച്ച് നിശ്ചലാവസ്ഥയിലുള്ള ക്രിക്കറ്റ്ബോളും ഇരുമ്പ് ബോളും അടിച്ച് തെറിപ്പിച്ചശേഷം അതിന്റെ ദൂരം നോക്കുന്നു.

B. ഒരു ക്രിക്കറ്റ് ബോളും, ഇരുമ്പുബോളും ഒരുമിച്ചിടുക ഏതാണ് പെട്ടെന്ന് നിശ്ചലമായതെന്ന് നോക്കുക.

C. വ്യത്യസ്ത മാസുള്ള രണ്ട് ബോളുകൾ നിരപ്പായ റോഡിലൂടെ ഉരുട്ടി അതിന്റെ ചലനം നിരിക്ഷിക്കുക.

D. രണ്ടു വസ്തുക്കളുടെ ചലനത്തെ ആസ്പദമാക്കി സമയ-പ്രവേഗ ഗ്രാഫ് വരച്ചു നോക്കുക.

PART 13

പരീക്ഷണം ചെയ്തപ്പോൾ കണ്ടെത്തിയ വിവരങ്ങളാണ് താഴെയുള്ള ഓരോ ചോദ്യങ്ങളിലും കൊടുത്തിരിക്കുന്നത്. ഈ വിവരങ്ങൾ ഉപയോഗിച്ച് ശരിയായ അനുമാനം കണ്ടെത്തി അതിനുചുറ്റം വട്ടംവരച്ച് അടയാളപ്പെടുത്തുക.

39) സന്തുലിതബലവും അസന്തുലിതബലവും എന്താണെന്ന് മനസ്സിലാക്കുന്നതിനായി അധ്യാപിക കുറച്ച് കുട്ടികളെ വിളിച്ച് ഇരുവശങ്ങളിൽനിന്നും ഒരു മേശ വലിക്കുവാനാവശ്യപ്പെടുന്നു. ഇരുവശത്തുമുള്ള കുട്ടികളുടെ എണ്ണം വ്യത്യസ്തമാണ്.

ആയതിനാൽ കൂടുതൽ കുട്ടികൾ വലിച്ച വശത്തേക്ക് മേശ നീങ്ങുന്നു. തന്നിരിക്കുന്ന വിവരങ്ങളിൽനിന്നും താഴെ തന്നിരിക്കുന്ന അനുമാനങ്ങളിൽ ഏതാണ് ശരി?

A. സന്തുലിതബലം വസ്തുവിനെ ചലിപ്പിക്കുന്നു.

B. അസന്തുലിതബലം വസ്തുവിനെ ചലിപ്പിക്കുന്നു.

C. സന്തുലിതബലവും അസന്തുലിതബലവും വസ്തുവിനെ ചലപ്പിക്കുന്നു.

D. അസന്തുലിത ബലം പ്രയോഗിക്കുമ്പോൾ വസ്തു നിൽക്കുന്ന തറയിൽ പോറലുണ്ടാകുന്നു.

40) രണ്ടു വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങൾ മണലിലേക്കെറിഞ്ഞ പരീക്ഷണത്തിൽ തുല്ല്യവേഗത്തിൽ എത്തിയിട്ടും മാസ് കൂടിയ ഗോളം, മണലിൽ കൂടുതൽ താഴ്ചയുണ്ടാക്കി, ഉയരം കൂടിയപ്പോൾ മണലിൽ പതിക്കുന്ന ഗോളത്തിന്റെ പ്രവേഗംകൂടി, പ്രവേഗം കൂടുന്നതനുസരിച്ച് മണലിലുണ്ടാക്കിയ ആഘാതംകൂടി. തന്നിരിക്കുന്ന വിവരങ്ങളിൽ നിന്നും താഴെ തന്നിരിക്കുന്ന അനുമാനങ്ങളിൽ ഏതാണ് ശരി?

A. ആക്കം ഒരു സദിശ അളവാണ് ഇത് പ്രവേഗത്തിന്റെ എതിർ ദിശയിൽ അനുഭവപ്പെടുന്നു.

B. ചലിച്ചുകൊണ്ടിരിക്കുന്ന വസ്തുക്കളുടെ സവിശേഷ ഗുണമാണ് ആക്കം. ഇത് വസ്തുവിന്റെ മാസിന്റെയും പ്രവേഗത്തിന്റേയും ഗുണിതമാണ്.

C. ചലിച്ചുകൊണ്ടിരിക്കുന്ന വസ്തുക്കളുടെ സവിശേഷ ഗുണമാണ് ആക്കം. ഇത് ഒരു അദിശ അളവാണ്.

D. ആക്കാം അനുഭവപ്പെടുന്നത് പ്രവേഗത്തിന്റെ വിപരീത ദിശയിലാണ്.

41) ഒരു കുട്ടി ബലൂൺ ഊതി വിർപ്പിച്ചശേഷം കാറ്റഴിച്ചുവിടുന്നു. ഇവിടെ ബലൂണിന്റെ ഉൾവശത്തുനിന്ന് വായു പുറത്തേക്ക് പോകുന്നതിന്റെ എതിർദിശയിലേക്ക് ബലൂൺ ചലിച്ചു. വായു ശക്തിയായി പുറത്തുപോകുമ്പോൾ ബലം ഉണ്ടാവുന്നത് പ്രവർത്തനവും ബലൂണിന്റെ ചലനം പ്രതി പ്രവർത്തനവും ആണ്. തന്നിരിക്കുന്ന വിവരങ്ങളിൽനിന്നും താഴെ തന്നിരിക്കുന്ന അനുമാനങ്ങളിൽ ഏതാണ് ശരി?

A. പ്രവർത്തനവും പ്രതിപ്രവർത്തനവും എല്ലാ രീതിയിലും തുല്ല്യമാണ്

B. പ്രവർത്തനം പ്രതിപ്രവർത്തനത്തെ ഇല്ലാതാക്കുന്നു.

C. പ്രവർത്തനവും പ്രതിപ്രവർത്തനവും തുല്യവും വിപരീതവുമാണ്.

D. ഏതൊരു പ്രവർത്തനത്തിനും തുല്ല്യവും ഒരേ ദിശയിലുമുള്ള ഒരു പ്രതി-പ്രവർത്തനം ഉണ്ടായിരിക്കും.

42) വ്യത്യസ്ത സന്ദർഭങ്ങളിൽ പ്രയോഗിച്ച ബലങ്ങളും അനുഭവപ്പെട്ട ആകെ ബലവുമാണ് താഴെ പട്ടികയിൽ കൊടുത്തിരിക്കുന്നത്. ഇവിടെ തന്നിരിക്കുന്ന അനുമാനങ്ങളിൽ ഏതാണ് ശരി?

സന്ദർഭം	F_1(N)	F_2(N)	ആകെ ബലം (N) പരിണിത ബലം
ഒരേ ദിശയിൽ ഒരേ ബലം പ്രയോഗിക്കുന്നു.	50	50	100
വ്യത്യസ്ത ദിശയിൽ ഒരേ ബലം പ്രയോഗിക്കുന്നു.	50	50	0
വ്യത്യസ്തദിശയിൽ വ്യത്യസ്ത ബലങ്ങൾ പ്രയോഗിക്കുന്ന	80	40	40
വ്യത്യസ്ത ദിശയിൽ ഒരേ ബലം പ്രയോഗിക്കുന്ന	120	120	0

A. പരിണിതബലം പൂജ്യമാണെങ്കിൽ അതു സന്തുലിത ബലമാണ്.

B. അസന്തുലിത ബലത്തിന്റെ പരിണിതബലം പൂജ്യമാണ്.

C. സന്തുലിത ബലത്തിനു വസ്തുവിനെ ചലിപ്പിക്കാൻ കഴിയും.

D. ചലിക്കുന്ന വസ്തുവിനെ നിശ്ചലമാക്കാൻ സന്തുലിതബലം വേണം

PART 14

ഒന്നിലേറെ സമാനമായ സന്ദർഭങ്ങൾ താഴെയുള്ള ഓരോ ചോദ്യത്തിലും ഉണ്ട്. ഈ സന്ദർഭങ്ങളെ ശ്രദ്ധയോടെ മനസ്സിലാക്കി ശരിയായ പൊതുതത്വത്തിൽ എത്തിച്ചേരുക.

43)
- ഓവർലോഡുമായ വന്ന ബസ്സ് വേഗക കുറയ്ക്കാതെ വളവ് തിരിക്കുന്നതിനിടെ ബാലൻസ് പോയി അപകടം സംഭവിച്ചു.
- ഒരു കുട്ടി ടാർ നിറച്ച ഒരു വീപ്പ വളരെ പ്രയാസത്തോടെ ഉരുട്ടിനീക്കി. എന്നാൽ ഒഴിഞ്ഞ ടാർവീപ്പ വളരെ എളുപ്പത്തിൽ കുറേ ദൂരം ഉരുട്ടിനീക്കി.
- ആന മതം പോട്ടി രാമുവിനെ കുത്താൻ വന്നപ്പോൾ വളഞ്ഞ് പുളഞ്ഞ് ഓടിയതിനാൽ ആനക്ക് രാമുവിനെ കുത്താനായില്ല.

ഈ സന്ദർഭങ്ങളിൽനിന്നും മാസും ജഡത്വും തമ്മിൽ ഉള്ള ബന്ധത്തെപ്പറ്റി എന്തു പൊതുതത്വത്തിലെത്താം?

A. മാസ് കൂടുതലുള്ള വസ്തുവിനെ വഹിച്ചുകൊണ്ടുപോവാൻ ബുദ്ധിമുട്ടാണ്. അതിന്റെ ജഡത്വം കുറവാണ്.

B. ജഡത്വം കൂടുതലുള്ള വസ്തുവിന് മാസ് കുറവായിരിക്കും.

C. ഒരു വസ്തുവിന്റെ മാസ് കൂടുന്നതിനനുസരിച്ച് ജഡത്വം കൂടുന്നു.

D. ഒരു വസ്തുവിന്റെ മാസ് കൂടുന്നതിനനുസരിച്ച് ജഡത്വം കുറയുന്നു.

44)
- അമ്യൂസ്മെന്റ് പാർക്കുകളിൽ റൊട്ടേറ്റിങ് വീൽ കറങ്ങുമ്പോൾ കുട്ടികൾ സീറ്റ് ബെൽറ്റിട്ടിട്ടുണ്ടെന്ന് ഉറപ്പുവരുത്തുന്നു.
- വർണ്ണപമ്പരം കറക്കുമ്പോൾ കാറ്റിന്റെ ലഭ്യത കുറഞ്ഞപ്പോൾ ചലനത്തിന്റെ ദിശയിലും വേഗതയിലും മാറ്റം സംഭവിച്ചു.
- ഒരു കയറിൽ കല്ല് കെട്ടി കറക്കുന്നു.

ഈ സന്ദർഭങ്ങളിൽനിന്നും വർത്തുളചലനത്തെക്കുറിച്ച് എന്ത് പൊതു തത്വത്തിലാണ് എത്തിച്ചേരുന്നത്?

A. വർത്തുള ചലനത്തിലുള്ള വസ്തുവിന് വൃത്ത കേന്ദ്രത്തിലേക്കാണ് ബലം അനുഭവപ്പെടുന്നത്.

B. വർത്തുള ചലനത്തിലുള്ള വസ്തുവിന് വൃത്തകേന്ദ്രത്തിൽനിന്ന് പുറത്തേക്കാണ് ബലം അനുഭവപ്പെടുന്നത്.

C. വർത്തുളചലനത്തിലുള്ള വസ്തുവിന് ത്വരണം സംഭവിക്കുന്നില്ല.

D. വർത്തുളചലനത്തിലുള്ള വസ്തുവിന് ദിശ ഇല്ല.

45) - ഒരു മുത്തശ്ശൻ പുഴയിലൂടെ തോണി തുഴയുന്നത് അദ്ഭുതത്തോടെ ഉണ്ണി വീക്ഷിക്കുന്നു.
- തോക്കിൽനിന്നും വെടിയുണ്ട പായുമ്പോൾ തോക്ക് പിറകോട്ട് ചലിക്കുന്നതായി അനുഭവപ്പെടുന്നു.
- തോണിയിൽനിന്ന് രാമു കരയിലേക്ക് ചാടിയപ്പോൾ തോണി പിറകോട്ടു നീങ്ങുന്നു.

ഈ സന്ദർഭങ്ങളിൽനിന്നും എന്ത് പൊതു തത്വത്തിലാണ് എത്തുന്നത്.

A. ഏതു പ്രവർത്തനത്തിനും ഒരു പ്രതിപ്രവർത്തനം ഉണ്ടായിരിക്കും

B. ഏതു പ്രവർത്തനത്തിനും തുല്ല്യവും വിപരീതവുമായ പ്രതിപ്രവർത്തനം ഉണ്ടായിരിക്കും

C. ഏതു പ്രവർത്തനത്തിനും തുല്ല്യമായ പ്രതിപ്രവർത്തനം ഉണ്ടായിരിക്കും.

D. ഏതൊരു പ്രവർത്തനത്തേയും പ്രതിപ്രവർത്തനം ഇല്ലാതാക്കുന്നു.

Appendix VII

CALICUT UNIVERSITY
DEPARTMENT OF EDUCATION
2022

PROBLEM SOLVING ABILITY TEST IN PHYSICS
(Malayalam - Final)

Dr. Bindhu CM | **Athira V**
Profession | Research Scholar

നിർദ്ദേശങ്ങൾ

1. ഈ ബുക്ക്‌ലറ്റിൽ 14 ഭാഗങ്ങൾ (Part 1 to part 14) 8 പേജുകളിലായി ഉണ്ട്. ഓരോ ഭാഗങ്ങളിലും 1 മുതൽ 3 വരെ ചോദ്യങ്ങളുണ്ട്.
2. ഓരോ ചോദ്യത്തിനും 1 മാർക്ക് ആണ്.
3. എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരം എഴുതുക. ഉത്തരക്കടലാസിൽ ഉത്തരം മാർക്ക് ചെയ്യുമ്പോൾ ശരിയായ ഉത്തരത്തിനു നേരെ വട്ടം വരക്കുക. ഉദാ:- നിങ്ങളുടെ ഉത്തരം B ആണെങ്കിൽ താഴെ കൊടുത്തതുപോലെ മാർക്ക് ചെയ്യുക.

   A B C D
4. നിങ്ങൾ തന്നിരിക്കുന്ന ഉത്തരങ്ങൾ ഗവേഷണ ആവശ്യങ്ങൾക്ക് മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ.
5. ചോദ്യപേപ്പറിൽ ഒന്നുംതന്നെ എഴുതാൻ പാടില്ല.

PART 1

ദൈനംദിന ജീവിതത്തിലെ ചില സന്ദർഭങ്ങളാണ് താഴെയുള്ള ചോദ്യങ്ങളിൽ പ്രതിപാദിച്ചിരിക്കുന്നത്. ഓരോ സന്ദർഭത്തോടും അനുബന്ധിച്ച് A, B, C, D എന്നിങ്ങനെ കൊടുത്തിരിക്കുന്ന നാലു വസ്തുതകളിൽ ഏറ്റവും അസ്വാഭാവികമെന്നു തോന്നുന്ന നമ്പറിനു ചുറ്റും വട്ടംവരച്ച് മാർക്ക് ചെയ്യുക.

1) രണ്ടു കുട്ടികൾ ചേർന്ന് ഒരു മേശ ഒരേ ദിശയിലേക്ക് ബലം പ്രയോഗിച്ച് തള്ളുന്നു. തള്ളുമ്പോൾ ഉണ്ടായ സാഹചര്യങ്ങളാണ് താഴെ കൊടുത്തിരിക്കുന്നത്. ഇതിൽ ഏതാണ് നിങ്ങളെ ആശ്ചര്യപ്പെടുത്തുന്നത്?

   A. മേശ തള്ളുമ്പോൾ ബുദ്ധിമുട്ട് അനുഭവപ്പെടുന്നു.

   B. മേശ വളരെ വേഗത്തിൽ ബുദ്ധിമുട്ടില്ലാതെ ഒരേ ദിശയിലേക്ക് നീങ്ങുന്നു.

   C. മേശ നീങ്ങുമ്പോൾ തറയിൽ പോറൽ ഉണ്ടാകുന്നു.

   D. മേശയുടെ സ്ഥാനത്തിന് കാര്യമായ മാറ്റം സംഭവിക്കുന്നില്ല.

2) മേശപ്പുറത്തുള്ള അമ്മുവിന്റെ പേപ്പറിനുമുകളിൽ അപ്പു വെള്ളം നിറച്ച വാട്ടർ ബോട്ടിൽ വെച്ചു. അമ്മു ബോട്ടിൽ മാറ്റാതെ പേപ്പർ ഒരു വശത്തേക്ക് വേഗത്തിൽ വലിക്കുന്നു. അപ്പോൾ ഉണ്ടായ സാഹചര്യങ്ങൾ താഴെ കൊടുത്തിരിക്കുന്നു. ഇതിൽ ഏതു സാഹചര്യമാണ് സാധാരണ നാം പ്രതീക്ഷിക്കുന്നതിൽനിന്നും വ്യത്യസ്തമായി അനുഭവപ്പെടുന്നത്?

   A. പേപ്പറിന്റെ വക്കിൽ ചുളിവുണ്ടാകുന്നു.

B. ബോട്ടിലിന്റെ മുകൾഭാഗം പിറകോട്ടു ചായുകയും, പൂർവ്വസ്ഥിതി തുടരുകയും ചെയ്യുന്നു.

C. ബോട്ടിലിൽനിന്നും പകുതിവെള്ളം പേപ്പറിലേക്ക് ചിന്തുന്നു.

D. പേപ്പർ എടുക്കാൻ ബുദ്ധിമുട്ടനുഭവപ്പെടുന്നു.

3) ചന്ദു തോണിയിൽനിന്നും ഇറങ്ങാനായി തോണിയുടെ അറ്റത്തുനിന്ന് കരയിലേക്ക് ചാടുന്നു; ചാടുമ്പോൾ ഉണ്ടായ സന്ദർഭങ്ങളാണ് താഴെ കൊടുത്തിരിക്കുന്നത്. ഇവിടെ നിങ്ങളുടെ ശ്രദ്ധ പിടിച്ചുപറ്റിയ സന്ദർഭം ഏതാണ്?

A. ചന്ദു പെട്ടെന്ന് കരയിലേക്ക് എത്തുന്നു.

B. വെള്ളം ചവിട്ടാതെ ചന്ദു കരയിലേക്കെത്തുന്നു.

C. ചന്ദു മുന്നോട്ടു ചാടിയപ്പോൾ തോണി പുറകോട്ടു നീങ്ങുന്നു.

D. കരയിലേക്ക് ചാടുമ്പോൾ കൂടുതൽ ബലം അനുഭവപ്പെടുന്നു.

PART 2

ദൈനംദിന ജീവിതത്തിലെ ചില സന്ദർഭങ്ങളാണ് താഴെയുള്ള ചോദ്യങ്ങളിൽ പ്രതിപാദിച്ചിരിക്കുന്നത്. ഓരോ സന്ദർഭത്തിലും ഒരു കാതലായ പ്രശ്നം അടങ്ങിയിട്ടുണ്ട്. ഓരോ സന്ദർഭത്തോടും അനുബന്ധിച്ച് കൊടുത്തിരിക്കുന്ന നാല്പ പ്രസ്താവനകളിൽ ഏതാണ് പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത് എന്ന് നമ്പറിനു ചുറ്റം വട്ടം വരച്ച് മാർക്ക് ചെയ്യുക.

4) നിങ്ങൾ സ്ഥിരമായി ബസ്സിൽ യാത്ര ചെയ്യാറില്ലേ. ബസ്സ് പെട്ടെന്ന് ബ്രേക്ക് ചവിട്ടുമ്പോൾ നിങ്ങൾ മുൻപോട്ട് വീണു പോവാറില്ലെ? താഴെ പറയുന്നവയിൽ ഏത് പ്രസ്ഥാവനയാണ് ഇവിടുത്തെ പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത്?

A. ചലനാവസ്ഥയിലുള്ള വസ്തു ചലനാവസ്ഥ തുടരാനുള്ള പ്രവണത കാണിക്കുന്നു.

B. ബസ്സ് അമിത വേഗതയിൽ ഓടുമ്പോൾ ബാലൻസ് ബുദ്ധിമുട്ടാണ്.

C. ബസ്സിൽ ആവശ്യത്തിലധികം തിരക്കുള്ളതിനാൽ

D. നിശ്ചലാവസ്ഥയിലുള്ള ബസ്സ് പെട്ടെന്ന് ചലിച്ചതിനാൽ.

5) രാജേഷും രമേഷും സുഹൃത്ത്ക്കളായിരുന്നു. അവർ ഒരുമിച്ച് ലോങ്ങ്-ജമ്പ് പരിശീലിക്കാറുണ്ടായിരുന്നു. രണ്ടുപേരും ഒരു മത്സരത്തിൽ പങ്കെടുത്തപ്പോൾ രാജേഷ് കുറേ ദൂരം ഓടിവന്ന് ലോങ്ങ്-ജമ്പ് ചാടുകയും, എന്നാൽ രമേഷ് പെട്ടെന്ന് ഓടിവന്ന് ചാടുകയും ചെയ്തു. മത്സരശേഷം രാജേഷ് നല്ല മാർജിനിൽ വിജയം കൈവരിച്ചു. എന്നാൽ രമേഷ് വളരെ പിന്നിലായിരുന്നു. താഴെ പറയുന്നവയിൽ ഏത് പ്രസ്ഥാവനയാണ് ഇതിലെ പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത്?

A. രമേഷിന് രാജേഷിനെക്കാൾ നീളം കുറവായതിനാൽ ചാടാൻ ബുദ്ധിമുട്ടനുഭവപ്പെട്ടു.

B. രാജേഷ് കൂടുതൽ ദൂരം ഓടി ചലന ജഡത്വം പ്രയോജനപ്പെടുത്തിയതിനാൽ

C. രാജേഷ് രമേഷിനേക്കാൾ കൂടുതൽ സമയം പരിശീലിച്ചതിനാൽ.

D. രാജേഷിന് പരിചയമുള്ള കളിസ്ഥലമായതിനാൽ ചാടാൻ വളരെ എളുപ്പമായിരുന്നു.

6) ചുരങ്ങളിലൂടെ ലോഡ് കയറ്റിയ വാഹനങ്ങൾ ഓടിക്കുമ്പോൾ പലപ്പോഴും അപകടം സംഭവിക്കാറുണ്ട്. താഴെ പറയുന്നവയിൽ ഏതു പ്രസ്താവനയാണ് ഇതിലെ പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത്?

A. ലോഡ് നിറച്ച വാഹനങ്ങൾക്ക് മാസ് കൂടുതലാണ് തന്മൂലം ജഡത്വം കൂടുതലായിരിക്കും.

B. ഭാരം കൂടിയ വാഹനങ്ങൾ വേഗത കുറയ്ക്കാതെ വളവ് തിരിക്കാൻ ശ്രമിക്കുന്നതുകൊണ്ട്.

C. ഉയരം കൂടുമ്പോൾ വാഹനങ്ങളുടെ വേഗത കുറയ്ക്കാൻ ബുദ്ധിമുട്ടാണ്.

D. ലോഡ് കയറ്റിയ വാഹനങ്ങൾ ബാലൻസ് ചെയ്യാൻ ബുദ്ധിമുട്ടാണ്.

PART 3

ദൈനംദിന ജീവിതത്തിലെ ചില സന്ദർഭങ്ങളാണ് താഴെയുള്ള ചോദ്യങ്ങളിൽ പ്രതിപാദിക്കുന്നത്. ഓരോ സന്ദർഭത്തിലും ഒരു ശാസ്ത്രപ്രശ്നം അടങ്ങിയിരിക്കുന്നു. ഈ പ്രശ്നത്തിലെ പ്രധാന ഘടകങ്ങൾ ഏതാണെന്ന് കണ്ടുപിടിക്കുകയാണ് നിങ്ങൾ ചെയ്യേണ്ടത്. പ്രധാന ഘടകങ്ങളുടെ ശരിയായ കൂട്ടം കണ്ടെത്തി അതിന്റെ നമ്പറിനുചുറ്റും വട്ടം വരക്കുക.

7) ഉണ്ണിയും കുട്ടനും വ്യത്യസ്ത ഭാരമുള്ള കുട്ടികൾ ആയിരുന്നു. സമാന വലുപ്പവും ആകൃതിയുമുള്ള രണ്ട് ഒഴിഞ്ഞ ഐസ്ക്രീം ബോളുകളെടുത്ത് അവയിൽ ഒന്നിൽ മണൽ നിറച്ച് അത് ഉണ്ണിയും നിറക്കാത്ത കാലിബോൾ കുട്ടനും എടുത്ത് തൊട്ടടുത്തുള്ള കടപ്പുറത്ത് പോയി ഒരു പാറയുടെ മുകളിൽ കയറി, താഴെ മണിലിലേക്ക് രണ്ടുപേരും ഒരേ സമയം ബോളുകൾ താഴേക്ക് വലിച്ചെറിയുന്നു. മണ്ണുനിറച്ച ബോൾ മണലിൽ കൂടുതൽ ആഘാതം ഉണ്ടാക്കി. താഴെ പറയുന്നവയിൽ ഏതൊക്കെ ഘടകങ്ങളാണ് ഈ സംഭവത്തെ സ്വാധീനിച്ചത്?

i. കുട്ടികളുടെ ഭാരം

ii. ബോളുകളുടെ വ്യത്യസ്ത ഭാരം

iii. ബോളുകൾ താഴേക്ക് എറിഞ്ഞപ്പോൾ അവയ്ക്ക് ലഭിച്ച് ആദ്യപ്രവേഗം

iv. ബോൾ നിർമ്മിച്ചിരിക്കുന്ന പദാർത്ഥം

A. i & ii

B. i, ii & iii

C. ii & iii

D. iv മാത്രം

8) അച്ചു തന്റെ വീടിന്റെ മുറ്റത്ത് കോൺക്രീറ്റ് പാകിയ നിരപ്പായ പ്രതലത്തിൽ പമ്പരം കറങ്ങിക്കൊണ്ടിരിക്കുമ്പോൾ ഒരു പൂച്ച വന്ന് കറങ്ങുന്നതിനിടയിലൂടെ ചാടിയപ്പോൾ പമ്പരം തെറിച്ചുപോയി. ഈ സന്ദർഭത്തിലെ പ്രധാന ഘടകങ്ങലുടെ കൂട്ടം ഏതെല്ലാമാണ്.

A. പ്രവേഗം, ത്വരണം, അഭികേന്ദ്രത്വരണം

B. അഭികേന്ദ്രബലം, അഭികേന്ദ്രത്വരണം

C. പമ്പരം, വേഗത, പ്രവേഗം, ത്വരണം

D. പൂച്ചയുടെ വേഗത, ബലം, ത്വരണം

9) രാമുവും രാജുവും ക്രിക്കറ്റ് കളി പരിശീലിക്കുകയായിരുന്നു. നല്ല ഫീൽഡർമാരായ രണ്ടുപേരും വേഗത്തിൽ വന്ന ബോൾ പിടിക്കാൻ ശ്രമിച്ചപ്പോൾ രാജുവിന്റെ കൈ വേദനയായി പരിശീലനം നിർത്തേണ്ടിവന്നു. പക്ഷേ ഇതേ സമയം രാമു വളരെ വിദഗ്ദമായി ബോൾ പിടിക്കുമ്പോൾ കൈ പുറകോട്ടു വലിച്ചു. അതിനാൽ വേദന അനുഭവപ്പെട്ടില്ല. ഇതുമായി ബന്ധപ്പെട്ട പ്രധാന ഘടകങ്ങൾ ഏതെല്ലാമാണ്?

A. സമയം, ക്രിക്കറ്റ്, വേഗത

B. ബലം, സമയം, ആവേഗം

C. ആക്കവ്യത്യാസം, ബലം, സമയം

D. വേഗത, പ്രവേഗം, മാസ്സ്

PART 4

താഴെ കൊടുത്തിരിക്കുന്ന സന്ദർഭങ്ങളിലെല്ലാം പ്രസക്തമായതും പരസ്പരം ബന്ധപ്പെട്ടതുമായ രണ്ട് ശാസ്ത്ര ആശയങ്ങൾ അടങ്ങിയിട്ടുണ്ട്. തന്നിരിക്കുന്ന സന്ദർഭങ്ങൾ ശ്രദ്ധയോടെ വായിച്ച് പ്രസക്തമായ ആശയങ്ങളുടെ ജോഡി കണ്ടെത്തി ഉത്തരത്തിനുചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക.

10) ഉത്സവപ്പറമ്പിൽ പെട്ടെന്നുള്ള വെടിപ്രയോഗത്തിന്റെ ഭാഗമായി ആന മതംപൊട്ടി ചീറി പായാൻ തുടങ്ങി. ആന ഒരാളെ ഉന്നംവെച്ച് ഓടിയപ്പോൾ അയാൾ വളഞ്ഞ് പുളഞ്ഞ് ഓടിയതിനാൽ ആനക്ക് അയാളെ ആക്രമിക്കാൻ സാധിച്ചില്ല. ഈ സന്ദർഭത്തിൽ ഏറ്റവും പ്രസക്തമായതും ബന്ധപ്പെട്ടതുമായ ആശയങ്ങളുടെ ജോഡി ഏത്?

A. മാസ്സും, പ്രവേഗവും

B. ദൂരവും മാസ്സും

C. ജഡത്വവും ദൂരവും

D. മാസ്സും ജഡത്വവും

11) അമ്മു മുത്തശ്ശന്റെ കൂടെ ഗ്ലാസ്സ് വാങ്ങിക്കാൻ കടയിൽ പോയി അവിടെ ഗ്ലാസ് പാത്രങ്ങൾ അടുക്കിവെച്ച പാക്കറ്റുകളിൽ സ്പോഞ്ച്, വൈക്കോൽ മുതലായവ നിറച്ച്വെച്ചിരിക്കുന്നത് അവളെ അത്ഭുതപ്പെടുത്തി. അവൾ മുത്തശ്ശനോട് കാരണം. തിരക്കി, പാത്രങ്ങൾ കൂട്ടിമുട്ടി പൊട്ടുന്നത് ഒഴിവാക്കാൻവേണ്ടി ആണെന്ന് മുത്തശ്ശൻ പറഞ്ഞു. ഈ സന്ദർഭത്തിൽ ഏറ്റവും പ്രസക്തമായതും പരസ്പരം ബന്ധപ്പെട്ടതുമായ ആശയങ്ങളുടെ ജോഡി ഏത്?

A. സമയവും ബലവും

B. മാസ്സും ബലവും

C. സമയവും മാസ്സും

D. മാസ്സും ജഡത്വവും

12) ക്ലാസ്സ്റൂമിൽ ഒരു പരീക്ഷണം ചെയ്യുന്നതിന്റെ ഭാഗമായി കുട്ടികൾ ഒരു സ്ട്രോയിലൂടെ നീളമുള്ള ഒരു ചരട് കടത്തി ക്ലാസ്മുറിയുടെ രണ്ടു ജനാലകളിലായി കെട്ടിവെയ്ക്കുന്നു. ഊതി വീർപ്പിച്ച ഒരു ബലൂൺ, സ്ട്രോയിൽ ഒട്ടിച്ചുവെക്കുന്നു. ബലൂണിലെ കാറ്റഴിച്ചുവിട്ടപ്പോൾ കാറ്റ് പുറത്തേക്ക് പോയതിന്റെ എതിർദിശയിലേക്ക് ബലൂൺ ശക്തിയായി ചലിച്ചു. ഇവിടെ ഏറ്റവും പ്രസക്തമായതും തമ്മിൽ ബന്ധപ്പെട്ടതുമായ ആശയങ്ങളുടെ ജോഡി ഏതാണ്?

A. ആഘാതവും പ്രവർത്തനവും

B. പ്രവർത്തനവും പ്രതിപ്രവർത്തനവും

C. ആവേശവും ആഘാതവും

D. ചലനവും ആഘാതവും

PART 5

താഴെ കൊടുത്തിരിക്കുന്ന ശാസ്ത്രീയ പ്രതിഭാസങ്ങൾക്ക് സമാനമായ അവസ്ഥ കണ്ടെത്തി അടയാളപ്പെടുത്തുക

13) ഒരു വസ്തുവിന് സ്വയം അതിന്റെ നിശ്ചലാവസ്ഥയ്ക്കോ, ചലനാവസ്ഥയ്ക്കോ മാറ്റം വരുത്താനുള്ള കഴിവില്ലായ്മയെ ജഡത്വം എന്ന് പറയുന്നു. ഈ പ്രതിഭാസത്തിന് സമാനമായ അവസ്ഥ താഴെ പറയുന്നവയിൽ ഏതാണ്?

A. ജലോപരിതലത്തിലുള്ള തോണിയിൽനിന്ന് ഒരാൾ കരയിലേക്ക് ചാടുന്നു.

B. ഓടിവരുന്ന അത്‌ലറ്റിന് ഫിനിഷിങ് ലൈനിൽ എത്തിയാലുടൻ ഓട്ടം അവസാനിപ്പിക്കാൻ കഴിയില്ല.

C. ഓടികൊണ്ടിരിക്കുന്ന ബസ്സിലെ യാത്രക്കാർക്ക് പുറത്തുള്ള മരങ്ങൾ ചലിക്കുന്നതായി തോന്നുന്നു

D. വളരെ വേഗത്തിൽ ഓടുന്ന ആൾ വേഗത കുറഞ്ഞ് ഓടുന്ന ആളെക്കാൾ നേരത്തെ ഫിനിഷിങ് പോയിന്റിൽ എത്തുന്നു.

14) ആക്കവ്യത്യാസം സ്ഥിരമായിരുന്നാൽ വസ്തുവിൻ അനുഭവപ്പെടുന്ന ബലം അത് പ്രയോഗിക്കാനെടുക്കുന്ന സമയത്തിന് വിപരീതാനുപാതത്തിലായിരിക്കും. ഈ തത്വത്തിന് സമാനമായ അവസ്ഥ താഴെ പറയുന്നതിൽ ഏതാണ്?

A. ഒരു അഭ്യാസി കൈകൊണ്ട് വളരെ വേഗത്തിൽ വീശി കട്ടപ്പമുള്ള ഇഷ്ടികകൾ തകർക്കുന്നു.

B. രണ്ടു കുട്ടികൾ ചേർന്ന് ഇഷ്ടിക വലിച്ച് കൊണ്ടുപോയി മുകളിൽനിന്ന് താഴേക്ക് എറിയുന്നു.

C. ഒരു മരംവെട്ടുകാരൻ കോടാലി ഉപയോഗിച്ച് മരം വെട്ടുന്നു.

D. ഒരാൾ മഴു ഉപയോഗിച്ച് കല്ല് പൊട്ടിക്കാൻ ശ്രമിക്കുന്നു.

15) 'ഏതൊരു പ്രവർത്തിനും തുല്യവും വിപരീതവുമായ ഒരു പ്രതിപ്രവർത്തനം ഉണ്ടായിരിക്കും.' ഇതാണ് ന്യൂട്ടന്റെ മൂന്നാം ചലനനിയമം. ഈ നിയമത്തിന് സമാനമായ അവസ്ഥ താഴെ പറയുന്നവയിൽ ഏതാണ്?

A. കുട്ടികൾ ചങ്ങാടത്തിലൂടെ കൈകൊണ്ടു തുഴഞ്ഞ് നീങ്ങുന്നു.

B. ചങ്ങാടത്തിന്റെ കെട്ടഴിഞ്ഞ് ചങ്ങാട്ടം ഉലയുന്നു.

C. ചങ്ങാടത്തിൽ ഒന്നിലധികം കുട്ടികൾ കയറുന്നു.

D. ചങ്ങാടത്തിന്റെ അറ്റം കയർകെട്ടി വലിക്കുന്നു.

PART 6

താഴെ കൊടുത്തിരിക്കുന്ന ഓരോ ചോദ്യത്തിലും ശാസ്ത്രീയമായി തെളിയക്കപ്പെട്ടിട്ടുള്ള ഒന്നിലേറെ പ്രസ്താവനകൾ അടങ്ങിയിരിക്കുന്നു. ആ പ്രസ്തവനകളെ മാത്രം അടിസ്ഥാനമാക്കിയാൽ ഏത് അനുമാനത്തിൽ എത്തിച്ചേരാനാകുമെന്ന് നിർണ്ണയിച്ച് ശരിയായ അനുമാനത്തിനുനെരെയുള്ള നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക.

16) താഴെ കൊടുത്ത മൂന്നു പ്രസ്താവനകൾ ശ്രദ്ധിക്കുക

(i) ഒരു കുട്ടി തോണിയിൽനിന്നും കരയിലേക്ക് ചാടുമ്പോൾ തോണി പുഴയിലേക്കുതന്നെ നീങ്ങുന്നു.

(ii) തോക്ക് നിറയൊഴിക്കുമ്പോൾ വെടിയുണ്ട മുന്നോട്ട് പായുകയും തോക്ക് പിന്നോട്ട് തെറിക്കുകയും ചെയ്യുന്നു.

(iii) റോക്കറ്റിന്റെ അറകളിൽ നിന്ന് ഉന്നത മർദ്ദത്തിലുള്ള വാതകം പുറത്തേക്ക് പോകുന്നതിന്റെ ഭാഗമായി റോക്കറ്റ് മുന്നോട്ടുകുതിക്കുന്നു.

ഈ പ്രസ്ഥാവനകളെ മാത്രം അടിസ്ഥാനപ്പെടുത്തി നമുക്ക് എന്ത് അനുമാനത്തിലെത്താം.

A. ഒരു പ്രവർത്തനത്തിന് തുല്ല്യമായ പ്രതിപ്രവർത്തനം ഉണ്ടാകും.

B. ഒരു പ്രവർത്തനത്തിന് എതിർ ദിശയിൽ പ്രതിപ്രവർത്തനം ഉണ്ടാകും.

C. ഒരു പ്രവർത്തനത്തിന് പ്രതിപ്രവർത്തനം ഉണ്ടാകും.

D. ഓരോ പ്രവർത്തനത്തിനോടും ഒരു ദിശ ബന്ധപ്പെട്ടിരിക്കുന്നു.

17) താഴെ കൊടുത്ത മൂന്നു വാചകങ്ങൾ ശ്രദ്ധിക്കുക

(i) ഭാരം കയറ്റിയ വാഹനങ്ങൾ വേഗത കുറയ്ക്കാതെ വളവു തിരിയുന്നത് അപകടത്തിന് ഇടയാക്കുന്നു.

(ii) ടാർ നിറച്ച ഒരു വീപ്പ ഉരുട്ടി നീക്കുന്നത് ഒഴിഞ്ഞ ടാർ വീപ്പ ഉരുട്ടുന്നതിനേക്കാൾ കൂടുതൽ പ്രയാസകരമാണ്.

(iii) രണ്ട് വ്യത്യസ്ത ഭാരമുള്ള കല്ലുകൾ ഒരേ സമയം ഉരുട്ടുമ്പോൾ ഭാരം കുറഞ്ഞ കല്ല് ഉരുണ്ടു കൊണ്ടെയിരിക്കുന്ന ഭാരം കൂടിയ കല്ല് പെട്ടെന്ന് നിശ്ചലാവസ്ഥയിലാവുന്നു.

ഈ വാചകങ്ങളെ മാത്രം അടിസ്ഥാനപ്പെടുത്തി നമുക്ക് എന്ത് അനുമാനത്തിലെത്താം.

A. ഒരു വസ്തുവിന്റെ മാസ് കൂടുമ്പോൾ ജഡത്വം കുറയുന്നു.

B. ഒരു വസ്തുവിന്റെ മാസും ജഡത്വവും തമ്മിൽ ബന്ധമില്ല.

C. ഒരു വസ്തുവിന്റെ മാസ് കൂടുമ്പോൾ ജഡത്വം കൂടുന്നു.

D. ഒരു വസ്തുവിന്റെ മാസ് എത്ര കൂടിയാലും ജഡത്വം തുല്ല്യമായിരിക്കും.

18) താഴെ കൊടുത്ത മൂന്ന് പ്രസ്താവനകൾ ശ്രദ്ധിക്കുക

(i) മാവിന്റെ കൊമ്പ് കുലുക്കുമ്പോൾ അതു ചലിക്കാൻ തുടങ്ങുന്ന അവസരത്തിൽ മാങ്ങ അടർന്നു വീഴുന്നു.

(ii) ഓടിക്കൊണ്ടിരിക്കുന്ന ബസ്സിൽ നിന്നും ഇറങ്ങുന്ന ആൾ അല്പദൂരം കൂടി മുന്നോട്ട് ഓടേണ്ടിവരുന്നു.

(iii) ഓട്ടമത്സരത്തിനുശേഷം അത്‌ലറ്റ് ഫിനിഷിങ് പോയിന്റ് കഴിഞ്ഞിട്ടും കുറച്ചുദൂരംകൂടി ഓടുന്നു.

ഈ പ്രസ്താവനകളെ മാത്രം അടിസ്ഥാനപ്പെടുത്തി നമുക്ക് എന്ത് അനുമാനത്തിലെത്താം.

A. ഒരു വസ്തുവിന് സ്വയം അതിന്റെ നിശ്ചലാവസ്ഥയ്ക്കോ ചലനാവസ്ഥയ്ക്കോ മാറ്റം വരുത്താനുള്ള കഴിവില്ല.

B. ഘർഷണം കൂടിയേ പ്രതലത്തിൽ വസ്തുവിന്റെ ചലനത്തിന്റെ വേഗത കുറയുന്നു

C. മാസ് കൂടുതലുള്ള വസ്തുക്കളുടെ ആക്കം വർദ്ധിക്കുന്നു.

D. ഒരേ ദിശയിൽ ചലിക്കുന്ന വസ്തുക്കൾ ഒരു നിശ്ചിത സമയംവരെ ചലിച്ചുകൊണ്ടിരിക്കേണ്ടിയിരിക്കുന്നു.

PART 7

താഴെ തന്നിരിക്കുന്ന സന്ദർഭങ്ങളിലെല്ലാം ഒരു ശാസ്ത്രപ്രശ്നം അടങ്ങിയിട്ടുണ്ട്. ഈ പ്രശ്നത്തെ മനസ്സിലാക്കിയതിനുശേഷം അതിന് ഒരു യുക്തിസഹമായ ന്യായീകരണം തരുന്ന പ്രസ്ഥാവനക്കുചുറ്റം വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക.

19) ലോങ്-ജമ്പ് ചാടുന്ന ഒരു അത്‌ലറ്റ് ഒരിടത്തുനിന്ന് ചാടുന്നതിനു പകരം ദൂരെനിന്നും കുതിച്ച് ഓടിവന്ന് ചാടുന്നു. എന്തായിരിക്കും ഇതിനു കാരണം.

A. അത്‌ലറ്റ് ഓടുന്ന ദൂരവും ലോങ്ജമ്പ് ചെയ്ത ഫിനിഷിങ് പോയിന്റും തമ്മിൽ ബന്ധമുണ്ടാകും

B. അത്‌ലറ്റ് ഓടിയടുക്കുന്ന വേഗതയും അത്‌ലറ്റിനു ലഭിക്കുന്ന പേശീബലവും തമ്മിൽ ബന്ധമുണ്ടാകും.

C. അത്‌ലറ്റ് ഓടിയെടുക്കുന്ന വേഗതയും അത്‌ലറ്റിനു ലഭിക്കുന്ന പേശീബലവും തമ്മിൽ ബന്ധമുണ്ടാകും

D. ഓടുന്ന ആൾക്ക് നന്നായി ബാലൻസ് ചെയ്ത് ലോങ്ജമ്പ് ചാടാൻ സാധിക്കുന്നുണ്ടാകും.

20) ഓടികൊണ്ടിരിക്കുന്ന ഒരു ബസ്സിൽനിന്നും പുറത്തേക്ക് ഒരാൾ ഇറങ്ങുകയാണ്, വീഴാതിരിക്കുന്നതിനുവേണ്ടി അയാൾ ബസ്സിന്റെ ദിശയിൽ അൽപ്പം ദൂരം മുന്നോട്ട് ഓടി പിന്നീട് പ്രയാസമില്ലാതെ നടന്നുപോവുകയും ചെയ്തു. ബസ്സിൽനിന്ന് ഇറങ്ങിയ ആൾ മുന്നോട്ട് അൽപ്പദൂരം ഓടിയതിനു കാരണമെന്ത്?

A. ചലനാവസ്ഥയിൽ തുടരുന്ന സ്വന്തം ശരീരത്തിന്റെ ചലനജഡത്വം ക്രമേണ കുറയ്ക്കുന്നതിനു വേണ്ടിയാവാം.

B. നിശ്ചലാവസ്ഥയിൽ തുടരുന്ന സ്വന്തം ശരീരത്തിന്റെ നിശ്ചല ജഡത്വം ക്രമേണ കുറയ്ക്കുന്നതിനു വേണ്ടിയാവാം.

C. നിശ്ചലാവസ്ഥയിലുള്ള ആളിന്റെ പ്രവേഗം ബസ്സിനൊപ്പം ആക്കുന്നതിനു വേണ്ടിയാവാം.

D. യാത്രക്കാരന്റെ ശരീരം തറയെ അപേക്ഷിച്ച് നിശ്ചലാവസ്ഥയിലായതിനാൽ ഓടുന്നതിന് സ്ഥിരത കൈവരിക്കാൻ ഉപകരിച്ചേക്കാം.

21) ഭാരമുള്ള വസ്തുക്കൾ വളരെ വേഗത്തിൽ എറിഞ്ഞ് അതു പിടിക്കുമ്പോൾ കൈ അൽപ്പം പുറകോട്ടു നീക്കുന്നു. ഇങ്ങനെ കൈ നീക്കാൻ കാരണമെന്ത്?

A. ആക്ക വ്യത്യാസത്തിനുള്ള സമയംകൂട്ടി ആഘാതം കുറയ്ക്കാൻ വേണ്ടായാവാം.

B. കയ്യിന്റെ പ്രവേഗം വസ്തുവിനൊപ്പം ആക്കാൻ വേണ്ടിയാവാം.

C. കയ്യും വസ്തുവും തമ്മിലുള്ള സമ്പർക്കം കുറച്ച് ആഘാതം കുറയ്ക്കാൻ വേണ്ടിയാവാം

D. ആക്ക വ്യത്യാസ നിരക്ക് കൂട്ടി ആഘാതം കുറയ്ക്കാൻ വേണ്ടിയാവാം.

PART 8

താഴെ കൊടുത്തിരിക്കുന്ന ഓരോ ചോദ്യത്തിലും അവതരിപ്പിച്ചിരിക്കുന്ന ശാസ്ത്രപ്രശ്നത്തിന് ന്യായീകരണമായേക്കാവുന്ന പ്രസ്താവനകളാണ് A, B, C, D എന്നിങ്ങനെ കൊടുത്തിരിക്കുന്നത്. ഇവയിൽ ഏറ്റവും യുക്തി സഹമായതും ഒരു ലഘുപരീക്ഷണം കൊണ്ട് തെളിയിക്കാനാവുന്നതുമായ അനുമാനം (പരികൽപന) അടയാളപ്പെടുത്തുക.

22) കുട്ടികൾ മൈതാനത്തിൽ ഓടി കളിക്കുമ്പോൾ നല്ല വണ്ണമുള്ള ആളിന് വേഗം ഓട്ടം നിർത്താനും അതുപോലെ ഓടിതുടങ്ങാനും പ്രയാസം അനുഭവപ്പെടുന്നു. ഇതിനുകാരണം മനസ്സിലാക്കുന്നതിന് മാസും ജഡത്വവും തമ്മിൽ ബന്ധമുണ്ടോ എന്ന് കണ്ടുപിടിക്കേണ്ടതുണ്ട്. ഇതിന് താഴെ പറയുന്നവയിൽ ഏത് അനുമാനമാണ് ഒരു ലഘുപരീക്ഷണം നടത്തി തെളിയക്കാനാവുന്നത്?

A. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങൾ മിനുസമുള്ള തറയിൽകൂടി ഒരേ വേഗതയിൽ ഉരുട്ടിവിട്ടാൽ മാസ് കൂടുതലുള്ള ഗോളം കൂടുതൽ സമയം ഉരുളും.

B. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങളിൽ മാസ് കൂടിയതിന്റെ ഭൂഗുരുത്വകേന്ദ്രം മദ്ധ്യത്തിലായിരിക്കും.

C. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങൾ ശൂന്യാകാശത്തിൽ ഉരുട്ടിനോക്കിയാൽ മാസ് കൂടുതലുള്ള ഗോളം കൂടുതൽ സമയം ഉരുളും.

D. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങൾക്ക് പാലായന പ്രവേഗം കൊടുത്താൽ എല്ലാ ഗോളങ്ങളും ശൂന്യാകാശത്ത് എത്തിച്ചേരും.

23) 8-ാം ക്ലാസ്സിലെ കുട്ടികൾക്ക് ഒരു അദ്ധ്യാപകൻ വർത്തുളചലനം വിശദീകരിച്ച കൊടുത്തപ്പോൾ അവർ മുന്നോട്ടുവച്ച യുക്തിസഹമായ പ്രസ്താവനകളാണ് താഴെ കൊടുത്തിരിക്കുന്നത്. ഇവയിൽ ഏതാണ് ഒരു ലഘു പരീക്ഷണത്താൽ തെളിയിക്കാവുന്നത്?

A. ഭൂമിക്കു ചുറ്റും ഗ്രഹങ്ങൾ കറങ്ങുമ്പോൾ അഭികേന്ദ്രബലം നഷ്ടമായാൽ ഗ്രഹങ്ങൾ വർത്തുള ചലനത്തിന്റെ തൊടുവരയിൽ കൂടി തെറച്ച് പുറത്തേക്ക് പോകുന്നു.

B. ഒരു ചരടിൽ അറ്റത്ത് കല്ല്കെട്ടി കറക്കുമ്പോൾ അഭികേന്ദ്രബലവും അഭികേന്ദ്ര ത്വരണവും കേന്ദ്രത്തിലേക്ക് അനുഭവപ്പെടുന്നു. പെട്ടെന്ന് ചരടുവിടുമ്പോൾ കല്ല് പുറത്തേക്ക് തെറിച്ചപോവുന്നു.

C. ഓടികൊണ്ടിരിക്കുന്ന കാറിന്റെ ചക്രത്തിലേക്ക് ഓരു ഉരുളൻ കല്ല് എറിയുമ്പോൾ വർത്തുളചലനം നഷ്ടപ്പെട്ട് കാർ മറയുന്നു.

D. ശൂന്യാകാശത്ത് നിന്ന് ഒരു ജയന്റ് വീൽ കറക്കുമ്പോൾ വൃത്തകേന്ദ്രത്തിലേക്ക് അഭികേന്ദ്രബലവും, അഭികേന്ദ്രത്വരണവും അനുഭവപ്പെടുന്നു.

24) പ്രവേഗവും ആക്കവും നേർ അനുപാതത്തിലാണ്. അതായത് പ്രവേഗം കൂടുമ്പോൾ ആക്കവും കൂടുന്നു. ഇതു മനസ്സിലാക്കുന്നതിന് താഴെ പറയുന്നവയിൽ ഏത് അനുമാനമാണ് ഒരു ലഘു പരീക്ഷണം നടത്തി തെളിയിക്കാനാവുന്നത്.

A. ഒരേ മാസുള്ള രണ്ട് ബോളുകൾ വ്യത്യസ്ത ഉയരത്തിൽ നിന്നും ഒരു മണൽമെത്തയിലേക്ക് ഇടുമ്പോൾ കൂടുതൽ ഉയരത്തിൽ നിന്നും ഇടുമ്പോൾ കൂടുതൽ ആഘാതം ഉണ്ടാക്കുന്നു.

B. ഓരേ മാസുള്ള രണ്ടു ബോളുകൾ വ്യത്യസ്ത ആദ്യപ്രവേഗത്തോടെ ശൂന്യാകാശത്തുനിന്ന് താഴെക്കിടുമ്പോൾ രണ്ടും ഒരേ സമയത്ത് താഴെയെത്തുന്നു.

C. ഒരേ മാസുള്ള ഗോളങ്ങൽക്ക് വ്യത്യസ്ത പാലായനപ്രവേഗം കൊടുത്താൽ എല്ലാ ഗോളങ്ങളും ഒരേ സമയം ശൂന്യാകാശത്തെത്തും.

D. ഒരേ മാസുള്ള രണ്ടു വ്യക്തികൾ വ്യത്യസ്ത ഉയരത്തിൽനിന്നും പുഴയിലേക്ക് ചാടുമ്പോൾ കൂടുതൽ ഉയരെനിന്നും ചാടിയ ആൾ കൂടുതൽ താഴെക്ക് എത്തുന്നു.

PART 9

ഒരു ശാസ്ത്ര പ്രക്രിയയെ സ്വാധീനിക്കുന്ന ഘടകങ്ങൾ ഒന്നിലേറെ ഉണ്ടാവുമല്ലോ. നിർണ്ണായകമായ ഇത്തരം ഘടകങ്ങളിൽ സ്വാധീനം മനസ്സിലാക്കി ശരിയായ ഉത്തരം അടയാളപ്പെടുത്തുക.

25) ചലിച്ചുകൊണ്ടിരിക്കുന്ന വസ്തുക്കളുടെ സവിശേഷഗുണമാണ് ആക്കം. ഇത് മാസിന്റെയും പ്രവേഗത്തിന്റെയും ഗുണിതമാണ്. ഇവ തമ്മിലുള്ള ബന്ധം മനസ്സിലാക്കാൻ സമാന ആകൃതിയുള്ള രണ്ടു വ്യത്യസ്ത ഭാരമുള്ള ഇരുമ്പുഗോളങ്ങളെടുക്കുന്നു. ഒരു പരന്ന പാത്രത്തിൽ നനഞ്ഞ മണൽ നിറച്ചശേഷം ഗോളങ്ങൾ ഒരേ ഉയരത്തിൽനിന്നും മണലിലേക്കിടുന്നു. ഈ പരീക്ഷണത്തിൽ സ്ഥിരമായി നാം നിലനിർത്തുന്ന ഘടകങ്ങൾ ഏതൊക്കെയാണ്?

A. വസ്തുവിന്റെ ഭാരം, ആകൃതി, പരീക്ഷണത്തിന്റെ സമയം

B. പരീക്ഷണം നടത്തുന്ന പ്രതലം, വസ്തുക്കളുടെ ആദ്യപ്രവേഗം വസ്തുവിന്റെ ആകൃതി

C. വസ്തുവിന്റെ ഭാരം, വസ്തുവിന്റെ ആകൃതി, ആദ്യപ്രവേഗം.

D. വസ്തുക്കൾ താഴെക്കിടക്കുന്ന സമയം, പരീക്ഷണം നടത്തുന്ന പ്രതലം, വസ്തുവിന്റെ ഭാരം.

26) ഒരു വസ്തുവിന് അസന്തുലിതമായ ബാഹ്യബലം കൊടുക്കുന്നതുവരെ അതിന്റെ ചലനാവസ്ഥ തുടരാനുള്ള പ്രവണതയാണ് ചലനജഡത്വം. ഇതു കാണിക്കുന്ന പരീക്ഷണത്തിൽ ഒരു വലിയ പാറക്കഷണവും, ഒരു ബോളും ഒരുമിച്ച് നിരപ്പായ പ്രതലത്തിലൂടെ ഉരുട്ടുന്നു. ഇവിടെ ബോൾ ചലിച്ചുകൊണ്ടേയിരിക്കുന്നു. പാറക്കഷണം അൽപ്പദൂരം ചലിച്ചശേഷം നിശ്ചലാവസ്ഥ കൈവരിക്കുന്നു. ഈ പരീക്ഷണത്തിൽ സ്ഥിരമായ നിലനിർത്തുന്ന ഘടകങ്ങൾ ഏതെല്ലാമാണ്.

A. വസ്തുവിന്റെ മാസ്, വേഗത

B. വസ്തു നിർമ്മിച്ച പദാർത്ഥം, മാസ്

C. വസ്തുവിന്റെ വേഗത, ഉരുട്ടുന്ന പ്രതലം

D. വസ്തുവിന്റെ ആകൃതി, ഭാരം

27) അനുവും കൂട്ടുകാരും ക്ലാസ്സിൽ വർത്തുള ചലനത്തെക്കുറിച്ച് പഠിച്ചതിന്റെ ഭാഗമായി ഒരു ഓല പമ്പരം ഉണ്ടാക്കിനോക്കി. കാറ്റത്ത് അവർ വേഗത്തിൽ ഓടുന്നതിനനുസരിച്ച് പമ്പരം വേഗത്തിൽ കറങ്ങാൻ തുടങ്ങി. കറങ്ങിക്കൊണ്ടിരിക്കുന്ന വർത്തുള പാതയിൽ തൊട്ടപ്പോൾ കറക്കം നിലക്കുന്നു. ഈ പരീക്ഷണത്തിൽ സ്ഥിരമായി നിലനിർത്തേണ്ട ഘടകങ്ങൾ ഏതെല്ലാമാണ്?

A. ഓലപമ്പരം കറക്കുന്ന കാറ്റിന്റെ ലഭ്യത.

B. ത്വരണം

C. അഭികേന്ദ്രത്വരണം, അഭികേന്ദ്രപ്രവേഗം

D. വേഗത, പ്രവേഗം

PART 10

താഴെ കൊടുത്തിരിക്കുന്ന സന്ദർഭങ്ങൾ സങ്കൽപ്പിച്ച് ഉണ്ടാക്കേണ്ടവയാണ് നമുക്കറിയാവുന്ന ശാസ്ത്ര സത്യങ്ങളുടെയും തത്വങ്ങളുടെയും വെളിച്ചത്തിൽ, ശരിയെന്ന് നമുക്ക് ഉറപ്പിക്കാവുന്ന ഉത്തരം നമ്പറിനു ചുറ്റും വട്ടംവരച്ച് അടയാളപ്പെടുത്തുക.

28) കുട്ടികൾ ചങ്ങാടമുണ്ടാക്കി അതിൽ പുഴയിലൂടെ സഞ്ചരിക്കുകയായിരുന്നു. ആറോളം കുട്ടികൾ ചങ്ങാടം തുഴയുന്നുണ്ടായിരുന്നു. അവർ സഞ്ചരിക്കുന്ന ദിശയിലേക്ക് അനുകൂലമായ ഒഴുക്ക് ഉണ്ടായിരുന്നതിനാൽ ചങ്ങാടത്തിന്റെ വേഗത കൂടിവന്നു. പെട്ടെന്ന് ചങ്ങാടം നിർത്താൻ കുട്ടികൾക്ക് തോന്നി. താഴെ പറയുന്നവയിൽ ഏതുകാര്യം ചെയ്യുന്നതാണ് ചങ്ങാടം വേഗം കുറഞ്ഞ് നിൽക്കുന്നതിന് ഏറ്റവും ഫലപ്രദം?

A. 6 പേരും തുഴകൾ വെള്ളത്തിൽ വിലങ്ങനെവച്ച് ചങ്ങാടത്തിന്റെ മുന്നോട്ടുള്ള ഗതി പ്രതിരോധിക്കുന്നു.

B. 6 പേരും എതിർദിശയിലേക്ക് തുഴയുന്നു.

C. മുന്നിലുള്ള മൂന്നുപേർ തുഴ വെള്ളത്തിൽ വിലങ്ങനെവച്ച് ചങ്ങാടത്തിന്റെ മുന്നോട്ടുള്ള ഗതി പ്രതിരോധിക്കുകയും പിറകിലുള്ള മൂന്നുപേർ എതിർദിശയിലേക്ക് തുഴയുകയും ചെയ്യുന്നു.

D. മുന്നിലുള്ള മൂന്നുപേർ എതിർദിശയിലേക്ക് തുഴയുകയും, പിറകിലുള്ള രണ്ടുപേർ തുഴകൾ വിലങ്ങനെ വച്ച് ചങ്ങാടത്തിന്റെ മുന്നോട്ടുള്ള ഗതി പ്രതിരോധിക്കുകയും ചെയ്യുന്നു.

29) മാസും ജഡത്വവും തമ്മിൽ ബന്ധപ്പെട്ടിരിക്കുന്നു എന്ന് നമുക്കറിയാം. ഇവ തമ്മിലുള്ള ബന്ധം എല്ലായിടത്തും ഒരുപോലെയാണോ എന്നും ഏതെങ്കിലും ഘടകങ്ങൾ ഇതിനെ ബാധിക്കുന്നുണ്ടോ എന്നും അറിയുന്നതിനായി വ്യത്യസ്ത മാസുള്ള കല്ലുകൾ ഒരു 15 നില ഫ്ളാറ്റിന്റെ മുകളിൽനിന്നും താഴക്കെറിയുന്നു. താഴെ പറയുന്നവയിൽ ഏതായിരിക്കും സംഭവിക്കുക?

A. രണ്ടു കല്ലുകളും ഒരുമിച്ച് താഴേക്ക് പതിക്കുന്നു.

B. മാസ് കൂടിയ കല്ല് പെട്ടെന്ന് താഴേക്ക് പതിക്കുന്നു.

C. മാസ് കൂടിയ കല്ല് കൂടുതൽ സമയം എടുത്ത് താഴേക്ക് പതിക്കുന്നു.

D. മാസ് കുറഞ്ഞ കല്ല് കൂടുതൽ സമയം എടുത്ത് താഴേക്ക് പതിക്കുന്നു.

30) ചലിക്കുന്ന വസ്തുക്കളുടെ സവിശേഷ ഗുണമാണ് ആക്കം. ഇതു മനസ്സിലാക്കുന്നതിനുള്ള പരീക്ഷണത്തിൽ രണ്ട് വ്യത്യസ്ത മാസുള്ള പാറക്കഷണങ്ങൾ ഒരേ ഉയരത്തിൽനിന്നും താഴെ മണ്ണിലേക്കിടുന്നു. പാറക്കഷണങ്ങൾ മണ്ണിൽ ഉണ്ടാക്കിയ ആഘാതം നോക്കുന്നു. മാസ്കൂടിയ പാറക്കഷണം കൂടുതൽ ആഘാതം ഉണ്ടാക്കുന്നു. ഇവിടെ വ്യത്യസ്ത മാസുള്ള പാറക്കഷണങ്ങൾക്കുപകരം ഒരേ മാസും ഒരേ ഉയരത്തിൽനിന്നും താഴേക്ക് ഇടുന്നതിനുപകരം വ്യത്യസ്ത ഉയരത്തിൽനിന്നും ഇടുകയും ചെയ്താൽ എന്തു സംഭവിക്കും?

A. രണ്ടു പാറക്കഷണങ്ങളും മണ്ണിൽ ഉണ്ടാക്കുന്ന ആഘാതം തുല്യമായിരിക്കും.

B. കൂടുതൽ ഉയരത്തിൽനിന്നും താഴേക്കിട്ട പാറക്കഷണം കൂടുതൽ ആഘാതം ഉണ്ടാക്കുന്നു.

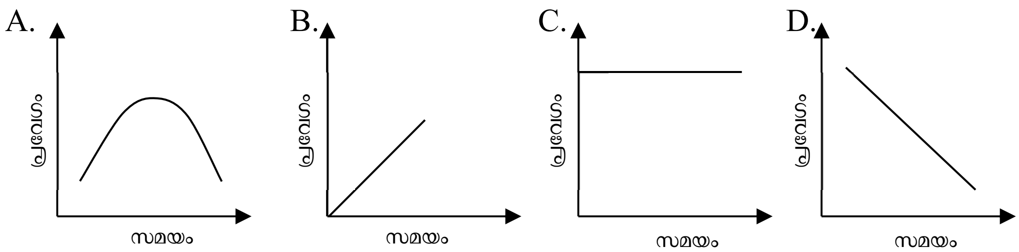
C. കുറഞ്ഞ ഉയരത്തിൽനിന്നും താഴേക്കിട്ട പാറക്കഷണം കൂടുതൽ ആഘാതം ഉണ്ടാക്കുന്നു.

D. മാസ് തുല്യമാക്കിയപ്പോൾ ഉണ്ടാക്കിയ ആഘാതത്തിന് വ്യത്യാസം സംഭവിച്ചിട്ടില്ല.

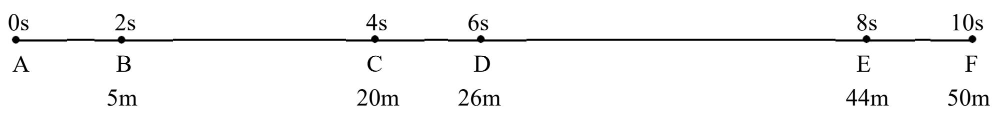
PART 11

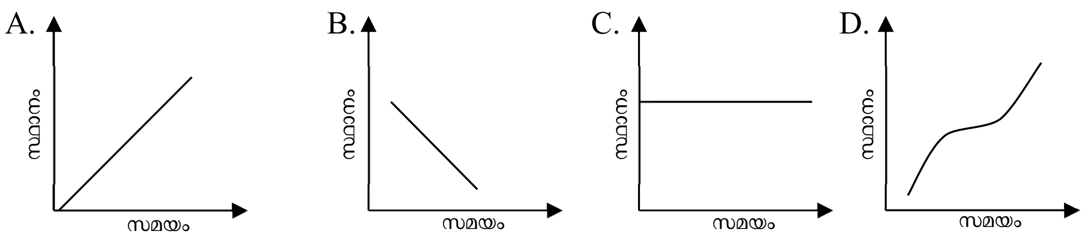
ഓരോ ചോദ്യത്തിനും തനിരിക്കുന്ന ചിത്രങ്ങളെ അപഗ്രഥിച്ച് ചോദ്യത്തിനുള്ള ഉത്തരങ്ങൾ അടയാളപ്പെടുത്തുക.

31) താഴെകൊടുത്തിരിക്കുന്ന ഗ്രാഫുകളിൽ ഏതാണ് സമചലനം സൂചിപ്പിക്കുന്നത്?

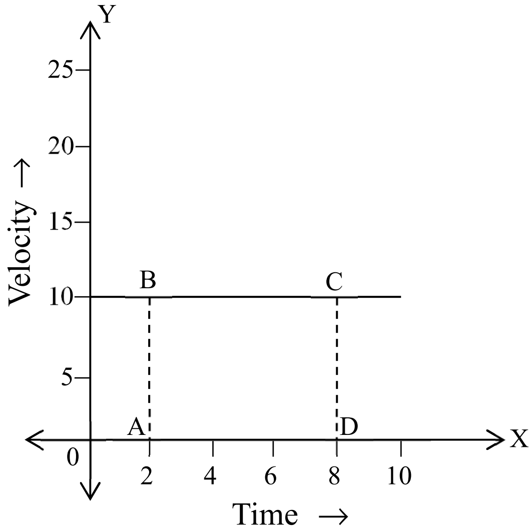


32) താഴെ കൊടുത്തിരിക്കുന്ന ചിത്രത്തിന്റെ അടിസ്ഥാനത്തിൽ ശരിയായ സമയ-സ്ഥാന ഗ്രാഫ് ഏതാണ്?





33) താഴെ തന്നിരിക്കുന്ന ഗ്രാഫ് അപഗ്രഥിച്ച് ശരിയായ പട്ടിക ഏതാണെന്ന് കണ്ടെത്തുക.



A

സമയം	0	2	4	6	8	10
പ്രവേഗം	10	10	10	10	10	10

B

സമയം	0	2	4	6	8	10
പ്രവഗം	4	4	4	4	4	4

C

സമയം	0	2	4	6	8	10
പ്രവേഗം	0	0	0	0	0	0

D

സമയം	0	2	4	6	8	10
പ്രവേഗം	8	8	8	8	8	8

PART 12

താഴെ കൊടുത്തിരിക്കുന്ന ഓരോ ചോദ്യത്തിലും ഒരു ശാസ്ത്ര പ്രസ്താവന കൊടുത്തിട്ടുണ്ട് ഈ പ്രസ്താവന ശരിയാണോ എന്ന് പരിശോധിച്ചറിയാൻ ഏറ്റവും അനിയോജ്യമായ പരീക്ഷണക്രമം തിരഞ്ഞെടുത്ത് നമ്പറിനുചുറ്റും വട്ടം വരച്ചടയാളപ്പെടുത്തുക.

34) ചലിച്ചുകൊണ്ടിരിക്കുന്ന വസ്തുക്കളുടെ സവിശേഷഗുണമാണ് ആക്കം. ഇത് അളക്കുന്നത് വസ്തുവിന്റെ മാസിന്റേയും പ്രവേഗത്തിന്റേയും ഗുണിതമായാണ്. ഈ പ്രസ്താവന ശരിയാണോ എന്നറിയാൻ താഴെ പറയുന്നതിൽ ഏതു പരീക്ഷണക്രമമാണ് കൂടുതൽ അനുയോജ്യം?

A. ഒരു പരന്ന പാത്രത്തിൽ നനഞ്ഞ മണൽ നിറച്ച ശേഷം വ്യത്യസ്ത ഭാരമുള്ള ബോളുകൾ തുല്ല്യ വേഗതയിൽ മണലിലേക്കിടുക. മണലിന്റെ താഴ്ച നോക്കുക.

B. വ്യത്യസ്ത മാസുള്ള ഇരുമ്പുഗോളങ്ങൾ ഒരു കൽ ഭിത്തിമേൽ എറിഞ്ഞ് ഗോളം തെറിച്ചുവീഴുന്ന ദൂരം അളക്കുന്നത്.

C. പ്രവേഗത്തിന്റേയും മാസിന്റെയും ഗ്രാഫ് വരയ്ക്കുന്നത്.

D. വ്യത്യസ്ത മാസുള്ള ഇരുമ്പുഗോളങ്ങൾ ഒരു മൺ കൂനമേൽ വീഴ്ത്തി അങ്ങനെ ഉണ്ടാവുന്ന കുഴിയുടെ താഴ്ച അളക്കുന്നത്.

35) അസന്തുലിതമായ ഒരു ബാഹ്യബലം പ്രയോഗിക്കുന്നതുവരെ ഓരോ വസ്തുവും അതിന്റെ നിശ്ചലാവസ്ഥയിലോ, നേർരേഖാ സമചലനത്തിലോ തുടരുന്നതാണ്. ഈ നിയമം

ശരിയാണോ എന്നറിയാൻ താഴെ പറയുന്നതിൽ ഏതു പരീക്ഷണ ക്രമമാണ് കൂടുതൽ അനുയോജ്യം?

A. ഒരു ഗ്ലാസ്സ് കാർഡ്ബോർഡിന്റെ പരുപരുത്ത പ്രതലത്തിൽ വെക്കുന്നു. ഹാർഡ്ബോർഡ് വേഗത്തിൽ ഒരു വശത്തേക്ക് ചലിക്കുന്നു.

B. വെള്ളം നിറച്ച ഒരു ഗ്ലാസ്സ് കാർഡ്ബോർഡിന്റെ പരുപരുത്ത പ്രതലത്തിൽ വച്ച്. കാർഡ്ബോർഡ് വലിക്കുന്നു.

C. ഒരു കാർപ്പറ്റ് നിറയെ മണ്ണ് വിതറിയശേഷം അത് കുത്തനെവച്ച് വടികൊണ്ട് തട്ടുന്നു.

D. കാരംസ് കോയിനുകൾ അട്ടിയായിവച്ച് അടിയിലെ കോയിൻ സ്ട്രൈക്കർ ഉപയോഗിച്ച് തെറിപ്പിക്കുന്നു.

36) ഒരു വസ്തുവിന്റെ ജഡത്വം അതിന്റെ മാസിനെ ആശ്രയിച്ചിരിക്കുന്നു. മാസ് കൂടുന്നതിനനുസരിച്ച് ജഡത്വം കൂടുന്നു. ഈ പ്രസ്ഥാവന ശരിയാണോ എന്നറിയാൻ താഴെ പറയുന്നവയിൽ ഏതു പരീക്ഷണക്രമമാണ് കൂടുതൽ അനുയോജ്യം?

A. ക്രിക്കറ്റ് ബാറ്റ് ഉപയോഗിച്ച് നിശ്ചലാവസ്ഥയിലുള്ള ക്രിക്കറ്റ്ബോളും ഇരുമ്പ് ബോളും അടിച്ച് തെറിപ്പിച്ചശേഷം അതിന്റെ ദൂരം നോക്കുന്നു.

B. ഒരു ക്രിക്കറ്റ് ബോളും, ഇരുമ്പുബോളും ഒരുമിച്ചിടുക ഏതാണ് പെട്ടെന്ന് നിശ്ചലമായതെന്ന് നോക്കുക.

C. വ്യത്യസ്ത മാസുള്ള രണ്ട് ബോളുകൾ നിരപ്പായ റോഡിലൂടെ ഉരുട്ടി അതിന്റെ ചലനം നിരിക്ഷിക്കുക.

D. രണ്ടു വസ്തുക്കളുടെ ചലനത്തെ ആസ്പദമാക്കി സമയ-പ്രവേഗ ഗ്രാഫ് വരച്ച നോക്കുക.

PART 13

പരീക്ഷണം ചെയ്തപ്പോൾ കണ്ടെത്തിയ വിവരങ്ങളാണ് താഴെയുള്ള ഓരോ ചോദ്യങ്ങളിലും കൊടുത്തിരിക്കുന്നത്. ഈ വിവരങ്ങൾ ഉപയോഗിച്ച് ശരിയായ അനുമാനം കണ്ടെത്തി അതിനുചുറ്റും വട്ടംവരച്ച് അടയാളപ്പെടുത്തുക.

37) രണ്ടു വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങൾ മണലിലേക്കെറിഞ്ഞ പരീക്ഷണത്തിൽ തുല്ല്യവേഗത്തിൽ എത്തിയിട്ടും മാസ് കൂടിയ ഗോളം, മണലിൽ കൂടുതൽ താഴ്ചയുണ്ടാക്കി, ഉയരം കൂടിയപ്പോൾ മണലിൽ പതിക്കുന്ന ഗോളത്തിന്റെ പ്രവേഗംകൂടി, പ്രവേഗം കൂടുന്നതനുസരിച്ച് മണലിലുണ്ടാക്കിയ ആഘാതംകൂടി. തന്നിരിക്കുന്ന വിവരങ്ങളിൽ നിന്നും താഴെ തന്നിരിക്കുന്ന അനുമാനങ്ങളിൽ ഏതാണ് ശരി?

A. ആക്കം ഒരു സദിശ അളവാണ് ഇത് പ്രവേഗത്തിന്റെ എതിർ ദിശയിൽ അനുഭവപ്പെടുന്നു.

B. ചലിച്ചുകൊണ്ടിരിക്കുന്ന വസ്തുക്കളുടെ സവിശേഷ ഗുണമാണ് ആക്കം. ഇത് വസ്തുവിന്റെ മാസിന്റെയും പ്രവേഗത്തിന്റേയും ഗുണിതമാണ്.

C. ചലിച്ചുകൊണ്ടിരിക്കുന്ന വസ്തുക്കളുടെ സവിശേഷ ഗുണമാണ് ആക്കം. ഇത് ഒരു അദിശ അളവാണ്.

D. ആക്കാം അനുഭവപ്പെടുന്നത് പ്രവേഗത്തിന്റെ വിപരീത ദിശയിലാണ്.

38) ഒരു കുട്ടി ബലൂൺ ഊതി വിർപ്പിച്ചശേഷം കാറ്റഴിച്ചുവിടുന്നു. ഇവിടെ ബലൂണിന്റെ ഉൾവശത്തുനിന്ന് വായു പുറത്തേക്ക് പോകുന്നതിന്റെ എതിർദിശയിലേക്ക് ബലൂൺ ചലിച്ചു. വായു ശക്തിയായി പുറത്തുപോകുമ്പോൾ ബലം ഉണ്ടാവുന്നത് പ്രവർത്തനവും ബലൂണിന്റെ ചലനം പ്രതി പ്രവർത്തനവും ആണ്. തന്നിരിക്കുന്ന വിവരങ്ങളിൽനിന്നും താഴെ തന്നിരിക്കുന്ന അനുമാനങ്ങളിൽ ഏതാണ് ശരി?

A. പ്രവർത്തനവും പ്രതിപ്രവർത്തനവും എല്ലാ രീതിയിലും തുല്ല്യമാണ്

B. പ്രവർത്തനം പ്രതിപ്രവർത്തനത്തെ ഇല്ലാതാക്കുന്നു.

C. പ്രവർത്തനവും പ്രതിപ്രവർത്തനവും തുല്യവും വിപരീതവുമാണ്.

D. ഏതൊരു പ്രവർത്തനത്തിനും തുല്ല്യവും ഒരേ ദിശയിലുമുള്ള ഒരു പ്രതി-പ്രവർത്തനം ഉണ്ടായിരിക്കും.

39) വ്യത്യസ്ത സന്ദർഭങ്ങളിൽ പ്രയോഗിച്ച ബലങ്ങളും അനുഭവപ്പെട്ട ആകെ ബലവുമാണ് താഴെ പട്ടികയിൽ കൊടുത്തിരിക്കുന്നത്. ഇവിടെ തന്നിരിക്കുന്ന അനുമാനങ്ങളിൽ ഏതാണ് ശരി?

സന്ദർഭം	F_1(N)	F_2(N)	ആകെ ബലം (N) പരിണിത ബലം
ഒരേ ദിശയിൽ ഒരേ ബലം പ്രയോഗിക്കുന്നു.	50	50	100
വ്യത്യസ്ത ദിശയിൽ ഒരേ ബലം പ്രയോഗിക്കുന്നു.	50	50	0
വ്യത്യസ്തദിശയിൽ വ്യത്യസ്ത ബലങ്ങൾ പ്രയോഗിക്കുന്ന	80	40	40
വ്യത്യസ്ത ദിശയിൽ ഒരേ ബലം പ്രയോഗിക്കുന്ന	120	120	0

A. പരിണിതബലം പൂജ്യമാണെങ്കിൽ അതു സന്തുലിത ബലമാണ്.

B. അസന്തുലിത ബലത്തിന്റെ പരിണിതബലം പൂജ്യമാണ്.

C. സന്തുലിത ബലത്തിനു വസ്തുവിനെ ചലിപ്പിക്കാൻ കഴിയും.

D. ചലിക്കുന്ന വസ്തുവിനെ നിശ്ചലമാക്കാൻ സന്തുലിതബലം വേണം

PART 14

ഒന്നിലേറെ സമാനമായ സന്ദർഭങ്ങൾ താഴെയുള്ള ഓരോ ചോദ്യത്തിലും ഉണ്ട്. ഈ സന്ദർഭങ്ങളെ ശ്രദ്ധയോടെ മനസ്സിലാക്കി ശരിയായ പൊതുതത്വത്തിൽ എത്തിച്ചേരുക.

40)
- ഓവർലോഡുമായ വന്ന ബസ്സ് വേഗക കുറയ്ക്കാതെ വളവ് തിരിക്കുന്നതിനിടെ ബാലൻസ് പോയി അപകടം സംഭവിച്ചു.
- ഒരു കുട്ടി ടാർ നിറച്ച ഒരു വീപ്പ വളരെ പ്രയാസത്തോടെ ഉരുട്ടിനീക്കി. എന്നാൽ ഒഴിഞ്ഞ ടാർവീപ്പ വളരെ എളുപ്പത്തിൽ കുറേ ദൂരം ഉരുട്ടിനീക്കി.
- ആന മതം പോട്ടി രാമുവിനെ കുത്താൻ വന്നപ്പോൾ വളഞ്ഞ് പുളഞ്ഞ് ഓടിയതിനാൽ ആനക്ക് രാമുവിനെ കുത്താനായില്ല.

ഈ സന്ദർഭങ്ങളിൽനിന്നും മാസും ജഡത്വും തമ്മിൽ ഉള്ള ബന്ധത്തെപ്പറ്റി എന്തു പൊതുതത്വത്തിലെത്താം?

A. മാസ് കൂടുതലുള്ള വസ്തുവിനെ വഹിച്ചുകൊണ്ടുപോവാൻ ബുദ്ധിമുട്ടാണ്. അതിന്റെ ജഡത്വം കുറവാണ്.

B. ജഡത്വം കൂടുതലുള്ള വസ്തുവിന് മാസ് കുറവായിരിക്കും.

C. ഒരു വസ്തുവിന്റെ മാസ് കൂടുന്നതിനനുസരിച്ച് ജഡത്വം കൂടുന്നു.

D. ഒരു വസ്തുവിന്റെ മാസ് കൂടുന്നതിനനുസരിച്ച് ജഡത്വം കുറയുന്നു.

41)
- അമ്യൂസ്മെന്റ് പാർക്കുകളിൽ റൊട്ടേറ്റിങ് വീൽ കറങ്ങുമ്പോൾ കുട്ടികൾ സീറ്റ് ബെൽറ്റിട്ടിട്ടുണ്ടെന്ന് ഉറപ്പുവരുത്തുന്നു.
- വർണ്ണപമ്പരം കറക്കുമ്പോൾ കാറ്റിന്റെ ലഭ്യത കുറഞ്ഞപ്പോൾ ചലനത്തിന്റെ ദിശയിലും വേഗതയിലും മാറ്റം സംഭവിച്ചു.
- ഒരു കയറിൽ കല്ല് കെട്ടി കറക്കുന്നു.

ഈ സന്ദർഭങ്ങളിൽനിന്നും വർത്തുളചലനത്തെക്കുറിച്ച് എന്ത് പൊതു തത്വത്തിലാണ് എത്തിച്ചേരുന്നത്?

A. വർത്തുള ചലനത്തിലുള്ള വസ്തുവിന് വൃത്ത കേന്ദ്രത്തിലേക്കാണ് ബലം അനുഭവപ്പെടുന്നത്.

B. വർത്തുള ചലനത്തിലുള്ള വസ്തുവിന് വൃത്തകേന്ദ്രത്തിൽനിന്ന് പുറത്തേക്കാണ് ബലം അനുഭവപ്പെടുന്നത്.

C. വർത്തുളചലനത്തിലുള്ള വസ്തുവിന് ത്വരണം സംഭവിക്കുന്നില്ല.

D. വർത്തുളചലനത്തിലുള്ള വസ്തുവിന് ദിശ ഇല്ല.

42)
- ഒരു മുത്തശ്ശൻ പുഴയിലൂടെ തോണി തുഴയുന്നത് അദ്ഭുതത്തോടെ ഉണ്ണി വീക്ഷിക്കുന്നു.
- തോക്കിൽനിന്നും വെടിയുണ്ട പായുമ്പോൾ തോക്ക് പിറകോട്ട് ചലിക്കുന്നതായി അനുഭവപ്പെടുന്നു.
- തോണിയിൽനിന്ന് രാമു കരയിലേക്ക് ചാടിയപ്പോൾ തോണി പിറകോട്ടു നീങ്ങുന്നു.

ഈ സന്ദർഭങ്ങളിൽനിന്നും എന്ത് പൊതു തത്വത്തിലാണ് എത്തുന്നത്.

A. ഏതു പ്രവർത്തനത്തിനും ഒരു പ്രതിപ്രവർത്തനം ഉണ്ടായിരിക്കും

B. ഏതു പ്രവർത്തനത്തിനും തുല്ല്യവും വിപരീതവുമായ പ്രതിപ്രവർത്തനം ഉണ്ടായിരിക്കും

C. ഏതു പ്രവർത്തനത്തിനും തുല്ല്യമായ പ്രതിപ്രവർത്തനം ഉണ്ടായിരിക്കും.

D. ഏതൊരു പ്രവർത്തനത്തേയും പ്രതിപ്രവർത്തനം ഇല്ലാതാക്കുന്നു.

Appendix VIII

CALICUT UNIVERSITY
DEPARTMENT OF EDUCATION
2022

PROBLEM SOLVING ABILITY TEST IN PHYSICS
(English - Final)

Dr. Bindhu CM	**Athira V**
Professor	Research Scholar

Instructions

1. This booklet has 14 parts (Part 1 to part 14) 8 pages. Each part has 1 to 3 questions.
2. Each question carries 1 mark.
3. Write answers to all the questions. Circle the correct answer while marking the answer on the answer sheet. Eg:- If your answer is B then mark as given below.

   A B C D
4. Answers given by you will be used for research purposes only.
5. Nothing should be written on the question paper.

PART 1

Below are some of the situations in daily life. Circle and mark the number that seems most unusual among the four facts given as A, B, C, D for each case.

1) Two children push a table in the same direction with force. Below are the situations that occurred while pushing. Which of these surprises you?

   A. Difficulty pushing the table.

   B. The table moves very quickly and effortlessly in the same direction.

   C. The floor is scratched when the table moves.

   D. The position of the table does not change significantly.

2) Appu placed a water bottle filled with water on top of Ammu's paper on the table. Ammu quickly pulls the paper to one side without changing the bottle. Below are the circumstances that arose. Which of these situations feels different from what we would normally expect?

   A. The edge of the paper is wrinkled.

   B. The top of the bottle tilts back and continues the previous position.

   C. Half the water from the bottle drips onto the paper.

   D. Difficulty picking up paper.

3) Chandu jumps from the end of the canoe to the shore to get off the canoe; Below are the instances that occurred while jumping. Which context caught your attention here?

A. Chandu quickly reaches the shore.

B. Chandu reaches the shore without treading water.

C. Chandu jumps forward and the canoe moves backwards.

D. A greater force is felt when jumping to land.

PART 2

Some of the situations in daily life are mentioned in the questions below. Each case contains a core problem. Circle the number and mark which of the four statements associated with each case best describes the problem.

4) Do you not travel by bus regularly? Don't you fall forward when the bus brakes suddenly? Which of the following statements best describes the problem here?

A. An object in motion tends to continue in motion.

B. Balance is difficult when the bus is running at high speed.

C. Because the bus is overcrowded

D. As the bus at rest suddenly moves.

5) Rajesh and Ramesh were friends. They used to practice long-jump together. Both participated in a competition. Rajesh ran a long distance and did a long-jump. But Ramesh suddenly came running and jumped. After the race, Rajesh won by a good margin. But Ramesh was far behind. Which of the following statements best describes the problem?

A. Ramesh found it difficult to jump because he was shorter than Rajesh.

B. Because Rajesh ran further and took advantage of inertia of motion

C. Because Rajesh practiced longer than Ramesh.

D. It was very easy for Rajesh to jump as it was a familiar playground.

6) Driving laden vehicles through passes often leads to accidents. Which of the following statements best describes the problem?

A. Loaded vehicles have more mass and therefore greater inertia.

B. Because heavier vehicles try to turn the curve without slowing down.

C. It is difficult for vehicles to slow down as the altitude increases.

D. Loaded vehicles are difficult to balance.

PART 3

The following questions represent some situations in daily life. Each case contains a scientific problem. What you need to do is figure out what are the key factors in this problem. Find the correct set of prime factors and circle its number.

7) Unni and Kuttan were children of different weights. Taking two empty ice cream balls of the same size and shape, filling one of them with sand, Unni and the unfilled Caliball boy go to the nearby beach and climb on top of a rock, both of them simultaneously throw the balls down to Manila below. A clay-filled ball made more impact on the sand. Which of the following factors influenced this event?

   i. Children's weight

   ii. Different weights of balls

   iii. The initial velocity acquired by the balls when they are thrown down

   iv. The material the ball is made of

      A. i & ii

      B. i, ii & iii

      C. ii & iii

      D. iv only

8) Achu was spinning the pampara on a flat concrete surface in the yard of his house when a cat came and jumped on the pampara and the pampara was thrown. What are the set of key elements in this context?

   A. Velocity, acceleration and centripetal force

   B. Centripetal force, centripetal force

   C. Speed, Velocity, Acceleration

   D. Velocity, force, and acceleration of the cat

9) Ramu and Raju were practicing cricket. Both were good fielders. During practice, Raju tried to hit a fast ball. Despite catching the ball, Raju's arm hurt and he had to stop training. But at the same time Ramu pulled the hand back while catching the ball very skillfully. So what are the main factors associated with not feeling pain?

   A. Time, Cricket, Speed

   B. Force, Time, and Momentum

   C. Momentum, Force, and Time

   D. Velocity, Velocity, and Mass

PART 4

All of the following contexts contain two relevant and related scientific concepts. Read the given contexts carefully and find the matching pairs of ideas and circle the answer and mark them.

10) As part of a sudden firing in the festival grounds, the elephant burst into flames and started running away. The elephant ran with one aloft. The elephant could not kill him because he twisted and ran. Which pair of concepts is most relevant and related in this context?

    A. Mass and velocity

    B. Distance and mass

    C. Inertia and distance

    D. Mass and Inertia

11) Ammu went to the shop to buy glasses with Grandpa and was surprised to find glassware stacked in packets filled with sponges, straws, etc. She owes it to her grandfather. Grandpa said it was to avoid the pots bumping and breaking in a hurry. Which pair of concepts are most relevant and related to each other in this context?

    A. Time and force

    B. Mass and force

    C. Time and mass

    D. Mass and Inertia

12) As part of a classroom experiment, children pass a long string through a straw and tie it to two windows in the classroom. An inflated balloon is attached to a straw. When the balloon is deflated, the balloon moves violently in the opposite direction to the direction of the outflow. Which pair of ideas are most relevant and related here?

    A. Impact and action

    B. Action and Reactivity

    C. Passion and trauma

    D. Motion and Impact

PART 5

Find and mark the conditions similar to the following scientific phenomena

13) Inertia is the inability of an object to change itself to either its state of rest or state of motion. Which of the following conditions is similar to this phenomenon?

    A. A person jumps ashore from a canoe on the surface of the water.

    B. A sprinting athlete cannot stop running once he reaches the finish line.

C. Passengers on a moving bus feel the trees outside move

D. A person running very fast reaches the finishing point earlier than a person running slowly.

14) If the momentum difference is constant then the force felt by the object is inversely proportional to the time it takes to exert it. Which of the following is similar to this principle?

A. A practitioner breaks hard bricks by swinging his hand very quickly.

B. Two children pull a brick together and throw it from top to bottom.

C. A woodcutter cuts wood with an axe.

D. A man tries to break the stone with an axe.

15) 'Every action has an equal and opposite reaction.' This is Newton's third law of motion. Which of the following conditions is similar to this phenomenon?

A. The children paddle through the raft with their hands.

B. The raft is loose and the raft sways.

C. More than one child gets on the raft.

D. Pulling the end rope on the raft.

PART 6

Each question below contains more than one scientifically proven statement. Determine which hypothesis you can reach based on those statements alone and circle the number opposite the correct hypothesis.

16) Note the three statements in this paragraph

(i) When a boy jumps from a canoe to the shore, the canoe moves to the side of the river.

(ii) When the gun is fired the bullet moves forward and the gun recoils.

(iii) The rocket moves forward as high pressure gas escapes from the rocket's chambers.

What conclusions can we reach based on these statements alone?

A. An action has an equal reaction.

B. An action has a reaction in the opposite direction.

C. An action has a reaction.

D. A direction is associated with each activity.

17) Note the three sentences in this paragraph

(i) Heavy laden vehicles turning curves without slowing down lead to accidents.

(ii) Rolling a barrel full of tar is more difficult than rolling an empty tar barrel.

(iii) When two stones of different weights are rolled simultaneously, the lighter stone keeps rolling and the heavier stone stops suddenly.

What can we conclude based on these sentences alone?

A. As mass of an object increases, inertia decreases.

B. Mass and inertia of an object are unrelated.

C. The greater the mass of an object, the greater the inertia.

D. Inertia remains the same no matter how much mass an object has.

18) Note the three statements in this paragraph

(i) The mango falls off when the horn starts to move when it is shaken.

(ii) A person alighting from a running bus has to run a little further.

(iii) After the race the athlete runs some distance beyond the finishing point.

Based on these statements alone we can conclude that

A. An object has no ability to change its state of rest or state of motion by itself.

B. Friction also slows down the motion of an object on a surface

C. Objects with greater mass increase in momentum.

D. Objects moving in the same direction must continue to move for a certain amount of time.

PART 7

All of the following cases contain a scientific problem. After understanding this problem circle the number that gives a logical justification for it.

19) A long-jump athlete jumps from a long distance rather than jumping from one place. What could be the reason for this?

A. There will be a correlation between the distance the athlete runs and the long jump finishing point

B. There will be a relationship between the speed at which the athlete runs and the amount of muscle power the athlete exerts.

C. There will be a relationship between the speed at which the athlete runs and the amount of muscle power the athlete exerts

D. A runner may be able to balance and long jump well.

20) A man is getting out of a moving bus, to avoid falling he runs a short distance in the direction of the bus and then walks away without difficulty. What is the reason why the person who got off the bus ran forward a little distance?

A. It may be to gradually reduce the inertia of one's own body which remains in motion.

B. May be to gradually reduce the static inertia of one's own body which remains at rest.

C. To make the velocity of the person at rest equal to that of the bus.

D. The rider's body is stationary relative to the floor and may help stabilize running.

21) Throws heavy objects very quickly and moves the hand back slightly when catching it. What is the reason for moving the hand like this?

A. Adding time to the momentum difference may be necessary to reduce the impact.

B. The velocity of the hand may be aligned with the object.

C. Hand-to-object contact may be necessary to reduce impact

D. The rate of change may be increased to reduce impact.

PART 8

A, B, C and D are statements that could be justified for the scientific problem presented in each of the following questions. Mark the hypothesis (hypothesis) that is most logical and can be proved by a simple experiment.

22) When children run and play in the field, a fat man finds it difficult to stop and start running quickly. To understand why, we need to understand the relationship between mass and inertia. Which of the following hypotheses can be used to prove this by a simple experiment?

A. If spheres of different masses are rolled across a smooth floor at the same speed, the sphere with greater mass will roll longer.

B. Spheres of different masses have a center of gravity of greater mass.

C. If spheres of different masses roll in vacuum, the sphere with greater mass will roll longer.

D. If spheres of different masses are given escape velocities, all spheres will reach vacuum.

23) The following are the logical statements made by the students of class 8 when a teacher explained rotation. Which of these can be proved by a simple experiment?

A. When the planets lose their centripetal force as they revolve around the Earth, the planets slide out in a series of circular motions.

B. Centripetal force and centripetal acceleration are felt toward the center when a string is rotated with a stone tied at the end. A sudden release of the string causes the stone to fly out.

C. When a pebble is thrown at the wheels of a moving car, the car loses momentum and overturns.

D. Centripetal force and centripetal acceleration are felt towards the center of a giant wheel as it rotates from vacuum.

24) Velocity and Momentum are related. As velocity increases, momentum increases. To understand this, which of the following hypotheses can be proved by conducting a simple experiment.

    A. Two balls of the same mass are dropped from different heights into a bed of sand. Throwing from a higher height causes more impact.

    B. When two balls of the same mass fall from vacuum with different initial velocities, they both fall at the same time.

    C. If spheres of the same mass are given different escape velocities, all spheres will reach vacuum at the same time.

    D. When two persons of the same age jump into a river from different heights, the person who jumped from higher reaches the bottom.

PART 9

There can be more than one factor influencing a scientific process. Understand the influence on such critical factors and mark the correct answer.

25) Momentum is a characteristic property of objects in motion. It is the product of mass and velocity. To understand the relationship between these two iron spheres of similar shape and weight are taken. After filling a flat bowl with wet sand, the spheres are dropped from the same height into the sand. What factors do we hold constant in this experiment?

    A. Weight of object, shape and time of experiment

    B. The surface on which the experiment is performed, the initial velocity of the object, the shape of the object

    C. Weight of the object, shape of the object, and initial velocity.

    D. The time the object rests, the surface on which the test is performed, and the weight of the object.

26) Inertia is the tendency of an object to continue its motion until an unbalanced external force is applied to it. In an experiment that demonstrates this, a large rock and a ball are rolled together on a level surface. Here the ball keeps moving. The rock reaches rest after moving a short distance. What are the factors that are kept constant in this experiment?

    A. Mass and velocity of the object

    B. The substance of which the object is made, mass

    C. Velocity of object, rolling surface

    D. Object shape and weight

27) Anu and his friends tried to make an Ola Pambaram as part of learning about Varthula movement in class. As they ran faster in the wind, the palm began to spin faster. The spinning wheel stops spinning when it touches the path. What factors are held constant in this experiment?

    A. Availability of wind blowing thatch.

B. Acceleration

C. Centripetal acceleration, centripetal velocity

D. Speed, velocity

PART 10

Circle and mark the answer number that you can be sure is correct in the light of the scientific truths and principles we know.

28) The children were making a raft and traveling across the river. About six children were rowing the raft. Because there was a favorable current in the direction they were traveling, the speed of the raft increased. Suddenly the kids felt like stopping the raft. Which of the following is most effective in slowing down the raft?

A. All 6 keep their oars in the water and resist the forward course of the raft.

B. All 6 row in opposite direction.

C. The front three keep the oars in the water to resist the forward course of the raft and the back three row in the opposite direction.

D. The three men in front row in the opposite direction, and the two men behind hold the oars to prevent the forward course of the boat.

29) We know that mass and inertia are related. Stones of different masses are dropped from the top of a 15-story flat to see if the relationship between them is the same everywhere and if any factors affect it. Which of the following will happen?

A. Both stones fall down together.

B. A stone with greater mass falls quickly.

C. A stone with greater mass takes longer to fall.

D. A stone with less mass takes longer to fall.

30) Momentum is a unique property of moving objects. In an experiment to understand this, two rocks of different masses are dropped from the same height onto the ground. Looking at the impact the rock fragments made on the soil. A denser rock causes more impact. Here, instead of rock pieces of different mass, what happens if the same mass is dropped from different heights instead of from the same height?

A. The impact of both rock pieces on the soil will be equal.

B. A rock dropped from a greater height produces more impact.

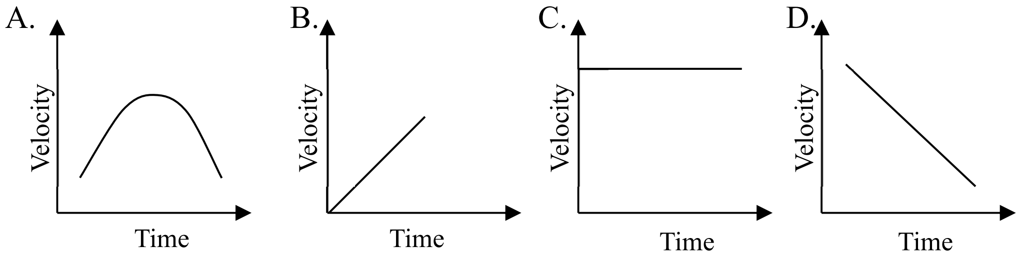
C. A rock dropped from a lower height produces more impact.

D. There is no difference in impact when mass is equalized.

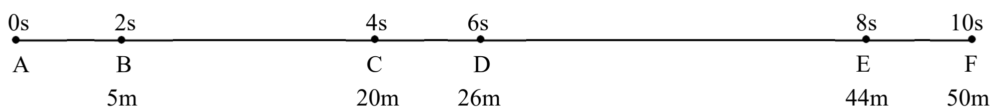
PART 11

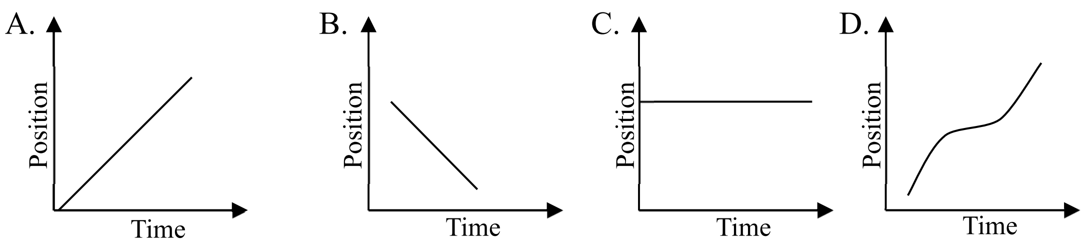
Analyze the pictures alone for each question and mark the answers to the question.

31) Which of the following graphs indicates convection?

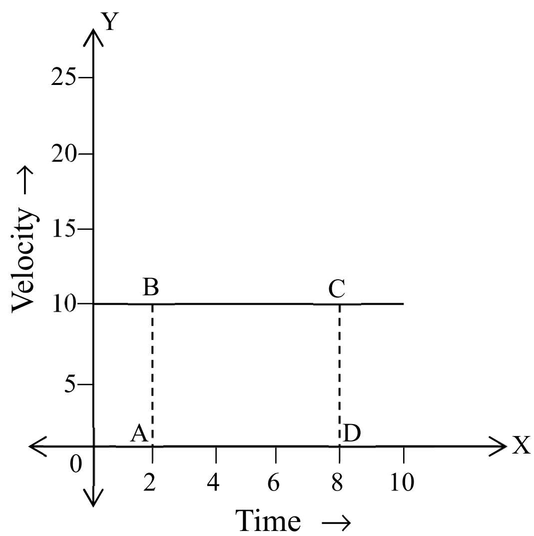


32) Which is the correct time-position graph based on the figure below?





33) Analyze the graph given below and find the correct table.



A

Time	0	2	4	6	8	10
Velocity	10	10	10	10	10	10

B

Time	0	2	4	6	8	10
Velocity	4	4	4	4	4	4

C

Time	0	2	4	6	8	10
Velocity	0	0	0	0	0	0

D

Time	0	2	4	6	8	10
Velocity	8	8	8	8	8	8

PART 12

In each of the following questions a scientific statement is given To check whether the statement is true choose the most inappropriate experiment and circle the number.

34) Momentum is a characteristic property of objects in motion. It is measured as the product of the object's mass and velocity. Which of the following is the most appropriate test to test whether this statement is true?

   A. Fill a flat bowl with wet sand and drop balls of different weights into the sand at equal speeds. Look at the depth of the sand.

   B. Throw iron balls of different masses against a stone wall and measure the distance the ball bounces.

   C. Sketching the graph of velocity and mass.

   D. By dropping iron balls of different mass on a mound of earth and measuring the depth of the hole formed.

35) Every object remains in its state of rest or linear equilibrium until an unbalanced external force is applied. Which of the following is the most appropriate test to determine if this law is correct?

   A. A glass is placed on a rough surface of cardboard. The hardboard moves quickly to one side.

   B. A glass filled with water on a rough surface of cardboard. Pulling the cardboard.

   C. After spreading a carpet full of soil, it is stood upright and tapped with a stick.

   D. Carrom coins are stacked and struck by the bottom coin striker.

36) The inertia of an object depends on its mass. As mass increases, so does inertia. Which of the following is the most suitable experimental procedure to test whether this statement is true?

   A. Hitting a stationary cricket ball and an iron ball with a cricket bat and seeing its distance after it bounces.

   B. Throw a cricket ball and an iron ball together and see which comes to rest more quickly.

   C. Roll two balls of different mass along a level road and observe their motion.

   D. Draw a time-velocity graph based on the motion of the two objects.

PART 13

The information found during the experiment is given in each of the questions below. Using this information, find the correct guess and circle its number.

37) In an experiment in which two spheres of different masses hit the sand at equal speeds, the sphere with greater mass made a greater depression in the sand. Which of the following inferences is true from the given information?

   A. Momentum is a vector quantity and is felt in the opposite direction of velocity.

   B. Momentum is a unique property of objects in motion. It is the product of the object's mass and velocity.

   C. Momentum is a unique property of objects in motion. It is an scalar quantity.

   D. Acham feels in the opposite direction of velocity.

38) A child inflates a balloon and releases the air. Here the balloon moves in the opposite direction to the air escaping from the inside of the balloon. Force is created when the air is forced out. This is a function and the motion of the balloon is a reciprocal function. Which of the following inferences is true from the given information?

A. Action and reaction are equal in every way

B. The action cancels the reaction.

C. Action and reaction are equal and opposite.

D. Any action has an equal and opposite reaction.

39) The forces applied and the total force felt in different cases are given in the table below. Which of the following assumptions is correct?

Context	F_1(N)	F_2(N)	Total force(N) Resultant force
The same force is applied in the same direction.	50	50	100
The same force is applied in different direction.	50	50	0
Applying different forces in different direction	80	40	40
Applying the same force in different direction	120	120	0

   A. If the resultant force is zero, it is an equilibrium force.

   B. The resultant force of the unbalanced force is zero.

   C. The equilibrium force can move the object.

   D. Balancing force is needed to bring a moving object to rest

PART 14

There is more than one similar case in each question below. Understand these contexts carefully and arrive at proper generalizations.

40)
- An overloaded bus lost its balance while turning a curve without slowing down and the accident occurred.
- A boy rolls a barrel full of tar with great difficulty. But the empty tarveepa rolled quite easily.
- When the elephant came to stab Ramu, the elephant turned around and ran, unable to stab Ramu.

What generalities can be drawn from these cases about the relationship between mass and inertia?

A. It is difficult to carry an object with greater mass. Its inertia is low.

B. An object with greater inertia will have less mass.

C. Inertia increases as the mass of an object increases.

D. As the mass of an object increases, inertia decreases.

41)
- Children are made sure to wear seat belts while riding the rotating wheel in amusement parks.
- When the wind supply decreased during the rotation of the varnapambar, the direction and speed of the movement changed.
- A stone is tied to a rope and spun.

What general principle about rotation is arrived at from these cases?

A. An object in circular motion experiences a force towards the center of the circle.

B. An object in circular motion experiences a force outward from the center of the circle.

C. A rotating object experiences no acceleration.

D. A rotating object has no direction.

42)
- Unni watches in wonder as a grandpa paddles a canoe across the river.
- When the bullet is fired from the gun, the gun feels recoil.
- When Ram jumps from the boat to the shore, the boat moves backwards.

What general principle is arrived at from these cases?

A. Every action has a reaction

B. Every action has an equal and opposite reaction

C. Any action has an equal reaction.

D. Eliminates reaction to any activity.

Appendix IX

CALICUT UNIVERSITY
DEPARTMENT OF EDUCATION
2022

PROBLEM SOLVING ABILITY TEST IN PHYSICS

RESPONSE SHEET

Name of Student : ....Class:..........Div:..........

Name of School : ....Age: ....

Gender : Boy/Girl   Locale: Urban/Rural

Type of Management: Govt./Aided/Unaided

Sl. No.	A	B	C	D
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				
21.				

Sl. No.	A	B	C	D
22.				
23.				
24.				
25.				
26.				
27.				
28.				
29.				
30.				
31				
32.				
33.				
34.				
35.				
36.				
37.				
38.				
39.				
40.				
41.				
42.				

Appendix X

CALICUT UNIVERSITY
DEPARTMENT OF EDUCATION
2022

PROBLEM SOLVING ABILITY TEST IN PHYSICS

SCORING KEY

Name of Student : ....Class:..........Div:..........

Name of School : ....Age: ....

Gender : Boy/Girl Locale: Urban/Rural

Type of Management: Govt./Aided/Unaided

Sl. No.	A	B	C	D
1.		B		
2.		B		
3.			C	
4.	A			
5.		B		
6.	A			
7.			C	
8.		B		
9.		B		
10.				D
11.				D
12.		B		
13.		B		
14.	A			
15.	A			
16.	A			
17.			C	
18.	A			
19.	A			
20.	A			
21.	A			

Sl. No.	A	B	C	D
22.	A			
23.		B		
24.	A			
25.			C	
26.			C	
27.			C	
28.		B		
29.	A			
30.		B		
31			C	
32.	A			
33.	A			
34.	A			
35.			C	
36.		B		
37.		B		
38.			C	
39.	A			
40.			C	
41.		B		
42.		B		

Appendix XI

FAROOK TRAINING COLLEGE

SELF CONCEPT SCALE

Dr.Bindhu.C.M
Associate Professor
Farook Training College

Alphonsa Roby Mathew
M.Ed.Student
Farook Training College

നിർദ്ദേശങ്ങൾ

താഴെ പറയുന്ന ഓരോ പ്രസ്താവനയും ശ്രദ്ധാപൂർവ്വം വായിച്ചശേഷം അവ നിങ്ങളുടെ ജീവിതവുമായി എത്രമാത്രം ബന്ധപ്പെട്ടിരിക്കുന്നു എന്ന തീരുമാനിക്കുക. ഓരോ പ്രസ്താവനയുടെ നേരേയും എല്ലായ്പ്പോഴും, മിക്കപ്പോഴും, ചിലപ്പോൾ, അപൂർവ്വമായി, ഒരിക്കലുമില്ല എന്നീ അഞ്ച് പ്രതികരണങ്ങൾ തന്നിരിക്കുന്നു. നിങ്ങളുടെ പ്രതികരണത്തിനുനേരെ ടിക് (✓) മാർക്ക് രേഖപ്പെടുത്തുക. എല്ലാ പ്രസ്താവനകൾക്കും പ്രതികരണങ്ങൾ രേഖപ്പെടുത്താൻ പ്രത്യേകം ശ്രദ്ധിക്കുക. ഇതിലൂടെ ലഭിക്കുന്ന വിവരങ്ങൾ പഠനാവശ്യത്തിനുമാത്രം ഉപയോഗിക്കുന്നതും തികച്ചും രഹസ്യമായി സൂക്ഷിക്കുന്നതുമായിരിക്കും.

1. നല്ല കാര്യങ്ങൾക്കുവേണ്ടി എത് അപകടം നിറഞ്ഞ ജോലിയും ചെയ്യാൻ ഞാൻ തയ്യാറാണ്.
2. മാനസികമായി അസ്വസ്ഥനാകുമ്പോൾ നല്ലതുമാത്രം ചിന്തിക്കുവാനും ഇഷ്ടമുള്ള ജോലികളിൽ മുഴകാനും ശ്രമിക്കാറുണ്ട്.
3. മറ്റുള്ളവരുടെ കാഴ്ചപ്പാടിനെ അംഗീകരിക്കുന്നതാണ് വിമർശനങ്ങൾ ഒഴിവാക്കാനുള്ള മാർഗമെന്ന് ഞാൻ കരുതുന്നു.
4. എന്റെ തെറ്റുകൾ മറ്റുള്ളവർ ശ്രദ്ധയിൽപെടുത്തിയിരുന്നെങ്കിൽ എന്ന് ആഗ്രഹിക്കാറുണ്ട്.
5. വൈകാരികമായി പെരുമാറുന്നവരോട് വിവേകത്തോടെ ആശയവിനിമയം നടത്താൻ ഞാൻ ശ്രമിക്കാറുണ്ട്.
7. ഭൗതിക സൗന്ദര്യത്തേക്കാൾ മാനസിക സൗന്ദര്യത്തിനാണ് ഞാൻ മുൻതൂക്കം നല്കുന്നത്.
8. വ്യക്തിപരമായ കാര്യത്തിൽ മറ്റൊരാൾ ഇടപെടുന്നത് ഞാൻ ഇഷ്ടപ്പെടുന്നില്ല
9. മറ്റുള്ളവർ എന്തു കരുതും എന്ന് വിചാരിച്ച് ഞാൻ പലകാര്യങ്ങളും ചെയ്യാൻ മടിക്കാറുണ്ട്.
10. സമൂഹത്തിലെ പ്രധാനപ്പെട്ട വ്യക്തികളുടെ ആശയങ്ങളാണ് ഞാൻ സ്വീകരിക്കാറുള്ളത്.
11. സഹപാഠിയുടെ വിജയത്തിന് ഞാൻ പ്രചോദനമാവാറുണ്ട്.
12. മറ്റുള്ളവരുടെ ബലഹീനതകളിൽ സഹതപിക്കുന്നതിനേക്കാൾ നല്ലത് അവരുടെ മനസ്സിന് കരുത്ത് നൽകുകയാണ് വേണ്ടത് എന്ന് ഞാൻ കരുതുന്നു.

13. എല്ലാവരോടും നല്ലൊരു ബന്ധം കാത്തുസൂക്ഷിക്കുവാൻ എപ്പോഴും ഞാൻ ശ്രമിക്കാറുണ്ട്.

14. ദേഷ്യപ്പെടേണ്ട സാഹചര്യം ഉണ്ടായാൽ അവിടെ നിന്നും ഞാൻ തന്ത്രപൂർവ്വം ഒഴിവാവാറുണ്ട്.

15. മറ്റുള്ളവരുടെ ആഗ്രഹങ്ങൾക്ക് മുൻതൂക്കം നൽകേണ്ടിവരുമ്പോൾ എനിക്ക് അസ്വസ്ഥത ഉണ്ടാകാറുണ്ട്.

16. അഭിമാനത്തിന് ക്ഷതമേൽക്കുന്ന അവസരങ്ങളിൽ നിന്ന് ഞാൻ മനപ്പൂർവ്വം ഒഴിഞ്ഞുമാറാറുണ്ട്.

17. തർക്കപരിഹാരത്തിനായി ശ്രമിക്കുമ്പോൾ എന്റെ അഭിപ്രായങ്ങൾക്ക് മാത്രമേ ഞാൻ പ്രാധാന്യം നൽകാറുള്ളൂ.

18. സഹായം തേടിവരുന്നവരെ കണ്ടില്ലെന്ന് നടിക്കാറുണ്ട്

19. മറ്റുള്ളവരുടെ സൗന്ദര്യത്തിൽ എനിക്ക് ചിലപ്പോഴൊക്കെ അസൂയ തോന്നാറുണ്ട്.

20. പഠനത്തെ ചിട്ടപ്പെടുത്താനായി കൃത്യമായ ഒരു ടൈംടേബിൽ തയ്യാറാക്കി ഉപയോഗിക്കാറുണ്ട്.

21. അദ്ധ്യാപകർ പഠിപ്പിക്കുന്ന സമയത്ത് ഞാൻ മറ്റ പല കാര്യങ്ങളും ആലോചിക്കാറുണ്ട്.

22. ക്ലാസിലെ ഗ്രൂപ്പ് പ്രവർത്തനങ്ങളിൽ സജീവമായി പങ്കെടുക്കാറുണ്ട്.

23. പഠനസംബന്ധമായ സംശയങ്ങൾ ചോദിച്ച് മനസ്സിലാക്കാൻ ശ്രമിക്കാറുണ്ട്.

24. പഠനകാര്യങ്ങളിൽ കൂട്ടുകാർക്ക് ഒപ്പമെത്താൻ കഴിയാറില്ല എന്ന് തോന്നാറുണ്ട്.

25. പരീക്ഷയിൽ മാർക്ക് കുറഞ്ഞാൽ രക്ഷിതാക്കളെ അഭിമുഖീകരിക്കാൻ എനിക്ക് ഭയമാണ്.

26. പഠനസംബന്ധമായ കാര്യങ്ങൾക്കായി വിദ്യാഭ്യാസ പരിപാടികളും പ്രസിദ്ധീകരണങ്ങളും പ്രയോജനപ്പെടുത്താറുണ്ട്.

27. പഠനാനുബന്ധ പ്രവർത്തനങ്ങൾ കൃത്യമായി പൂർത്തീകരിക്കാൻ ശ്രമിക്കാറില്ല

28. വീട്ടിൽ മെച്ചപ്പെട്ട പഠനസൗകര്യങ്ങൾ ഇല്ലാത്തത് എന്നെ വിഷമിപ്പിക്കാറുണ്ട്.

29. പഠനശേഷം പാഠഭാഗം ഹൃദ്യസ്ഥമായോ എന്നറിയാനായി ഞാൻ സ്വയം ചോദ്യങ്ങൾ ചോദിക്കാറുണ്ട്.

30. പഠിക്കുവാൻ വിഷമകരമായ പാഠഭാഗങ്ങൾ ഒഴിവാക്കാറുണ്ട്.

31. സംഘപ്രവർത്തനങ്ങളിൽ ഏർപ്പെടുമ്പോഴൊക്കെ എനിക്ക് പല തടസ്സങ്ങൾ നേരിടേണ്ടിവരുകയും അസ്വസ്ഥത ഉണ്ടാവുകയും ചെയ്യാറുണ്ട്.

Appendix XII

FAROOK TRAINING COLLEGE

SELF CONCEPT SCALE

(Response Sheet)

വിദ്യാർത്ഥിയുടെ പേര് ....വയസ്സ്.................................

വിദ്യാലയത്തിന്റെ പേര് .... ക്ലാസ്സ് ....

ആൺ/പെൺ .... ഗവൺമെന്റ്/പ്രൈവറ്റ്.........................അർബൻ/റൂറൽ................

Sl. No	എല്ലായ്പ്പോഴും	മിക്കപ്പോഴും	ചിലപ്പോൾ	അപൂർവ്വമായി	ഒരിക്കലുമില്ല	Sl. No	എല്ലായ്പ്പോഴും	മിക്കപ്പോഴും	ചിലപ്പോൾ	അപൂർവ്വമായി	ഒരിക്കലുമില്ല
1						16					
2						17					
3						18					
4						19					
5						20					
6						21					
7						22					
8						23					
9						24					
10						25					
11						26					
12						27					
13						28					
14						29					
15						30					

Appendix XIII

UNIVERSITY OF CALICUT

DEPARTMENT OF EDUCATION

Verbal Group Test of Intelligence

Dr. P.K. Susheesh Kumar

Hameed. A & Prasanna. A

വിദ്യാർത്ഥികളുടെ മാനസികമായ കഴിവുകൾ പരിശോധിക്കുന്നതിനു വേണ്ടി തയ്യാറാക്കിയിട്ടുള്ളതാണ് ഈ ടെസ്റ്റ്. വിവിധ തരത്തിലുള്ള 5 ടെസ്റ്റുകൾ ഇതിൽ ഉൾക്കൊള്ളിച്ചിരിക്കുന്നു. ഓരോ ടെസ്റ്റിന്റെയും ആരംഭത്തിൽ കൊടുത്തിട്ടുള്ള നിർദ്ദേശങ്ങൾ എഴുതിതുടങ്ങുന്നതിന് മുൻപ് ശ്രദ്ധിച്ച് വായിക്കുക. ഉത്തരം എഴുതേണ്ട രീതി ഉദാഹരണസഹിതം വ്യക്തമാക്കിയിട്ടുണ്ട്. നിർദ്ദിഷ്ട സമയത്തിനുള്ളിൽ ഉത്തരം എഴുതിത്തീർക്കാൻ ശ്രദ്ധിക്കുകയും, പറഞ്ഞതിനുശേഷം മാത്രം എഴുതിത്തുടങ്ങുകയും, ഏറ്റവും വേഗത്തിൽ എഴുതിത്തീർക്കാൻ ശ്രമിക്കുകയും ചെയ്യേണ്ടതാണ്. തന്നിരിക്കുന്ന ഈ ചോദ്യക്കടലാസിൽ എന്തെങ്കിലും എഴുതുകയോ, അടയാളപ്പെടുത്തുകയോ ചെയ്യരുത് . പ്രത്യേകം തന്നിട്ടുള്ള ഉത്തരക്കടലാസിൽ മാത്രമേ ഉത്തരം എഴുതാവൂ.

TEST I VERBAL ANOLOGY

ഈ വിഭാഗത്തിൽ കൊടുത്തിട്ടുള്ള ചോദ്യങ്ങളിൽ മൂന്ന വാക്കുകൾ വീതം തന്നിട്ടുണ്ട്. നാലാമത്തെ വാക്ക് നിങ്ങൾ എഴുതേണ്ടതാണ്. തന്നിരിക്കുന്ന മൂന്ന വാക്കുകളിൽ ആദ്യത്തെ രണ്ടുവാക്കുകൾ തമ്മിലുള്ള ബന്ധം മനസ്സിലാക്കി മൂന്നാമത്തെ വാക്കിനോട് യോജിക്കുന്ന വാക്ക് A, B, C, D എന്നീ ക്രമത്തിൽ കൊടുത്തിരിക്കുന്ന നാലുവാക്കുകളിൽ നിന്നും തെരഞ്ഞെടുത്ത് ഉത്തരക്കടലാസ്സിൽ അടയാളപ്പെടുത്തുക.

ഉദാഹരണം:

ദാഹം: വെള്ളം, വിശപ്പ്: ....

A. മാംസം, B. വിശ്രമം, C. ആഹാരം, D. ക്ഷീണം

ദാഹം വരുമ്പോൾ വെള്ളം കുടിക്കുന്നു. അതുപോലെ വിശപ്പവരുമ്പോൾ ആഹാരം കഴിക്കുന്നു. അതുകൊണ്ട് 'C'യാണ് ശരിയായ ഉത്തരം.

A	B	C	

1. കൗശലം: കുറുക്കൻ: വിഡ്ഢിത്തം:........................

   A. കുരങ്ങൻ B. കരടി C. മാൻ D.കഴുത

2. ദയ: ക്രൂരത: :നിശ്ശബ്ദത:........................

   A. നിശ്ചലം B. ശബ്ദം C. ശാന്തത D.ധ്യാനം

3. നാടകം: സംവിധായകൻ: വിഡ്ഢിത്തം:........................

   A. മാനേജർ B. പത്രാധിപർ C. ഉടമസ്ഥൻ D.പ്രസ്സ്

4. കപ്പൽ: ക്യാപ്റ്റൻ: : വിമാനം:........................

   A. കടൽ B. എയർപോർട്ട് C. ഡ്രൈവർ D.പൈലറ്റ്

5. കരച്ചിൽ: ചിരി: : വിഷമം:........................

   A. സന്തോഷം B. ഉന്മേഷം C. ശാന്തി D.തയ്യൽക്കാരൻ

6. ഷർട്ട്: തുണി: :ചെരുപ്പ് :........................

   A. ഉളി B. തുകൽ C. ചെരുപ്പുകുത്തിD.തയ്യൽക്കാരൻ

7. കാക്ക: കറുപ്പ്: :ഹംസം:........................

   A. പക്ഷി B. വെള്ളം C. വെളുപ്പ് D.തവിട്ട്

8. മാസിക: വായനക്കാരൻ: :റേഡിയോ: ....

   A. പരസ്യക്കാരൻ B. അറിയിപ്പുകാർ C. കാഴ്ചക്കാർ D.കേൾവിക്കാർ

9. വിറക് : കോടാലി : : തുണി : : ....

   A.മെഷീൻ B. സൂചി C. കത്രിക D.നൂല്

10. വിദ്യാർത്ഥി : ക്ലാസ്സ്റൂം: : കളിക്കാരൻ: ....

   A.സ്റ്റേഡിയം B. മത്സരം C. കോച്ച് D.കളി

11. വീട് : മേൽക്കുര : : ഭൂമി : ....

A.വായു B. ആകാശം C. അന്തരീക്ഷം D.ദ്രവങ്ങൾ

12. കുട്ടി : മാതാപിതാക്കൾ : : ബുക്ക് : ....

A.അധ്യാപകൻ B. പ്രസാധകൻ C. പ്രസ്സ് D.ഗ്രന്ഥകർത്താവ്

13. വർഷം : മാസം : : ആഴ്ച: ....

A.മണിക്കൂർ B. മിനുട്ട് C. രണ്ടാഴ്ച D.ദിവസം

14. രാത്രി: പകൽ : : ദേഷ്യം : ....

A.സഹായം B. ദയ C. ഇഷ്ടം D.സന്തോഷം

15. കവി : കവിത : : സംഗീതം : : ....

A.രചയിതാവ് B. എഴുത്തുകാരൻ C. നിർമ്മാതാവ് D.കണ്ടകൂർ

16. മഞ്ഞ്: വെളുപ്പ്: : കൽക്കരി: ....

A.പുക B. ചുവപ്പ് C. കറുപ്പ് D.മഞ്ഞ

17. പശു : മൃഗം : : കോഴി : ....

A.വീട് B. പക്ഷി C. മുട്ട D.കൂട്

18. നീന്തൽ: വെള്ളം: : സ്കേറ്റിങ്: ....

A.മഞ്ഞ് B. ആകാശം C. പർവ്വതം D.ശൂന്യാകാശം

19. മനുഷ്യൻ: ആത്മകഥ : : രാഷ്ട്രം : ....

A.ജനങ്ങൾ B. ജനസംഖ്യ C. ഭൂമിശാസ്ത്രം D.ചരിത്രം

20. മരുന്ന് : രോഗം: : പുസ്തകം : ....

A.അറിവ് B. അധ്യാപകൻ C. ഗ്രന്ഥകാരൻ D.രചയിതാവ്

TEST II VERBAL CLASSIFICATION

ഈ വിഭാഗത്തിലുള്ള ചോദ്യങ്ങളിൽ ഓരോന്നിലും A, B, C, D എന്നിങ്ങനെ നാലുവാക്കുകൾ വിതം തന്നിട്ടുണ്ട്. അതിൽ ഒരെണ്ണം മറ്റ മൂന്ന വാക്കുകളോടും യോജിക്കാതെ നിൽക്കുന്നു. അത് ഏതെന്ന കണ്ടുപിടിച്ച് ഉത്തരക്കടലാസ്സിൽ അടയാളപ്പെടുത്തുക.

ഉദാഹരണം:

1.A.മധുരം, B.മുളക് C.എരിവ്, D.കയ്പ്പ്

ഇതിൽ A, C, D എന്നിവ വിവിധ രുചികളെ കാണിക്കുന്നു. B (മുളക്) രുചികളിൽ ഉൾപ്പെടുന്നതല്ല,

അതുകൊണ്ട് ശരി ഉത്തരം 'B' ആണ്

A	B	C	

1.	A. അധ്യാപകൻ	B.പ്രിൻസിപ്പാൾ	C.വിദ്യാർത്ഥി	D.പ്രൊഫസർ
2.	A. ബസ്സ്	B.വിമാനം	C.സൈക്കിൾ	D.ലോറി
3.	A. നടക്കുക	B.ചിന്തിക്കുക	C.നീന്തുക	D.ചാടുക
4.	A. വൃത്തം	B.ചതുരം	C.ത്രികോണം	D.ഷഡ്ഭുജം
5.	A. സൗന്ദര്യം	B.വാർദ്ധക്യം	C.മിടുക്കൻ	D.യൗവ്വനം
6.	A. ഗ്രാം	B.കിലോഗ്രാം	C.മീറ്റർ	D.ക്വിന്റൽ
7.	A. സമാധാനം	B.ശബ്ദം	C.ധ്യാനം	D.നിശ്ചലം
8.	A. സംവിധായകൻ	B.നടൻ	C.പാട്ടുകാരൻ	D.പ്രാസംഗികൻ
9.	A. ദിവസം	B.കലണ്ടർ	C.മാംസം	D.ആഴ്ച
10.	A. ക്വിന്റൽ	B.ഇഞ്ച്	C.മൈൽ	D.വാര
11.	A. നാവ്	B.കണ്ണ്	C.പല്ല്	D.മൂക്ക്
12.	A. ഗോതമ്പ്	B.റാഗി	C.നെല്ല്	D.പയറ്
13.	A. പാമ്പ്	B.തിമിംഗലം	C.അരണ	D.ആമ
14.	A. പെൻസിൽ	B.കട	C.പെയിന്റ്	D.ക്യാൻവാസ്
15.	A. മാവ്	B.പ്ലാവ്	C.തെങ്ങ്	D.തേക്ക്
16.	A. മാങ്ങ	B.ആപ്പിൾ	C.തക്കാളി	D.ഉരുളകിഴങ്ങ്
17.	A. ചെവി	B.വിരൽ	C.കൈ	D.കാൽ
18.	A. കോഴി	B.ആട്	C.പശു	D.കാക്ക
19.	A. ഓഫീസ്	B.വീട്	C.ബംഗ്ലാവ്	D.കുടിൽ
20.	A. അറിയിപ്പുകാർ	B.കാഴ്ചക്കാർ	C.രചയിതാവ്	D.കേൾവിക്കാർ

TEST III NUMERICAL REASONING

താഴെ കൊടുത്തിരിക്കുന്ന 6 ചോദ്യങ്ങളിൽ കുറെ സംഖ്യകൾ ഓരോ ക്രമത്തിൽ കൊടുത്തിരിക്കുന്നു. ഒന്ന് എഴുതാതെയും വിട്ടിരിക്കുന്നു. താഴെ A, B, C, D എന്നീ ക്രമത്തിൽ നാല് ഉത്തരങ്ങൾ കൊടുത്തിരിക്കുന്നു. ഇവയിൽ നിന്നും ശരിയുത്തരം കണ്ടെത്തി അടയാളപ്പെടുത്തുക.
ഉദാഹരണം: 1, 2, 4, 6, ..., 10

A.5, B.8, C.7, D.11

A	B	C	

1. 4, 9, 16, 25, 36, ...

   A.39 B.47 C.49 D.59

2. 25, 24, 22, 19, ..., 10

   A.15 B.16 C.17 D.14

3. 6, 8, ..., 20, 36

   A.15 B.14 C.16 D.12

4. 2, 6, 12, 20, 30, ...

   A.42 B.46 C.40 D.36

5. 3, 3, 6, 18,...............

   A.68 B.33 C.72 D.29

6. 2, 2, 4, 6, ... 10

   A.7 B.5 C.8 D.9

7 മുതൽ 10 വരെയുള്ള ചോദ്യങ്ങളിൽ ഓരോന്നിലും A, B, C, D എന്നിങ്ങനെ നാലു സംഖ്യകൾ തന്നിട്ടുണ്ട്. അതിൽ ഒരു സംഖ്യ മറ്റ മൂന്നു സംഖ്യകളോടും യോജിക്കാതെ നിൽക്കുന്നു. അത് ഏതെന്ന് കണ്ടുപിടിച്ച് ഉത്തരക്കടലാസിൽ അടയാളപ്പെടുത്തുക.

ഉദാഹരണം:

A.1, B.3, C.6, D.7

ഇതിൽ A,B,D എന്നിവ ഒറ്റ സംഖ്യകളെ സൂചിപ്പിക്കുന്നു. എന്നാൽ 'C' ഒറ്റ സംഖ്യയല്ല. അതുകൊണ്ട് ഉത്തരം 'C' യാകുന്നു.

A	B	C	

7. A.1, B.5, C.25, D.75

8. A.3, B.4, C.7, D.9

9. A.12, B.24, C.35, D.48

10. A.150, B.36, C.12, D.4

11 മുതൽ 20 വരെയുള്ള ചോദ്യങ്ങളിൽ മൂന്നു സംഖ്യകൾ വീതം തന്നിട്ടുണ്ട്. നാലാമത്തെ സംഖ്യ നിങ്ങൾ എഴുതേണ്ടതാണ്. തന്നിരിക്കുന്ന മൂന്നു സംഖ്യകളിൽ ആദ്യത്തെ രണ്ടു സംഖ്യകൾ തമ്മിലുള്ള ബന്ധം മനസ്സിലാക്കി മൂന്നാമത്തെ സംഖ്യയോട് ജോജിക്കുന്ന സംഖ്യ A,B,C,D എന്നീ ക്രമത്തിൽ കൊടുത്തിരിക്കുന്ന സംഖ്യകളിൽ നിന്നും തെരഞ്ഞെടുത്ത് ഉത്തരക്കടലാസിൽ അടയാളപ്പെടുത്തുക.

ഉദാഹരണം: 1: 2 : : 2 : ....

A.6, B.4, C.1, D.5

ഒന്നിന്റെ ഇരട്ടിയാണ് രണ്ട്. അതുപോലെ രണ്ടിന്റെ ഇരട്ടിയാണ് നാല്, അതുകൊണ്ട് ഉത്തരം 'B'യാണ്.

A	B	C	

11. 3 : 5 : : 11 : ....

A.12, B.13, C.14, D.15

12. 5 : 25 : : 3 : ....

A.6, B.12, C.15, D.9

13. 1 : 6 : : 7 : ....

A.12, B.13, C.11, D.14

14. 10 : 20 : : 18 : ....

A.26, B.36, C.46, D.32

15. 4 : 5 : : 8 : ....

A.6, B.7, C.5, D.9

16. 12 :72 : : 6 : ....

A.58, B.38, C.46, D.52

17. 12 : 4 : : 24 : ....

A.6, B.10, C.8, D.12

18. 28 :22 : : 46 : ....

A.40, B.38, C.42, D.29

19. 49 : 7 : : 4 : ....

A.16, B.8, C.2, D.12

20. 48 : 8 : : 18 : ....

A.8, B.4, C.2, D.3

TEST IV VERBAL REASONING

ഈ വിഭാഗത്തിലുള്ള ഓരോ ചോദ്യങ്ങൾക്കും A, B, C, D എന്ന ക്രമത്തിൽ നാലുവീതം ഉത്തരങ്ങൾ കൊടുത്തിട്ടുണ്ട്. ചോദ്യം ശരിയായി വായിച്ച് മനസ്സിലാക്കി ശരിയായ ഉത്തരം ഉത്തരക്കടലാസിൽ അടയാളപ്പെടുത്തുക.

ഉദാഹരണം ബിന്ദുവിന് സിന്ധുവിനേക്കാൾ വണ്ണം കൂടുതലാണ്. മഞ്ജുവിന് ബിന്ദുവിനേക്കാൾ വണ്ണം കുറവാണ്. മഞ്ജുവിനും സന്ധ്യയ്ക്കും തുല്യവണ്ണമാണുള്ളത്. എന്നാൽ ഇവരിൽ ആർക്കാണ് ഏറ്റവും വണ്ണം കൂടുതൽ?

A.മഞ്ജു B.ബിന്ദു C.സിന്ധു D.സന്ധ്യ

ബിന്ദുവിനാണല്ലോ മറ്റെല്ലാവരേക്കാളും വണ്ണം കൂടുതൽ, അതുകൊണ്ട് ഉത്തരം ‘B’ എന്ന്

അടയാളപ്പെടുത്തുക.

A	B	C	

1. അപ്പു ചിപ്പുവിനേക്കാൾ നന്നായി പാടും. ദേവന് കണ്ണനോളം പാടാൻ കഴിയില്ല. കണ്ണന് അപ്പുവിനേക്കാൾ പാടാൻ കഴിയും എന്നാൽ ഇവരിൽ ആരാണ് നന്നായി പാടുന്നത്?

A.അപ്പു B. കണ്ണൻ C.ചിപ്പു D.ദേവൻ

2. രാമൻ രമയേക്കാൾ പിന്നിലാണ് നടക്കുന്നത്. രമണി രമയേക്കാൾ പിന്നിലും രാമനേക്കാൾ മുന്നിലുമാണ് നടക്കുന്നത്. രഞ്ജു രമണിയേക്കാൾ മുൻപിലാണ് നടക്കുന്നത്. എങ്കിൽ ഏറ്റവും പുറകിൽ നടക്കുന്നത് ആരാണ്?

A.രാമൻ B. രമണി C.രമ D.രഞ്ജു

3. അജയ് വിയജിനേക്കാൾ ജോലി ചെയ്യും. അശോകും അജിത്തും ജോലി ചെയ്യുന്നതിൽ തുല്ല്യരാണ്. വിജയ് അശോകിനേക്കാൾ നന്നായി ജോലി ചെയ്യും. ഇവരിൽ ഏറ്റവും കൂടുതൽ ജോലി ചെയ്യുന്നതാര്?

A.അശോക് B. അജിത്ത് C.വിജയ് D.അജയ്

4. രമ്യ ഭവ്യയോളം നൃത്തം ചെയ്യില്ല. ദിവ്യ രമ്യയേക്കാൾ നന്നായി നൃത്തം ചെയ്യും. വിദ്യ ദിവ്യയേക്കാൾ നൃത്തത്തിൽ മിടുക്കിയാണ്. എങ്കിൽ ഇവരിലാരാണ് നൃത്തത്തിൽ മിടുമിടുക്കി?

A.ദിവ്യ B. ഭവ്യ C.രമ്യ D.വിദ്യ

5. ദീപകിന്റെ അച്ഛനാണ് മോഹനന്റെ മകൻ എങ്കിൽ ദീപകും മോഹനനും തമ്മിലുള്ള ബന്ധമെന്താണ്?

A.മകൻ B. സഹോദരൻ C.അനന്തരവൻ D.കൊച്ചുമകൻ

6. റഫീഖിന് മുനീറിനേക്കാൾ കാഴ്ചയുണ്ട്. ഷമീറിന് സുധീറിനേക്കാൾ കാഴ്ച കുറവാണ്. സുധീറിന് റഫീക്കിനോളം കാഴ്ച ശക്തിയില്ല. ഇവരിൽ ആർക്കാണ് കാഴ്ച ഏറ്റവും കൂടുതൽ?

A.സുധീറിന് B. ഷമീറിന് C.റഫീഖിന് D.മുനീറിന്

7. രണ്ടു പേർ ചേർന്ന് പത്തു ദിവസം കൊണ്ട് ഒരു ജോലി ചെയ്തു തീർത്തു. എങ്കിൽ ഒരാൾക്ക് ഒരു ദിവസം കൊണ്ട് എത്ര ജോലി ചെയ്യാൻ കഴിയും?

A.1/2 B. 1/5 C.1/10 D.1/20

8. ഒരു വെടിയൊച്ച Aഎന്ന സ്ഥലത്തു നിന്നും B എന്ന സ്ഥലത്തെത്താൻ എടുക്കുന്ന സമയം 2 മിനുട്ട്. എന്നാൽ 5 വെടിയൊച്ചകൾ A എന്ന സ്ഥലത്തു നിന്നും B എന്ന സ്ഥലത്തെത്താൻ എത്ര സമയമെടുക്കും?

A.10 മി B. 2 മി C.4 മി D.5 മി

9. ഷർമിളയ്ക്ക് മാലയേക്കാൾ പ്രായം കുറവാണ്. കുഞ്ചനും നന്ദയ്ക്കും തുല്യ പ്രായമാണുള്ളത്. സുധിഷിന് നന്ദയേക്കാൾ പ്രായം കുറവാണ്. സുധീഷിന് ഷർമിളയേക്കാൾ പ്രായം കൂടുതലാണ്. മാലയ്ക്ക് സുധീഷിനോളം പ്രായം ഇല്ല. എന്നാൽ ഏറ്റവും കൂടുതൽ പ്രായം ആർക്കാണ്?

A.സുധീഷ് B. മാല C.ഷർമിള D.കുഞ്ചൻ

10. ഒരു കോളേജിലെ ഫീസടയ്ക്കാൻ നിൽക്കുന്ന ക്യൂവിലെ കുട്ടികളുടെ എണ്ണം 70 ആകുന്നു. അതിൽ മോഹനന്റെ സ്ഥലം ജനലിന്റെ അടുത്തു നിന്നും 54-മത്തേതാണെങ്കിൽ അവന്റെ പുറകിൽ എത്ര പേരു കാണും?

A.15 B. 16 C.17 D.18

11. തെക്കു പടിഞ്ഞാറ് വടക്കാണെങ്കിൽ വടക്കു കിഴക്ക് എന്തായിരിക്കും?

A.പടിഞ്ഞാറ് B. തെക്കുപടിഞ്ഞാറ് C.കിഴക്കുപടിഞ്ഞാറ് D.തെക്ക്

12. A, B യുടെ മകനാണ്. B യും C യും സഹോദരികളാണ്. D, C യുടെ അമ്മയും E, D യുടെ മകനുമാണ്. എന്നാൽ താഴെ പറയുന്നവയിൽ ഏതാണ് ശരി?

A.Aയുടെ അമ്മയുടെ സഹോദരിയാണ് E

B. C യും E യും സഹോദരീസഹോദരന്മാരാണ്

C. C, Aയുടെ അമ്മൂമ്മയാണന്ന

D.Aയും Eയും സഹോദരന്മാരാണ്.

13. ഒരു കമ്പനിയിലെ തൊഴിലാളികളുടെ എണ്ണം 80 ആകുന്നു. അതിൽ 1/4 പേർക്ക് കാറു1/2 പേർക്ക് സ്കൂട്ടറും 1/10 പേർക്ക് കാറും സ്കൂട്ടറുമുണ്ട്. എന്നാൽ എത്ര പേർക്കാണ് കാറോ സ്കൂട്ടറോ ഇല്ലാത്തത്?

A.12 B. 32 C.30 D.28

14. 51 പേരുള്ള ഒരു ക്ലാസ്സിൽ അഖിലിന് 21-ാമത്തെ റാങ്കാണ്. ◌ഏറ്റവും ഒടുവിലത്തെ റാങ്കുള്ള കുട്ടിയിൽ നിന്നും കണക്കാക്കുമ്പോൾ അഖിലിന് എത്രാമത്തെ റാങ്കായിരുക്കും ഉണ്ടാവുക?

A.12 B. 30 C.31 D.35

15. ഒരാൾ 'x' എന്ന സ്ഥലത്തു നിന്നും 4 മൈൽ കിഴക്കോട്ടു നടന്ന് ഇടത്തോട്ട് തിരിഞ്ഞ് വീണ്ടും 5 മൈൽ നടന്ന് വീണ്ടും ഇടത്തോട്ട് തിരിഞ്ഞ് 2 മൈൽ നടന്നും. എങ്കിൽ അയാൾ ഇപ്പോൾ നടക്കുന്ന ദിശയേത്?

A.വടക്ക് B. പടിഞ്ഞാറ് C.കിഴക്ക് D.തെക്ക്

16. F, Aയുടെ സഹോദരനാണ്. C, A യുടെ മകളാണ്. K, F ന്റെ സഹോദരിയാണ്. G,C യുടെ സഹോദരനാണ്. ഇതിൽ ആരാണ് G യുടെ അമ്മാവൻ?

A.F B. C C.K D.A

17. വിനുവിനേക്കാൾ രണ്ടു വയസ്സുള്ള ജിനുവിന് മീനുവിനേക്കാൾ രണ്ടു മടങ്ങ് പ്രായമുണ്ട്. മൂന്നുപേരുടെയും വയസ്സു കൂട്ടിയാൽ 19 കിട്ടും. എങ്കിൽ ജീനുവിന്റെ വയസ്സ് എത്ര?

A.5 B. 3 C.9 D.10

18. ഒരു മാവേലി സ്റ്റോറിന്റെ മുന്നിലുള്ള ക്യൂവിൽ നിൽക്കുന്ന X എന്നയാളിന്റെ സ്ഥാനം മുന്നിൽ നിന്നും 22ാമത്തേതും പിന്നിൽ നിന്നും 28ാമത്തേതുമാണെങ്കിൽ ആകെ ക്യൂവിലുള്ള ആളുകളുടെ എണ്ണമെത്ര?

A.48 B. 52 C.50 D.54

19. A യ്ക്ക് Y യേക്കാൾ നീളം കൂടുതലാണ്. B യ്ക്ക് X നേക്കാൾ നീളം കുറവാണ്. X നും Y യ്ക്കും തുല്യ നീളമാണുള്ളത്. Z ന് A യേക്കാൾ നീളം കൂടുതലുണ്ട്. എങ്കിൽ ഏറ്റവും നീളം കുറവാർക്ക്?

A.X B. Y C.A D.B

20. ശ്യാമിന്റെ അച്ഛനാണ് സഞ്ജയിന്റെ മകനെങ്കിൽ ശ്യാമും സഞ്ജയും തമ്മിലുള്ള ബന്ധമെന്ത്?

A.മകൻ B. കൊച്ചുമകൻ C.സഹോദരൻ D.അനന്തരവൻ

TEST V VERBAL REASONING

ഈ വിഭാഗത്തിലുള്ള ചോദ്യങ്ങളിൽ ഓരോന്നിലും എതാനും ചില പ്രസ്താവനകൾ കൊടുത്തിട്ടുണ്ട്. ഇവ ശ്രദ്ധാപൂർവ്വം വായിച്ച് അതിനു താഴെ കൊടുത്തിരിക്കുന്ന ചോദ്യങ്ങൾക്ക് ഇത്തരം കണ്ടെത്തുക. A, B, C, D എന്നീ ക്രമത്തിൽ നാലു ഉത്തരങ്ങൾ കൊടുത്തിരിക്കുന്നു. ശരി ഉത്തരം കണ്ടെത്തി ഉത്തരക്കടലാസിൽ അടയാളപ്പെടുത്തുക.

ഉദാഹരണം: സതീഷിന്റെ പുത്രന്മാരാണ് Aയും Bയും, പുത്രിമാരാണ് Cയും Dയും. ശ്യാമയുടെ മക്കളാണ് Xഉം Yയും. മനോജിന്റെ മക്കളായ Eയും Fഉം ഒരു കമ്പനിയിൽ ജോലിയുള്ളവരാണ്. Aയും Dയും വിവാഹിതരാണ്. X വിവാഹം ചെയ്തിരിക്കുന്നത് C യെയും F, വിവാഹം ചെയ്തിരിക്കുന്നത് A യെയും ആണ്. മനോജിനും ശ്യമയ്ക്കും തമ്മിൽ സഹോദരീസഹോദര ബന്ധമാണ്.

1. X ഉം E യും തമ്മിലുള്ള ബന്ധമെന്ത്?

A. അച്ഛനും മകനും

B. സഹോദരീസഹോദരന്മാർ

C. സഹോദരീസഹോദരന്മാരുടെ മക്കൾ

D. മകളും അച്ഛനും

A	B	C	

I. ഒരു വീട്ടിലെ നാല് അംഗങ്ങളാണ് W, X, Y, Z ഇവരിൽ W,X,Y വിദ്യാഭ്യാസമുള്ളവരാണ്. W,Y,Z സത്യസന്ധരും Y,Z എന്നിവർ ജോലിയുള്ളവരുമാകുന്നു. W, X, Z എന്നിവർക്ക് വിനയവുമുണ്ട്.

1. ആർക്കാണ് വിദ്യാഭ്യാസം, സത്യസന്ധത എന്നീ ഗുണങ്ങളുള്ളതും എന്നാൽ ജോലിയില്ലാത്തതും?

A.W B.X C.Y D.Z

2. ജോലിയും വിദ്യഭ്യാസവും സത്യസന്ധതയും ഉള്ളതാർക്കാണ്?

A.W B.X C.Y D.Z

3. ആർക്കാണ് ജോലിയും സത്യസന്ധതയുമുള്ളതും എന്നാൽ വിദ്യാഭ്യാസമില്ലാത്തതും?

A.W B.X C.Y D.Z

4. വിദ്യാഭ്യാസവും വിനയവും ഉണ്ടെങ്കിലും സത്യസന്ധതയും ജോലിയും ഇല്ലാത്ത് ആർക്ക്?

A.W B.X C.Y D.Z

5. സത്യസന്ധതയും ജോലിയും വിനയവും ഉണ്ടായിട്ടും വിദ്യാഭ്യാസമില്ലാത്തതാർക്കാണ്?

A.W B.X C.Y D.Z

II. ദിനേശിന് A, B എന്നീ പുത്രിമാരും C എന്ന പുത്രനുമുണ്ട്. ശ്യാമിന് P, Q എന്ന പുത്രന്മാരും R എന്ന പുത്രിയുമുണ്ട്. P യും C യും വിവാഹിതരാണ്. M ഉം N ഉം അവരുടെ പുത്രന്മാരും രോഹിതിന്റെ പുത്രൻ S, പുത്രി T യുമാണ്. T വിവാഹം കഴിച്ചിരിക്കുന്നത് B യെ അവരുടെ പുത്രിമാരാണ് D യും E യും പുത്രൻ G.

6. Q വിന് N മായുള്ള ബന്ധമെന്താണ്?

A.അച്ഛൻ B.മുത്തച്ഛൻ C.അമ്മാവൻ D.പുത്രൻ

7. ദിനേശന് E യുമായുള്ള ബന്ധമെന്താണ്?

A. മുത്തച്ഛൻ B. അമ്മാവൻ C. അച്ഛൻ D.പുത്രൻ

8. M ന് R നോടുള്ള ബന്ധമെന്താണ്?

A. അമ്മ B. മകൾ C. അനന്തിരവൾ D.അമ്മായി

9. B യ്ക്ക് G യോടുള്ള ബന്ധമെന്താണ്?

A. മകൻ B. അമ്മ C. അമ്മായി D.അനന്തിരവൾ

10. E യ്ക്ക് S നോടുള്ള ബന്ധമെന്താണ്?

A. പേരക്കിടാവ് B. അമ്മാവൻ C. സഹോദരിപുത്രി D.അച്ഛൻ

III. 5 PQ 8 = 52 + 8 = 25 + 8 = 33 ആയാൽ

11. 4PQ 4 = ?

A. 16 B. 20 C. 24 D. 12

12. 4PQ 1 = ?

A. 17 B. 12 C. 8 D. 9

13. 5PQ 5 = ?

A. 20 B. 30 C. 15 D. 25

14. 6PQ ? = 108

A. 72 B. 82 C. 52 D. 42

15. ?PQ 9 = 109

A. 50 B. 25 C. 20 D. 10

IV. ഒരു വീട്ടിലെ ആറ് അംഗങ്ങളാണ് U,V,W,X,Y,Z ഇവരിൽ ഒരാൾ ഫുഡ്ബോൾ കളിക്കാരനും മറ്റൊരാൾ ചെസ് കളിക്കാരനും, ഇനിയുമൊരാൾ ക്രിക്കറ്റ് കളിക്കാരനുമാണ്. അവിവാഹിതകളായ U യും X ഉം ഒരു കളിയിലും പങ്കെടുക്കുന്നില്ല. ഒറ്റ സ്ത്രീകളും ഫുഡ്ബോൾ കളിയിലോ ക്രിക്കറ്റ് കളിയിലോ ഏർപ്പെട്ടുന്നില്ല. ഇവരിൽ ഒരു വിവാഹ ജോടിയിലെ ഭർത്താവാണ് Z. Wന്റെ സഹോദരനായ V ഒരു ചെസ്സ് കളിക്കാരനോ ക്രിക്കറ്റ് കളിക്കാരനോ അല്ല. Y, Vയുടെ കൂട്ടുകാരനും ക്രിക്കറ്റുകളിക്കാരനുമാണ്.

16. ആരാണ് ഫുഡ്ബോൾ കളിക്കാരൻ?

A.X B. U C.Y D. Z

17. ആരാണ് ചെസ് കളിക്കാരി?

A.U B. V C.W D. X

18. ആരാണ് Z ന്റെ ഭാര്യ?

A.W B. V C.U D. Y

19. ആരെല്ലാമാണ് സ്ത്രീകൾ?

A.UXV B. VYX C.XZY D. UXW

20. ആരെല്ലാമാണ് പുരുഷന്മാർ?

A.XUY B. UXV C.VYZ D. WXZ

Appendix XIV

Department of Education

University of Calicut

VERBAL GROUP TEST OF INTELLIGENCE

RESPONSE SHEET

Name: .... Class: .... Age: ....

School: .... Govt./Aided .... Division: ....

Boy/Girl: ....

Sl. No.	Answers Test I				Sl. No.	Answers Test II				Sl. No.	Answers Test III				Sl. No.	Answers Test IV				Sl. No.	Answers Test V			
	A	B	C	D		A	B	C	D		A	B	C	D		A	B	C	D		A	B	C	D
1					1					1					1					1				
2					2					2					2					2				
3					3					3					3					3				
4					4					4					4					4				
5					5					5					5					5				
6					6					6					6					6				
7					7					7					7					7				
8					8					8					8					8				
9					9					9					9					9				
10					10					10					10					10				
11					11					11					11					11				
12					12					12					12					12				
13					13					13					13					13				
14					14					14					14					14				
15					15					15					15					15				
16					16					16					16					16				
17					17					17					17					17				
18					18					18					18					18				
19					19					19					19					19				
20					20					20					20					20				

Appendix XV

SOCIO ECONOMIC STATUS SCALE

2018

Vineetha Prakash	**Dr. Bindhu C.M**
Research Scholar	Professor
School of Pedagogical Sciences	Dept. of Education
Kannur University	University of Calicut

INSTRUCTIONS

Given below are certain facts related with your family. Read them carefully and record your responses using a tick mark in the relevant place. Be careful in expressing your response to all facts separately. Your responses are meant for research purposes and will be kept confidential.

SOCIO ECONOMIC STATUS OF THE FAMILY

1. Educational qualification of father

Professional	☐	Master Degree	☐
University graduate	☐	Semi Professional	☐
Higher Secondary	☐	Secondary	☐
Primary	☐	Illiterate	☐

2. Educational qualification of mother

Professional	☐	Master Degree	☐
University graduate	☐	Semi Professional	☐
Higher Secondary	☐	Secondary	☐
Primary	☐	Illiterate	☐

3. Occupation of father

Central	☐	State	☐
Public Undertaking	☐	Owner of a company	☐
Self-employed	☐	Farmer	☐
Skilled labor	☐	Unskilled labor	☐
Unemployed	☐		

4. Occupation of mother

Central	☐	State	☐
Public Undertaking	☐	Owner of a company	☐
Self-employed	☐	Farmer	☐
Skilled labor	☐	Unskilled labor	☐
Unemployed	☐		

5. The valuables or house hold items in my house

Four-wheeler	☐	Bike/Scooter	☐
Washing Machine	☐	Refrigerator	☐
Credit Card	☐	Telephone	☐
Mobile Phone	☐	Cable Connection	☐
T.V	☐	Electricity	☐

6. Do you possess any buildings or shops etc. apart from the house in which you are staying?

Yes	☐	No	☐

7. How many earning members are there in your family?

More than four	☐	Four	☐
Three	☐	Two	☐
One	☐		

8. Monthly income of the family from all sources

Rs.

9. Type of family

Single	☐	Joint	☐

10. Do your family go to foreign countries

Monthly	☐	Once in 3 months	☐
Once in 6 months	☐	Once in a year	☐
No	☐		

11. Type of our house

Concrete two storey	☐	Concrete one storey	☐
House with tiles roofing	☐	Thatched roof	☐
Rented house	☐		

12. Is there any salaried servant in your house?

    Yes ☐ No ☐

13. Type of your residential area?

    Urban ☐ Rural ☐

14. Does your family go for tours?

    Yes ☐ No ☐

15. Is there anyone in your family working abroad?

    Yes ☐ No ☐

16. Are there any pets or cattle in your house?

    Yes ☐ No ☐