INFLUENCE OF CERTAIN COGNITIVE AND NON COGNITIVE VARIABLES ON ACHIEVEMENT IN CHEMISTRY AMONG SECONDARY SCHOOL STUDENTS

Thesis
Submitted for the Degree of
DOCTOR OF PHILOSOPHY IN EDUCATION

By

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2025

DECLARATION

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Sukanya Rani P

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Abstract

Achievement in Chemistry at the secondary school level is influenced by a variety of Cognitive and Noncognitive factors. Cognitive variables such as Verbal Intelligence and Scientific Reasoning help students process, analyze, and apply scientific concepts, while Noncognitive variables like Attitude towards Chemistry and Self-efficacy in Chemistry influence motivation and inspiration. Understanding the combined effect of these variables is crucial for enhancing student Achievement in Chemistry.

The present study investigates the influence of selected cognitive and Noncognitive variables on Achievement in Chemistry among secondary school students. Cognitive variables considered were Verbal Intelligence and Scientific reasoning, while Noncognitive variables included Attitude towards Chemistry and Self-efficacy in chemistry. Gender, locale and Type of Management of the school were considered as classificatory variables. Achievement in Chemistry was taken as the dependent variable and Cognitive and Noncognitive variables as independent variables. Accordingly, objectives have been framed and hypotheses formulated. survey method was employed and relevant data were collected from a stratified random sample of 1100 students. To measure the variables, standardised tools were used, and the collected data were analysed using descriptive statistics, independent sample t-tests, two-way ANOVA, Pearson's product moment correlation coefficient and multiple regression analysis.

The study found significant differences in both Cognitive and Noncognitive variables, as well as Achievement in Chemistry, based on gender, school locale, and type of school management. Female students and government school students scored higher in Verbal Intelligence and Scientific Reasoning, and these key factors are crucial for success in chemistry. However, there was no significant difference between rural and urban students in these cognitive variables, suggesting that locale does not strongly influence them. Female students also showed a more positive Attitude towards chemistry than male students, though both genders had similar levels of Self-efficacy. In terms of Noncognitive factors, locale of the school showed significant differences, and students in government schools had more positive Attitudes towards Chemistry than those in aided schools.

The study also revealed that cognitive variables particularly Verbal Intelligence and Scientific Reasoning independently influence Achievement in Chemistry. The study throws light that a positive attitude is strongly correlated with higher achievement in chemistry across all student sub groups.

A significant interaction observed among male and rural students, suggest that the combined influence of Attitude and Self-efficacy substantially enhances academic performance. Verbal Intelligence, Scientific Reasoning in Chemistry and Attitude towards Chemistry collectively serve as significant predictors of Achievement in Chemistry. Workshops may be organised for teachers on integrating cognitive skill-building strategies, modules to improve Verbal Intelligence and Scientific Reasoning in boys, such as debate peer tutoring or inquiry-based activities, inclusive classroom environments that promote confidence in boys and girls. Gender - neutral encouragement programmes may be organised in schools, for both boys and girls to perform equally well in chemistry. Science curriculum should incorporate with a cross-disciplinary approach from the school level onwards promoting the integration of language and Science. Curriculum should also include provisions for inquiry based learning, contextualising chemistry concepts within everyday experience and fostering curiosity in the subject.

Keywords: Achievement in Chemistry, Cognitive Variables, Noncognitive variables, Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry, Multiple Regression and Secondary School Students.

സംഗ്രഹം

സെക്കൻഡറി സ്കൂൾ വിദ്യാർത്ഥികളുടെ രസതന്ത്രവിഷയത്തിലുള്ള പഠനനേട്ടങ്ങൾ, വൈജ്ഞാനികവും (Cognitive) വൈജ്ഞാനികേതരവുമായ (Noncognitive) വിവിധ ഘടകങ്ങളുമായി ബന്ധപ്പെട്ടിരിക്കുന്നു. വെർബൽ ഇന്റലിജൻസ്, സൈന്റിഫിക്ക് റീസണിങ്ങ് തുടങ്ങിയ വൈജ്ഞാനിക വേരിയബിളുകൾ വിദ്യാർത്ഥികളെ ശാസ്ത്രീയ ആശയങ്ങൾ പ്രൊസസ്സ് ചെയ്യാനും, വിശകലനം ചെയ്യാനും, പ്രായോഗികമാക്കാനും സഹായിക്കുന്നു. അതേസമയം രസതന്ത്രത്തോടുള്ള മനോഭാവം (Attitude towards Chemistry), രസതന്ത്രത്തിലെ സ്വയം-ഫലപ്രാപ്തി (Self-efficacy in Chemistry) തുടങ്ങിയ വൈജ്ഞാനികമല്ലാത്ത വേരിയബിളുകൾ പഠനത്തിന് പ്രേരണയും പ്രചോദനവും നൽകുന്നു. ഈ വേരിയബിളുകളുടെ സംയോജിതഫലം മനസ്സിലാക്കുന്നത് വിദ്യാർത്ഥികളുടെ രസതന്ത്രത്തിലെ പഠനനേട്ടങ്ങൾ വർദ്ധിപ്പിക്കുന്നതിന് നിർണ്ണായകമായിരിക്കും.

സെക്കൻഡറി വിദ്യാർത്ഥികളുടെ രസതന്ത്ര വിഷയത്തിലുള്ള പഠനനേട്ടങ്ങളിൽ വൈജ്ഞാനികവും, വൈജ്ഞാനികേതരവുമായ വേരിയബിളുകളുടെ സ്വാധീനത്തെക്കുറിച്ച് ഈ പഠനം അന്വേഷിക്കുന്നു. ഈ പഠനത്തിനായി തെരഞ്ഞെടുത്ത വൈജ്ഞാനിക വേരിയബിളുകളിൽ വാക്കാലുള്ള ബുദ്ധിയും (Verbal Intelligence), ശാസ്ത്രീയ യുക്തിയും (Scientific Reasoning) ഉൾപ്പെടുന്നു. അതേസമയം വൈജ്ഞാനികേതരമായ വേരിയബിളുകളിൽ രസതന്ത്രത്തോടുള്ള മനോഭാവവും രസതന്ത്രത്തിലെ സ്വയം-ഫലപ്രാപ്തിയും ഉൾപ്പെടുന്നു. വിദ്യാർത്ഥികളുടെ ലിംഗഭേദം (Gender), സ്കൂളുകളുടെ സ്ഥാനം (Locale of School), സ്കൂൾ മാനേജ്മെന്റിന്റെ തരം (Type of Management) എന്നിവ വർഗീകരണ വേരിയബിളുകളായ് (Classificatory variables) ഉൾപ്പെടുത്തുകയും ചെയ്തു. രസതന്ത്രത്തിലെ നേട്ടം (Achievement in Chemistry) ആശ്രിത വേരിയബിളായി (Dependent variables) കണക്കാക്കുകയും വൈജ്ഞാനികവും വൈജ്ഞാനികേതരവുമായ വേരിയബിളുകൾ സ്വതന്ത്ര വേരിയബിളുകളായി (Independent variables) കണക്കാക്കുകയും ചെയ്തു. അതനുസരിച്ച്, പഠനലക്ഷ്യങ്ങൾ രൂപപ്പെടുത്തുകയും, അനുമാനങ്ങൾ നിജപ്പെടുത്തുകയും ചെയ്തു. സർവ്വേ രീതിയിൽ സ്റ്റാൻഡേർഡൈസ് ചെയ്ത ടൂളുകൾ ഉപയോഗിച്ച് 1100 വിദ്യാർത്ഥികളിൽനിന്നും സ്ട്രാറ്റിഫൈഡ് റാൻഡം സാമ്പ്ലിംങ് രീതിയിൽ പ്രസക്തമായ ഡാറ്റ ശേഖരിച്ചു. ശേഖരിച്ച ഡാറ്റ, വിവരാത്മക സ്ഥിതിവിവരണക്കണക്കുകൾ, സ്വതന്ത്ര സാമ്പിൾ ടീ-ടെസ്റ്റുകൾ, ടൂ-വേ അനോവ, പിയേഴ്സൺസ് പ്രൊഡക്റ്റ് മോമെന്റ് കോറിലേഷൻ കോ-എഫിഷ്യന്റ്, മൾട്ടിപ്പിൾ റിഗ്രഷൻ അനാലിസിസ് എന്നിവ ഉപയോഗിച്ച് വിശകലനം ചെയ്തു.

ലിംഗഭേദം, സ്കൂൾ സ്ഥാനം, സ്കൂൾ മാനേജ്മെന്റിന്റെ തരം എന്നിവയെ അടിസ്ഥാനമാക്കി വൈജ്ഞാനികവും വൈജ്ഞാനികേതരവുമായ വേരിയബിളുകളിലും രസതന്ത്ര നേട്ടത്തിലും കാര്യമായ വ്യത്യാസങ്ങൾ പഠനം കണ്ടെത്തി. പെൺകുട്ടികളും സർക്കാർ സ്കൂൾ വിദ്യാർത്ഥികളും വാക്കാലുള്ള ബുദ്ധിയിലും ശാസ്ത്രീയ യുക്തിയിലും ഉയർന്ന സ്കോർ നേടി, രസതന്ത്രത്തിലെ വിജയത്തിന് ഈ ഘടകങ്ങൾ നിർണായകമാണ്. എന്നിരുന്നാലും, ഈ വൈജ്ഞാനിക വേരിയബിളുകളിൽ ഗ്രാമീണ, നഗര വിദ്യാർത്ഥികൾക്കിടയിൽ കാര്യമായ വ്യത്യാസമൊന്നുമില്ല, ഇത് സൂചിപ്പിക്കുന്നത് പ്രാദേശിക സ്വഭാവം അവരെ ശക്തമായി സ്വാധീനിക്കുന്നില്ല എന്നാണ്.

ആൺകുട്ടികളേക്കാൾ പെൺകുട്ടികൾ രസതന്ത്രത്തോട് കൂടുതൽ പോസിറ്റീവ് മനോഭാവം കാണിച്ചു, എന്നിരുന്നാലും രണ്ട് ലിംഗക്കാർക്കും സ്വയം ഫലപ്രാപ്തിയുടെ സമാനമായ തലങ്ങളുണ്ടായിരുന്നു. വൈജ്ഞാനികേതരമായ ഘടകങ്ങളുടെ കാര്യത്തിൽ, സ്കൂളിന്റെ സ്ഥാനം കാര്യമായ വ്യത്യാസങ്ങൾ കാണിച്ചു, കൂടാതെ സർക്കാർ സ്കൂളുകളിലെ വിദ്യാർത്ഥികൾക്ക് എയ്ഡഡ് സ്കൂളുകളിലെ വിദ്യാർത്ഥികളേക്കാൾ രസതന്ത്രത്തോട് കൂടുതൽ പോസിറ്റീവ് മനോഭാവങ്ങളുണ്ടായിരുന്നു. വാക്കാലുള്ള ബുദ്ധി, ശാസ്ത്രീയ യുക്തി എന്നീ വൈജ്ഞാനിക വേരിയബിളുകൾ സ്വതന്ത്രമായി രസതന്ത്രത്തിലെ നേട്ടത്തെ സ്വാധീനിക്കുന്നുണ്ടെന്നും പഠനം വെളിപ്പെടുത്തി. എല്ലാ വിദ്യാർത്ഥി ഉപഗ്രൂപ്പുകളിലും, രസതന്ത്രത്തിലെ ഉയർന്ന നേട്ടവുമായി പോസിറ്റീവ് മനോഭാവം വളരെയധികം ബന്ധപ്പെട്ടിരിക്കുന്നുവെന്ന് പഠനം വെളിപ്പെടുത്തുന്നു.

ആൺകുട്ടികളിലും ഗ്രാമപ്രദേശങ്ങളിൽനിന്നും വരുന്ന വിദ്യാർത്ഥികളിലും കാണപ്പെടുന്ന ഇടപഴകലുകൾ, മനോഭാവത്തിന്റെയും സ്വയം-ഫലപ്രാപ്തിയുടെയും സംയോജിത സ്വാധീനം അക്കാദമിക് പ്രകടനത്തെ ഗണ്യമായി വർദ്ധിപ്പിക്കുന്നുവെന്ന് സൂചിപ്പിക്കുന്നു. വാക്കാലുള്ള ബുദ്ധി, രസതന്ത്രത്തിലെ ശാസ്ത്രയുക്തി, രസതന്ത്രത്തോടുള്ള മനോഭാവം എന്നിവ രസതന്ത്രത്തിലെ നേട്ടത്തിന്റെ പ്രധാന പ്രവചനഘടകങ്ങളായി വർത്തിക്കുന്നു. ആൺകുട്ടികളിലും പെൺകുട്ടികളിലും ആത്മവിശ്വാസം വളർത്തുന്ന സംവാദ പിയർ ട്യൂട്ടറിംഗ് അല്ലെങ്കിൽ അന്വേഷണാധിഷ്ഠിത പ്രവർത്തനങ്ങൾ ഉൾക്കൊള്ളുന്ന ക്ലാസ് മുറി അന്തരീക്ഷങ്ങൾ സൃഷ്ടിക്കുന്നതിനെക്കുറിച്ചും, ആൺകുട്ടികളിൽ വാക്കാലുള്ള ബുദ്ധിയും ശാസ്ത്രീയ യുക്തിയും മെച്ചപ്പെടുത്തുന്നതിനുള്ള വൈജ്ഞാനിക വൈദഗ്ധ്യ വികസന തന്ത്രങ്ങളുടെ മൊഡ്യൂളുകൾ സംയോജിപ്പിക്കുന്നതിനെക്കുറിച്ചും അധ്യാപകർക്കായി വർക്ക്ഷോപ്പുകൾ സംഘടിപ്പിക്കാവുന്നതാണ്. ആൺകുട്ടികൾക്കും പെൺകുട്ടികൾക്കും രസതന്ത്രത്തിൽ ഒരുപോലെ മികച്ച പ്രകടനം കാഴ്ചവയ്ക്കുന്നതിനായി സ്കൂളുകളിൽ ലിംഗ-നിഷ്പക്ഷ പ്രോത്സാഹന പരിപാടികൾ സംഘടിപ്പിക്കാവുന്നതാണ്. സ്കൂൾ തലം മുതൽ ഭാഷയുടെയും ശാസ്ത്രത്തിന്റെയും സംയോജനം പ്രോത്സാഹിപ്പിക്കുന്ന തരത്തിൽ ഒരു ക്രോസ്-ഡിസിപ്ലിനറി സമീപനം ശാസ്ത്ര പാഠ്യപദ്ധതിയിൽ ഉൾപ്പെടുത്താവുന്നതാണ്. അന്വേഷണാധിഷ്ഠിത പഠനം, ദൈനംദിന അനുഭവത്തിനുള്ളിൽ രസതന്ത്ര ആശയങ്ങൾ സന്ദർഭോചിതമാക്കൽ, വിഷയത്തിൽ ജിജ്ഞാസ വളർത്തൽ എന്നിവയ്ക്കുള്ള വ്യവസ്ഥകളും പാഠ്യപദ്ധതിയിൽ ഉൾപ്പെടുത്താവുന്നതാണ്.

കീവേഡുകൾ: രസതന്ത്രത്തിലെ നേട്ടം, വൈജ്ഞാനിക വേരിയബിളുകൾ, വൈജ്ഞാനികേതര വേരിയബിളുകൾ, വാക്കാലുള്ള ബുദ്ധി, ശാസ്ത്രീയ യുക്തി, രസതന്ത്രത്തോടുള്ള മനോഭാവം, രസതന്ത്രത്തിലെ സ്വയം ഫലപ്രാപ്തി, മൾട്ടിപ്പിൾ റിഗ്രഷൻ, സെക്കൻഡറി സ്കൂൾ വിദ്യാർത്ഥികൾ.

Chapter One

INTRODUCTION

- Need and Significance of the Study
- Statement of the Problem
- Definition of Key Terms
- Variables Selected for the Study
- Objectives of the Study
- Hypotheses of the Study
- Methodology in Brief
- Scope and Limitations of the Study
- Organisation of the Report

Education is the most powerful tool for driving social transformation and fostering socio-economic development. The creation of a modern, progressive society hinges on the effective implementation of a high-quality education system. In its broadest sense, education is a process of shaping individuals and building character. It should cultivate values such as humanism, tolerance, compassion, cooperation, and peace. Additionally, education serves as a critical foundation for scientific and technological advancements, making it indispensable for societal progress.

In the digital era, the nation requires a high-quality education system that delivers up-to-date and advanced knowledge, unlocks innate potential and abilities, enhances competencies, and fosters intelligence and Scientific Reasoning. Education must also cultivate foundational skills, transform attitudes and interests, and instil human values. These elements collectively contribute to the holistic growth of individuals and the overall progress of the nation.

Education is an act of discovery. Its ultimate goal is to nurture learners who are capable of innovation and creativity, rather than merely replicating the achievements of past generations. Society expects education to produce individuals who can serve as originators, inventors, creators, and pioneers. Education truly becomes an investment when it yields returns in the form of skilled professionals—scientists, doctors, engineers, teachers, farmers, and labourers—who contribute to societal progress. This continuous academic pursuit hinges on the quality and standards of the curriculum, as well as its thoughtful and strategic implementation. Ultimately, the success of this endeavour rests in the hands of dedicated, resourceful, and competent teachers.

Science is a systematic endeavour that builds and organises knowledge through testable explanations and predictions about the world. It is an ongoing process of discovery, aimed at uncovering new knowledge, refining explanations, and deepening our understanding. At its core, science involves the application of knowledge and the systematic exploration of the natural and social world, guided by evidence-based methodologies (Lederman & Lederman, 2005).

Science is a systematic process of observing, describing, and exploring the physical world. It encompasses a body of knowledge and a set of methods used to test hypotheses and validate ideas. Through empirical observation, science leads to the development of concepts, principles, and theories. The fundamental outcomes of science are facts, concepts, principles, and theories, while its core processes include observation, comparison, classification, communication, measurement, estimation, and prediction.

In the context of the internationalisation of education, science education has emerged as a critical and prioritised subject within school curricula worldwide. Advances in science and technology have revolutionised the teaching and learning of science, transforming the broader educational landscape. Science education plays a pivotal role in shaping national educational goals and fostering the development of enlightened, informed citizens, essential for societal progress.

The entire educational landscape has undergone significant transformation due to advancements in science and technology. Information technology, in particular, has brought about fundamental changes in the field of pedagogical sciences. The present investigation aims to explore the Influence of specific Cognitive and Noncognitive variables on Achievement in Chemistry among Secondary School Students. While the study focuses broadly on science education, it places particular emphasis on the domain of Chemistry education.

Need and Significance of the Study

Science education in schools initiates scientific thought in learners, develops their logical reasoning, enables them to acquire the strategy for problem solving method of enquiry to draw inferences and make decisions. Learning Science in school will open the most intellectual and honest method of seeking scientific truth. The knowledge of scientific method is the most important cognitive strategy a student is supposed to learn to participate in social life and succeed in personal life.

Science education involves more than just teaching science; it also involves engaging with the social influences that surround science, whether those influences are found at home or in a laboratory. This includes learning about the processes that teachers and scientists use to teach science. Research proponents have argued that the study and understanding of the interactions and interrelationship of Science – Technology – Society (STS) needs to become an integral part of contemporary and future science education for all (Yager, 1993; Wakes & Prakash, 1985).

By connecting science to everyday life, students become more engaged and motivated to learn. This approach also helps create responsible individuals who understand the impact of science on society. When students see the relevance of science to real-life issues, they are more likely to develop a deeper interest in the subject and its social implications.

Among the different science subjects that the secondary school students learn, Chemistry is an important subject, as it has direct and immediate effect on the day to day life of the individual and the society. The advancement of science and technology has paved the way for drastic changes in the discipline of Chemistry. The exponential growth of knowledge in the discipline of Chemistry has created a challenge for curricular experts, researchers, teachers and students. To cope up with new situation, it is mandatory on the part of NCERT and SCERT to take initiative for systemic revision and necessary modification in the Chemistry curriculum at secondary level.

At the time of curriculum transaction the teacher has to stimulate the minds of students and invoke in them scientific temper. To create interest in the subject, the teacher has to explain the concept thoroughly and if the teacher is fails in this academic process, the subject of chemistry becomes a phobia for students, and this leads to poor performance and failure in the subject.

Studies have shown that Chemistry is considered as a difficult subject for young students (Ayas & Demirbuker, 1994). Chemistry teachers, scholars and researchers have been trying to explain how students can be helped to understand Chemistry better (Eylon, 1986). Tsaparlis (1998) revealed that a majority of secondary school pupils are poor in Chemistry. Sherwood and Enoch (1984) reported that many of the secondary school students lack the understanding of chemical principles behind the equations and formulae. It is found that Organic Chemistry is a very important subject for all students of Chemistry. But, even the textbooks are not successful in offering a reasonable understanding of Chemistry concepts. Rote learning of formulae and principles without proper conceptual understanding in Organic Chemistry creates working memory difficulties (Hussein & Reid, 2009).

While, reviewing the literature, the investigator has identified certain psychological variables which have positive correlation in Achievement in Chemistry, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry. Sibomana (2021) observed that the secondary school students continue to consider Chemistry as difficult to learn and develop a negative attitude towards it. This leads to low Achievement in Chemistry even after applying innovative instructional strategies. Ranjusha (2021) in her study reveals that the extrovert personality shows positive correlation with Scientific Reasoning. Study has also shown that as extroversion increases Scientific Reasoning also tends to increase.

Shilina (2017) found that there exists significant effect of Self-efficacy on Achievement in Chemistry. Cognitive instructional strategy has significant effect on student Self-efficacy in Chemistry achievement. Prathibha (2018) in her study reveals that the total score of multiple intelligence and Achievement in Chemistry shows highly significant positive correlation for the whole sample and relevant subsamples. According to Kusumaningtyas (2020) Self-efficacy represents students' belief in their ability for high achievement. Students with high Self-efficacy are more engaged and motivated in school activities. They tend to perform better in science and are more likely to succeed in high school programs. Singh (2020) reveals that the scientific attitude is a major objective of science teaching and it should be cultivated and developed among high school students. Attitude towards science practicals and achievement in science is highly correlated.

The investigator has also observed from the literature review that, the chemistry is generally a difficult subject for secondary school students. The content incorporated in the syllabus is overloaded and students face difficulties in understanding the concepts, ideas and principles properly. The achievement of students in chemistry was also found poor and low. In order to overcome these situations, the factors associated with the backwardness in learning chemistry are to be identified. Effective strategies are to be evolved for improving the quality of teaching and learning chemistry thereby enhancing the Achievement in Chemistry at secondary level.

Based on research findings, key highlights of the National Education Policy 2020, the existing SCERT Chemistry curriculum at the secondary level, discussions with subject experts and the supervising teacher, as well as the investigator's own experience as a physical science teacher, the need for a thorough inquiry into the selected problem became evident. Furthermore, a review of existing studies confirmed that no prior research had combined these relevant factors. Consequently, the investigator decided to undertake this study.

Statement of the Problem

Identifying the determinant correlates of academic achievement has been a major area of research in education. The objective of identifying the correlates of Achievement in Chemistry will provide a solid foundation for future researchers in the field. It will enhance the development of more effective strategies for improving the performance in chemistry. As a result, the investigator has identified Verbal Intelligence and Scientific Reasoning as Cognitive variables and Attitude towards Chemistry and Self-efficacy in Chemistry as Noncognitive variables. Hence, the study is entitled as “Influence of Certain Cognitive and Non Cognitive variables on Achievement in Chemistry among Secondary School Students”.

Definition of Key Terms

Influence

According to Creswell (2014) Influence refers to the power or capacity of a variable to produce an effect on another variable, shaping outcomes and relationships within a research study.

In the present study, Influence means power or capacity of independent variables, selected Cognitive and Noncognitive variables, to produce an effect on dependent variable, Achievement in Chemistry among secondary school students.

Cognitive Variables

Cognitive variables are factors that contribute to information processing, including perception, attention, memory, reasoning, and problem-solving, which influence learning and academic achievement (Sternberg & Sternberg, 2016).

In the present study, Cognitive variables denote certain selected Cognitive variables on Achievement in Chemistry among secondary school students such as Verbal Intelligence and Scientific Reasoning.

Noncognitive Variables

Noncognitive variables denote, individual characteristics, attitudes, and socio-emotional skills that influence learning, academic achievement, and personal development but are not directly related to cognitive intelligence or intellectual ability. These variables include motivation, Self-efficacy, emotional regulation, resilience, and interpersonal skills, which significantly impact educational and life outcomes.

In the present study Noncognitive variables denote certain selected Noncognitive variables on Achievement in Chemistry among Secondary School students such as, Attitude towards Chemistry and Self-efficacy in Chemistry.

Achievement in Chemistry

Achievement is the demonstrated level of competence or mastery in a particular domain, typically measured by performance indicators such as test scores, grades, or other standardised assessments (Snow & Farr, 1987).

In the present study, Achievement in Chemistry denotes the accomplishment or acquired proficiency in the performance of IX standard Secondary School students in Chemistry.

Secondary School Students

Students attending standard VIII, IX, and X of Government/Aided Schools recognised by the Department of Education, Government of Kerala is considered as Secondary School students.

Variables Selected for the Study

Dependent Variable

In the present study, Achievement in Chemistry among Secondary School Students is taken as dependent variable.

Independent Variables

An independent variable is one that is predicted to influence the dependent variable. In the present study the investigator has selected certain Cognitive and Noncognitive variables as independent variables, they are:

Cognitive Variables

Verbal Intelligence

Scientific Reasoning

Noncognitive Variables

Attitude towards Chemistry

Self-efficacy in Chemistry

Classificatory Variables

The research studies have shown that gender, locale of the school and type of management of the school have an influence on differences in the academic achievement among the students. Hence, the investigator has included the following classificatory variables. They are:

Gender

Locale

Type of management of the school

Objectives of the Study

The present study is intended to find out the influence of selected Cognitive and Noncognitive variables on Achievement in Chemistry among Secondary School Students.

The following are the objectives of the study:

1. To find out whether there exists any significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and

the dependent variable, Achievement in Chemistry among secondary school students, based on subsamples, gender, locale and type of management.

2. To find out the main and interaction effects of selected Cognitive variables, namely Verbal Intelligence and Scientific Reasoning, on Achievement in Chemistry for the total sample and subsamples based on gender, locale and type of management.

3. To find out the main and interaction effects of selected Noncognitive variables, namely Attitude towards Chemistry and Self-efficacy in Chemistry, on Achievement in Chemistry for the total sample and subsamples based on gender, locale and type of management.

4. To find out the extent of relationship between selected Cognitive variables, namely Verbal Intelligence and Scientific Reasoning, and Achievement in Chemistry among secondary school students.

5. To find out the extent of relationship between selected Noncognitive variables, namely Attitude towards Chemistry and Self-efficacy in Chemistry, and Achievement in Chemistry among secondary school students.

6. To develop a regression equation for predicting Achievement in Chemistry based on selected Cognitive and Noncognitive variables.

Hypotheses of the Study

The following are the hypotheses formulated for the study:

1. There exists significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and the dependent variable, Achievement in Chemistry among secondary school students, based on subsample, gender.

2. There exists significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and the dependent variable, Achievement in Chemistry among secondary school students, based on subsample, locale.

3. There exists significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and the dependent variable, Achievement in Chemistry among Secondary School students, based on subsample, type of management.

4. Selected Cognitive variables have significant main and interaction effects on Achievement in Chemistry for the total sample and the subsamples based on gender, locale and type of management.

5. Selected Noncognitive variables have significant main and interaction effects on Achievement in Chemistry for the total sample and the subsamples based on gender, locale and type of management.

6. There exists significant relationship between selected Cognitive variables and Achievement in Chemistry.

7. There exists significant relationship between selected Noncognitive variables and Achievement in Chemistry.

8. Achievement in Chemistry can be predicted from a combination of selected Cognitive and Noncognitive variables.

Methodology in Brief

The present study is intended to find out the Influence of Certain Cognitive and Noncognitive variables on Achievement in Chemistry among Secondary School Students.

Method

Survey method is used for the present study.

Sample Selected for the Study

The data required for the present study were collected from a representative sample of 1200 secondary school students from Malappuram, Kozhikode and Kannur districts by using stratified random sampling technique giving due representation to strata like gender, locale and type of management of the institution. After discarding the incomplete answer scripts, the investigator has selected 1100 secondary school students as final sample for the study.

Tools Used for the Study

In order to measure the variables, the following tools were used for collecting the data.

1. Verbal Group Test of Intelligence (VGTI) (Kumar et al., 1997)
2. Scientific Reasoning Test in Chemistry (Chandran & Jaleel, 2017)
3. Scale of Self-efficacy in Chemistry (Rani & Saleem, 2020)
4. Scale of Attitude towards Chemistry (Rani & Saleem, 2020)
5. Achievement Test in Chemistry (Rani & Saleem, 2020)

Statistical Techniques for Analysis

The statistical techniques used for data analysis are as follows:

1. Basic Descriptive Statistics
2. Independent Sample t-Test
3. Two-way ANOVA (3 × 3 Factorial)
4. Pearson's Product Moment Correlation Coefficient
5. Multiple Regression Analysis

Scope and Limitations of the Study

Scope of the Study

The primary aim of the study is to determine the Influence of selected Cognitive and Noncognitive variables on Achievement in Chemistry among secondary school students. In the light of the research topic, the investigator has thoroughly reviewed and evaluated the findings and conclusions of earlier studies. The genuineness and relevance of the problem under consideration were also assessed in the light of the present Chemistry curriculum, syllabus and text books in use at the secondary school level.

The study was undertaken with Verbal Intelligence and Scientific Reasoning as Cognitive variables, and Attitude towards Chemistry and Self-efficacy in Chemistry as Noncognitive variables, all treated as independent variables. Achievement in Chemistry was identified as the dependent variable, while gender, locale, and type of management were considered as classificatory variables.

Therefore, it is expected that the study's conclusions would aid in the revision and systematic reform of the secondary school chemistry curriculum. The findings and conclusions will also throw light in the development of new instructional strategies and techniques, envisaged in the Kerala School Curriculum Revision, and the highlights of National Education Policy 2020.

In view of the development of information and technology and in the context of digital era, the findings will be useful for formulating more effective strategies and techniques for implementing continuous and comprehensive evaluation and assessment successfully for maximising the outcome based teaching and learning chemistry at secondary level.

Limitations of the Study

To make the study feasible and focused, the investigator confined the scope of investigation within the following delimitations:

1. The sample of the study was limited to Standard IX secondary school students.

2. Only twelve representative schools from the districts of Kannur, Kozhikode, and Malappuram were selected for data collection.

3. Among the cognitive and non-cognitive variables, only four variables were included in the study.

The study was also subject to certain limitations beyond the control of the investigator. These included variations in teaching quality, instructional methods, and availability of school resources, which might have influenced students' achievement in Chemistry, as well as differences in the sincerity of students' responses to the attitude and self-efficacy scales.

Organisation of the Report

The report of the study has been organised into six chapters:

Chapter I: Introduction

The introductory chapter discusses the rationale of selecting the problem, need and significance of the study, statement of the problem, definitions of key terms, objectives of the study, hypotheses of the study, methodology in brief, scope and limitations of the study, and organisation of the research report.

Chapter II: Review of Related Literature

This chapter presents a theoretical overview of the variables selected and review of related literature from the areas of selected variables.

Chapter III: Methodology

This chapter presents a detailed description of the methodology followed for the present study, namely methods adopted for the study, description of the variables selected, sample selected for the study, tools used for data collection, data collection procedure, and statistical techniques used for analysis of data.

Chapter IV: Analysis and Interpretation

The detailed analysis and interpretation of the collected data is presented in Chapter IV.

Chapter V: Summary, Findings and Conclusion

This chapter presents a brief summary of the study, major findings and conclusions.

Chapter VI: Recommendations and Suggestions

The final chapter presents recommendations, educational implications of the study and suggestions for further research.

The main body of the report is followed by references and appendices used for the study.

REVIEW OF RELATED LITERATURE

Chapter Two

- Theoretical Overview
- Review of Related Studies
- Conclusion

REVIEW OF RELATED LITERATURE

This chapter provides a brief overview of the theoretical framework of the variables selected and an in-depth review of relevant studies connected to the variables of the present study.

Theoretical Overview

The theoretical background of each variable selected are presented below:

Theoretical Overview of Intelligence

Intelligence - Origin, Meaning and Definition

The Latin word intelligentia, or intellects, which implies power of understanding, is where the word intelligence originates. The word intellectus became the academic technical term for understanding in the Middle Ages. Intelligence is also derived from Latin verb Intelligere means to understand, to comprehend or perceive in the Middle Ages, the word intellectus become the scholarly technical term for understanding (Harper, 2019). According to Wechsler (1958) the individual differs in the degree of there intelligence just as their heart rate or weight. An individual is highly intelligent in Egypt might not be considered so in USA for example. Talent for oratory was considered as sign for intelligence by ancient Greek and mastery of the written word was considered as a sign intelligence in China. Although specific definition of intelligence vary from person to person researchers have found that many individuals in our societies share the implicit assumptions about people who are intelligent, such people are described as having a practical problem solving ability, for instance the ability to reason logically, keep an open mind and see all sides of a problem and having verbal ability, for example, the capacity to express ones ideas coherently and clearly, and having the ability to interact with others (Sternberg et al., 1981).

Theories of Intelligence

One of the first influential theories of intelligence was suggested many years ago by Spearman (1927) who applied Sophisticated statistical analysis to the results of test scores on many kinds of abilities from reading comprehension to visualisation of spatial relationships. The study concluded that the score on any test depends in part on an 's' factor, meaning a specific kind of skill at that particular kind of task. But people with high level of 's' factor on one task also tend to make high scores on other tasks - a fact that the study revealed could only be explained by a pervasive, overall mental ability that the author called the 'g' factor, or general intelligent factor.

Thurston (1938) disagreed the above idea of general intelligence and set out to disapprove it. He proposed the theory that intelligence is composed of this general factor plus seven specific skills that he called primary mental abilities, namely;

Verbal Comprehension. Indicated by the size of vocabulary, ability to read, and skill at understanding analogies and the meaning of proverbs (Thurstone, 1938).

Word Fluency. The ability to think of words quickly as when making rhymes or solving word puzzles (Thurstone, 1938).

Number Facility. The ability to solve arithmetic problems and to manipulate numbers (Thurstone, 1938).

Spatial Visualisation. The ability to visualise spatial relationships, as in recognising a design after it has been placed in a new context (Thurstone, 1938).

Associative Memory. The ability to memorise quickly, as in learning a list of paired words (Thurstone, 1938).

Perceptual Speed. Indicated by the ability to grasp visual details quickly and to observe similarities and differences between patterns and pictures (Thurstone, 1938).

Reasoning. The ability to solve problems, draw logical conclusions, and think abstractly, often involving novel or complex situations (Thurstone, 1938).

People who are skillful at any one of them do not always do well on others. The correlations among them are so low. Recent theories also focusses on specific rather than general mental abilities, for example, one view proposed by Gardner (1983) is that individuals display a set of seven fundamental but separate intelligences, linguistic ability, skills in logic and mathematics, the ability to use spatial concept music ability, skills in logic and mathematics, the ability to use spatial concepts, musical ability skills of motor movement co-ordination, interpersonal skills and the ability to understand oneself.

Another view advanced by Sternberg (1985) proposes a Triarchic theory of intelligence emphasising that intelligence involves the ability to adapt to the particular environment in which analytical, creative and practical aspect of intelligence and the ability to apply it in various contexts, in which we find ourselves.

Theoretical Overview of Verbal Intelligence

Verbal Intelligence – Origin, Meaning and Definition

Verbal Intelligence, also known as verbal aptitude or linguistic intelligence, refers to an individual's ability to understand, use, and manipulate language effectively. It encompasses a range of language-related skills and capabilities, including vocabulary, grammar, syntax, reading comprehension, writing, speaking, and the ability to effectively communicate and express ideas. Verbal Intelligence is one of the multiple intelligences proposed by Gardner (1983) in his theory of multiple intelligences, which suggests that intelligence is not a single, fixed entity but a combination of different abilities and talents. The origin of Verbal Intelligence, like other forms of human intelligence, is a complex interplay of genetics and environmental factors. Some of the key factors that contribute to the development of Verbal Intelligence are as follows:

Genetics. Some individuals may have a genetic predisposition for strong language and communication skills. This genetic component can influence factors such as language acquisition and the ability to process and manipulate linguistic information.

Early Childhood Environment. A child's exposure to language and communication from an early age significantly impacts their Verbal Intelligence.

Children raised in environments rich in language, where they are read to, spoken to, and encouraged to engage in conversations, tend to develop stronger verbal skills.

Education. Formal education plays a crucial role in the development of Verbal Intelligence. Schools teach grammar, vocabulary, reading, writing, and critical thinking skills, all of which contribute to an individual's verbal aptitude.

Socioeconomic Factors. Socioeconomic status can affect a person's access to educational resources and opportunities. Individuals from more privileged backgrounds may have better access to books, language-rich environments, and quality education, which can enhance their Verbal Intelligence.

Cultural Influences. Language is deeply influenced by culture, and exposure to different languages and cultures can broaden one's Verbal Intelligence. Bilingualism or multilingualism, for example, can have a positive impact on verbal aptitude.

Personal Motivation and Practice. An individual's motivation to improve their Verbal Intelligence and their willingness to practice and refine their language skills can also play a significant role in its development.

Verbal Intelligence refers to Gardner (1983) an individual's capacity to effectively use and understand language, encompassing skills such as vocabulary, grammar, reading comprehension, writing, speaking, and the ability to express thoughts and ideas clearly. It involves the cognitive abilities associated with language processing and communication, making it a vital component of human intelligence.

Characteristics of Verbal Intelligence

Verbal Intelligence, also known as linguistic intelligence, is characterised by a range of cognitive and linguistic abilities related to language. These characteristics are as follows:

Strong Vocabulary. Individuals with high Verbal Intelligence tend to have an extensive and varied vocabulary. They can easily learn new words and use them effectively in communication.

Grammar and Syntax Mastery. They have a strong grasp of grammar rules and sentence structure, allowing them to construct grammatically correct and well-structured sentences.

Reading Comprehension. Verbal Intelligence is often associated with excellent reading comprehension skills. People with high Verbal Intelligence can understand complex texts, extract key information, and analyze written material effectively.

Writing Skills. They excel in written communication, demonstrating the ability to express their thoughts and ideas clearly and persuasively through writing. They often produce well-organised and articulate essays, reports, or creative works.

Oral Communication. Individuals with high Verbal Intelligence are skilled in oral communication. They can express themselves eloquently, engage in meaningful conversations, and communicate their ideas effectively in various social and professional settings.

Critical Thinking. Verbal Intelligence is often linked to critical thinking abilities. These individuals can analyze and evaluate arguments, identify logical fallacies, and engage in meaningful debates.

Wordplay and Humour. They may have a talent for wordplay, puns, and humour. Verbal Intelligence often includes the ability to recognise and create clever linguistic jokes and witticisms.

Language Adaptability. Verbal Intelligence extends to adaptability in using different languages and dialects. Bilingual or multilingual individuals can switch between languages effortlessly and understand cultural nuances in language.

Story Telling. People with high Verbal Intelligence excel in storytelling. They can captivate an audience through narrative, using vivid descriptions and compelling characters.

Linguistic Analysis. They can dissect language effectively, analysing texts for deeper meanings, rhetorical devices, and literary techniques.

Theories of Verbal Intelligence

Verbal intelligence is a component of human intelligence that relates specifically to language-related abilities. While there isn't a single theory exclusively to verbal intelligence, some of the theories related verbal intelligence are as follows

General Intelligence (g) Theory. Spearman's (1904) theory of general intelligence, also known as the "g" factor theory, proposes that there is a single underlying factor (g factor) that influences all cognitive abilities, including verbal intelligence. In this theory, individuals who excel in verbal tasks are likely to excel in other cognitive domains also.

Theory of Multiple Intelligences. Theory of Multiple Intelligences proposed by Gardner (1983) representing different cognitive abilities. Verbal intelligence, or linguistic intelligence, is one of the intelligences identified by Gardner. It deals with individuals' linguistic and language-related abilities.

Triarchic Theory of Intelligence. Here verbal abilities are associated with analytical intelligence. Sternberg's (1985) Triarchic Theory of Intelligence consists of three components: analytical intelligence (related to problem-solving and critical thinking), creative intelligence (related to generating novel ideas), and practical intelligence (related to adapting to real-life situations).

Cattell-Horn-Carroll Theory. Cattell-Horn-Carroll theory (2005) of cognitive abilities is a comprehensive model that includes verbal comprehension as one of its broad abilities. In this theory, verbal comprehension encompasses understanding and using language effectively.

Information Processing Theories. Miller’s (1956) theory of Information processing theories focus on how cognitive processes, including those related to language and verbal tasks, work. These theories examine how individuals perceive, encode, store, and retrieve information. Verbal intelligence plays a role in language processing and comprehension within these frameworks

Theoretical Overview of Scientific Reasoning

Scientific Reasoning - Origin, Meaning and Definition

The origin of Scientific Reasoning can be traced back to ancient civilisations, with contributions from various cultures and thinkers throughout history. However, the modern scientific method as we know it today emerged during the Scientific Revolution of the 16th and 17th centuries, with notable figures like Galileo Galilei, Johannes Kepler, and Sir Isaac Newton playing key roles in developing the principles of empirical observation, hypothesis testing, and mathematical modelling. Over time, Scientific Reasoning has evolved and been refined, incorporating new methodologies and tools as technology advanced.

Scientific reasoning is a key component of the scientific method, which involves investigating natural phenomena, making observations, developing hypotheses, conducting tests, and drawing conclusions. It involves a structured and logical thought process aimed at understanding and explaining the world around us.

Scientific Reasoning is a rigorous and systematic approach to understanding the natural world. It emphasises objectivity, repeatability, and the reliance on empirical evidence to draw conclusions about the physical and natural phenomena. It is characterised by the following key principles:

Empiricism. Scientific Reasoning relies on observable, measurable evidence as the basis for forming conclusions. It values data obtained through experimentation and observation.

Hypothesis Testing. Scientists propose hypotheses that can be tested and potentially falsified through experimentation. This distinguishes Scientific Reasoning from other forms of reasoning.

Openness to Revision. Scientific conclusions are provisional and subject to change in the face of new evidence. Scientists are willing to modify or abandon hypotheses and theories if they no longer align with the data.

Peer Review. Scientific work is subject to peer review by other experts in the field to ensure rigour and credibility.

Scientific Reasoning can be defined as the process of using critical thinking, empirical evidence, and logical principles to:

Observe and Collect Data. Scientists begin by making systematic observations of natural phenomena and collecting data through experimentation, measurement, and observation.

Formulate Hypotheses. Based on these observations, scientists develop hypotheses or educated guesses about the underlying principles or causes of the phenomena they are studying.

Design Experiments. Scientists design controlled experiments to test their hypotheses. These experiments are carefully structured to isolate specific variables and control for other factors that might affect the outcome.

Collect and Analyse Data. During the experiments, data is collected and analysed to determine whether it supports or contradicts the hypothesis.

Draw Conclusions. Based on the data analysis, scientists draw conclusions about whether their hypotheses are supported or refuted. These conclusions are subject to critical review and may lead to the revision of existing theories or the development of new ones.

Communicate Findings. Scientists communicate their findings through research papers, presentations, and other forms of dissemination, allowing the broader scientific community to evaluate, replicate, and build upon their work.

Characteristics of Scientific Reasoning

Scientific Reasoning is characterised by a set of distinctive features that distinguish it from other forms of reasoning. These characteristics ensure that the scientific method is a reliable and systematic way to investigate and understand the natural world. Here are the key characteristics of Scientific Reasoning:

Empirical Observation. Scientific Reasoning relies on direct observations of the physical world. It emphasises the collection of empirical data through sensory experiences and measurements. This empirical evidence forms the basis for scientific conclusions.

Systematic and Logical. Scientific Reasoning follows a systematic and logical process. It involves the careful design of experiments, the formulation of hypotheses, the collection of data, and the application of logical reasoning to draw conclusions.

Objectivity. Scientists strive to maintain objectivity by minimizing bias and personal beliefs in their research. They use standardised methods and procedures to ensure that their observations and measurements areas objective as possible.

Falsifiability. Scientific hypotheses and theories must be testable and potentially falsifiable. This means that they can be subjected to experiments or observations that could prove them wrong. The ability to be proven false is a hallmark of scientific claims (Popper, 2005).

Replicability. Scientific experiments and observations should be replicable, meaning that other researchers should be able to reproduce the results using the same methods and conditions. Replication adds credibility to scientific findings.

Generalisability. Scientific Reasoning seeks to identify general principles or laws that apply beyond the specific circumstances of a single experiment. Generalisability allows scientists to make predictions and apply their findings to a broader context.

Cumulative. Scientific knowledge is cumulative, building upon previous discoveries and theories. New research is conducted in the context of existing knowledge, and scientific theories are refined and expanded over time.

Open to Revision. Scientific conclusions are provisional and subject to revision in the light of new evidence. Scientists are willing to adjust or even discard theories if they are no longer supported by data.

Peer Review. Scientific work undergoes peer review, where other experts in the field critically evaluate research methods, data, and conclusions. Peer review helps ensure the quality and reliability of scientific findings.

Mathematical and Quantitative. Many scientific disciplines use mathematical and quantitative methods to describe and analyze natural phenomena. Mathematics provides a precise language for expressing scientific relationships.

Theories of Scientific Reasoning

Scientific Reasoning encompasses various theories and approaches that aim to understand and describe the processes involved in scientific inquiry and problem-solving. Here are some prominent theories and perspectives on Scientific Reasoning:

Inductivism. This traditional theory of Scientific Reasoning, associated with philosophers like Bacon, suggests that scientific knowledge is built through a process of induction. It involves making numerous observations and drawing generalisations or theories from these observations. However, inductivism has been criticised for its failure to account for the problem of induction and the under determination of theories by data.

Deductive Reasoning. Deductive reasoning involves starting with general premises and using logical rules to derive specific conclusions. While it's not the primary method of scientific inquiry, deductive reasoning plays a role in hypothesis testing and theory validation. It is particularly important in mathematics and formal sciences.

Hypothetico-Deductive Model. Proposed by Hempel (1965) and others, this model emphasises the formulation of hypotheses (educated guesses) and the deduction of testable predictions from these hypotheses. Scientific Reasoning then involves testing these predictions through experimentation or observation. The model emphasises the falsifiability of hypotheses.

Bayesian Reasoning. Bayesian reasoning (Howson, 2006) is based on the use of probability theory to update beliefs and make inferences in light of new evidence. It is particularly useful in fields where uncertainty and probability play a significant role, such as statistical analysis, machine learning, and decision-making under uncertainty.

Abductive Reasoning. Abductive reasoning, championed by philosophers like Peirce (1998) involves generating the best possible explanation for observed phenomena. It often starts with observations or data and seeks to infer the most likely hypothesis or explanation that accounts for the observations. Abduction is common in hypothesis generation and problem-solving.

Popper's Falsificationism. Popper (1959) proposed that Scientific Reasoning involves making conjectures or hypotheses and subjecting them to rigorous tests to see if they can be falsified (proven wrong). He argued that scientific knowledge advances through the rejection of false theories rather than their verification. This approach emphasizes the importance of falsifiability and empirical testing.

Kuhn's Paradigm Shifts. Kuhn's (2012) theory of Scientific Reasoning emphasizes that scientific progress occurs through paradigm shifts. In his view, scientists work within established paradigms or frameworks until anomalies accumulate, leading to a crisis and eventually a paradigm shift. During these shifts, Scientific Reasoning may undergo fundamental changes.

Social Constructivism. This perspective on Scientific Reasoning suggests that scientific knowledge is not solely a product of individual reasoning but is influenced by social and cultural factors. It emphasises the role of communities of scientists, peer review, and consensus- building in the development of scientific theories.

Inference to the Best Explanation. This theory, proposed by philosophers like Harman (1965) and Lipton (2004), posits that Scientific Reasoning involves selecting the hypothesis that provides the best overall explanation for the available evidence. It involves weighing competing hypotheses and assessing their explanatory power.

Pragmatism. Pragmatic approaches to Scientific Reasoning, as advocated by philosophers like James (1907) and Peirce (1998), emphasise the practical consequences of scientific beliefs and theories. Scientific Reasoning is seen as a tool for achieving specific goals or solving practical problems.

Theretical Overview of Attitude towards Chemistry

Attitude towards Chemistry - Origin, Meaning and Definition

The term "attitude" has its origin in the Latin word "aptitudo," which means "aptitude" or "fitness." Over time, its meaning evolved to encompass the psychological and social concept we understand today.

Attitude refers to Eagly and Chaiken (1993) a person's emotional and cognitive evaluation or disposition towards an object, person, group, idea, situation, or any other aspect of their environment. It reflects an individual's feelings, beliefs, and behavioural tendencies that can be positive, negative, or neutral.

The concept of "Attitude towards Chemistry" refers to Collins (2003) an individual's feelings, beliefs, opinions, and predispositions regarding the subject of chemistry. It encompasses how a person perceives, evaluates, and responds to chemistry as a discipline or field of study. Thus, attitude can be positive, negative, or neutral and may influence a person's engagement with and success in learning chemistry.

Attitude towards Chemistry can be defined as Kho (2005) a person's overall outlook, emotions, and cognitive evaluations related to the study and practice of chemistry. It includes:

Affective Component. This aspect involves the emotional responses and feelings associated with chemistry. For example, someone with a positive attitude may find chemistry exciting and enjoyable, while someone with a negative attitude may find it boring or intimidating.

Cognitive Component. This component relates to a person's beliefs and thoughts about chemistry. It encompasses perceptions of its relevance, importance, and difficulty. Someone with a positive cognitive component may believe that chemistry is essential and can be mastered with effort, whereas someone with a negative cognitive component may see it as unimportant or too complex.

Behavioural Component. Attitude can also influence a person's behaviour towards chemistry. It may affect their motivation to study the subject, their willingness to seek help when needed, and their persistence in overcoming challenges.

An attitude is a mental and neural state of readiness, organised through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related (Allport, 1935).

Allport's definition emphasises several key points such as

Mental and Neural State. Attitudes are not directly observable but exist as mental and neural states within an individual.

Readiness. Attitudes reflect a readiness or predisposition to respond to objects, people, or situations in a certain way.

Organised through Experience. Attitudes are shaped and organized through an individual's past experiences, including social and personal interactions.

Directive or Dynamic Influence. Attitudes have the capacity to influence a person's behaviour and responses to various objects and situations.

Characteristics of Attitude towards Chemistry

Attitudes toward chemistry Eagly and Chaiken (1993) can vary widely among individuals, and they are characterised by several key attributes:

Valence. Attitudes toward chemistry can be positive, negative, or neutral. Positive attitudes reflect a favorable disposition toward chemistry, while negative attitudes indicate an unfavorable or aversive disposition. Neutral attitudes suggest a lack of strong positive or negative feelings.

Intensity. Attitudes can vary in intensity. Some individuals may have strong and deeply held attitudes toward chemistry, while others may have milder or less passionate attitudes.

Stability. Attitudes can be relatively stable over time, but they can also change or evolve based on experiences, education, and exposure to new information or perspectives.

Components. Attitudes are multifaceted and typically consist of three components:

Affective Component. This involves emotional responses and feelings related to chemistry, such as excitement, boredom, or fear.

Cognitive Component. This includes beliefs, thoughts, and perceptions about chemistry, such as its importance, relevance, and difficulty.

Behavioural Component. Attitudes can influence behaviour, such as a student's motivation to study chemistry, their willingness to participate in chemistry-related activities, and their persistence in overcoming challenges.

Subject-Specific. Attitudes can be subject-specific. An individual's attitude toward chemistry may differ from their attitude toward other subjects or areas of interest.

Influence on Learning. Attitudes toward chemistry can significantly impact an individual's approach to learning the subject. Positive attitudes are often associated with greater motivation, engagement, and success in chemistry-related tasks, while negative attitudes can hinder learning and achievement.

Theories of Attitude Toward Chemistry

There are several theories and models in psychology and education that provide insights into attitudes toward various subjects, including chemistry. These theories help explain how attitudes are formed, changed, and how they influence behaviour. While there may not be specific theories exclusively focused on attitudes toward chemistry, the following psychological and educational theories can be applied to understand attitudes toward this subject:

Theory of Planned Behaviour (TPB). This theory, developed by Ajzen (1991), posits that attitudes, subjective norms, and perceived behavioural control collectively determine an individual's intention to perform a behaviour, which, in turn, predicts the actual behaviour. In the context of chemistry, this theory can help explain how students intend to participate in chemistry-related events or courses are influenced by their attitudes, perceptions of social norms, and sense of control.

Social Cognitive Theory. This theory, developed by Bandura (1986), emphasises the role of social influences and Self-efficacy in shaping behaviour. In the context of attitudes toward chemistry, it can help explain how observing others' experiences with chemistry and one's perceived ability to succeed in the subject influence attitudes and engagement.

Elaboration Likelihood Model (ELM). Developed by Petty and Cacioppo (1986), this model describes how individuals process persuasive messages and make decisions based on the central route (careful, thoughtful processing) or the peripheral route (quick, heuristic processing). In chemistry education, this model can be applied to understand how different teaching methods and communication strategies affect students' attitudes and engagement.

Expectancy-Value Theory. This theory (Eccles & Wigfield, 2002) rooted in motivation and decision-making, suggests that attitudes are influenced by expectations of success and the perceived value of an activity or goal. In the context of chemistry, it can help explain how students' perception about their ability to succeed in chemistry and the perceived value of chemistry in their lives influence their attitudes and engagement.

Theoretical Overview of Self-efficacy in Chemistry

Self-efficacy in Chemistry - Origin, Meaning and Definition

The concept of Self-efficacy was developed by Bandura (1977) in the field of psychology. Bandura introduced the concept of self- efficacy in the 1970s as a part of his social cognitive theory, which focuses on the role of self-beliefs in human behaviour. This concept is derived from Bandura's broader theory of Self-efficacy, which focuses on an individual's beliefs about their capabilities in various domains. In the context of chemistry, or any other subject, Self-efficacy would relate to a student's confidence in their ability to comprehend and excel in that subject.

In the context of Chemistry, Self-efficacy is the conviction that one can comprehend, acquire and carry out task activities or academic endeavours pertaining to chemistry easily. It is a particular component Self-efficacy that related to one's confidence and impression of their ability in the subject of Chemistry.

In the realm of education, Self-efficacy can be developed and nurtured through various means:

Mastery Experiences. Successfully completing chemistry tasks, assignments, or experiments can boost one's Self-efficacy. As students experience success and improvement, their belief in their chemistry abilities grows.

Vicarious Learning. Observing others, such as teachers or peers, successfully handle chemistry concepts or problems can also enhance Self-efficacy. This is why having effective role models or mentors in the field of chemistry can be beneficial.

Verbal Persuasion. Encouragement, positive feedback, and supportive language from teachers, parents, or peers can influence a student's Self-efficacy beliefs. Constructive feedback and praise can build confidence.

Emotional and Physiological States. Managing anxiety and stress related to chemistry can be crucial. When students learn to regulate their emotions and reduce stress, they are more likely to believe in their ability to handle chemistry challenges.

Cognitive Appraisals. Helping students develop realistic and optimistic self-assessments of their chemistry abilities can contribute to higher Self-efficacy. This involves addressing and reframing negative or self-limiting beliefs.

Teachers and educational institutions play an important role in developing students Self-efficacy and attitude, when it comes to chemistry education. Students with high feeling of Self-efficacy in Chemistry is more likely to be interested in the subject and will persist in difficulties and ultimately perform better academically.

Self-efficacy in Chemistry is the belief an individual holds about their capacity to comprehend and excel in chemistry-related endeavors. It encompasses their confidence in solving chemistry problems, conducting experiments, understanding chemical concepts, and achieving success in chemistry coursework.

In terms of Education, Self-efficacy in Chemistry can have a substantial impact on a student's motivation, learning and academic performance. Students with strong Self-efficacy in Chemistry are more likely to engage in learning activities, persevere through difficulties and do better on assignments pertaining to chemistry.

The foundational work on Self-efficacy is primarily found in Bandura's publications and research papers. In this, he outlines the theory of Self-efficacy and its implications for understanding human behaviour and motivation. While this work does not focus specifically on chemistry, it provides the theoretical framework upon which the concept of Self-efficacy in Chemistry is based.

Characteristics of Self-efficacy in Chemistry

Self-efficacy in the context of Chemistry, possesses certain characteristics that describe how individuals perceive their own abilities and how these perceptions influence their behaviour and performance in the field of chemistry. Here are some key characteristics of Self-efficacy in Chemistry:

Confidence. Individual with strong Self-efficacy in Chemistry feel that they can comprehend and perform in chemistry related activities effectively. They have confidence in their understanding and proficiency in Chemistry.

Task-Specific. Self-efficacy beliefs are task-specific. This means that individuals may have varying levels of Self-efficacy for different chemistry-related activities, such as solving equations, conducting experiments, or grasping complex concepts.

Impact on effort and Persistence. People with high levels of Self-efficacy in Chemistry encourages people to work hard and persevere when facing challenges.

Outcome Expectations. Self-efficacy is tied to outcome expectations. Individuals with high chemistry Self-efficacy believe that their efforts will lead to successful outcomes, such as good grades or a deeper understanding of the subject.

Feedback Sensitivity. People with strong chemistry Self-efficacy are more open to feedback and view it as away to improve their skills. They see constructive feedback as a means to enhance their chemistry proficiency.

Vicarious Learning. Observing others succeed in chemistry tasks, especially role models or peers, can positively influence one's Self-efficacy in Chemistry. Seeing others achieve success can boost one's belief in their own capabilities.

Emotional Regulation. High Self-efficacy in Chemistry is associated with better emotional regulation. Individuals with strong Self-efficacy tend to experience less anxiety and stress when dealing with Chemistry related challenges.

Success and Failure attribution. Chemistry students with strong Self-efficacy are more likely to attribute success to their own efforts and skills, while failures are inclined to external variables that can be changed or improved.

Domain Specific. Self-efficacy is domain-specific, meaning that a person's belief in their chemistry abilities may not necessarily extend to other subjects or domains.

Theories of Self-efficacy

Broader theories of Self-efficacy such as Bandura (1977) Social cognitive theory of Self-efficacy, can be applied to understand and study Self-efficacy in the context of Chemistry, researchers frequently apply broad ideas of Self-efficacy in the field of Chemistry education. are some main theories about Self-efficacy in the context of teaching chemistry.

Social Cognitive Theory (Bandura). The theory of Self-efficacy is the basis for understanding Self-efficacy in any subject, including Chemistry. This idea holds that Self-efficacy beliefs influence an individual's motivation, behaviour, and performance.

Self-Regulated Learning Theories. Self-regulated learning theories, such the social cognitive model of self-regulation developed by Zimmerman's (2000) are important for comprehending students' sense of Self-efficacy in Chemistry classes. These theories look at how students plan their learning strategies, establish goals and track their progress in chemistry tasks, all linked to Self-efficacy beliefs.

Theoretical Overview of Achievement in Chemistry

Achievement in Chemistry – Origin, Meaning and Definition

The word "achievement" comes from the Middle English word *acheven*, which means "to finish or complete." It was derived from Old French *achever*, meaning "to bring to an end," with roots in the Latin *ad caput venire*, which translates as "to come to a head" or "to reach the end." The term has evolved over time to focus more on the success and accomplishment of goals or tasks (Harper, 2004)

The word Achievement denotes something that one has done successfully, through hard work or skill. According to Collins dictionary (2022), an achievement is something, which someone has succeeded in doing, especially after a lot of effort. It is the process of achieving something.

Achievement is defined as the act of accomplishing something successfully, typically through effort, skill or courage. It refers to the attainment of a goal, milestone or standard of excellence. Achievement can be personal, academic or professional and are often used as indicators of success (Merriam-Webster.com dictionary, 2022).

The concept of achievement tests and standardised testing has evolved over time, and it is not attributed to a single originator. However, some key figures and developments in the history of achievement testing are worth noting:

Francis Galton (1822-1911). Galton (1883) made significant contributions to the field of psychological testing. He developed tests to assess sensory acuity and reaction time, laying the groundwork for the later development of standardised tests.

Alfred Binet (1857-1911). Binet (1905) a French psychologist, is often credited with pioneering the modern concept of intelligence testing. In 1905, he developed the Binet-Simon scale, which aimed to assess a child's cognitive abilities and intellectual development. While his work primarily focused on intelligence, it was an important precursor to achievement testing.

Lewis Terman (1877-1956). Terman (1916), an American psychologist, adapted Binet's intelligence tests for use in the United States. Terman's revisions of the Binet-Simon scale led to the creation of the Stanford-Binet Intelligence Scales, which assessed a person's cognitive abilities and intelligence quotient (IQ).

The term "achievement test" is quite self-explanatory. It refers to a test designed to measure what an individual has achieved or learned in a specific subject or area. These tests typically focus on the content and skills that are taught within a curriculum or instructional programme. The purpose is to assess how well a person has mastered the material and can apply it in practice. Achievement tests are typically contrasted with aptitude tests, which assess a person's potential to learn or acquire new skills. Achievement test is designed to measure the knowledge and skill among students, learned from schools or to determine the academic progress they have made over a period of time.

Achievement tests have been used in educational and assessment contexts for many years. The concept of assessing individuals' achievements and knowledge dates back to the early days of formal education. Over time, these assessments became more standardised and structured, leading to the development of modern achievement tests. The origin of achievement testing can be traced back to the need for objective and consistent measures of educational progress. The origin of achievement tests in chemistry, like achievement tests in other subjects, can be traced back to the broader history of standardised testing and the need for objective measures of academic achievement.

The expansion of formal education systems and the requirement to evaluate and compare student learning outcomes are related to the development of standardised achievement tests. As educational systems changed, teachers and researchers were looked for new evaluation methodologies to assess students' academic performances.

Chemistry, as a distinct field of study within science education, would have been included in the broader context of educational assessment. Over time, as chemistry education became more standardised and curriculum-based, there would have been a demand for assessments specifically tailored to chemistry content and skills.

Characteristics of Achievement Test in Chemistry

Achievement tests in chemistry, like other achievement tests, are intended to evaluate an individual's knowledge and abilities in a particular subject area, or in this case, Chemistry. Here are some key characteristics of achievement tests in chemistry:

Subject-Specific Focus. Achievement tests in chemistry are subject-specific, meaning they concentrate exclusively on assessing the knowledge and skills related to chemistry topics. They typically cover a range of chemistry concepts, including chemical reactions, atomic structure, chemical bonding, stoichiometry, and more, depending on the level of the test (e.g., high school chemistry, college-level chemistry, etc.).

Curriculum Alignment. These tests are aligned with the curriculum and learning objectives for chemistry education. They assess what students are expected to have learned in their chemistry courses, making them valuable tools for educators to gauge the effectiveness of their teaching.

Content Coverage. Chemistry Achievement tests cover a wide range of topic in the field. They frequently consist of questions on applying concept of chemistry to real world situations, problem solving techniques, theoretical knowledge and laboratory abilities.

Standardised Format. Standardised formats often incorporate multiple-choice short response and essay style questions. Standardisation guaranties consistency in test administration and scoring.

Scoring and Grading. Achievement tests in chemistry are scored objectively, using predetermined criteria. Points are awarded based on the accuracy and completeness of the responses. The scoring system may vary depending on the specific test, but it's typically designed to provide a clear measure of a student's performance.

Norm-Referenced or Criterion-Referenced. These tests can be either norm-referenced or criterion-referenced. Norm-referenced tests compare a student's performance to that of a group (the norming group), while criterion-referenced tests assess whether a student has met specific performance criteria or standards (Brown, 2011).

Validity and Reliability. Like all assessments, achievement tests in chemistry should be designed, administered, and scored in a way that ensures validity (they measure what they are supposed to measure) and reliability (they produce consistent results). Test developers typically conduct research to establish these characteristics.

Review of Related Studies

Any research study must include a review of related studies in order to get current knowledge about previous ideas and research in the specific field chosen for the investigation. It is an essential part in the research process that can articulate and support claims about the knowledge in the field of investigation. It helps to know the latest developments in the area of knowledge since to be a challenge, especially in the context of knowledge exploration, but an understanding of the present development in the area, helps the researcher to expand the knowledge base.

It also act as a guideline for the whole research work, it helps the researcher to know varies trends and designs of research work done on the topic earlier. This attempt also provided the investigator a base for the formulation of objectives, framing the hypotheses, defining the problem and knowing delimitations.

Based on a detailed analysis of the literature available on the topic of investigation, the investigator has classified and carried out and presented under the following headings:

Studies related to Verbal Intelligence

Studies related to Scientific Reasoning

Studies related to Attitude towards Chemistry

Studies related to Self-efficacy in Chemistry

Studies related to Achievement in Chemistry

Studies Related to Verbal Intelligence

Albulene et al. (2022) studied the non-Verbal Intelligence and the importance of group functioning in developing narrative skills and school success in children aged 7-9 Years The study aimed to investigate the relationships between non-Verbal Intelligence, storytelling abilities, academic accomplishment, and social group functioning. Mixed-design study included 109 youngsters as a sample, who were first subjected to the sociometric approach to determine which socioeconomic group they belong to. Second, the novel "Frog Where Are You?" was used to evaluate their narrative abilities. Records of grade point averages have been compiled in the corresponding class record books. The findings indicated that there are disparities between social group types in terms of academic success and non-verbal IQ. Success in school is significantly correlated with nonVerbal Intelligence, narrative ability, and other talents. Narrative abilities and nonVerbal Intelligence are predictive of academic performance.

Deepali and Dubey (2021) analyzed the level of Verbal Intelligence among students of government upper primary school'. The goal of the study was to evaluate Verbal Intelligence of pupils at Government Upper Primary School in relation to their age and family income. 80 kids in all were chosen at random from Kurebhar Block's government Upper Primary schools in Sultanpur. Children's verbal IQ was evaluated using the Verbal IQ Test. There were relatively few responders that fell into the Very Superior, Superior, Borderline, and Defective categories of Verbal Intelligence, with the majority of the youngsters falling into the Normal category. The main result of this study was that the majority of males (31.25 percent) and the majority of girls (27.50 percent) both had normal Verbal Intelligence

Allison et al. (2021) explored sources of individual differences in children's interest in science. although efforts have been made to encourage children's interest in science, little is known about the relationships between science interest and other traits like Verbal Intelligence, domain-general epistemic curiosity, and science-specific curiosity. The study analyzed at the relationship between these variables and individual variations in kids' self-reported interest in science-related subjects. Children aged 7 to 10 (n = 91) performed tests of Verbal Intelligence, domain-general epistemic curiosity, and science-specific curiosity in addition to rating their interest in scientific and non-science subjects. A total of 94 children aged 7 to 10 assessed their inclination towards science and non-science subjects and finished the science-specific curiosity questionnaire. The findings indicated significant relationship between individual variations in children's interest in science and scientific curiosity is the desire to learn new things and obtain information.

Filiz and Bijen (2020) examined the relation between effective communication skills and Verbal Intelligence levels of faculty of sport sciences students. This study sought to investigate the association between students' Verbal Intelligence and effective communication skills across a range of faculty of sports sciences variables, including gender, department, age, academic grade point average (GPA), and method of enrolment in the Effective Communication Skills (ECS) course., the correlational survey model was employed. The subjects, who volunteered to be university students, were selected using a basic random sample technique. The effective communication skills scale and the multiple intelligence areas inventory were applied. The outcome demonstrated a statistically significant gender difference in effective listening skills for female pupils. Regarding the sub-dimensions of Verbal Intelligence, language, and self-recognition/self-disclosure, a statistically significant difference was observed in favour of the Recreation Department. The age variable revealed a substantial difference in favour of the 21–23 age group in the self-recognition/self-disclosure sub-dimension. Academic GPA revealed a significant difference in the Verbal Intelligence sub-dimension, favouring individuals with an academic GPA between 3.15 and 3.57. Furthermore, based on the method of completing the ECS course, a noteworthy distinction was observed favouring the required course in the sub-dimensions of language, self-recognition/self-disclosure, and ego-supporting language. Furthermore, a strong and positive correlation was found between students' verbal IQ scores and their ability to communicate effectively. Consequently, it has been concluded that the ECS course should be required as part of the curriculum in order to support the development of communication skills.

Selma et al. (2020) examined how children's verbal and nonverbal abilities developed in relation to their capacity to predict, observe, and explain three causal processes that are pertinent to physics, biology, and chemistry. Sample: Youngsters (N = 107) between the ages of 5 and 11 from Oxford and London, representing a wide range of language and ethnic backgrounds and socioeconomic statuses (SES). Techniques: To encourage attention to mechanism, children were evaluated individually on causal tasks centred on sinking, absorption, and dissolving. A novel approach was adopted in which children witnessed contrasting examples of each activity. Additional tests evaluated the participants' non-verbal (block design) and verbal (expressive language) skills. The findings of the study are although reports varied depending on the task, they improved with age. Even the younger individuals provided insightful accounts of what they saw Although they developed more slowly, causal explanations had a stronger correlation with observation than with prior knowledge-based prediction. Performance was predicted by nonverbal but not general verbal competence.

Gurcay and Ferah (2017) conducted a study on the effect of multiple intelligences based instruction on student's physics achievement and attitudes. 95 ninth-grade students made up the study's sample, was selected by random sampling methods. The sample was split into experimental and control groups, and each received instruction using a different approach based on multiple intelligences. Data from the sample was gathered using the Force and Motion Achievement Test, the Force and Motion Attitude Scale, and the Multiple Intelligence Profile Questionnaire. The study came to the conclusion that multiple intelligences-based instruction plays a significant effect in students' academic progress.

Nikolaev et al. (2016) conducted a study on the relative Verbal Intelligence and happiness, the findings regarding the relationship between happiness and relative Verbal Intelligence. Results indicated a small, but significant, positive, and positive association between verbal IQ and happiness from the General Social Survey for a large representative sample of Americans. The findings indicated a significant correlation between verbal intelligence and happiness, suggesting that individuals with superior verbal skills compared to their peers are more like to report higher levels of happiness. Even after accounting for a substantial number of socioeconomic factors, including relative income, the positional effect of happiness persists.

Ahvan and Pour (2016) investigated the correlation of multiple intelligences for the achievements of secondary students based on Gardner's Multiple Intelligences hypothesis, to determine the relationship between multiple intelligences and the academic achievement levels of high school pupils. The research involved descriptive correlation. 270 pupils from Bandar Abbas High School were chosen using clustered random selection. Regression and descriptive statistics, such as Mean, Standard Deviation, Pearson coefficient correlation, were used. The results showed that there is a moderate inter-correlation between verbal language, visual-spatial, and academic ability. Students' academic performance and achievement are significantly positively correlated with several intelligences such as logical-mathematical, visual-spatial, verbal-linguistic intrapersonal, bodily-kinesthetic, interpersonal, and naturalistic intelligences. Musical intelligence negatively predicted students' academic success, although many intelligences such as visual-spatial, verbal-linguistic, and interpersonal were statistically significant predictors of academic achievement.

Shahzada et al. (2014) analyzed the interrelation of multiple intelligences and their correlation with students academic achievement. Data was collected through random sampling technique and the sample consisted of 905 secondary school students from Khyber Pakhtunkhwa′s southern districts. Data analysis used Pearson′s coefficient of correlation. Results indicated that there exist stronger relationship between achievement in learning, Verbal Intelligence, and mathematical intelligence.

Ramkumar (2012) conducted a study on the effectiveness of multiple intelligence approach for enhancing the scholastic achievement of children with learning disabilities. The main objective was to examine the relationship between intelligence, a teaching strategy based on multiple intelligences, and academic accomplishment. The dependent variables are multiple intelligence, scholastic achievement, and learning disability. The independent variables in this study are the two levels of instructional processes, namely Multiple Intelligence based teaching approach and traditional style of teaching. The Learning Disability Assessment Scale, Multiple Intelligence Assessment Scale, Achievement Test, Intelligence Test, and Interview Schedule were the instruments utilised to collect the data. Forty pupils in upper primary made up the sample. The t test, F test, and ANCOVA were among the statistical methods utilised. The findings demonstrated that using a teaching strategy based on multiple intelligences can both considerably lessen learning impairments in kids and also help them develop their many intelligences. According to the results of the study, multiple intelligence and academic achievement are strongly correlated.

Boomsma et al. (2007) conducted a longitudinal genetic study of verbal and nonverbal IQ from early childhood to young adulthood. The investigators explored the mechanisms behind the stability of verbal and nonverbal skills in a longitudinal genetic study, as well as the degree to which the relationship between these skills grows stronger with age. At ages 5, 7, 10, 12, and 18, Dutch twin pairs had their verbal and nonverbal IQs tested. With correlations with time ranging from 0.47 for the 13-year time span to 0.80 for shorter time intervals, both verbal and nonverbal abilities showed high stability. Age-related increases in heritability were observed by structural equation modelling, from 48 percent (verbal) and 64 percent (nonverbal) at age 5 to 84 percent and 74 percent at age 18. In the results, stability appeared to be primarily driven by genetic factors and genes are the only factor that explains why nonverbal ability is stable. Results also indicated that the continuity of verbal talents was accounted for by shared environmental factors and genetic factors and genes affecting both verbal and nonverbal abilities adequately explained the overlap between the two types of skills. From early childhood through young adulthood, the genetic association between verbal and nonverbal IQ grew from 0.62 to 0.73.

Studies Related to Scientific Reasoning

Csapo (2023) explored inductive reasoning, Scientific Reasoning and science motivation, and their role in predicting stem achievement across grade levels. The purpose of this study is to look into how children perform at different grade levels in the areas of inductive reasoning, Scientific Reasoning, and science motivation. The investigator also looked at how these variables interacted with parental characteristics to predict STEM achievement in students. 726 students from six secondary schools′ sixth, eighth, tenth, and eleventh grades were evaluated in a cross-sectional study. The results demonstrated that although students' willingness to learn science fell slightly throughout grade cohorts, those in the upper grades outperformed their peers in the lower grade cohorts on reasoning exams. The findings of two cognitive tests across grade levels showed similar developmental trends, despite the pupils ′superior performance on an inductive reasoning test. In general, we discovered that parental education had a beneficial impact on both STEM performance and parental involvement in their children's education, and that inductive reasoning and Scientific Reasoning were closely related and both significantly influenced STEM achievement. Parental participation and science motivation, on the other hand, had a smaller and distinct impact on students' STEM achievement in each grade cohort. In light of this, the implications for improving kids ′STEM performance are further explored.

Sahin and Oren (2022) conducted a study on laboratory as an instrument in improving the Scientific Reasoning skills of pre-service science teachers with different cognitive styles. This study looked into how pre-service science instructors with various cognitive styles' Scientific Reasoning abilities were affected by laboratory applications based on guided inquiry learning approaches. Furthermore, views from pre-service science instructors with varying cognitive styles regarding the impact of the study's application on the development of their Scientific Reasoning abilities were also investigated. Five pre-service science instructors enrolled in a state institution in western Turkey made up the sample. The partially mixed sequential dominant status design, a mixed-method research design, was employed in the study. The Classroom Test of Formal Reasoning was used to assess the participants′ Scientific Reasoning abilities, while the Group Embedded Figures Test was used to ascertain their cognitive styles. Following the application, focus groups were conducted to get the participants ′opinions. The investigation revealed that, in comparison to individuals with field-independent cognitive styles, those with field-dependent and field-intermediate cognitive styles achieved more targeted outcomes.

Researchers were advised to consider the idea of information processing while analysing the possible relationship between this discovery and the applications of the guided inquiry learning technique and the hypothetico-deductive reasoning cycle.

Prasart (2021) conducted a study on socio-scientific issues based classroom intervention on grade 10 students' learning achievement and Scientific Reasoning. The purpose of this study was to compare pupils in grade 10 in terms of their academic performance and scientific thinking. With 90 pupils in grade 10 over two classrooms, the subject of "DNA technology" was covered. Comparing learning accomplishment and scientific thinking between two learning organizations led to the design of the quasi-experimental study. Lesson plans based on socio-scientific problems served as research tools, as did achievement tests with 30 items and a 4-choice multiple-choice format as well as tests of scientific thinking. Independent t-test was the statistic employed to evaluate the hypothesis. The findings showed that there was no difference in the students' learning achievement scores among learning organizations. At the 0.05 level of statistical significance, socio-scientific-issues-based learning got a higher score for Scientific Reasoning than inquiry-based learning

Moritz et al. (2020) conducted a study on Scientific Reasoning competencies in science teaching. It is required of Australian science teachers to engage their students in the inquiry and investigation processes of science. In this article, Scientific Reasoning competences are described as the skills required for scientific problem-solving ("doing") and the ability to reflect on the problem-solving process at a meta-level ("understanding"). An empirical case study on pre-service teachers' proficiency in Scientific Reasoning abilities was conducted at Victoria university. The results suggested that pre-service teachers possess a fair degree of scientific thinking abilities; yet, there is no noteworthy rise in this level over the first year of their Master of Teaching programme. It is argued that the process of developing Scientific Reasoning competencies is lengthy and could be aided by offering opportunities for explicit reflection along with a series of relevant problem-solving exercises.

Ayu et al. (2020) examined the Scientific Reasoning abilities of eighty-two science pre-service teachers at the Universiti Teknologi MARA (UiTM), a public university in Malaysia, in the Faculty of Education. Students studying science, technology, engineering, and mathematics (STEM) need to strengthen their general scientific skills in order to be able to tackle open-ended real-world challenges when they are employed in the future. Developing broad scientific skills and strengthening content knowledge are two of the teaching objectives in STEM education. Critical thinking abilities are included in Scientific Reasoning and are an essential component of current science education. Conservative Concept, Proportional Concept, Control Variable and Probabilistic Thinking, and Hypothetical-Deductive Reasoning are the four areas into which Lawson (1978) divided Scientific Reasoning. For this investigation, a Lawson (1978) instrument was modified. The results indicated that most science pre-service instructors are not very good at using Scientific Reasoning. Additionally, it was discovered that, when it came to the science pre-service instructors in the fields of chemistry, biology, and physics, there were no notable differences. The findings indicated that biology students exhibited a moderate proficiency across all four Scientific Reasoning patterns, whereas physics students displayed superior proficiency in Conservative Concept, Proportional Concept, and

Hypothetical-Deductive Reasoning. In contrast, chemistry students showed enhanced capability in Control Variable and Probabilistic Thinking.

Jaleel and Premachandran (2017) examined the relationship between Scientific Reasoning and Achievement in Chemistry of secondary school students, to determine the association between scientific thinking and chemistry achievement among secondary school students, both overall and for the subsample of gender. Additionally, they looked into whether there was any gender-based differences in the Scientific Reasoning and chemistry achievement of secondary school students. Data collection, standardisation, and analysis were all done using the correct statistical methods. Sample consisted of secondary school students the Scientific Reasoning Test and the Chemistry Achievement Test. The results indicated that Chemistry achievement and Scientific Reasoning skills among secondary school students for the entire sample and the subsample by gender were significantly positively correlated. Secondary school pupils' Scientific Reasoning does not significantly differ dependent on the gender of the subsample. Secondary school pupils' chemistry achievement does not significantly change based on gender.

Srisawasdi et al. (2014) conducted a study on effect of gender on students Scientific Reasoning. Four co-educational schools in Thailand's north-eastern region and a total of 400 grade 11 students took part in the study. We looked into “students’ Scientific Reasoning” using the Lawson Classroom Test of Scientific Reasoning (LCTSR). The findings showed that a student's capacity for scientific thinking is not considerably impacted by their gender. The results showed that there is room for development in the students’ capacity for scientific thinking. This indicated that to enhance students' scientific reasoning abilities, science classroom pedagogy should prioritise instruction on (i) causal reasoning through hypothesis generation, (ii) the design of rigorous scientific experiments, and (iii) the assessment of correlation and causation among target variables.

Fabby and Koenig (2013) compared student Scientific Reasoning abilities with student ability to correctly solve problems. 476 students from the University of Cincinnati's first semester introductory physics course made up the sample. Lawson's Classroom Test of Scientific Reasoning, or LCTSR, was the instrument utilised. The results indicated that, students with stronger reasoning abilities outperformed those with average and lower skills in problem solving. This implied that pupils with average and lower levels of reasoning skills would rely more heavily on memorising basic steps in order to solve difficulties. The findings also indicated that pupils use more formal thought processes are better learners.

Studies Related to Attitude towards Chemistry

Nzomo et al. (2023) conducted a study on relationship between inquiry-based learning and students' attitudes towards chemistry. The purpose of this study was to determine whether or not IBL has been utilized to teach chemistry and whether or not it has affected students' attitudes towards the subject. Using a correlational research approach, the study included 357 students chosen at random from among the 21 classrooms these teachers taught, as well as 21 teachers who were purposefully chosen for the survey. The findings showed that students had favorable attitudes towards chemistry (M=3.945) and that teachers employed IBL once a week (M=4.062).

Furthermore, a noteworthy correlation was observed between IBL and students' perspectives regarding chemistry ($r=0.997$, $p<0.05$, $R^2=0.994$).

Edwige et al. (2021) conducted a study on factors affecting secondary schools students' attitudes toward learning chemistry. This study offered an overview of the literature with a focus on the variables influencing the attitudes of secondary school pupils towards chemistry. Thirty-six studies covering the years 1977 to 2019 were chosen from the Google Scholar and ERIC databases. Students' views towards chemistry were shown to be positively impacted by gender, grade level, and instructional techniques most frequently. Nonetheless, in order to determine whether there is a relationship between students' attitudes towards learning chemistry and the scientific disciplines, other factors were also examined, including students' interest, the classroom atmosphere, the relevance of the curriculum, teachers ′behavior, perceived difficulty, and self-directed effort The results showed that these variables needed to be under control in order to enhance secondary students' positive attitudes towards chemistry and to enhance their performance in the subject.

Sibomana et al. (2021) analyzed the factors affecting secondary school students' academic achievements in chemistry with the help of 13 articles identified between 2011 and 2021. The results of review emphasized how teaching strategies affect students' performance, providing teachers with information about the variables influencing students' performance in Chemistry, common misconceptions about Chemistry instruction, and strategies for clearing up misconceptions as well as ways to raise students' academic performance. A review study examining the factors influencing students' academic achievement identified eight key categories: school-related factors, subject content, teacher and student characteristics, innovative teaching methods, class size effects, family socioeconomic background, and leadership styles. Students' misconceptions often stem from a lack of interest in the subject and ineffective teaching methods. These issues can be addressed by providing teachers with ongoing professional development and structured training programmes. Challenges in chemistry education can be mitigated through the effective use of innovative teaching strategies, strong school leadership, adequate teaching resources, and active parental involvement in students' learning.

Kenni (2019) examined the attitude of female students towards learning of chemistry in selected secondary schools In Ikere Local Government Area of Ekiti State, Nigeria. The research approach used for the study was a descriptive survey. All of the senior high school Chemistry students in Ekiti State's Ikere Local Government Area comprised target group. Four hundred twenty (420) students were chosen as the sample. A structured questionnaire served as the data gathering tool. The instrument's dependability was evaluated utilizing the split-half method of reliability and statistical analysis of Pearson Product Moment Correlation. The examination of the data showed that there are no appreciable differences in the attitudes of female students in various age groups towards learning chemistry; There is a noticeable difference between how interested female students are in learning chemistry depending on their age group, but there is no discernible difference between how interested female students are in learning chemistry depending on their class. It is important to note that the interest levels of female students of different ages in learning chemistry are not significantly different. However, there is no significant difference in how the female students of different ages and classes feel about learning chemistry.

Singh and Bai (2019) explored the scientific attitude of secondary school students in West Tripura district. The descriptive survey method of research was employed. From seven schools in the West Tripura area, a sample of 110 secondary school pupils was randomly chosen. The study found no notable difference in scientific attitude between boys and girls. However, factors such as place of residence, medium of instruction, and type of school showed significant variations in scientific attitude, leading to the rejection of the hypothesis. Students from secondary schools in urban areas and schools that used English had a slightly more scientific attitude than students from secondary schools in rural areas and schools that used Bengali.

Montes et al. (2018) conducted study on explaining secondary school students' attitudes towards Chemistry in Chile. 523 secondary school students from Chile's public, privately supported, and privately run schools participated in the study. To validate ASCIv2, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were first used. The CFA findings demonstrated that ASCIv2 maintained the two-factor structure and demonstrated the best model fit, however three items from the original instrument had to be eliminated. The study also revealed that people's attitudes towards science were neither good nor negative, which is a situation that is common in other nations. Both multivariate and univariate analyses of variance revealed that year group and chemical achievement had a substantial impact on attitudes towards chemistry. As student's progress through school, their attitudes decline, but as their chemistry grades rise, their attitudes improve, according to follow-up analyses.

Wan and Lee (2017) studied Hong Kong Secondary school students' attitude towards science using structural models and by considering gender differences. The study indicated that secondary school pupils 'attitudes towards science were examined in two different domains. These are the structural models, as well as the function that schools provide. 360 Hong Kong ninth-grade students made up the sample. The results found that student attitudes towards science and gender disparities are significantly influenced by school bands.

Kapici and Akcay (2016) analyzed middle school students' attitude towards science, scientists, science teachers and classes. 2063 pupils in grades four through eight from all throughout Turkey participated in the study. Assessing attitudes and preferences in science (AAPS) scale was the research tool employed. The findings indicated that students from western Turkey had a more favorable attitude towards science, and that girls are more likely than boys to have this attitude. The reults also showed that pupils 'attitudes towards science change according to grade level.

Lee and Kim (2016) examined scientific knowledge and attitude towards science in South Korea. This study indicated that the relationships between various categories of scientific knowledge and various determinants of science attitude. The findings showed that South Koreans 'attitudes towards science were negatively related to both factual and procedural scientific knowledge. The study also discovered that knowledge has a favorable or negative impact on one's attitude towards science, depending on the mediators and type of knowledge used.

Zeidan and Jayosi (2015) analyzed the relationship of science process skill and attitude towards science among Palestinian secondary school students .The study also indicated that students' gender and place of residence affected their understanding of science process abilities and attitudes towards science. A science process competency exam and a questionnaire about scientific attitudes were the tools employed. The findings indicated that, there is no discernible difference in attitude towards science based on gender or place of residence. Additionally, attitude towards science and science process skills were found to be positively connected.

Siddiqui (2013) conducted a comparative study of the effects of traditional teaching and computer assisted instruction on secondary school students' attitude and achievement in Physical Science. To create three measuring tools-the Physical Science Attitude Scale, Computer Assisted Instruction Attitude Scale, and Physical Science Achievement Test-and compare the attitudes of students in the control group, teacher-centred CAI group (TCCAI), and student-centred CAI group (SCCAI) towards physical science at the pre-test and post-test stages, respectively. The sample in this study included 210 students in the tenth grade at Aligarh, Uttar Pradesh's Ayesha Tarin Modern Public School. The instruments employed were the Computer Assisted Instruction Attitude Scale, the Physical Science Achievement Test, and the Physical Science Attitude Scale. Statistics were analysed using the t test, ANOVA, and ANCOVA. The results of this experimental investigation that the TCCAI group had a bigger increase in attitude at the pre-test stage than the other groups when the attitude towards physical science of the TCCAI, SCCAI, and control groups were compared. The study indicated that the TCCAI group had a much better attitude than the SACAI group, which in turn had a significantly better attitude than the control group, in the post-test stage.

Sekar and Mani (2013) conducted a study on scientific attitude of higher secondary students showed that higher secondary students' attitudes towards science and their choice of permanent residency are significantly different. The results aslso showed that urban students greatly differ from rural pupils in terms of where they live permanently in scientific attitude. Higher secondary pupils 'attitudes towards science fluctuate significantly depending on the sort of school management. The comparison of pupils in aided and government schools, showed that higher secondary students from unaided institutions demonstrated a more positive attitude towards science. The results also indicated that both boys and girls in the biology and computer groups of students have a largely consistent attitude towards science. But there was a big difference between males and girls in the computer and biology groups in terms of thinking abilities.

Tortop and Hasan (2013) conducted a study on development of teachers' attitude scale towards science fair. The results of the exploratory factor analysis, attitude scale towards science fairs consisted of five components and 23 dimensions, including contributions to students' development, value of education, judgment, bad behavior, and mentorship. The results indicated that the newly developed teacher attitude scale for assessing educators' attitudes towards science fairs is a reliable and valid instrument.

Khan and Ali (2012) conducted a study on higher secondary school students' Attitude towards Chemistry. This study looked at how higher secondary school pupils felt about chemistry, their chemistry instructor, and the ways in which they were taught. Similar to academic success, attitude is regarded as a crucial outcome of higher secondary education. All of the upper secondary school students in Khyber Pakhtunkhwa (Pakistan) comprised the study's population, and 35 second-year students from the government higher secondary school Jamrud Khyber Agency were included as a convenience sample. The resuls found that although students had concerns about the subject of chemistry and the teaching approach, they were generally satisfied with their chemistry teacher.

Belge and Hatice (2012) examined the students attitudes toward school chemistry and the effect of interaction between gender and grade level. There are 197 kids in the sample, who are in grades 9 through 11. The two components of the scale that were identified by principal component analysis were enjoyment of chemistry and importance of chemistry. The findings indicated a statistically significant interaction effect between gender and grade level on students' views about school chemistry, specifically on enjoyment and a critical component. The findings suggested that Turkey falls short of its educational goal of cultivating favorable attitudes towards chemistry lessons.

Festus and Ekpete (2012) investigated the influence of PBST on students' Performance and Attitude towards Chemistry. The researcher has employed pretest, posttest two group research designs in the study. The researcher chose 98 pupils between the ages of 14 and 16 from two senior secondary public schools in Obio to carry out the study's objectives. Method divide the sections into groups, the researcher divided two sections into experimental groups and control groups. The study observed that problem-based learning techniques can alter students' performance and attitudes towards chemistry after intervention.

Hiremath (2011) conducted a study on the interaction effect of student's school adjustment, attitude and socioeconomic status on academic achievement in science among secondary school students. The objective of the study was to find out the effect of students' attitude, school adjustment and socio economic status on academic achievement in science. Ex post facto research design was used for the study. Moderator variables were sex, locale and type of management Tools used for the study were adjustment inventory, socio economic status scale, science attitude scale and achievement test in science. Random sampling technique was used. Sample consisted of 500 IX standard students studying in Chikkodi educational district. The interaction effects 3-way ANOVA was used here. The results indicated that the students with favorable attitudes towards science, high school adjustment and low socioeconomic status have more influence on student's academic achievement in science.

Hong and Lin (2011) investigated students' personality traits and attitudes toward science. The results showed that across all school levels, female students showed greater interest in science and contributed more to teams than their male counterparts. The most accurate indicators of students' attitudes towards science were their results on the scales measuring agreeableness, extraversion, and conscientiousness.

Patil (2011) conducted a comparative study of scientific attitude about secondary and higher secondary level students. It focused on secondary and upper secondary students' attitudes towards science. 120 pupils were chosen at random from

Navapur town for this study. Students in higher secondary schools who are male and female have different attitudes towards science. There is no discernible difference between secondary level students and higher secondary level students in terms of their attitudes towards science.

Etuk et al. (2011) objectified to study achievement and attitude towards primary science using constructivist instructional strategy. The study used an experimental research approach with two intact groups. In Nigeria's River state's 21 public primary Senatorial Districts, there were 650 students. Four entire classes from four local schools total 180 students in all. Primary Science Achievement Test and Primary Science Attitude Scale were utilized by the study's researchers to collect data. Analysis of covariance and multiple classification analysis were the types of statistical analysis performed in the study. The students who were taught using a constructivist instructional technique scored higher on achievement tests and attitude tests than students who were taught using an expository strategy. The study found that in terms of achievement and attitude, students from urban schools performed better than those from rural schools.

Aydin and Yilmaz (2010) examined the impact of the constructivist approach on students' attitude towards science education, higher order cognitive skills, and gender disparities in their comprehension of the acid-base concept. 300 eighth-grade kids made up the sample for the study. Two group pre-post designs was employed. The control group received traditional instruction whereas the experimental group received 5E learning. Before the experiment began, tests on acid-base knowledge, science process skills, and logical thinking were given. As a pre test and post test, the

Acid-Base Achievement Test and Attitude Scale towards Science Education were used. The findings suggested that the constructivist approach's 5E learning model was more efficient in fostering a positive attitude towards science and higher order cognitive skills.

Charif (2010) analyzed the impact of problem-based learning (PBL) on students' performance and Attitude towards Chemistry. The pretest posttest experimental-control group design was employed by the problem-solver. Students from a private school in Lebanon in the seventh grade made up the study's sample. Data was gathered using the chemistry achievement test and the attitude questionnaire, and it was then examined using the mean, standard deviation, and t-test. PBL was utilized to instruct the research group, while the control group received instruction using the traditional manner. Results showed that putting the PBL approach into practice enhances attitude and achievement.

Nurulazam and Robertus (2010) had a study entitled improving students attitudes toward science using instructional congruence. Specifically in the notions of the practical work of science, science outside of school, future participation in science, and a combined interest in science, the results demonstrated that instructional congruence in science education fosters favorable student attitudes towards science. The findings indicated that greater efforts should be made to link science education in the classroom with extracurricular science activities.

Studies Related to Self-efficacy in Chemistry

Mueni et al. (2023) conducted a study on Inquiry-based learning and students' Self-efficacy in Chemistry among secondary schools in Kenya. 357 Form three Chemistry students were chosen at random from the 21 classrooms that these instructors taught in, and there were a total of 21 Chemistry teachers. A mixed-methods concurrent triangulation research approach was used. A class observation schedule was utilised to appraise the teachers' use of IBL in practical Chemistry lessons, and data were collected using an adjusted teachers ′self-reported IBL instrument. 26-item test was developed from previously published research to gauge students' Self-efficacy in Chemistry to assess the adequacy of measurement instruments, exploratory factor analysis (EFA) and principal component analysis (PCA) were utilized. The findings indicated that teachers employed inquiry-based learning once per week (median across all subjects = 3.89) and students gave themselves high marks for their chemistry Self-efficacy (Mean = 3.929). The total outcomes of the correlation and regression analysis showed a significant positive association (r = 0.903, p 0.05, R2 = 0.8155) between inquiry-based learning and students' Self-efficacy in Chemistry.

Asfaw (2022) investigated the assessment on students' Self-efficacy, academic achievement, locality and gender in chemistry at Woreillu Secondary School. The study showed that the students have a medium degree of Self-efficacy (57.8) and rural students of both genders outperformed urban students in terms of accomplishment. The study found that Self-efficacy and academic achievement varied by gender but that local environment had no bearing on students' Self-efficacy. These results support the Self-efficacy theory, which contends that people are far more likely to succeed at tasks they believe they are good at if they do them.

Kusumaningtyas and Laksono (2020) examined high school students' Self-efficacy towards chemistry and compare it across grade levels. 255 high school students from a public senior high school in Blora Regency, Central Java, Indonesia, took part in the study. straightforward random selection method has used. High school students' Self-efficacy towards chemistry was evaluated using the High School Chemistry Self-efficacy Scale (HCSS), which combines the Self-efficacy scale for cognitive skills (CSCS) and chemistry laboratory (SCL). The results revealed that the majority of high school pupils have ordinary levels of Self-efficacy. In both CSCS and SCL, students' Self-efficacy increases with grade level. This finding also utilized to predict how well the kids will study chemistry.

Jamil and Mahmud (2019) conducted study on Self-efficacy relationship on science achievement amongst national secondary school students. The purpose of this study was to determined the association between science Self-efficacy and academic achievement among students in the Rompin district of national secondary schools. Questionnaire and the survey method are used. The study included a total of 191 kids from 4 different schools in the Rompin. Both descriptive and inferential statistical methods were used to analyse the data. The study discovered that practical work contributed most to students' Self-efficacy ($M = 3.77$, $SD = 0.572$), whereas cognitive skills contributed least ($M = 3.13$, $SD = 0.437$). Male and female students significantly differed in their Self-efficacy in science, according to an independent sample t-test analysis. The study also revealed that female students had stronger Self-efficacy (M

= 3.49, SD = 0.363) than male students (M = 3.28, SD = 0.384) Self-efficacy and Academic Achievement did not significantly correlate, as demonstrated by the Pearson correlation tests, where $r = 0.124$ and $p = 0.09$.

Oyelekan, et al. (2019) conducted a study on relationships among senior school students' Self-efficacy, metacognition and their achievement in chemistry. 300 senior secondary school II students from Ilorin, Nigeria, were chosen from 10 senior secondary schools used. 30 pupils from each of the 10 senior secondary schools that were purposefully picked were chosen using a simple random sampling procedure. We used the Chemistry Achievement Test, the Chemistry Self-efficacy Questionnaire, and the Chemistry Metacognition Questionnaire to get the information. These tests had reliability scores of 0.83, 0.73, and 0.86, respectively. At the 0.05 level of significance, the assumptions were tested using regression, analysis of variance, and Pearson Product Moment Correlation. The results showed a strong positive relationship between high school seniors' chemistry skills and their metacognition and Self-efficacy, or $F(2, 297) = 332.482$, p 0.05.

Koloa et al. (2017) examined the relationship between academic Self-efficacy believed of college students and academic performance. Data collected using a questionnaire. A total of 339 respondents, stratified and randomly chosen from the College's five faculties, took part in the study. The respondents ranged in age from 19 to 34, with a mean age of 23.19 (SD=2.64). The results showed that, 80.82 percent of the respondents in the college have better levels of academic Self-efficacy. the data showed that there was a strong and positive link (r=0.342, p0.01) between students' academic Self-efficacy beliefs and their performance.

Baanu et al. (2016) examined the Self-efficacy and the academic achievement of chemistry students in senior secondary schools in Nigeria. Self-efficacy reflects the degree to which kids believe that they can effectively perform in school, which is usually positively connected with outcome expectations. The study employed an ex-post facto research and a descriptive survey for 1150 senior secondary school students. The findings revealed that there was no correlation between the chemistry students' academic success and Self-efficacy. The results also indicated that in order to achieve high academic achievement in chemistry, students' Self-efficacy needed to be supplemented with a factor.

Boz et al. (2016) investigated the relationships among students' Self-efficacy beliefs, their perceptions of classroom learning environment, gender, and chemistry achievement through structural equation modelling. Samples 356 high school students from three separate schools in the same district, ranging in age from 14 to 19. The development and evaluation of a structural equation model. Survey on the constructivist learning environment and a Self-efficacy scale. The study gathered were the students' gender and prior semester's chemistry grades. The study also revealed a substantial relationship between chemical achievement and students' ideas about their own ability, their judgements of the constructivist learning environment, and their gender. The results also demonstrated that students' assessments of their learning environment and their achievement in chemistry were mediated by their ideas about their own chemistry Self-efficacy.

Erdem (2015) investigated the relationship between the attitudes of chemistry teacher candidates towards chemistry in laboratory classes and their Self-efficacy beliefs. Using a relational survey paradigm, the study was conducted. The Chemistry Attitude Scale and Chemistry Self-efficacy Scale were used to collect the data. There is a meaningful linear relationship between teacher candidates' Self-efficacy scores and their attitude scores. Both the Self-efficacy scores and the attitude scores of teacher candidates went up as they moved up in grade levels. The results showed that this was the case for both simple correlation and one-way analysis of variance in independent groups. The findings indicated that chemistry teacher candidates should engage in activities that will improve their Self-efficacy, such as information analysis, generalization, application of chemistry concepts and skills in chemistry classes, and doing things that will help them develop positive attitudes towards chemistry.

Icoz (2014) investigated secondary school students' self - efficacy beliefs toward chemistry lessons and how it change across grade levels and gender. 72 female and 42 male secondary school students made up the sample. High School Chemistry Self-efficacy Scale for Cognitive Skills (CSCS) was developed to assess secondary school students' Self-efficacy views regarding chemistry lectures. The results of the two-way ANOVA revealed that secondary school pupils had a medium degree of Self-efficacy towards chemistry lectures and that there was no discernible difference between boys and girls in this regard. The results also revealed that compared to ninth graders, tenth and twelfth graders have weaker Self-efficacy beliefs regarding chemistry lectures.

Cook (2013) examined the Self-efficacy beliefs, attitudes towards general chemistry, and their preferences to take future chemistry courses among college students. The study also found how much of a variance in students' intents Self-efficacy and attitudes might predict. Sample included 1126 college students. The results of the conventional multiple regression analysis, Self-efficacy and attitude are both important predictors of the variance in intentions. The findings showed that, Self-efficacy and attitude are significant motivating factors that should be taken into account when attempting to gauge students' intents to participate and persevere, especially in chemistry class. Students with low self-esteem and negative attitudes about chemistry won't want to major in the subject. Therefore, chemistry classes should be designed by educators at both the secondary and postsecondary levels to increase students' Self-efficacy and attitudes towards chemistry.

Tenaw (2013) conducted study on relationship between Self-efficacy, academic achievement and gender in analytical chemistry at Debre Markos College of Teacher Education. The purpose of this study was to ascertain the degree of students' Self-efficacy, gender differences in Self-efficacy and achievement, and relationships between Self-efficacy and achievement for second-year students enrolled in Debre Markos College of Teacher Education's (DMCTE) Analytical Chemistry I (ACI) in the autumn of 2012. The Likert scale questionnaire was used to collect the data for the Self-efficacy survey. The difference between Self-efficacy and achievement by gender is assessed using inferential statistics (t-test), and the associations between Self-efficacy and achievement were examined using Pearson correlation. The results showed that students have a moderate level of Self-efficacy (50.08), and Self-efficacy doesn't differ significantly between sexes ($t(98) = 0.161$, $p > 0.1$), but achievement does differ significantly between sexes ($t(98) = 0.68$, p 0.1), and there is a significant link between Self-efficacy and achievement (r=0.385, at the 0.05 level).

Kondakci et al. (2011) examined the relationship between academic success, expected grade, the number of chemistry courses taken, participation in a chemistry project, and gender in college students' opinions about their own chemistry abilities. 488 college students made up the study's sample, and the data were gathered using the College Chemistry Self-efficacy Scale (CCSS). The results showed that participation in chemistry projects, expected grades, and the number of chemistry courses taken were all significant predictors of Self-efficacy beliefs.

Senay (2010) investigated the contribution of secondary school students' Chemistry Self-efficacy for Cognitive Skills (CSCS), and Self-efficacy for Chemistry Laboratory (SCL), along with some other variables to their chemistry achievement. The sample had 604 students-261 males and 343 girls. Self-efficacy Scale for Chemistry (Aydi and Uzuntiryaki, 2009). The simultaneous multiple regression analysis, the students' CSCS was a substantial positive predictor of success. The findings suggested that teachers should work to support students' CSCS in chemistry classes by giving each student individual attention, teaching the material in a way that is understandable to all students, and relating instructional designs to the sources of Self-efficacy to enhance students' Self-efficacy beliefs. The results also help students feel confident in their ability to learn the course material. This will improve the students' perceptions of their own efficacy.

Kurbanoglu and Akin (2010) conducted a study on relationships between university students' chemistry laboratory anxiety, attitudes, and Self-efficacy beliefs.

The study investigated the connections between Self-efficacy, chemistry attitudes, and laboratory anxiety. 395 university students took part. The Chemistry Laboratory Anxiety Scale, Chemistry Attitudes Scale, and Self-efficacy Scale were all completed by the participants. The findings indicated a negative correlation between Self-efficacy and chemical attitudes as well as laboratory fear. The study also discovered that chemical attitudes were favorably related to Self-efficacy. The study also indicated that Self-efficacy has a direct and favorable impact on chemical attitudes, which in turn has an impact on anxiety in chemistry labs. Finally, negative chemistry attitudes were used to explain laboratory fear.

Studies Related to Achievement in Chemistry

Vallespin and Prudente (2023) conducted a study on indicators of senior high school students' performance in online chemistry learning during the COVID-19 pandemic In the Philippines, the COVID-19 pandemic compelled both public and private schools to move their whole curriculum online. The goal of the study was to examine the performance metrics of senior high school students in Northern Mindanao, Philippines, who were enrolled in online chemistry courses at both public and private universities. A quantitative study was carried out with 100 participants utilising an online survey questionnaire. The findings demonstrated that online and remote chemistry learning had a statistically significant positive impact on creative and innovative thinking (CI), as well as collaborative abilities (CS). Findings demonstrated that, from the standpoint of the students, the COVID-19 pandemic provided opportunities for students' performance in online chemistry courses to enhance their critical thinking and creative thinking abilities.

Ali and Javaid (2023) conducted a study on Investigating Academic Achievements in Chemistry at the Secondary School Level through a Laboratory-Centred Instructional Approach. This study compared laboratory-centred instruction with traditional classroom approaches to examine how Chemistry education could be improved in secondary schools. Although lectures and textbooks had been the mainstay of science instruction for a long time, using laboratory tools was thought to be a more engaging method. The study was carried out in Pakistan, evaluated the effects of lesson plans that focused mostly on laboratories on students' academic performance. The results showed that laboratory-based instruction greatly enhanced students' chemistry proficiency. Differences in learning patterns based on gender were also observed, highlighting the significance of individualized teaching strategies. This study shed light on the effectiveness and advantages of this strategy by showing how adding laboratory activities into the curriculum might significantly improve Chemistry instruction in secondary schools. This study clarifies how laboratory activities might facilitate and improve secondary school students' understanding of Chemistry.

Musa et al. (2022) conducted a study on evaluating the impact of chemistry practical on students' performance in chemistry in public secondary schools of Nasarawa State Nigeria The study looked into how Chemistry practical affected the Chemistry performance of students in public secondary schools in the Nigerian state of Nasarawa. In the Nasarawa North Senatorial zone, the study was carried out in Akwanga, Nasarawa-Eggon, and Wamba LGA. This study used a quasi-experimental design and a quantitative methodology. Pre- and post-test formats were used in the design. Questionnaire was used. A combination of stratified, purposive, and systematic sampling techniques was used to choose 15 sample schools from this group. 300 SS2 Chemistry students-200 boys and 100 girls-as well as 30 chemistry professors participated in the activity. Independent samples t tests and descriptive statistics like mean and standard deviation were applied. The performance was significantly enhanced when chemistry practical was used in secondary school chemistry instruction and learning. The results indicated that students who learned chemistry through practical performed significantly better than those who studied chemistry without practical.

Fanai (2020) examined achievement in science among higher secondary school students of Aizawl. The study also determined the current study is to determine the science accomplishment levels of upper secondary school pupils and to compare gender, government, deficit, and private school performance. The results showed that there was no clear difference in how well boys and girls did in science. The study also revealed that there was no discernible difference between students attending government and private schools, but there was a discernible difference between deficit and both government and private schools and students from deficit schools performed better than those from public and private institutions.

Tanwar (2020) analyzed Achievement in Chemistry at higher secondary stage. The current study focuses on students' success in higher secondary schools in Delhi NCR who are studying chemistry. 200 pupils from government and private schools make up the sample. The data were analyzed using a two sample t test. The finding supported a significant gap between government school and private school pupils' performance on the chemistry Achievement test.

Vivian (2018) reviewed on factors affecting chemistry students performance. This study aimed to identify factors influencing the performance of chemistry students. Thus, attempts will be made in this chapter to analyse the works and findings of other researchers that are pertinent to this study and convenient; conclusions will also be drawn under the main headings of the teacher's academic background and level of qualification, the teacher's sex, the teacher's workload, and the socioeconomic status of the teacher's parents.

Jane and Anditi (2017) conducted the study on effects of computer-based simulations teaching approach on students' achievement in the learning of chemistry among secondary school students in Nakuru Sub County, Kenya. Quasi-experimental methods was used and the Solomon Four Non- Equivalent Control Group Design was employed. A sample size of 175 pupils from four co-educational schools in Nakuru East Sub-County were included in the study. The Chemistry attainment Test (CAT) was used in this study to measure the students' academic attainment levels. The findings indicated that, there is a statistically significant difference between students who are taught Chemistry using the CBS teaching style and those who are taught using the traditional teaching method. Using the CBS teaching methodology, the findings also indicated that statistically significant difference in the achievement of males and girls in chemistry.

Santhosh (2015) conducted a study on classroom climate and Achievement in Chemistry in relation to certain selected psychological variables. The study used the normative survey method. The main variable in this study was chemical achievement, whereas the independent factors were classroom atmosphere, parental support, and socioeconomic status. 800 higher secondary students studying in the Perambalur and Salim districts made up the sample, which was chosen using a straightforward random selection procedure. The statistical techniques for data analysis included descriptive analysis, differential analysis, correlation analysis, and regression analysis. The results indicated that the climate of the classroom is more strongly influenced by chemistry achievement.

Brown (2015) conducted a study on attitude to the study of chemistry and its relationship with achievement in an introductory undergraduate course in 125 undergraduates enrolled in an introductory chemistry course as part of a BSc Chemistry major, the Attitude to the Study of Chemistry Inventory (ASCI), a validated instrument to quantify attitude, was used to measure Attitude towards Chemistry. The results showed that there was only one weak positive connection (0.409) between the affective score and achievement in the LA group and no link between attitude and success in the HA group.

Bindu (2013) conducted a study on Apprenticeship Type Learning (ATL) model development and its effect on higher secondary school students Achievement in Chemistry. The study's main goals were to create an Apprentice Type Learning model for teaching chemistry at the secondary school level, assess how well Higher

Secondary students learned the subject using the model, and assess how well the model performed in comparison to Direct Instruction. Students in grade XI from two districts in Kerala made up the study's entire sample, and it was carried out utilising an experimental methodology. ANCOVA was used to compare the ATL model with the direct instruction in learning chemistry model. The results indicated that the study is that the ATL model improves students' academic performance and attitude towards laboratory experiences while increasing their enjoyment of experimental work.

Paramasivam and Mani (2013) conducted a study to find out the influence of emotional intelligent on Achievement in Chemistry among higher secondary school students. 500 first-year higher secondary students were included in a stratified random sample for the study.. The study used the survey method. Correlation and multivariate analysis were utilized to determine the emotional intelligence's major impact on chemistry achievement. The findings indicated that, there is a strong correlation between higher secondary students' chemical achievement and emotional intelligence. It also emphasized how success in chemistry for Higher Secondary students is influenced by factors of emotional intelligence such as self-motivation, emotional stability, and self-awareness.

Tenaw (2010) studied the attitude and achievement of students in chemistry as a correlate of teacher classroom management behaviour (TCMB). Five junior elementary schools were used to select a random sample of 50 chemistry students and 5 teachers. Data were gathered using direct observation tools and questionnaires was discovered. The findings indicated that TCMB did not significantly correlate with achievement or attitude. It was also discovered that the TCMB categories of student involvement, interest-boosting, and varied instruction had a strong positive and significant correlation with chemistry achievement.

Conclusion

The review of the related studies conducted in India and abroad helped the investigator to get a thorough and in-depth understanding of the related researches carried out in the field of Chemistry education at secondary level. An overall analysis of the studies helped the investigator on finalising the topic of the study, identification of the variables, framing the objectives and formulating the hypothesis, selection of tools and techniques and methodology to be followed. It also helped in moulding the findings, interpretations, implications and conclusions. The investigator also ensured that no studies have conducted by taking all the selected variables together in a single frame.

METHODOLOGY

Chapter Three

- Method Adopted
- Variables Selected for the Study
- Hypotheses of the Study
- Tools Used for Data Collection
- Sample Selected for the Study
- Data Collection Procedure
- Statistical Techniques for Analysis

METHODOLOGY

Methodology is the foundation of any scientific investigation. The research approach is totally determined by the nature of the problem selected and the type of data to be collected in order to solve a specific problem. The success of any research study is determined by the methodology used, as well as the tools and techniques applied.

Methodology deals with description of the techniques and procedures followed in the study, the tool developed, sample selected, data collected and statistical technique employed. Therefore, a carefully constructed and planned approach gives the researcher a scientific and practical scheme for solving the problem

This chapter provides a comprehensive summary of the methodology used in performing the research, which consists of the following headings.

- Method Adopted.
- Variables Selected for the Study
- Objectives of the Study
- Hypotheses of the Study
- Tools used for Data Collection
- Description of the Tools Employed

- Sample Selected for the Study
- Data Collection Procedure
- Statistical Techniques Used for Data Analysis

Method Adopted

Survey method is used for the present study. The method of selecting data from a large number of samples representing a specific population by using various data gathering tools is known as survey method. The data thus collected were employed for analysis, interpretation and deriving conclusions.

According to Best and Kahn (1998), the survey method is a research technique used to gather data about people's thoughts, beliefs, behaviours, or characteristics by asking questions to a predefined group of individuals. This method focuses on gathering quantitative data through standardised instruments, such as questionnaires or interviews, to ensure consistent information collection and analysis across respondents.

Variables Selected for the Study

A variable is a fundamental concept in research, statistics, mathematics, and scientific inquiry, representing any characteristic, number, or quantity that can be measured or changed. Variables are essential for formulating hypotheses and determining relationships between factors in experiments or data analysis.

In research and experimentation, the dependent variable is the outcome or effect that is being studied. It is the variable that is observed and measured to determine how it is influenced by changes in the independent variable. The variable that is measured in an experiment; it is expected to change as a result of the manipulation of the independent variable (Best & Kahn, 2006).

In the present study, Achievement in Chemistry among secondary school students has been taken as dependent variable.

An independent variable is a fundamental concept in research and experimentation. The researcher manipulates or controls the variable in order to observe its impact on the dependent variable. The independent variable is thought to cause changes in the dependent variable, which is the outcome being measured. It is the variable that is manipulated or controlled in an experiment to test its effects on the dependent variable (Best & Kahn, 2006).

In the present study, the investigator has used selected Cognitive variables namely, Verbal Intelligence, Scientific Reasoning and Noncognitive variables namely, Attitude towards Chemistry, Self-efficacy in Chemistry as independent variables.

In the words of Best & Kahn (2006), classificatory variables are those that can be grouped into categories or classes. These variables are used to sort data into different categories without implying any order or ranking among them.

The results of the research studies have shown that gender, locale of the school, and type of management of the school have an influence in differentiating the academic achievement among the students. Hence the investigator has included the following classificatory variables namely, Gender

Locale of the school

Type of management of the school

Rationale for the Selection of Variables

The findings of several relevant research reports have shown that most of the time, school students are unable to excel in Chemistry due to a multitude of factors. The experiences and observations of the investigator, who has been actively engaged as a Chemistry teacher, also substantiate this viewpoint. Research on Chemistry achievement has consistently revealed that Chemistry is perceived as a difficult subject by young students (Ayas & Demirbas, 1994). Students face considerable challenges in understanding chemical principles, equations, and formulae. Sibomana (2021) observed that secondary school students continue to perceive Chemistry as difficult to learn and often develop a negative attitude towards it, leading to poor achievement in the subject.

In understanding students' Achievement in Chemistry, both Cognitive and Noncognitive variables play a critical role. Among cognitive variables, Verbal Intelligence and Scientific Reasoning are particularly important. Verbal Intelligence is essential for comprehending and interpreting complex chemical terminology, understanding theoretical concepts, and solving word-based problems in Chemistry. Students with higher Verbal Intelligence are better equipped to process the language and structure of Chemistry content. Scientific Reasoning, on the other hand, enables students to apply logical thinking, formulate hypotheses, design experiments, and interpret data — all of which are fundamental skills for success in Chemistry. Students possessing strong Scientific Reasoning abilities are more likely to excel in tasks requiring critical thinking and problem-solving, which are core to Chemistry learning.

In addition to Cognitive variables, Noncognitive variables like Attitude towards Chemistry and Self-efficacy in Chemistry are equally significant. A positive Attitude towards Chemistry can greatly enhance students’ motivation, interest, and willingness to engage with the subject matter, thereby promoting better academic achievement. Self-efficacy in Chemistry, i.e. students’ belief in their ability to successfully perform Chemistry tasks, strongly influences their effort, persistence, and academic outcomes. Students with high Self-efficacy are more likely to approach challenging tasks with confidence, persist in the face of difficulties, and achieve higher levels of performance.

In view of the above findings, the investigator has selected Verbal Intelligence and Scientific Reasoning (Cognitive variables) and Attitude towards Chemistry and Self-efficacy (Noncognitive variables) as independent variables. Achievement in Chemistry as dependent variable. The investigator has also included gender, locale and type of management of the school as classificatory variables.

Objectives of the Study

The following are the objectives of the study:

1. To find out whether there exists any significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and

the dependent variable, Achievement in Chemistry among secondary school students based on subsamples, gender, locale and type of management.

2. To find out the main and interaction effects of selected Cognitive variables, namely Verbal Intelligence and Scientific Reasoning, on Achievement in Chemistry for the total sample and subsamples based on gender, locale and type of management.

3. To find out the main and interaction effects of selected Noncognitive variables, namely Attitude towards Chemistry and Self-efficacy in Chemistry, on Achievement in Chemistry for the total sample and subsamples based on gender, locale and type of management.

4. To find out the extent of relationship between selected Cognitive variables, namely Verbal Intelligence and Scientific Reasoning, and Achievement in Chemistry among secondary school students.

5. To find out the extent of relationship between selected Noncognitive variables, namely Attitude towards Chemistry and Self-efficacy in Chemistry, and Achievement in Chemistry among secondary school students.

6. To develop a regression equation for predicting Achievement in Chemistry based on selected Cognitive and Noncognitive variables.

Hypotheses of the Study

The following are the hypotheses formulated for the study:

1. There exists significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and the dependent variable, Achievement in Chemistry among secondary school students based on subsample, gender.

2. There exists significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and the dependent variable Achievement in Chemistry among secondary school students based on subsample, locale.

3. There exists significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and the dependent variable Achievement in Chemistry among Secondary School students based on subsample, type of management.

4. Selected Cognitive variables have significant main and interaction effects on Achievement in Chemistry for the total sample and the subsamples based on gender, locale and type of management.

5. Selected Noncognitive variables have significant main and interaction effects on Achievement in Chemistry for the total sample and the subsamples based on gender, locale and type of management.

6. There exists significant relationship between selected Cognitive variables and Achievement in Chemistry.

7. There exists significant relationship between selected Noncognitive variables and Achievement in Chemistry.

8. Achievement in Chemistry can be predicted from a combination of selected Cognitive and Non -Cognitive variables.

Tools Used for Data Collection

The tools of research are the instruments that provide for the collection of data up on which hypotheses may be tested (Good,1989). The success of collecting data through a tool depends mainly on how proficiently and creatively the tool has been designed.

The following are the tools selected for the study:

1. Verbal Group Test of Intelligence (VGTI) (Kumar et al., 1997)

2. Scientific Reasoning Test in Chemistry (Chandran & Jaleel, 2017)

3. Scale of Self-efficacy in Chemistry (Rani & Saleem, 2020)

4. Scale of Attitude towards Chemistry (Rani & Saleem, 2020)

5. Achievement Test in Chemistry (Rani & Saleem, 2020)

Description of Tools

A detailed description of tools used for the measurement of dependent and independent variables are presented below:

Verbal Group Test of Intelligence (VGTI) (Kumar et al., 1997)

The Variable Verbal Intelligence was measured by adopting Verbal Group Test of Intelligence (VGTI) developed by (Kumar et al., 1997). The test consists of five components namely *Verbal Analogy*, *Verbal Classification*, *Numerical Reasoning*, *Verbal Reasoning* and *Comprehension*, that could be completed within one hour of time for the subjects between the age group of 10-15 years. Maximum score was one hundred and minimum, zero. A composite score attained for the five sub tests is treated as the subjects' score of Verbal Intelligence. Each subtests are explained with appropriate examples.

Test I - Verbal Analogy. The test intended to measure the ability of pupils in understanding implied relationships between two sets of words. Questions under this category include three words of which the first two have a relationship. The subjects' task is to find out the missing word to suit the third one from the given relationship.

Eg: student: classroom: player: ……………

A. stadium B. competition C. coach D. play

A✓	B	C	D

Test II - Verbal Classification. In this section, for each item, four words are given of which three can be grouped together according to some principles or laws.

The subject has to find out the *odd man* and mark it on the response sheet according t to the instruction given. An illustrative item is the following.

Eg: A. bus B. aeroplane C. cycle D. lorry

A	B✓	C	D

Test III - Numerical Reasoning. Items in this subtest include *series* items, *Odd man out* items, and *analogy* type items. The mental process involved in answering this type of items require the perception of some sort of relationship holding between the given numbers. Three examples are given.

Series Type

Eg: 4, 9, 16, 25, 36 …………

A. 39 B. 47 C. 49 D. 59

A	B	C✓	D

Odd man out Type

Eg: A. 1 B. 5 C. 25 D. 75

A✓	B	C	D

Analogy Type

Eg: 3:5:: 11: ……………..

A. 12 B. 13 C. 14 D. 15

A	B✓	C	D

Test IV - Verbal Reasoning. Items in this type require an exercise of reasoning power. As the stem of the item is long, when the subject proceeds with the item, a part of it may be forgotten which needs more time for reading and re-reading. Such items considerably slow down the speed of reasoning. If carefully attempted, it can provide the correct answer within a limited time. An illustrative item is given:

Eg: F is the brother of A. C is the daughter of A. K is the sister of F and G is the brother of C. Then who is the uncle of G?

A. F B. C C. K D. A

A✓	B	C	D

Test V - Comprehension. Items of this subtest are in the form of puzzles involving several relationships and persons. In this subtest, four types of items are included. Under each type of items five questions are given. At first, the subject is required to understand and analyse the relationship given in each type of items. Then the subject has to choose the right answer for the five questions put at the end of each type of item, from the given alternatives and mark it on the response sheet. An illustrative example is given:

Eg; P, Q, R, S, T and U are sitting in two rows. In each row three persons are sitting face to face. The position of R is second from the left side of P. Q and T are sitting face to face. R is not the neighbour of Q. S and P are sitting in opposite direction.

Eg: In the given alternatives, which set of persons are sitting in the same row.

A. PTR B. PQR C. UTS D. PUS

A✓	B	C	D

Validity of the VGTI

The validity of the Verbal Group Test of Intelligence was established using criterion related technique by the developers. The obtained validity coefficients are presented in Table 1.

Table 1

Validity Coefficients Obtained for Verbal Group Test of Intelligence (Sub-test wise and Total test)

Sl. No.	Subtests of VGTI	Obtained 'r'
1	Verbal Analogy	0.5498**
2	Verbal Classification	0.5436**
3	Numerical Reasoning	0.5249**
4	Verbal Reasoning	0.4041**
5	Comprehension	0.4606**
6	Intelligence - Total	0.6557**

**P < 0.01

Reliability of the VGTI

Reliability of the VGTI was established by the developers of the tool using the Split-half method and the reliability coefficient was corrected using Spearman Brown

Prophecy formula. The reliability coefficients of the five subtests and the total test are given in Table 2.

Table 2

Reliability Coefficients Obtained for Verbal Group Test of Intelligence (Sub-test wise and Total test)

Sl. No.	Subtests of VGTI	Obtained 'r'
1	Verbal Analogy	0.6636**
2	Verbal Classification	0.5649**
3	Numerical Reasoning	0.7214**
4	Verbal Reasoning	0.6328**
5	Comprehension	0.4700**
6	Intelligence - Total	0.8283**

**P<0.01

Re-establishing the Validity of the VGTI

The validity of the Verbal Group Test of Intelligence was re-established using criterion related technique. Performance of students in midterm examination was used as the external criterion. To obtain the concurrent validity of the VGTI, the obtained score is compared with the midterm exam score. The midterm examination scores were used as the external criterion, as they included substantial assessment of verbal reasoning, comprehension, and language skills, which are closely related to Verbal Intelligence. The product-moment correlation obtained between these two tests score is 0.76. It shows high validity of the tool. Since the content was adapted from reputed tests of Verbal Intelligence, the VGTI possesses high level of content validity as reported by the test constructors.

Re-establishing the Reliability of the VGTI

Reliability of the VGTI was re-established using the Split-half method and the reliability coefficient was corrected using Spearman Brown Prophecy formula. The reliability coefficients of the five subtests and the total test are given in Table 3.

Table 3

Re-established Reliability Coefficients Obtained for Verbal Group Test of Intelligence (Subtest wise and Total test)

Sl. No.	Subtests of VGTI	Obtained 'r'
1	Verbal Analogy	.77**
2	Verbal Classification	.73**
3	Numerical Reasoning	.78**
4	Verbal Reasoning	.65**
5	Comprehension	.83**
	Total	.88**

**P<0.01

The obtained ‘r’ value reveals the high degree of correlation between the scores. Thus, the test is highly reliable in the present scenario also. The internal structure of the VGTI was also examined by correlating the component wise score with Total score on the VGTI. The inter correlation matrix is presented in Table 4.

Table 4

Inter Correlation of the Components of Verbal Group Test of Intelligence with Total Score

Sl. No.	Components	Verbal Analogy	Verbal Classification	Numerical Reasoning	Verbal Reasoning	Comprehension	Total
1	Verbal Analogy	-	.728**	.570**	.514**	.535**	.813**
2	Verbal Classification		-	.624**	.522**	.503**	.815**
3	Numerical Reasoning			-	.669**	.698**	.867**
4	Verbal Reasoning				-	.642**	.799**
5	Comprehension					-	.829**

The magnitude of the correlation coefficient obtained for the inter-component correlation ranges between 0.50 and 0.73. It shows that the selected components are distinct yet related and contribute meaningfully to the construct of Verbal Intelligence. The correlation between the total Verbal Intelligence score and the components also shows a moderate to strong correlation.

The validity and reliability of the test suggest that the test has acceptable psychometric qualities to measure Verbal Intelligence of the sample. A copy of the Malayalam and English versions of the Verbal Group Test of Intelligence along with the Response sheet and Scoring key are presented in Appendices I, II, III and IV respectively.

Scientific Reasoning Test in Chemistry (Chandran & Jaleel, 2017)

The variable Scientific Reasoning was measured by adopting the Scientific Reasoning Test in Chemistry developed by (Chandran & Jaleel, 2017). The tool was prepared on the basis of dimensions as significant in predicting the Scientific Reasoning ability of students such as, Problem Identification, Inductive Reasoning, Deductive Reasoning, Interpretation of Results/Data and Making logical conclusions.

The final form of the Scientific Reasoning Test consists of 26 items with a total 45 scores, carefully organised into five basic components. Each component represents a separate aspect of scientific thought and investigation. Problem Identification and Inductive Reasoning examine the capacity to recognise and generalise patterns from observations, whereas Deductive Reasoning evaluates the application of general principles to specific cases, resulting in a higher weightage in marks. Interpretation of Results/Data assesses the capacity to analyse and comprehend empirical information, whereas Making Logical Conclusions assesses the ability to draw logical inferences based on evidence. This distribution ensures a thorough assessment of a learner's Scientific Reasoning ability across several cognitive processes. An illustrative of items included in the test is given below

1. What is the total number of hydrogen atoms in Cyclohexane?

   a) 6 b) 10 c) 12 d) 8

2. Which are the elements giving high reactivity towards acid and water? .

   a) Fe & K b) Na & K c) K & N d) Na & Zn

3. Which form of carbon dioxide is used as a freezing agent?

   a) Graphite b) Carborundum c) Dry Ice d) Charcoal

4. From which components, proteins are made up of?

   a) Nucleic acid b) Nitrates c) Amino Acids d) Nitric Acid

5. The reason behind the use of chlorine for drinking water purification:

   a) The oxidising property of chlorine

   b) The reducing property of chlorine

   c) High density of chlorine

   d) The dehydrating nature of chlorine

Validity of Scientific Reasoning Test

The test developers have reported that each measuring item aligns clearly with the conceptual domain of Scientific Reasoning as per the expert's judgment. Therefore, the test demonstrates strong face validity. The degree to which the content is valid is assessed by an objective comparison of the test items with curricular content. Since the test is prepared giving due weightage to content and components and as it was subject to expert judgment, content validity of the test is ensured.

Reliability of Scientific Reasoning Test

Reliability of Scientific Reasoning test was ensured by the developers using Test-retest reliability method. The value of correlation coefficient for total test items is reported as 0.99. The correlation coefficients for various components of Scientific Reasoning are Problem Identification (0.90), Inductive Reasoning (0.97), Deductive Reasoning (0.96), Interpretation of Results/Data (0.97) and Making logical conclusions (0.95). The correlation coefficient values indicate that the Scientific Reasoning Test demonstrates high reliability.

Additionally, the internal consistency of the test was evaluated using Cronbach's alpha (α). The Cronbach's alpha coefficient for the entire test was reported as 0.99, signifying excellent internal reliability. The component-wise Cronbach's alpha values were: Problem Identification (0.94), Inductive Reasoning (0.98), Deductive Reasoning (0.98), Interpretation of Results/Data (0.98), and Making Logical Conclusions (0.97). These results confirm that the Scientific Reasoning Test possesses a high level of internal consistency and reliability.

Re-establishing the Validity of the Scientific Reasoning Test

According to expert assessment, every item on the exam is clearly in line with the conceptual area of Scientific Reasoning, demonstrating the test's strong face validity. To determine content validity, the items are evaluated objectively to the course material. Because the test was created with attention for relevant content and components and was reviewed by specialists, its content validity is assured.

Re-establishing the Reliability of the Scientific Reasoning test

The reliability of the Scientific Reasoning Test was reestablished using the Test–retest method, which evaluates the stability of scores over time (Mcntire & Miller, 2007). The same test was administered to a sample of 50 secondary school students after a two-week interval. The scores from both administrations were analysed using Pearson's product-moment correlation coefficient, yielding a reliability coefficient of 0.89. This high correlation indicates that the Scientific Reasoning Test possesses strong reliability. The final version of the Scientific Reasoning Test, along with the Response Sheet and Answer Key, are provided in Appendices V, VI, VII, and VIII, respectively.

Scale of Attitude towards Chemistry (Rani & Saleem, 2020)

The scale of Attitude towards Chemistry was constructed and standardised by the investigator with the help of supervising teacher. This scale is designed to measure students' Attitudes toward Chemistry.

Planning and Preparation

The concept of Attitude towards Chemistry refers to an individual's feelings, beliefs, opinions and predispositions regarding the subject of Chemistry. It encompasses how a person perceives, evaluates and responds to Chemistry as a discipline or fields of study. Thus, attitude can be positive, negative or neutral and may influence a person's engagements with and success in learning Chemistry. Positive attitudes are often associated with greater motivation, engagement and success in Chemistry-related tasks, while negative attitudes can hinder the process of learning Chemistry. Here, Attitude towards Chemistry can be defined as a person's overall outlook, emotions and cognitive evaluations related to the study and practice of Chemistry. It involves the emotional responses and feelings associated with Chemistry, it also includes a person's beliefs and thoughts about Chemistry.

Based on the literature reviewed and considering the theories of Attitude towards Chemistry, the investigator decided to construct and standardise an appropriate tool for assessing the attitude of students towards Chemistry. For the purpose of constructing the items, the investigator identified four specific dimensions in Chemistry, viz., Nature of Chemistry, Chemistry as a subject of study in the classroom situation, Chemistry related co-curricular activities and Evaluation practices in Chemistry. The four dimensions were chosen based on a thorough understanding of the complex nature of students' attitudes towards the subject: the nature of chemistry, chemistry as a subject of study in the classroom, chemistry-related extracurricular activities, and evaluation practices in chemistry. Together, these factors reflect the fundamental areas that have a big impact on how students view and interact with chemistry. While Chemistry as a subject of study in the classroom captures students' experiences with teaching methods, learning environments, and interactions in formal academic settings, Nature of Chemistry addresses students' conceptual and emotional responses to the subject's inherent characteristics and relevance. Informal and extended learning opportunities, such scientific fairs and clubs, are examples of chemistry-related extracurricular activities that can boost motivation and interest outside of the conventional classroom. Finally, chemistry evaluation processes are linked to students' opinions about how assessments are conducted, their perception of fairness, and their exam anxiety, all of which have a significant impact on how they view the world in general. When taken as a whole, these factors provide a comprehensive and equitable method of evaluating attitudes towards chemistry. By giving equal consideration to each category, 47 preliminary items were prepared. Brief description of dimension selected along with the illustration of items from that dimension is presented below:

Nature of Chemistry. This dimension measures the students' attitude towards the subject Chemistry including Chemistry likeness, interest, feelings towards Chemistry and Chemistry in media.

Eg: Chemistry is one of the most difficult subjects in science

Chemistry in the Classroom Situations. This dimension measures Attitude towards Chemistry teacher, teaching learning experiences in Chemistry, Chemistry Laboratory, homework, Library functioning, relevant books and magazines.

Eg: I tend to be more interested in Chemistry as it is more related to life.

Chemistry Related Co-curricular Activities. This dimension measures the attitude of students towards Science fair, Science club, Science books fair, Websites on Science Programmes, Quiz Programmes on Science and Programmes on the contribution of Scientists.

Eg: I am sure that Chemistry students can contribute more in environmental protection programmes.

Evaluation and Assessment Practices in Chemistry. This part of the items measures the Attitude towards Chemistry like Chemistry examination, assessment practices, submission of projects, assignments, action research and practical examinations.

Eg: I feel very sad when I fail in Chemistry exams.

Pilot Testing and Item Analysis

For the purpose of standardisation of the tool, the investigator has selected 370 students randomly giving importance to gender, locale and type of management. After getting permission of the authorities concerned, the tool was administered among the students. Necessary instructions were given to the candidates. They were asked to respond to each item of the statement in terms of Agree, Undecided and Disagree. The response alternatives are weighted 3,2,1 respectively. While scoring, the scores on negative items would reverse. The scores were organised for the item analysis.

The investigator executed the procedure recommended by Likert (1932) for item analysis in order to evaluate the effectiveness of items in the Scale of Attitude towards Chemistry. The total scores were arranged in descending order, and 370 response sheets were arranged for the item analysis. For the purpose of item discrimination, the top 27 percent (high scorers) and the bottom 27 percent (low scorers) were identified. t-values were calculated by comparing the mean scores of the two groups in order to ascertain the discriminating power of each item. Items with a t-value of 1.96 or higher were deemed to possess acceptable discriminative power. Hence 42 out of 47 items were accepted, with scores exceeding 1.96.

Validity and Reliability

Validity and Reliability of the Scale of Attitude towards Chemistry was established. Details of the validity and reliability are presented below.

The items in the Scale of Attitude towards Chemistry were developed based on an extensive review of relevant literature and through consultation with the research supervisor and subject matter experts in the field of chemistry education. The content and relevance of each item were critically evaluated by the panel of experts in chemistry, who unanimously endorsed the scale for its appropriateness and alignment with the intended construct. Hence, the scale demonstrates strong content validity, as it adequately represents the domain of students' attitudes towards chemistry from both theoretical and practical perspectives.

The reliability of the tool was established using the test–retest method, which assesses the consistency of results over time. The same tool was re-administered to the same sample of 50 participants after a two-week interval. To evaluate the stability of the scores, Pearson's product-moment correlation coefficient was calculated, yielding a reliability coefficient of 0.85. This high correlation value indicates that the tool has good temporal stability and can be considered reliable for measuring the intended construct.

A copy of the final versions of the scale of Attitude towards Chemistry in Malayalam and English including the response sheet are provided as Appendices IX, X and XI respectively.

Scale of Self-efficacy in Chemistry (Rani & Saleem, 2020)

The scale of Self-efficacy in Chemistry was constructed and standardised by the investigator with the help of supervising teacher. This scale measures the efficacy beliefs of secondary school students in Chemistry.

Planning and Preparation

Bandura (1977), a cognitive psychologist introduced the concept of Self-efficacy as a part of his Social Cognitive Theory which focuses on the role of self-beliefs in human behaviour. Self-efficacy refers to an individual's belief in their own ability to accomplish a specific task or achieve a particular goal. It is a cognitive construct that influences motivation, behaviour and performance in the context of Chemistry or any other subject. If a student has a strong sense of Self-efficacy, they are more likely to engage with subject and ultimately perform better academically.

Self-efficacy in Chemistry is the belief an individual holds about their capacity to comprehend and excel in school Chemistry-related activities. It will boost the students' confidence in solving Chemistry-related problems, conducting experiments, understanding chemical concepts and motivating students in learning Chemistry.

Self-efficacy in the context of Chemistry can be understood and studied through the application of broader theories such as Bandura's Social Cognitive Theory of Self-efficacy. But there may not be specific theories of Self-efficacy exclusively for Chemistry. Based on the literature reviewed and considering the specific theories of Self-efficacy, the investigator aimed to construct and standardise an appropriate tool for assessing the efficacy beliefs of students in Chemistry.

For item construction, the investigator identified four key dimensions of Chemistry: Nature of Chemistry, Chemistry as a subject in the classroom, Chemistry-related co-curricular activities, and Evaluation practices in Chemistry. By giving due consideration for each of the dimensions, the investigator developed 39 statements as initial items. Here, respondents are asked to read and react the series of statements regarding efficacy beliefs in Chemistry in terms of degrees of frequency. Brief description of dimension selected along with the illustration of items from that dimension is presented below:

Nature of Chemistry. This measures the efficacy beliefs of students regarding memory and competence in Chemistry learning and clarifying doubts.

Example:

1. I used to discuss doubts related to Chemistry lessons with my friends.

2. I find it difficult to read and understand Chemistry.
3. I try to remove the difficulties faced by my classmates regarding the study of Chemistry.

Chemistry in Classroom Context. This dimension measures the efficacy beliefs of students based on the questions asked by teachers and the students responses, Learning experiences in the classroom and in the Laboratory, Exercises and Assignments and Peer tutoring.

Example:

1. I can present papers in Chemistry-related seminars.
2. I can identify exactly what different equipments and chemicals are in a Chemistry lab.
3. I am able to help my classmates in observational experiments in Chemistry Lab.

Chemistry Related Co-Curricular Activities. The statements under this category, prepared based on Chemistry related co-curricular activities measure the efficacy beliefs of students regarding the Science clubs, Chemistry-related social issues like air pollution, environmental issues and Chemistry in day-to-day life.

1. I use the knowledge gained through Chemistry when I buy things like soap, detergent etc. from the shops for household purposes.
2. I am aware of new possibilities or opportunities in Chemistry.
3. I can do any type of work related to Chemistry.

Evaluation Practices in Chemistry. This part of the statements measures the efficacy beliefs of students regarding the assessment practices, problems related to examination anxiety, achievement motivation, writing of assignments and submission of projects.

Example:

1. I feel a sense of hope when I think about the skills it takes to become a chemist.
2. I believe even before the exam result comes that I can achieve high success.
3. I am able to complete learning activities appropriately.

Pilot Testing and Item Analysis

For the purpose of standardisation of the scale, the investigator selected 370 students. The selected students were instructed to respond to each item of the statement in terms of Agree, Undecided and Disagree. The response alternatives are weighed 3, 2, 1 respectively. While scoring, the scores on negative items would reverse. The scores were arranged for item analysis.

For item analysis, the investigator adopted the procedure suggested by Likert (1932) to examine the effectiveness of items in the Self-efficacy Scale for Chemistry. Responses were collected from 370 students, and the total scores were arranged in descending order. The top 27 percent (high scorers) and the bottom 27 percent (low scorers) were identified for the purpose of item discrimination. To determine the discriminating power of each item, t-values were computed by comparing the mean scores of the two groups. Items with a t-value of 2.58 or above were considered to have acceptable discriminative power and thus out of 39 Items 37 items having scores greater than 2.58 were accepted. Hence a total of 37 items were considered for the final test.

Validity and Reliability

The validity of 37 items in the scale were established based on the authentic literature reviewed. The investigator also consulted with selected experts in the field as well as the supervising teacher. The content and relevance of each item were critically evaluated by the panel of experts in chemistry, who unanimously endorsed the scale for its appropriateness and alignment with the intended construct. Hence, the scale demonstrates strong content validity, as it adequately represents the domain of students' Self-efficacy in Chemistry from both theoretical and practical perspectives.

The Scale of Self-efficacy in Chemistry was administered to 50 secondary school students twice, with a two-week interval between administrations. The responses were collected, scored, and analysed using Pearson's product-moment correlation, yielding a correlation coefficient of 0.82. This high correlation confirms that the scale demonstrates strong reliability.

A copy of the final versions of the scale of Self-efficacy in Chemistry in Malayalam and English and Response Sheet are appended as Appendices XII, XIII and XIV.

Achievement Test in Chemistry (Rani & Saleem, 2020)

For the present study, the investigator constructed and standardised an Achievement Test in Chemistry to assess the Achievement in Chemistry among IX standard students. As an initial step, the investigator consulted with the supervising teacher, senior Chemistry teachers, and subject experts to discuss key aspects such as the content selection, and the systematic steps involved in the development of the test. Details of construction and standardisation of the achievement test in chemistry is describes as follows.

Planning of the Test

After determining the scope of the test, a design was developed. Accordingly, based on the blue print prepared, the investigator referred to the IX standard Chemistry text book and pooled 90 multiple choice items for the draft tool. These questions were analysed by the senior Chemistry teachers and experts in the field, in terms of its objectives, content, level of questions, marks and estimated time, 10 items were discarded and 80 items were selected for the draft test. Instructions for the students were also given in the test. Thus, the draft test contains 80 multiple choice items and the students were asked to put a tick mark in the separate score sheet provided. Detailed description on blueprint as follows.

Weightage to Content

Questions from seven areas of IX standard chemistry textbook viz. Structure of Atoms, Chemical Bonding, Redox & Reactions and rate of chemical reactions, Periodic table, Acid bases salts, Non-Metals and The world of Carbon were polled based on the relative importance of content areas. The details of the content and their relative weightage are presented below:

Table 5

Content and their Relative Weightage

Sl. No.	Content	Marks	Percentage
1.	Structure of Atoms	21	27
2.	Chemical Bonding	9	11
3.	Redox & Reactions and rate of chemical reactions	6	8
4.	Periodic table	9	11
5.	Acid bases salts	13	16
6.	Non-Metals	13	16
7.	The world of Carbon	9	11
	Total	80	100

Weightage to Educational Objectives

It was decided to give relative weightage to different objectives based on Blooms classification. The details of the weightage given to the specification of objective are presented below.

Table 6

Weightages given to the Educational Objectives

Sl. No.	Educational Objectives	Marks	Percentage
1.	Remembering (R)	19	24
2.	Understanding (U)	19	24
3.	Applying (Ap)	16	20
4.	Analysing (An)	13	16
5.	Evaluating (E)	8	10
6.	Creating (C)	5	6
	Total	80	100

Weightage to Difficulty Levels

While constructing the test, due consideration was given to the three levels of students in a Classroom namely, Above average, average and below average. The test will cater to the needs of all these categories. Weightage given to the difficulty levels of questions is presented below.

Table 7

Details of Weightage to Difficulty Levels

Sl. No.	Level of Difficulty	Marks	Percentage
1.	Easy	24	30
2.	Average	35	44
3.	Difficult	21	26
	Total	80	100

Preparation of the Draft Blue Print

The investigator took due care in the preparation of a draft blue-print which presents the concrete details of its design. The distribution of questions was represented across three dimensions of the blueprint: objective-wise, content-wise, and level of difficulty. Details of the draft blue print is presented below.

Table 8

Details of the draft Blue-Print

Sl. No.	Content	Objective Categories						Total
		R	U	Ap	An	E	C	
1	Structure of Atoms	5	5	4	3	2	2	21
2	Chemical Bonding	2	2	2	1	1	1	9
3	Redox & Reactions and rate of chemical reactions	2	2	2	0	0	0	6
4	Periodic table	2	2	2	2	1	0	9
5	Acid bases salts	3	3	3	2	2	0	13
6	Non-Metals	3	3	2	3	2	0	13
7	The world of Carbon	2	2	1	2	1	1	9
	Total	19	19	16	13	9	4	80

Preparation of the Final Test

The draft version of the test comprised 80 multiple-choice questions. However, only 60 items were planned for retention in the final test. To choose the best items, standardisation procedure were adopted. This procedure includes assessing each question's difficulty level and discriminating power. Based on the results of item analysis, 60 high-quality items were carefully selected to construct the final version of the Chemistry Achievement Test.

Item Analysis

For the standardisation process, the test was administered on a random sample of 370 Students of IX standard from Kozhikode district by giving due representation to gender, locale and type of management. Following the administration of the draft test, the responses were assessed, and the sum of the scores on each response sheet was recorded. Subsequently, the total scores were sorted in descending order, and the top 27 percent and bottom 27 percent are distinguished based on their relative positions. To facilitate analysis, the top 27 percent (100) of the sheets with the highest score and the bottom 27 percent (100) of the sheets with the lowest score were selected and designated as the upper group (U) and lower group (L) respectively.

Determining the Difficulty Index of an Item

The difficulty index of an item is defined as the percentage of students who answered it correctly. A higher percentage of correct responses indicates an easier item. To determine the difficulty index, the total number of correct responses from both the upper and lower groups is calculated and then converted into a percentage. The formula used to compute the difficulty index is:

$$Di = (U + L) / 2N$$

Where:

Di = Difficulty Index

U = Number of correct responses in the upper group

L = Number of correct responses in the lower group

N = Number of students in each group

Determining the Discriminating Power

The discriminating power of an item refers to its ability to distinguish between high-performing (upper group) and low-performing (lower group) students. This is assessed by comparing the number of correct responses in the two groups. A greater difference in correct responses indicates stronger discriminating power. The discrimination index is calculated by converting this difference into a standardised value using the formula:

$$DP = (U - L) / N$$

Where:

DP = Discrimination Power

U = Number of correct responses in the upper group

L = Number of correct responses in the lower group

N = Number of students in each group

Finalization of the Test

For the finalization of the test, a difficulty index 0.40 and above were considered and the discriminating power 0.40 were considered to be having satisfactory difficulty index and discriminating power. Thus, the investigator selected 60 items for the final test. The time was fixed as 60 minutes. The necessary instructions were given at the beginning of the test. A scoring key for the final test was also prepared. The blue print for the final test is presented below,

Weightage to Content

The details of the content and their relative weightage are presented below:

Table 9

Content and their Relative Weightage

Sl. No.	Content	Marks	Percentage
1.	Structure of Atoms	16	26
2.	Chemical Bonding	8	13
3.	Redox & Reactions and rate of chemical reactions	3	5
4.	Periodic table	7	12
5.	Acid bases salts	7	12
6.	Non-Metals	10	17
7.	The world of Carbon	9	15
	Total	60	100

Weightage to Educational Objectives

The details of the weightage given to specifications of objective are presented below.

Table 10

Weightage given to the specifications of Educational Objectives

Sl. No.	Educational Objectives	Marks	Percentage
1.	Remembering (R)	17	28
2.	Understanding (U)	15	26
3.	Applying (Ap)	11	18
4.	Analysing (An)	8	13
5.	Evaluating (E)	6	10
6.	Creating (C)	3	5
	Total	60	100

Weightage to Difficulty Levels

Weightage given to the difficulty levels of questions is presented below.

Table 11

Details of Weightage to Difficulty Levels

Sl. No.	Level of Difficulty	Marks	Percentage
1.	Easy	15	25
2.	Average	28	47
3.	Difficult	17	28
	Total	60	100

Preparation of the Final Blue Print

The investigator took due care in the preparation of a final blue-print which presents the concrete details of its design. The distribution of questions was represented across three dimensions of the blueprint: objective-wise, content-wise, and level of difficulty. Details of the final blue print is presented below.

Table 12

Final Blue Print of the Test

Sl. No.	Content	Objective Categories						Total
		R	U	Ap	An	E	C	
1	Structure of Atoms	5	4	3	2	1	1	16
2	Chemical Bonding	2	2	1	1	1	1	8
3	Redox & Reactions and rate of chemical reactions	1	1	1	0	0	0	3
4	Periodic table	2	2	2	1	0	0	7
5	Acid bases salts	2	2	2	1	0	0	7
6	Non-Metals	3	2	2	2	1	0	10
7	The world of Carbon	2	2	2	1	1	1	9
	Total	17	15	13	8	4	3	60

Table 13

Question wise analysis for the final test

Q.No	Content Area	Objective	Difficulty Level
1	Structure of Atoms	R	Easy
2	Structure of Atoms	R	Easy
3	Structure of Atoms	R	Average
4	Structure of Atoms	U	Average
5	Structure of Atoms	U	Difficult
6	Chemical Bonding	R	Easy
7	Chemical Bonding	U	Average
8	Chemical Bonding	Ap	Average
9	Periodic Table	R	Average
10	Periodic Table	U	Difficult
11	Acids, Bases and Salts	R	Easy
12	Acids, Bases and Salts	U	Average
13	Acids, Bases and Salts	Ap	Average
14	Non-Metals	R	Easy
15	Non-Metals	U	Average
16	Non-Metals	Ap	Difficult
17	Structure of Atoms	An	Average
18	Structure of Atoms	An	Difficult
19	Structure of Atoms	E	Difficult
20	Chemical Bonding	An	Average
21	Chemical Bonding	E	Difficult
22	Chemical Bonding	C	Difficult
23	Redox Reactions and Rate of Reactions	R	Easy
24	Redox Reactions and Rate of Reactions	U	Average
25	Redox Reactions and Rate of Reactions	Ap	Average
26	Periodic Table	R	Easy
27	Periodic Table	U	Average
28	Periodic Table	Ap	Difficult
29	Acids, Bases and Salts	R	Easy

Q.No	Content Area	Objective	Difficulty Level
30	Acids, Bases and Salts	U	Average
31	Acids, Bases and Salts	Ap	Difficult
32	Non-Metals	An	Average
33	Non-Metals	An	Difficult
34	Non-Metals	E	Difficult
35	The World of Carbon	R	Easy
36	The World of Carbon	U	Average
37	The World of Carbon	Ap	Average
38	The World of Carbon	An	Difficult
39	The World of Carbon	E	Difficult
40	The World of Carbon	C	Difficult
41	Non-Metals	R	Easy
42	Non-Metals	U	Average
43	Non-Metals	Ap	Average
44	Acids, Bases and Salts	R	Average
45	Acids, Bases and Salts	U	Difficult
46	Acids, Bases and Salts	Ap	Difficult
47	Periodic Table	An	Average
48	Periodic Table	An	Difficult
49	Periodic Table	R	Easy
50	Periodic Table	U	Average
51	Non-Metals	R	Easy
52	Non-Metals	U	Average
53	Non-Metals	Ap	Difficult
54	Non-Metals	An	Difficult
55	Non-Metals	E	Difficult
56	Structure of Atoms	R	Easy
57	Structure of Atoms	U	Average
58	Structure of Atoms	Ap	Difficult
59	Structure of Atoms	An	Difficult
60	Structure of Atoms	C	Difficult

Validity and Reliability of the test.

Achievement test in chemistry was constructed in accordance with the existing IX standard chemistry text book and syllabus of Kerala state. The investigator strictly followed the blueprint and the predetermined objectives while developing the test. The investigator also consulted with selected experts in the field as well as the supervising teacher. The content and relevance of each item were critically evaluated by the panel of experts in chemistry, who unanimously endorsed the scale for its appropriateness and alignment with the intended construct. Hence, the scale demonstrates strong content validity, as it adequately represents the domain of students' Achievement in Chemistry from both theoretical and practical perspectives.

Reliability of the Achievement Test in Chemistry was established by administering the test to 50 secondary school students twice, with a three-week interval between administrations. The responses were collected, scored, and analysed using Pearson's product-moment correlation, yielding a correlation coefficient of 0.80. This high correlation confirms that the scale demonstrates strong reliability. A copy of final version of Achievement Test in Chemistry in Malayalam and English along with response sheet and answer key are provided in Appendix XV, XVI, XVII and XVIII respectively.

Sample Selected for the Study

Selection of a sample is an integral part of any scientific research. The reliability of the research findings solely depends on the sample selected. A good sample of a population is one which will reproduce the characteristics of the population with great accuracy. In the present study investigator selected an initial sample of 1200 students from Malappuram, Kozhikode and Kannur revenue districts. Stratified random sampling technique is accepted as the procedure for the selection of sample.

The Initial Sample

Based on the characteristics of entire population, an initial breakdown of a tentative sample was determined, and it was chosen over a basal sample of 1200 students. The distribution of the initial sample based on gender, locale and management was done as per table 14 given below.

Table 14

Details Regarding Break up of Initial Sample

Gender				Locale				Type of Management			
Male		Female		Rural		Urban		Govt.		Aided	
N	%	N	%	N	%	N	%	N	%	N	%
551	46	649	54	689	57	511	43	621	48	579	52
Total N		1200		Total N		1200		Total N		1200	

The details of the data presented in table 14 indicate that the sample consists of 551 male and 649 female of which 689 were from rural setting and 511 from urban setting, with respect to type of management of the school 621 from government school and 579 from aided school.

The Final Sample

The data from the initial 1200 sample were examined and scrutinised and the incomplete data score sheets were discarded. The remaining 1100 sample, found complete and correct in respect of all the necessary information required, were chosen for analysis. The data available for 1100 sample were used for final analysis. The details of the breakup of the final sample in terms of gender, locale of the institutions and type of management of the schools are presented below in table 15

Table 15

Details Regarding the Break up the Final Sample

Gender				Locale				Type of Management			
Male		Female		Rural		Urban		Govt.		Aided	
N	%	N	%	N	%	N	%	N	%	N	%
500	46	600	54	658	60	442	40	591	54	509	46
Total N		1100		Total N		1100		Total N		1100	

The table 18 shows that the sample consists of 500 male and 600 female of which 658 were from rural setting and 442 from urban setting. With respect to type of management of the school, 591 were from government schools and 509 from aided schools.

Data Collection Procedure

After finalizing the sample and tools to be used, arrangements for data collection were made after seeking permission from the school authorities.

The investigator personally met the Headmaster concerned and Teachers of the selected schools to ensure their co-operation. The investigator reviewed test manuals and references to familiarise herself with the procedures before conducting the tests. Copies of the test booklets and the answer sheets in the final form in sufficient numbers were prepared.

The investigator administered all the tools with the help of school teachers of IXth standard students. An interval of 10 minutes was allowed in between the administration of the tools. Uniform and systematic procedure was adopted in administering all the tools in the different selected schools. The collected data sheets were systematically arranged for further processing and scoring. A few incomplete answer sheets were identified and eliminated. Thus, a sample of 1100 was available for analysis.

Statistical Techniques for Analysis

Statistical Techniques refer to methods used to collect, analyse, interpret and organise data. These techniques help in understanding data, trends, making predictions, testing hypothesis and in making informed decisions based on numerical information.

The statistical techniques used for data analysis are as follows:

1. Basic Descriptive Statistics
2. Independent Sample t-Test
3. Two-way ANOVA (3×3 Factorial)
4. Pearson's Product Moment Correlation Coefficient
5. Multiple Regression Analysis

Basic Descriptive Statistics

Basic descriptive statistics involve the calculation of measures of dispersion, such as standard deviation, and measures of central tendency, such as mean, median and mode. For each independent and dependent variable, the values for skewness and kurtosis were determined. Additionally, descriptive statistics were adopted for the entire sample and pertinent subsamples separately, namely male-female, rural-urban, and government-aided secondary school students. The nature of the distribution of independent and dependent variables was also determined by using descriptive statistics.

Independent Sample t-Test

The means of two unrelated groups were compared using an independent sample t-test to see if there was a statistically significant difference. The dependent variable is assumed to be continuous and regularly distributed for both groups in this test. The t-test assisted in determining whether the observed group differences were statistically significant or could be explained by chance. In the present study, the mean difference of dependent and independent variables based on gender, locale and type of management was also calculated using independent sample t-test.

Two-way ANOVA (3 $\times$3 Factorial)

The main effect and interaction effect of two independent cognitive variables, namely, Verbal Intelligence and Scientific Reasoning on the dependent variable were estimated using two-way analysis of variance. Three fixed factors were identified for each of the independent variables. Verbal Intelligence was classified into low, moderate and high Verbal Intelligence category. The levels of Scientific Reasoning were low, moderate and high Scientific Reasoning. As such, Data was analysed using 3x3 ANOVA, which includes two independent variables at three levels. Data were examined for the entire sample and for male, female, urban, rural, government, and aided secondary school students. Scheffe's post hoc test was used to compare significant F values.

Similarly, main effect and interaction effect of two independent Noncognitive variables namely, Attitude towards Chemistry and Self-efficacy in Chemistry on the dependent variable, Achievement in Chemistry were estimated using two-way analysis of variance. Three fixed factors were identified for each of the independent variables. Attitude towards Chemistry was classified into low, average and high-level Attitude towards Chemistry category. The levels of Self-efficacy in Chemistry were low, moderate and high Self-efficacy in Chemistry. Hence 3x3 ANOVA, with two independent variables at three levels was used to analyse data. Data were analysed for total sample and separately for male, female, urban, rural, government, and aided secondary school students. The significant F value was subjected to Scheffe's test of post hoc comparison.

Pearson's Product Moment Coefficient of Correlation

The relationship between each independent variable, Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, and Self-efficacy in Chemistry and the dependent variable, Achievement in Chemistry was determined by using Pearson's Product Moment Coefficient of Correlation.

Multiple Regression Analysis

Multiple regression analysis was used to predict the independent factor's individual and joint contributions to the dependent variables. Multiple regression was performed using the enter approach, in which all independent variables were input simultaneously. A regression equation was also created to predict the dependent variable using the selected independent factors.

Chapter Four

ANALYSIS AND INTERPRETATION

- Preliminary Analysis
- Mean Comparison of Cognitive and Noncognitive variables in Achievement in Chemistry based on gender, locale and type of management
- Main and Interaction effect of Cognitive and Noncognitive independent variables on Achievement in Chemistry
- Relationship between independent variables namely, Verbal Intelligence, Scientific Reasoning in Chemistry, Attitude towards Chemistry, Self-efficacy in Chemistry, and dependent variable Achievement in Chemistry.
- Regression Analysis

ANALYSIS AND INTERPRETATION

This chapter deals with analysis of data and interpretation of results. ‘Analysis of data is the heart of research report’ (Best, 2007). ‘Analysis of data means studying the organised material in order to discover inherent facts. The data are studied from as many angles as possible to explore the new facts’ (Koul, 1984). This process involves a number of closely related operations that are performed with the objectives of summarising the collected data and organising these in such a way that they yield answers to the research questions.

The major objective of the study is to investigate the influence of specific Cognitive and Noncognitive variables on Achievement in Chemistry among secondary students. The cognitive variables under scrutiny include Verbal Intelligence and Scientific Reasoning, while the Noncognitive variable analysed are Attitude towards Chemistry and Self-efficacy in Chemistry. The statistical techniques employed for the major analysis in this study are independent sample t-test, two-way ANOVA, Pearson’s Product Moment Correlation Coefficient and Regression analysis.

Analysing the data through statistical techniques allows for a rigorous examination of the relationships between the selected variables and Achievement in Chemistry. The two-way ANOVA serves as a powerful tool for exploring the main effects and interactions of the Cognitive and Noncognitive variables on students’ chemistry performance. By considering these variables simultaneously, the ANOVA analysis helps to determine their individual and combined contributions to the observed outcomes.

Furthermore, multiple regression analysis provides a comprehensive assessment of the unique influence of each variable while controlling for potential confounding factors. This technique allows for the estimation of the specific effects of Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, and Self-efficacy in Chemistry on students' Achievement in Chemistry. The results of the regression analysis will enable a clearer understanding of the relative importance of these variables in predicting chemistry performance among secondary school students.

In the following sections of this chapter, will present and interpret the results of the analyses, providing an in-depth understanding of the relationships between the Cognitive and Noncognitive variables and Achievement in Chemistry.

Preliminary Analysis

As an initial step in the analysis, preliminary examination was carried out to determine the score distribution of Cognitive variables such as Verbal Intelligence, Scientific Reasoning, Noncognitive variables such as Attitude towards Chemistry and Self-efficacy in Chemistry and Achievement in Chemistry among secondary school students. Important descriptive statistics, including the mean, median, mode, standard deviation, Skewness and kurtosis, for total sample and relevant subsample were calculated. The data and resulting statistics are presented below as Table 16 to 20.

Table 16

Descriptive Statistics of the Variable Verbal Intelligence for Total Sample and Relevant Subsample

Statistics	Total	Male	Female	Rural	Urban	Government	Aided
N	1100	500	600	658	442	591	509
Mean	52.99	47.46	57.59	52.66	53.47	55.80	49.73
Median	52.00	46.00	57.00	51.00	53.00	56.00	49.00
Mode	50.00	20.00	57.00	50.00	57.00	31.00	52.00
Std. Deviation	19.06	19.04	17.81	19.03	19.10	19.44	18.08
Skewness	.079	.391	-.101	.133	-.001	-.099	.260
Kurtosis	-.977	-.782	-.913	-.918	-1.05	-1.01	-.800

The results displayed in Table 16 above provide the descriptive statistics for Verbal Intelligence among secondary school students. The mean 52.99, median 52 and mode 50 values for Verbal Intelligence for total sample are almost equal. The skewness of the distribution is 0.079, indicating a slight positive skew. The calculated kurtosis value is -0.977, indicating platy kurtic distribution. Collectively, these findings indicate that the scores for Verbal Intelligence of the total sample do not deviate significantly from a normal distribution.

The mean, median and mode values for Verbal Intelligence are almost equal among male, female, urban, rural, government and aided secondary school students. Among male, rural and aided secondary school students, the indices of skewness and kurtosis indicate a slightly positively skewed and platykurtic distribution. On the other hand, among female, urban and government secondary school students, the indices of skewness and kurtosis suggest a slightly negatively skewed and platykurtic distribution. The obtained values of descriptive statistics indicate that the data for all subsamples exhibit characteristics that are close to a normal distribution.

Figure 1 and Figure 2 presents a histogram and P-P Plot for the total sample respectively.

Figure 1

Smoothed Frequency Curve of Verbal Intelligence for the Total Sample

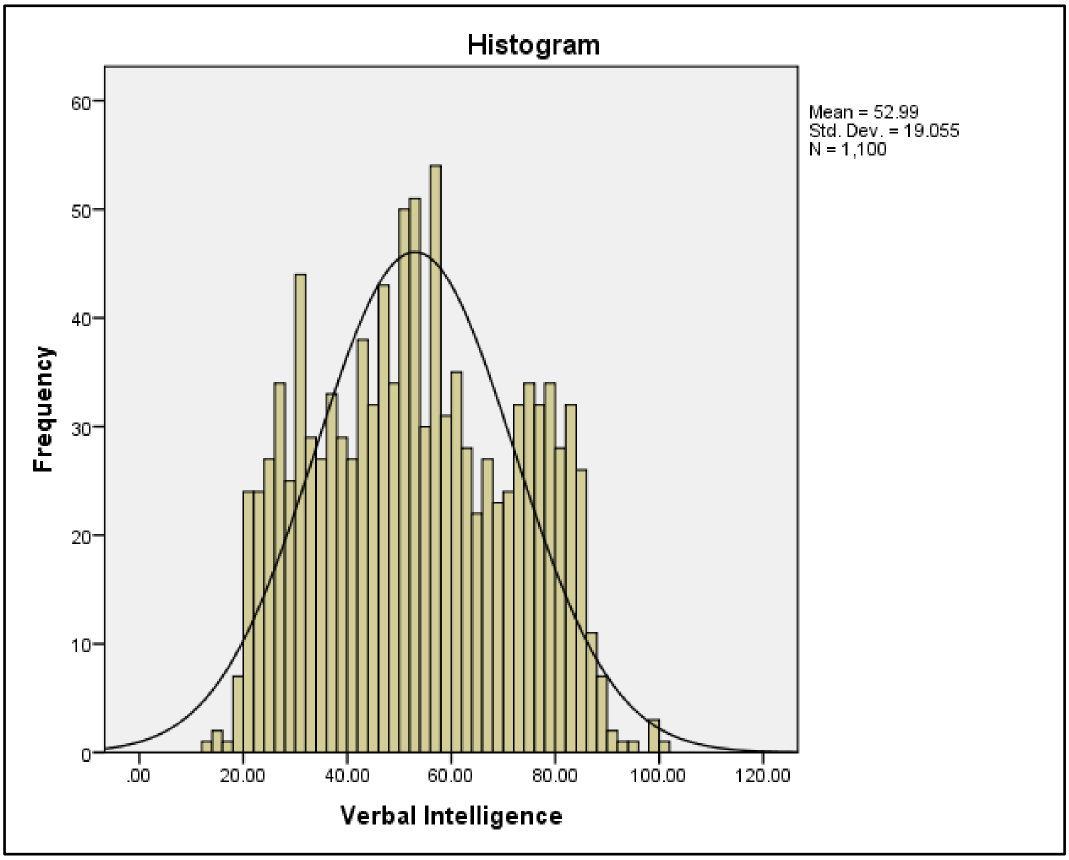
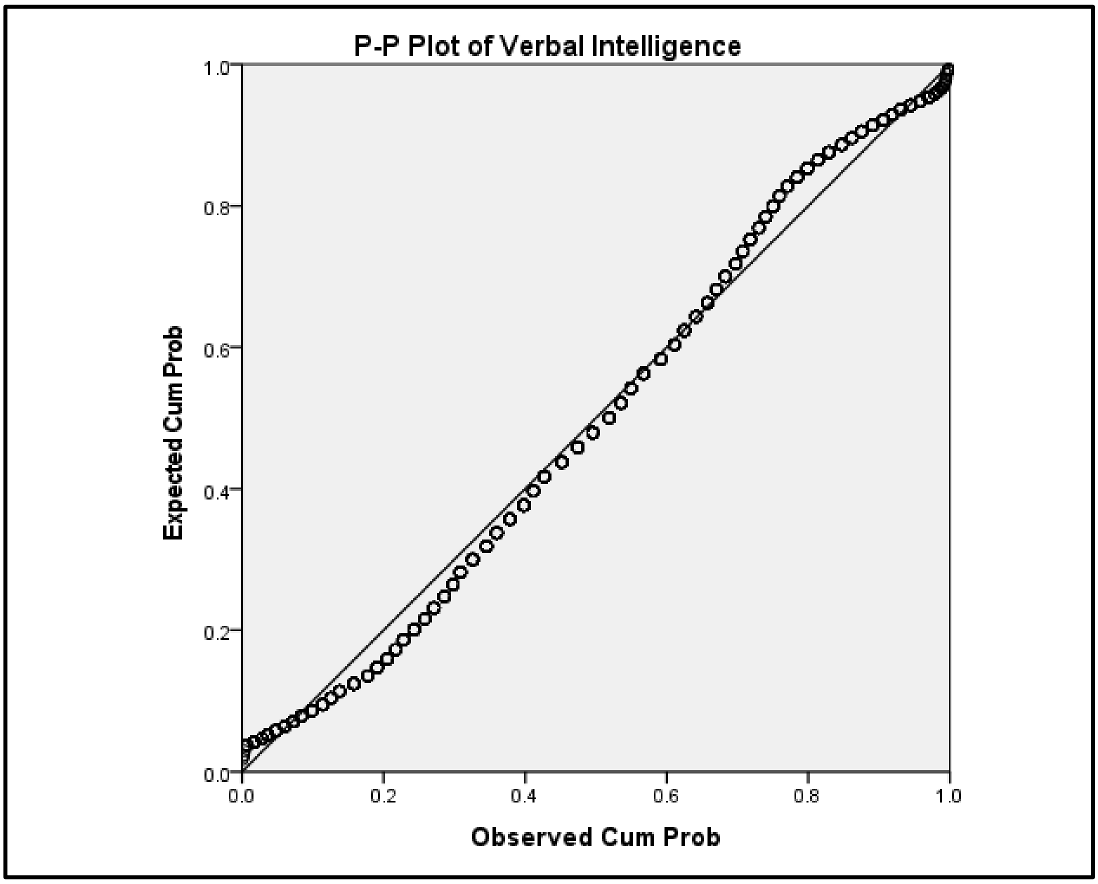


Figure 2

P-P Plot of Verbal Intelligence for the Total Sample



Visual inspection of the histogram with normal curve and P-P Plot suggest that data is not largely deviated from normality

Descriptive statistics of the variable Scientific Reasoning in Chemistry is presented in Table 17.

Table 17

Descriptive Statistics of the Variable Scientific Reasoning in Chemistry for Total Sample and Relevant Subsample

Statistics	Total	Male	Female	Rural	Urban	Government	Aided
N	1100	500	600	658	442	591	509
Mean	16.20	15.16	17.06	16.02	16.45	17.56	14.61
Median	14.00	14.00	14.00	14.00	14.00	16.00	14.00
Mode	12.00	12.00	14.00	12.00	10.00	12.00	12.00
Std. Deviation	7.90	7.36	8.24	7.63	8.30	8.52	6.79
Skewness	1.06	1.27	0.91	1.28	0.80	0.86	1.26
Kurtosis	0.81	1.62	.363	1.78	-.237	.189	1.79

The results displayed in Table 17 above provide the descriptive statistics for Scientific Reasoning in Chemistry among secondary school students. The mean 16.20, median 14 and mode 12 values for Scientific Reasoning in Chemistry for total sample are almost equal. The skewness of the distribution is 1.06, indicating a positive skew. The calculated kurtosis value is 0.812, indicating lepto kurtic distribution. Collectively, these findings indicate that the scores for Scientific Reasoning in Chemistry of the total sample do not deviate significantly from a normal distribution.

The mean, median and mode values for Scientific Reasoning in Chemistry are almost equal among male, female, urban, rural, government and aided secondary school students. Among male, female, rural, government and aided secondary school students, the indices of skewness and kurtosis indicate a slightly positively skewed and leptokurtic distribution. On the other hand, among urban secondary school students, the indices of skewness and kurtosis suggest a slightly positively skewed and platykurtic distribution. The obtained values of descriptive statistics indicate that the data for all subsamples exhibit characteristics that are close to a normal distribution.

Figure 3 and Figure 4 presents a Histogram with a normal curve and P-P Plots for the total sample respectively.

Figure 3

Smoothed Frequency Curve of Scientific Reasoning in Chemistry for the Total Sample

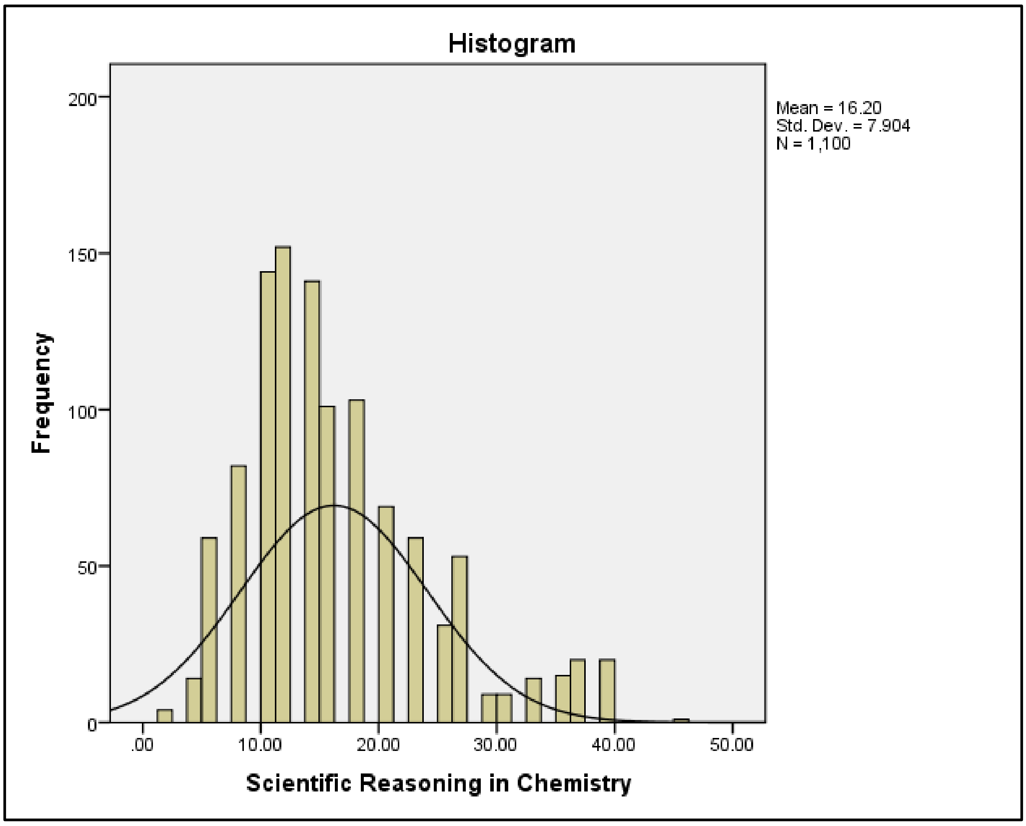
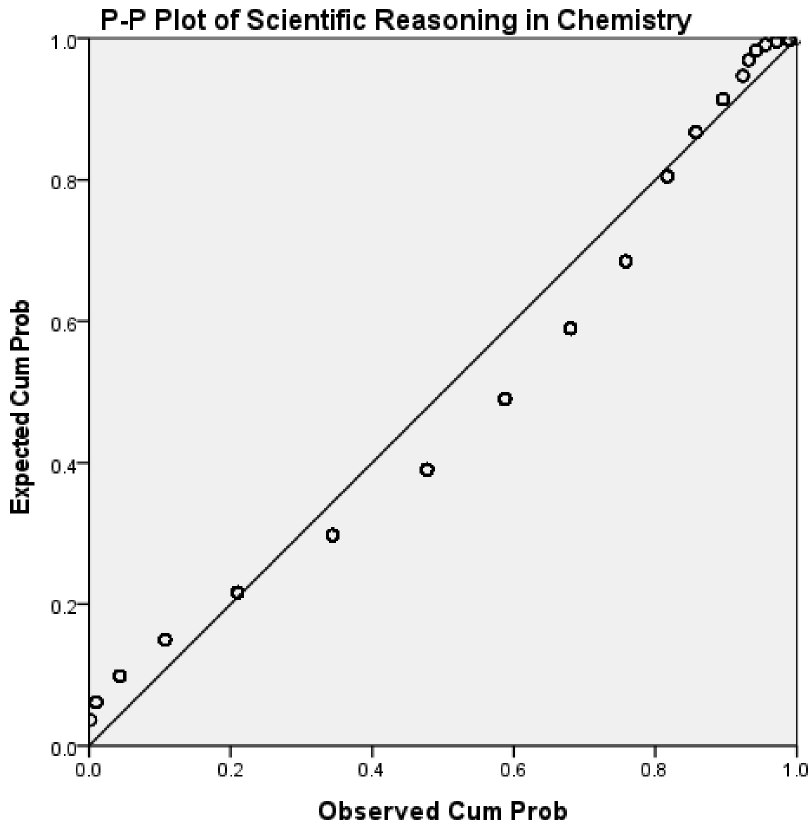


Figure 4

P-P Plot of Scientific Reasoning in Chemistry for the Total Sample



Visual inspection of the histogram with normal curve and P-P Plot suggest that data is not largely deviated from normality.

Descriptive statistics of the variable Attitude towards Chemistry is presented in Table 18

Table 18

Descriptive Statistics of the Variable Attitude towards Chemistry for Total Sample and Relevant Subsample

Statistics	Total	Male	Female	Rural	Urban	Government	Aided
N	1100	500	600	658	442	591	509
Mean	93.03	91.62	94.20	93.25	92.70	94.31	91.54
Median	92.00	90.00	94.00	92.00	92.00	93.00	90.00
Mode	86.00	86.00	97.00	89.00	86.00	93.00	90.00
Std. Deviation	10.40	9.51	10.96	10.91	9.60	10.61	9.95
Skewness	.300	.501	.120	.349	.160	.252	.325
Kurtosis	-.208	.158	-.369	-.271	-.229	-.429	.104

The results displayed in Table 18 above shows the descriptive statistics for Attitude towards Chemistry among secondary school students. The mean 93.03, median 92 and mode 86 values for Attitude towards Chemistry for Total Sample are almost equal. The skewness of the distribution is .30, indicating a positive skew. The calculated kurtosis value is -0.208, indicating platykurtic distribution. Collectively, these findings indicate that the scores for Attitude towards Chemistry of the Total Sample do not deviate significantly from a normal distribution.

The mean, median and mode values for Attitude towards Chemistry are almost equal among male, female, urban, rural, government and aided secondary school students. Among male, and aided secondary school students, the indices of skewness and kurtosis indicate a slightly positively skewed and leptokurtic distribution. On the other hand, among female, rural, urban and government secondary school students, the indices of skewness and kurtosis suggest a slightly positively skewed and platykurtic distribution. The obtained values of descriptive statistics indicate that the data for all subsamples exhibit characteristics that are close to a normal distribution.

Figure 5 and Figure 6 presents a histogram with a normal curve and P-P Plots for the total sample respectively.

Figure 5

Smoothed Frequency Curve of Attitude towards Chemistry for the Total Sample

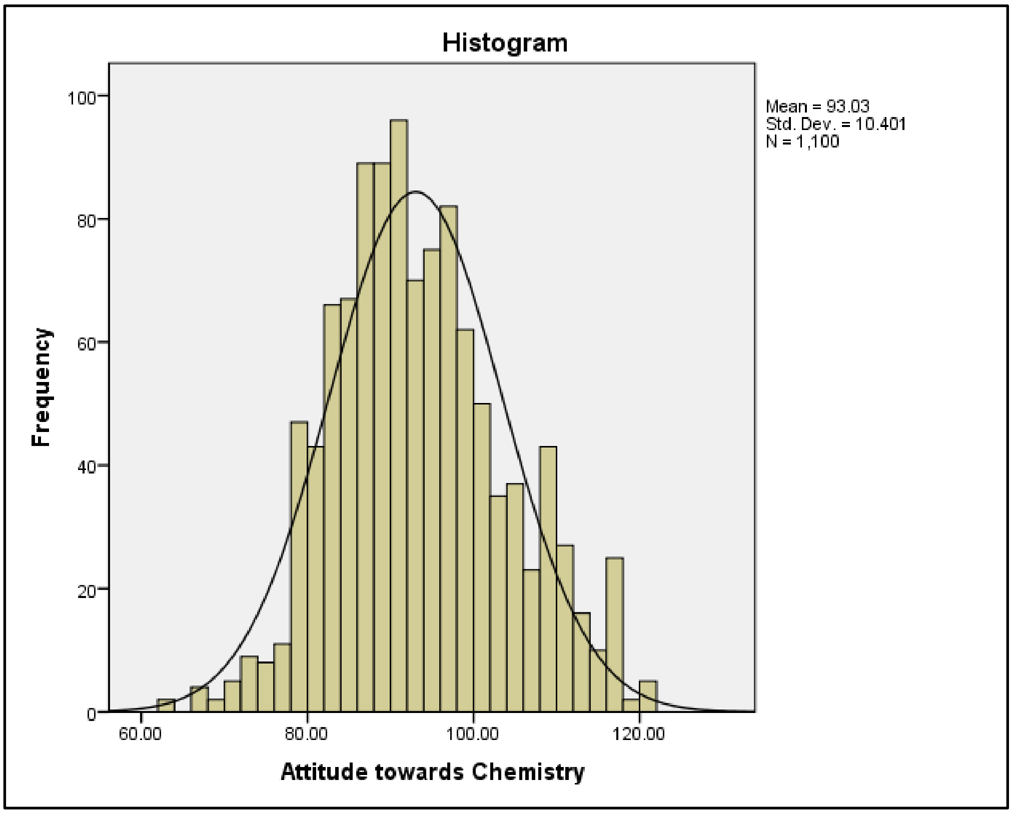
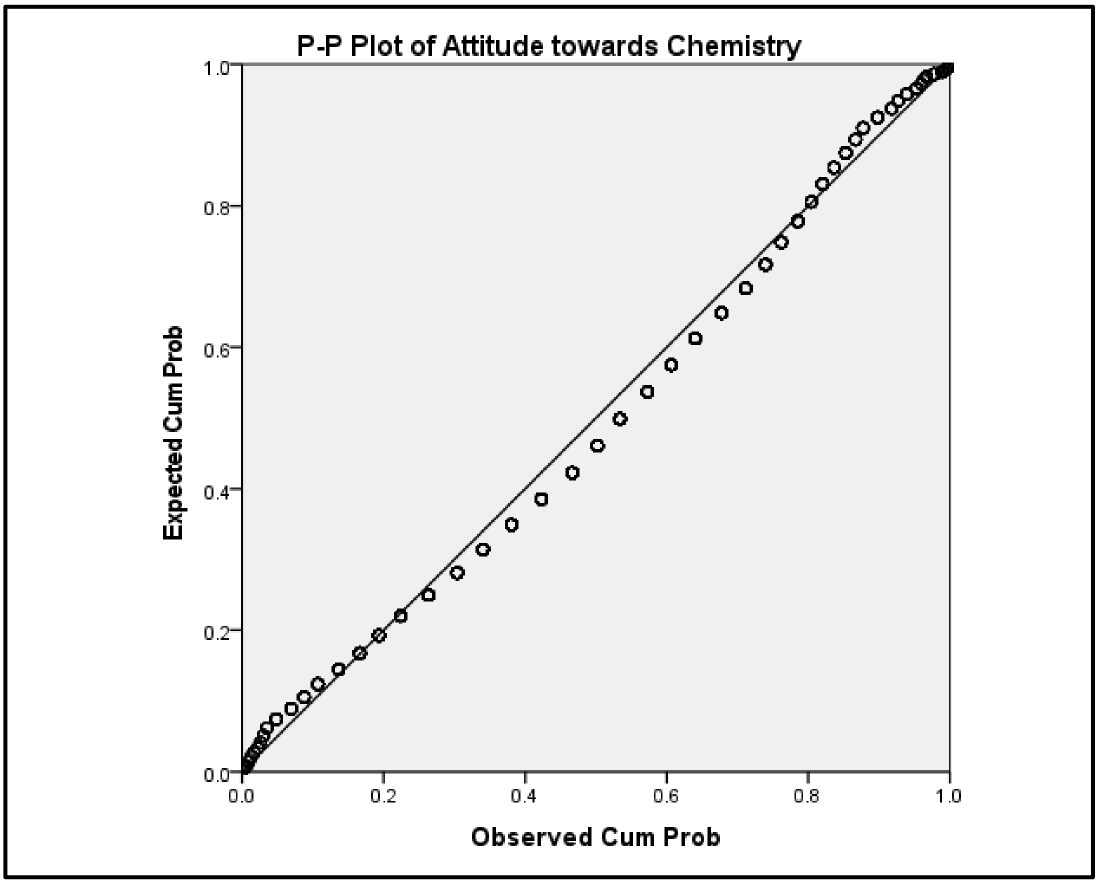


Figure 6

P-P Plot of Attitude towards Chemistry for the Total Sample



Visual inspection of the histogram with normal curve and normal P-P Plot suggest that data is not largely deviated from normality.

Descriptive statistics of the variable Self-efficacy in Chemistry is presented in Table 19.

Table 19

Descriptive Statistics of the variable Self-efficacy in Chemistry for Total Sample and Relevant Subsample

Statistics	Total	Male	Female	Rural	Urban	Government	Aided
N	1100	500	600	658	442	591	509
Mean	78.58	78.31	78.80	78.40	78.84	78.86	78.25
Median	78.00	78.00	78.00	78.00	78.00	78.00	78.00
Mode	78.00	75.00	78.00	75.00	79.00	75.00	78.00
Std. Deviation	10.04	9.45	10.50	10.27	9.68	10.39	9.61
Skewness	.104	.184	.043	.154	.025	.180	-.025
Kurtosis	.471	.735	.289	.595	.240	.342	.608

The results displayed in Table 19 shows the descriptive statistics for Self-efficacy in Chemistry among secondary school students. The mean 78.58, median 78 and mode 78 values for Self-efficacy in Chemistry for total sample are almost equal. The skewness of the distribution is .104, indicating a positive skew. The calculated kurtosis value is 0.471, indicating leptokurtic distribution. Collectively, these findings indicate that the scores for Self-efficacy in Chemistry of the total sample do not deviate significantly from a normal distribution.

The mean, median and mode values for Self-efficacy in Chemistry are almost equal among male, female, urban, rural, government and aided secondary school students. Among male, female, rural, urban and government secondary school students, the indices of skewness and kurtosis indicate a slightly positively skewed and leptokurtic distribution. On the other hand, among aided secondary school students, the indices of skewness and kurtosis suggest a slightly negatively skewed and leptokurtic distribution. The obtained values of descriptive statistics indicate that the data for all subsamples exhibit characteristics that are close to a normal distribution.

Figure 7 and Figure 8 presents a histogram with a normal curve and P-P Plots for the Total Sample respectively.

Figure 7

Smoothed Frequency Curve of Self-efficacy in Chemistry for the Total Sample.

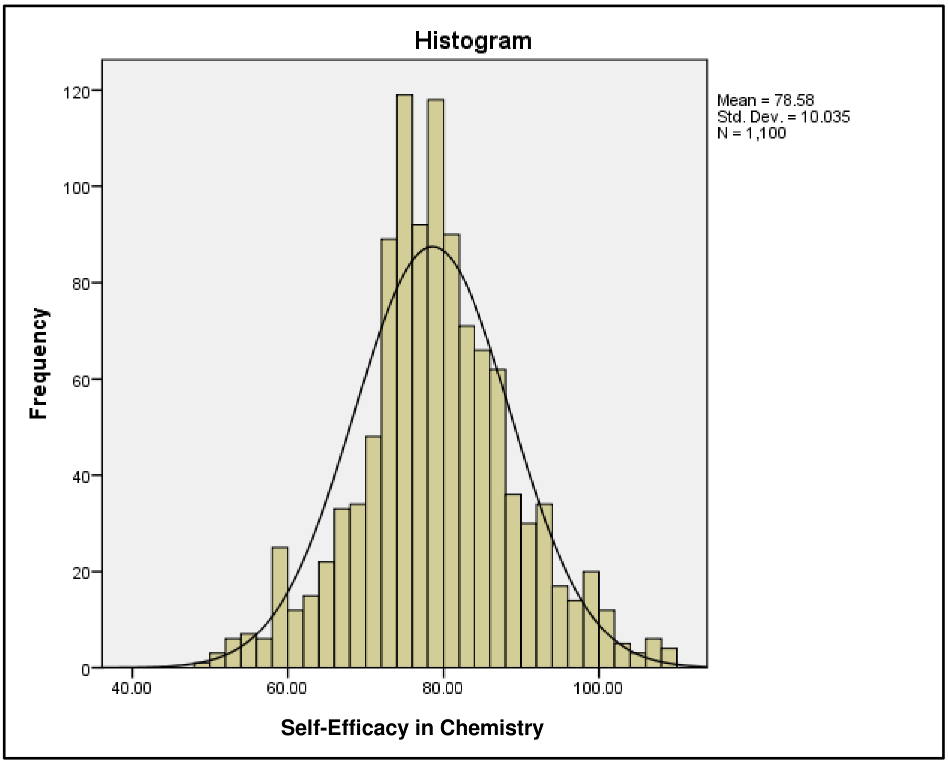
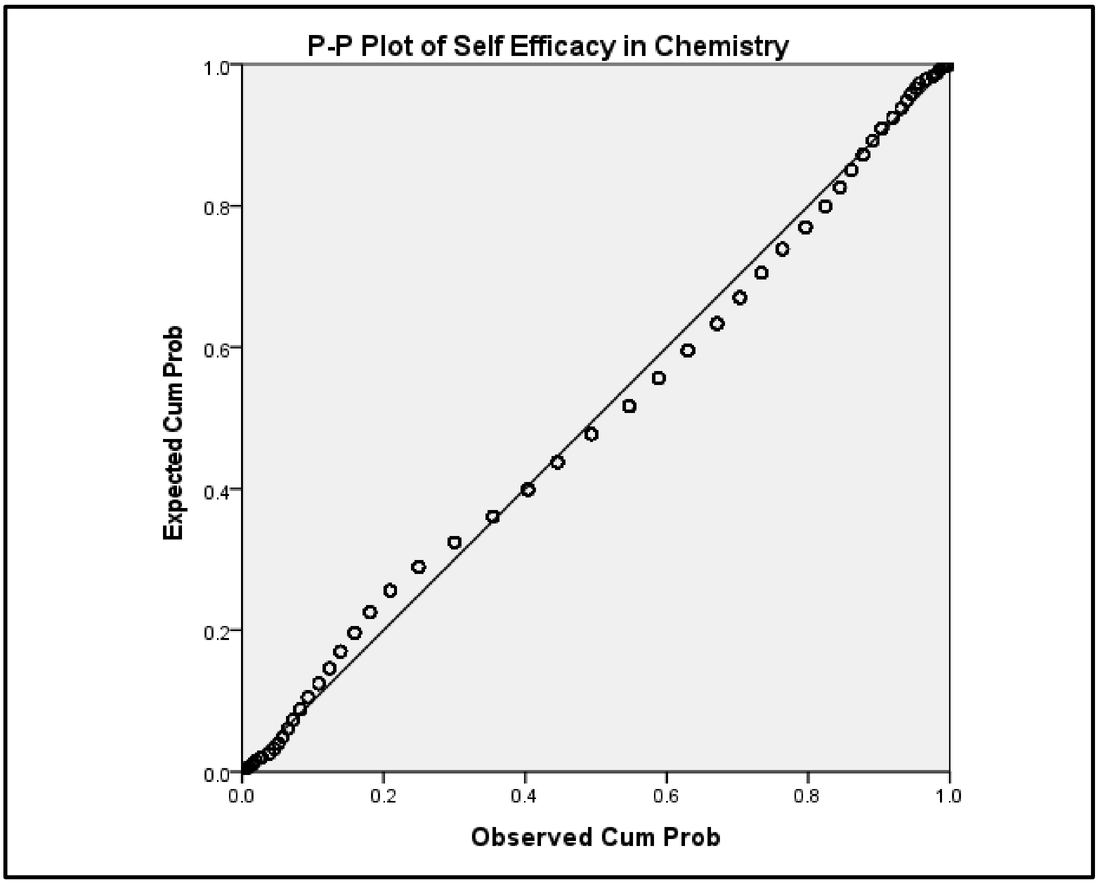


Figure 8

P-P Plot of Self-efficacy in Chemistry for the Total Sample



Visual inspection of the histogram with normal curve and normal P-P Plot of suggest that data is not largely deviated from normality.

Descriptive statistics of the variable Achievement in Chemistry is presented in Table 20.

Table 20

Descriptive Statistics of the Variable Achievement in Chemistry for Total Sample and Relevant Subsample

Statistics	Total	Male	Female	Rural	Urban	Government	Aided
N	1100	500	600	658	442	591	509
Mean	30.13	26.89	32.83	31.08	28.70	32.15	27.77
Median	30.00	24.00	34.00	31.00	27.00	32.00	27.00
Mode	17.00	16.00	24.00	17.00	10.00	58.00	16.00
Std. Deviation	13.78	13.47	13.46	13.57	13.98	15.22	11.46
Skewness	.252	.678	-.064	.289	.227	.104	.196
Kurtosis	-.981	-.492	-.957	-.853	-1.203	-1.186	-1.102

The results presented in Table 20 illustrate the descriptive statistics for Achievement in Chemistry among secondary school students. The mean 30.13 and median 30 values for Achievement in Chemistry are almost equal and mode 17 values for Achievement in Chemistry is slightly deviated from mean and median. The skewness of the distribution is 0.252, indicating a slight positive skew. The calculated kurtosis value is -0.981, indicating platy kurtic distribution. Collectively, these findings indicate that the scores for Achievement in Chemistry of the Total Sample do not deviate significantly from a normal distribution.

The mean and median values for Achievement in Chemistry are almost equal among male, female, urban, rural, government and aided secondary school students and mode values for Achievement in Chemistry is slightly deviated from mean and median for all subsamples. Among male, urban, rural, government, and aided secondary school students, the indices of skewness and kurtosis indicate a slightly positively skewed and platykurtic distribution. On the other hand, among female students, the indices of skewness and kurtosis suggest a slightly negatively skewed and platykurtic distribution. The obtained values of descriptive statistics indicate that the data for all subsamples exhibit characteristics that are close to a normal distribution.

Figure 9 and Figure 10 presents a histogram and P-P Plots for the Total Sample respectively.

Figure 9

Smoothed frequency Curve of Achievement in Chemistry for the Total Sample.

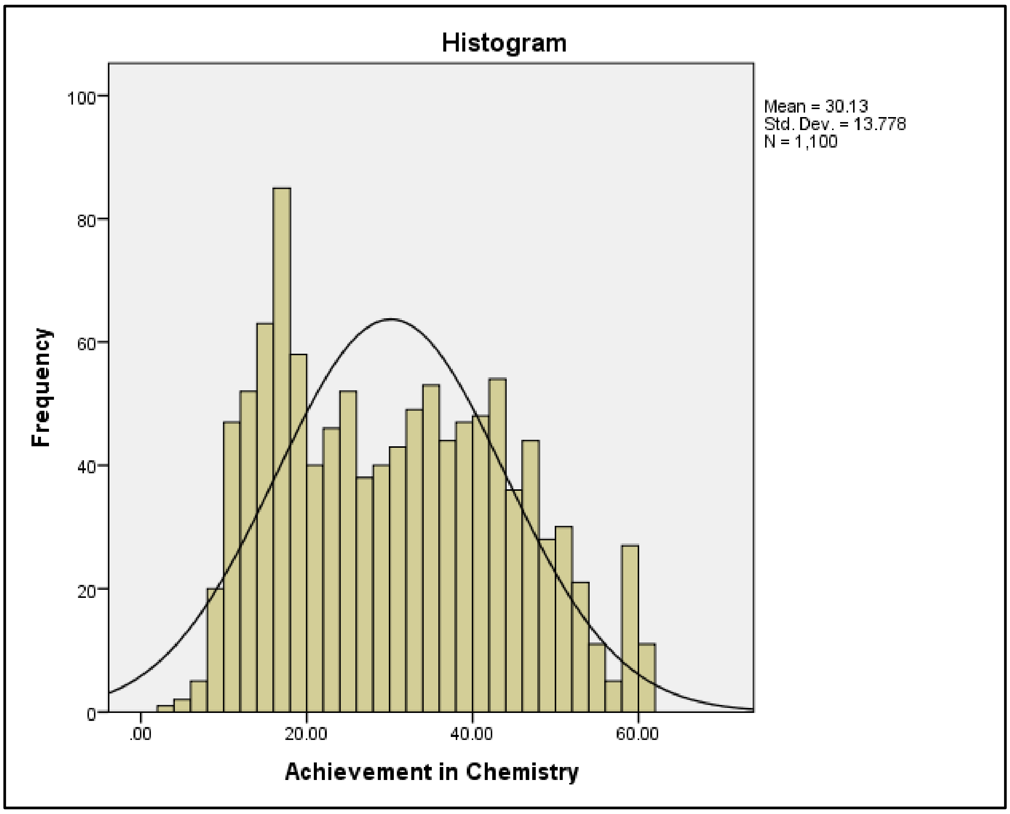
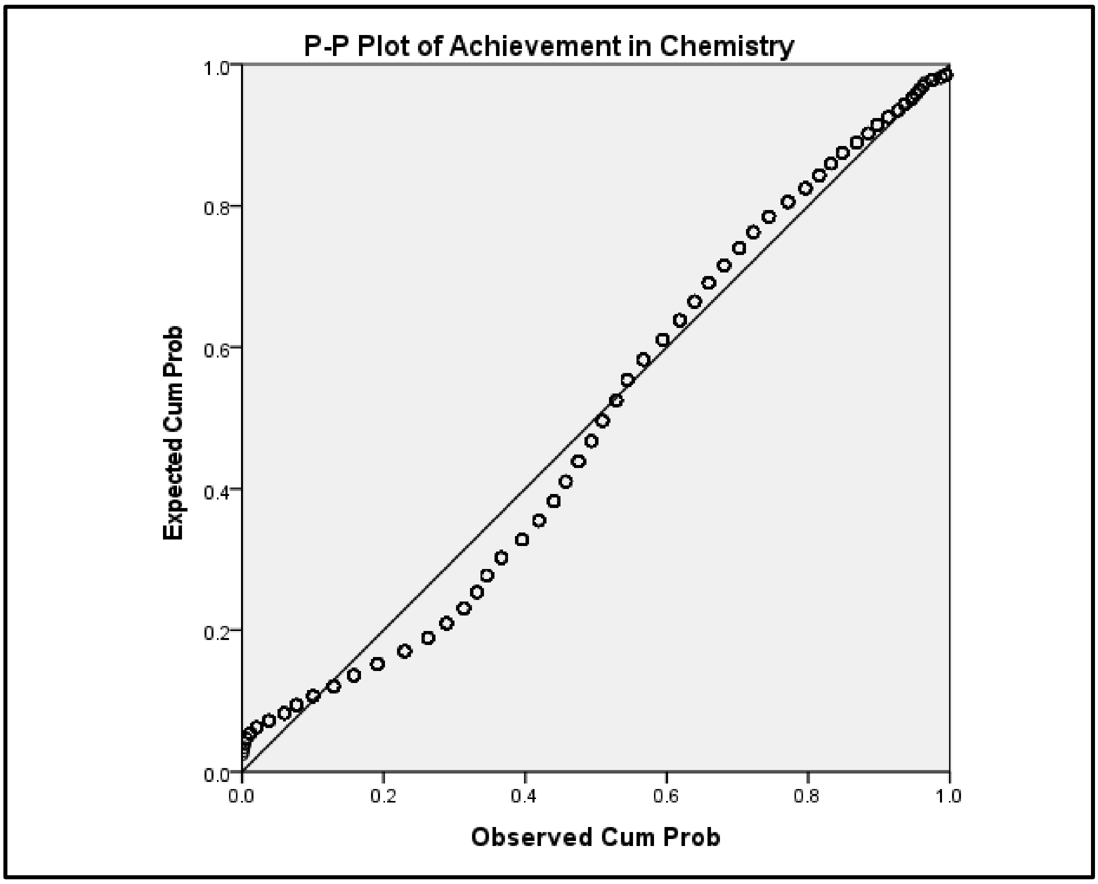


Figure 10

P-P Plot of Achievement in Chemistry for the Total Sample



Visual inspection of the histogram with normal curve and P-P Plot suggest that data is not largely deviated from normality.

Mean Comparison of Cognitive and Noncognitive Variables on Achievement in Chemistry Based on Gender, Locale and Type of Management

In this section, the investigator mainly intended to compare the mean scores of Cognitive Variables such as Verbal Intelligence, Scientific Reasoning, Non-cognitive variables such as Attitude towards Chemistry and Self-efficacy in Chemistry and Achievement in Chemistry based on subsample gender, locale, and type of management. To conduct the comparison, used independent sample t-test for large samples. The independent sample t-test is a statistical test that allows to determine whether there is a significant difference between the means of two independent groups. In the present study, the investigator has multiple groups within each factor (gender, locale, and type of management), and wanted to investigate whether the mean scores of the variables varied significantly across these groups. Mean Comparison Analysis presented under the headings

- Mean Comparison of Gender on *Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry*

- Mean Comparison of Locale on *Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry*

- Mean Comparison of Type of Management on *Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry*

Mean Comparison of Gender on Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry

Data and Results of Mean Comparison of Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry, based on Gender are presented in Table 21.

Table 21

Mean Comparison of Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry, Based on Gender

Variable	Gender	N	Mean	Std. Deviation	t-value
Verbal Intelligence	Male	500	47.46	19.04	9.10**
	Female	600	57.59	17.81	
Scientific Reasoning in Chemistry	Male	500	15.16	7.36	3.99**
	Female	600	17.06	8.24	
Attitude towards Chemistry	Male	500	91.62	9.51	4.12**
	Female	600	94.20	10.96	
Self-efficacy in Chemistry	Male	500	78.31	9.45	0.80
	Female	600	78.80	10.50	
Achievement in Chemistry	Male	500	26.89	13.47	7.29**
	Female	600	32.83	13.46	

**Significant at .01 level

Table 21 shows that there exist a significant difference in the mean scores of the variable Verbal Intelligence between male and female secondary school students ($t = 9.10$, $p < .01$). The mean score analysis indicated that female students ($M = 57.59$) had higher mean scores than male students ($M = 47.46$). This finding suggests that female secondary school students exhibited higher levels of Verbal Intelligence compared to their male counterparts.

Table 21 revealed that there exist a significant difference in the mean scores of the variable Scientific Reasoning in Chemistry between male and female secondary school students ($t = 3.99$, $p < .01$). The mean score analysis indicated that female students ($M = 17.06$) had higher mean scores than male students ($M = 15.16$). This finding suggests that female secondary school students exhibited higher levels of Scientific Reasoning in Chemistry compared to their male counterparts.

From Table 21 it is evident that there exist a significant difference in the mean scores of the variable Attitude towards Chemistry between male and female secondary school students ($t = 4.12$, $p < .01$). The mean score analysis indicated that female students ($M = 94.20$) had higher mean scores than male students ($M = 91.62$). This finding suggests that female secondary school students exhibited higher levels of Attitude towards Chemistry compared to their male counterparts.

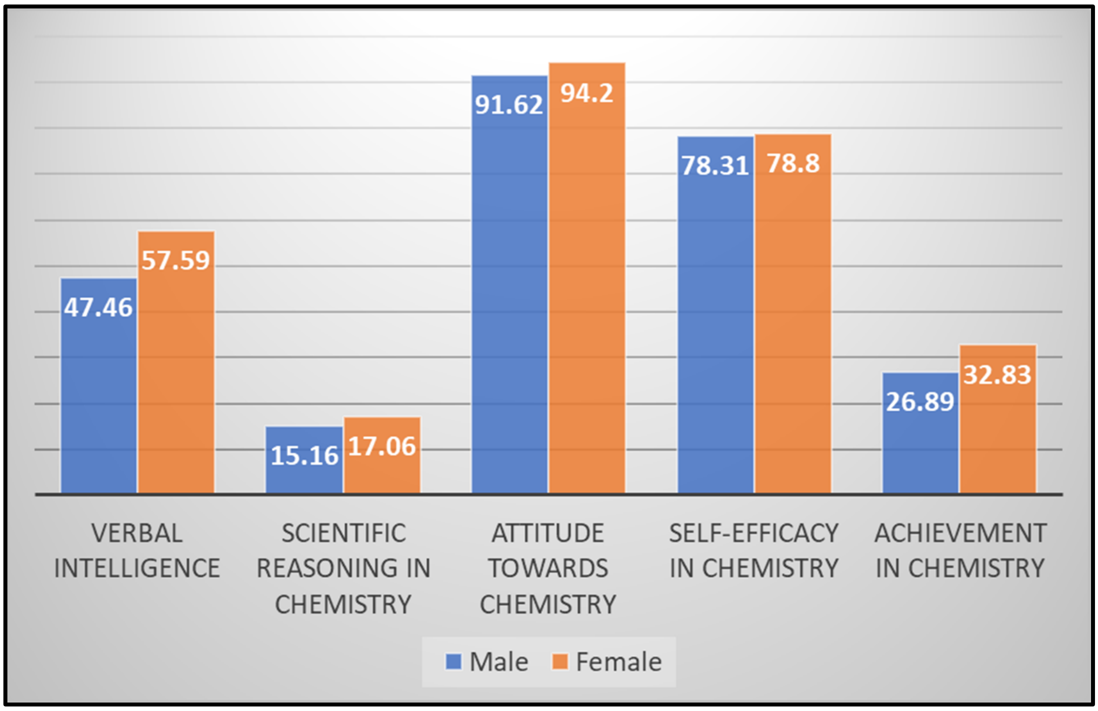
The results of the data in Table 21 shows that there is no significant difference in the mean scores of the variable Self-efficacy in Chemistry between male and female secondary school students ($t = .80$, $p > 0.05$). This finding suggests that male and female secondary school students exhibited same levels of Self-efficacy in Chemistry.

From the results of an independent sample t-test for large samples, revealed a significant difference in the mean scores of the variable Achievement in Chemistry between male and female secondary school students ($t = 7.29$, $p < .01$). The mean scores analysis indicated that female students ($M = 32.83$) had higher mean scores than male students ($M = 26.89$). This finding suggests that female secondary school students exhibited higher levels of Achievement in Chemistry compared to their male counterparts.

Graphical representation of mean comparison of Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry, based on Gender is presented in Figure 11.

Figure 11

Graphical representation of mean comparison of Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry, Based on Gender



Mean Comparison of Locale on Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry

Data and results of mean comparison of Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry based on Locale are presented in Table 22.

Table 22

Mean Comparison of Verbal Intelligence, Scientific Reasoning, Attitude Towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry Based on Locale

Variable	Locale	N	Mean	Std. Deviation	t-value
Verbal Intelligence	Rural	658	52.66	19.03	0.69
	Urban	442	53.47	19.10	
Scientific Reasoning in Chemistry	Rural	658	16.02	7.63	0.89
	Urban	442	16.45	8.30	
Attitude towards Chemistry	Rural	658	93.25	10.91	0.85
	Urban	442	92.70	9.60	
Self-efficacy in Chemistry	Rural	658	78.40	10.27	0.72
	Urban	442	78.84	9.68	
Achievement in Chemistry	Rural	658	31.08	13.57	2.82**
	Urban	442	28.70	13.98	

** Significant at .01 level

From Table 22 it is clear that there is no significant difference in the mean scores of the variable Verbal Intelligence between rural and urban secondary school students ($t = .69$, $p > .05$). This finding suggests that rural and urban secondary school students exhibited same levels of Verbal Intelligence.

The results of the data in Table 22 revealed that there is no significant difference in the mean scores of the variable Scientific Reasoning in Chemistry between rural and urban secondary school students ($t = .89$, $p > .05$). This finding suggests that rural and urban secondary school students exhibited same levels of Scientific Reasoning in Chemistry.

The findings in Table 22 shows that there is no significant difference in the mean scores of the variable Attitude towards Chemistry between rural and urban secondary school students ($t = .85$, $p > .05$). This findings also suggests that rural and urban secondary school students exhibited same levels of Attitude towards Chemistry.

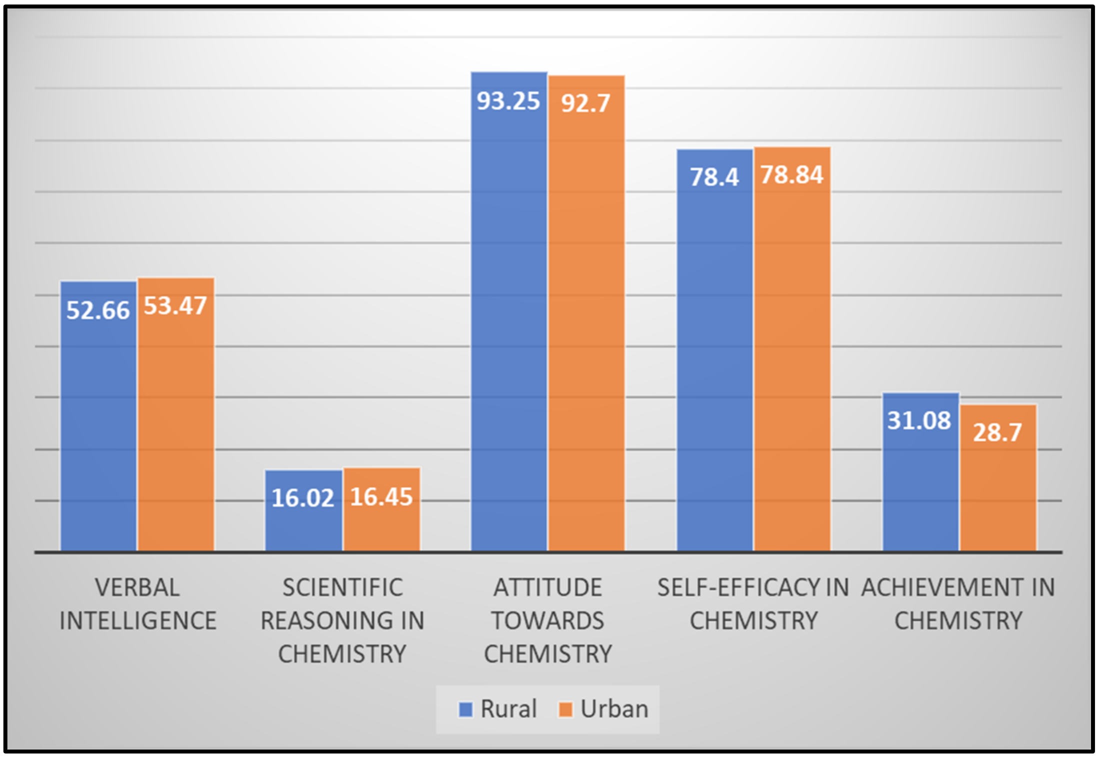
The data in Table 22 shows that there is no significant difference in the mean scores of the variable Self-efficacy in Chemistry between rural and urban secondary school students ($t = .72$, $p > .05$). This finding suggests that rural and urban secondary school students exhibited same levels of Self-efficacy in Chemistry.

Results of the independent sample t-test for large samples, a significant difference was found in the mean scores of the variable Achievement in Chemistry between urban and rural secondary school students ($t = 2.82$, $p < .01$). The mean score analysis indicated that rural students ($M = 31.08$) had higher mean scores than urban students ($M = 28.70$). This finding suggests that rural secondary school students exhibited higher levels of Achievement in Chemistry compared to their urban counterparts.

Graphical representation of mean comparison of Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry based on Locale are presented in Figure 12.

Figure 12

Graphical Representation of Mean Comparison of Verbal Intelligence, Scientific Reasoning, Attitude Towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry Based on Locale



Mean Comparison of Type of Management on Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry

Data and results of mean comparison of on Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry based on Type of Management are presented in Table 23.

Table 23

Mean Comparison of on Verbal Intelligence, Scientific Reasoning, Attitude Towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry Based on Type of Management

Variable	Type of Management	N	Mean	Std. Deviation	t-value
Verbal Intelligence	Government	591	55.80	19.44	5.33**
	Aided	509	49.73	18.08	
Scientific Reasoning in Chemistry	Government	591	17.56	8.52	6.28**
	Aided	509	14.61	6.79	
Attitude towards Chemistry	Government	591	94.31	10.61	4.45**
	Aided	509	91.54	9.95	
Self-efficacy in Chemistry	Government	591	78.86	10.39	1.01
	Aided	509	78.25	9.61	
Achievement in Chemistry	Government	591	32.16	15.22	5.33**
	Aided	509	27.77	11.46	

** Significant at .01 level

Results in Table 23 shows that there exist a significant difference in the mean scores of the variable Verbal Intelligence between government and aided secondary school students ($t = 5.33$, $p < .01$). The mean score analysis indicated that government school students ($M = 55.80$) had higher mean scores than aided school students ($M = 49.73$). This finding suggests that government secondary school students exhibited higher levels of Verbal Intelligence compared to their aided counterparts.

The data in Table 23 revealed that there exists a significant difference in the mean scores of the variable Scientific Reasoning in Chemistry between government and aided secondary school students ($t = 6.28$, $p < .01$). The mean score analysis indicated that government school students ($M = 17.56$) had higher mean scores than aided school students (M = 14.61). This finding suggests that government secondary school students exhibited higher levels of Scientific Reasoning in Chemistry compared to their aided counterparts.

It is evident from the Table data that there exists a significant difference in the mean scores of the variable Attitude towards Chemistry between government and aided secondary school students ($t = 4.45$, $p < .01$). The mean score analysis indicated that government students (M = 94.31) had higher mean scores than aided students (M = 91.54). This finding suggests that government secondary school students exhibited higher levels of Attitude towards Chemistry compared to their aided counterparts.

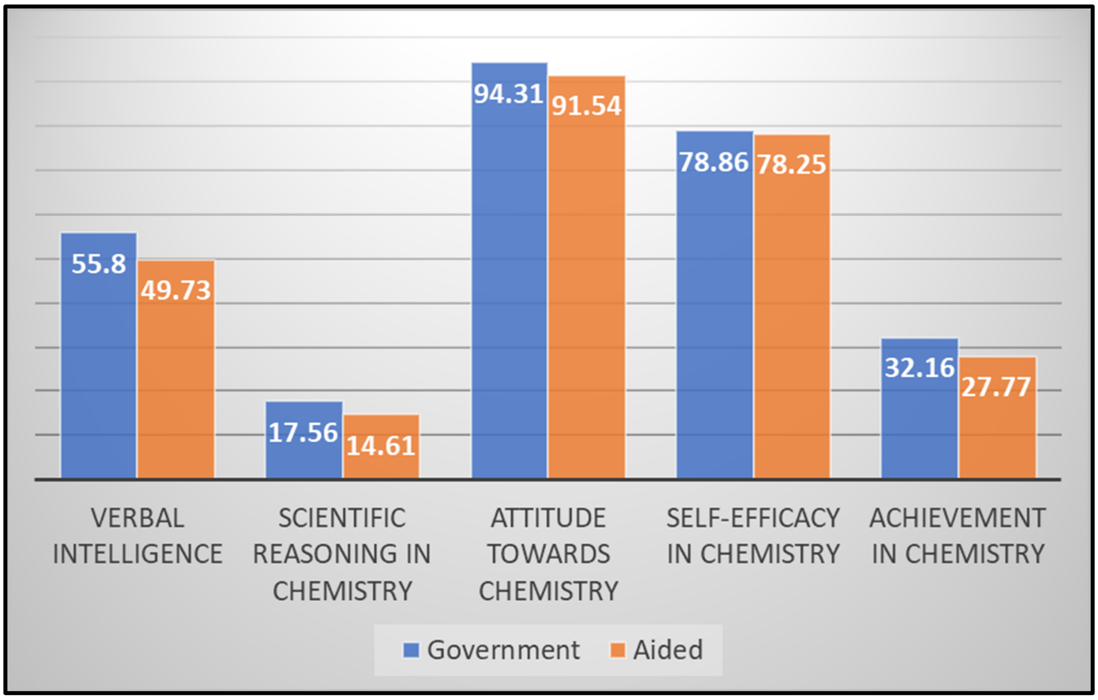
The results of the data in Table 23 shows that there is no significant difference in the mean scores of the variable Self-efficacy in Chemistry between government and aided secondary school students ($t = 1.01$, $p > .05$). This finding suggests that government and aided secondary school students exhibited same levels of Self-efficacy in Chemistry.

From the results of an independent sample t-test for large samples, a significant difference was found in the mean scores of the variable Achievement in Chemistry between government and aided secondary school students ($t = 5.33$, $p < .01$). The mean scores analysis indicated that government students (M = 32.16) had higher mean scores than aided students (M = 27.77). This finding suggests that government secondary school students exhibited higher levels of Achievement in Chemistry compared to their aided counterparts.

Graphical representation of Mean Comparison of on Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry based on Type of Management presented in Figure 13.

Figure 13

Graphical Representation of Mean Comparison of on Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry, Self-efficacy in Chemistry and Achievement in Chemistry Based on Type of Management



Main and Interaction Effect of Cognitive and Noncognitive Independent Variables on Achievement in Chemistry

One of the major objective of the present study is to determine the Main and Interaction effect of specific cognitive variables, namely Verbal Intelligence and Scientific Reasoning in Chemistry, as well as select Noncognitive variables, such as Attitude towards Chemistry and Self-efficacy in Chemistry, on Achievement in Chemistry. For this purpose, a two-way ANOVA was employed as the statistical technique. Before conducting the analysis, the independent variables are categorised into groups as it is a fundamental requirement for conducting a two-way ANOVA.

Grouping Technique

The data collected from various tools were divided into three distinct groups: High, Average/Moderate, and Low. To accomplish this, the mean and standard deviation of the obtained scores were initially calculated. Students with scores above the mean plus half standard deviation were classified as part of the high group, while students with scores below the mean minus half standard deviation were categorised as part of the low group. Students with scores falling between the mean minus half standard deviation and the mean plus half standard deviation were assigned to the average/moderate group.

Main and Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Total Sample and Subsample.

The aim was to investigate the Main and Interaction Effect of independent cognitive variables, Verbal Intelligence and Scientific Reasoning in Chemistry, on the dependent variable, Achievement in Chemistry of secondary school students. For this two-way ANOVA with a 3x3 factorial design was used. The analysis was conducted separately for both the total sample and subsamples based on variables such as Gender, Locale, and Type of Management of Schools. Verbal Intelligence was categorised into three groups: Low Verbal Intelligence group, Moderate Verbal Intelligence group, and High Verbal Intelligence group. Similarly, Scientific Reasoning in Chemistry was grouped into three categories: Low Scientific Reasoning group, Moderate Scientific Reasoning group, and High Scientific Reasoning group.

Data and results of analysis of Main and Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for total sample is presented in Table 24.

Table 24

Summary of 3X3 Factorial ANOVA of Main and Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Total Sample

Source	Sum of Squares	df	Mean Square	F
Verbal Intelligence	23559.466	2	11779.733	88.75**
Scientific Reasoning	13801.568	2	6900.784	51.99**
Verbal Intelligence × Scientific Reasoning	1291.941	4	322.985	2.43*
Error	144804.648	1091	132.727	

Significant at .05 level* * Significant .01 level*

The two-way ANOVA revealed a significant main effect for Verbal Intelligence ($F (2, 1091) = 88.75$, $p < .01$) and Scientific Reasoning in Chemistry ($F (2,1091) = 51.99$, $p < .01$) on Achievement in Chemistry. This indicates that both Verbal Intelligence and Scientific Reasoning in Chemistry have individual effects on the Achievement in Chemistry.

In addition to the main effect, the investigator found that there is significant interaction effect between Verbal Intelligence group and Scientific Reasoning in Chemistry on Achievement in Chemistry ($F (4,1091) = 2.43$, $p < .05$). This indicates that the relationship between Verbal Intelligence and Achievement in Chemistry varies depending on the levels of Scientific Reasoning in Chemistry.

To assess the differences between groups in both variables, the Scheffé's post hoc test for comparisons was employed. The corresponding results presented in Table 25.

Table 25

Scheffé's Post hoc Test for Comparisons for Total Sample

Variable	Group		Mean difference	Std. Error
Verbal Intelligence	Low Verbal Intelligence group (M =22.59)	Moderate Verbal Intelligence group (M= 29.45)	6.869**	.845
	Low Verbal Intelligence group	High Verbal Intelligence group (M= 38.68)	16.09**	.853
	Moderate Verbal Intelligence group	High Verbal Intelligence group	9.23**	.854
Scientific Reasoning in Chemistry	Low Scientific Reasoning group (M= 23.83)	Moderate Scientific Reasoning group (M= 32.54)	8.72**	.782
	Low Scientific Reasoning group	High Scientific Reasoning group (M= 38.2)	14.37**	.930
	Moderate Scientific Reasoning group	High Scientific Reasoning group	5.66**	.946

*** Significant at .01 level*

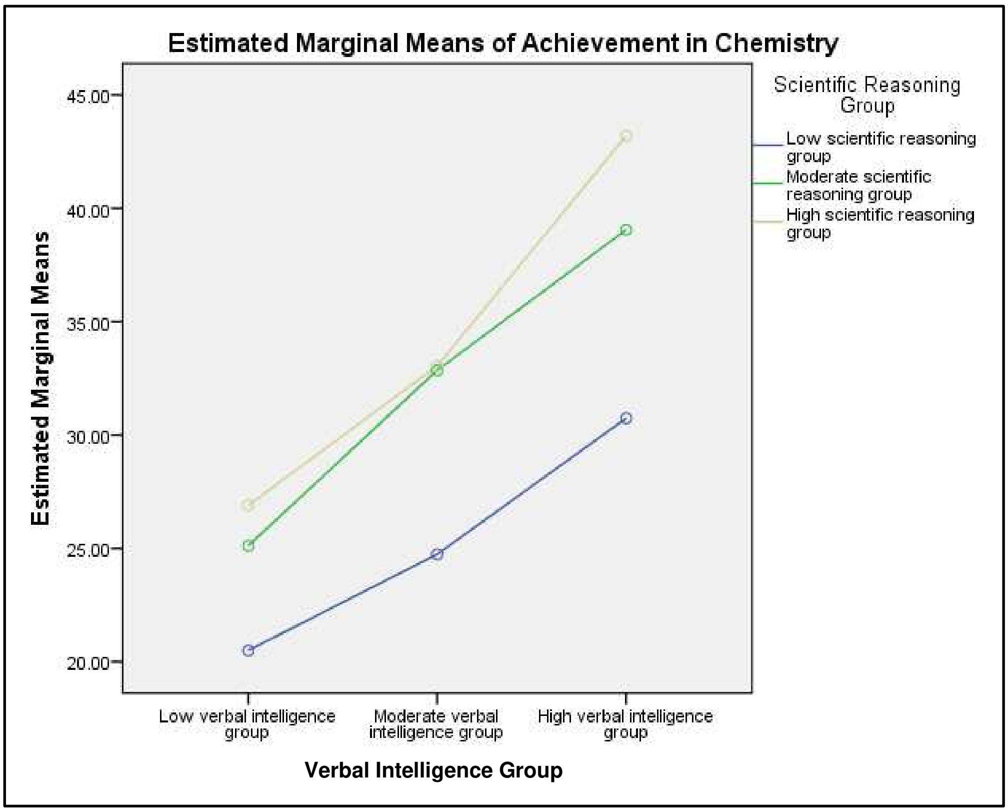
. The mean difference between the low Verbal Intelligence group (M = 22.59) and the moderate Verbal Intelligence group (M = 29.45) is 6.869. The standard error is 0.845, and the p-value is .001 (indicating statistical significance). Therefore, the mean Verbal Intelligence score of the moderate group is significantly higher than that of the low group. The mean difference between the low Verbal Intelligence group (M = 22.59) and the high Verbal Intelligence group (M = 38.68) is 16.09. The standard error is 0.853, and the p-value is .000 (indicating statistical significance). This suggests that the mean Verbal Intelligence score of the high group is significantly higher than that of the low group. The mean difference between the moderate Verbal Intelligence group (M = 29.45) and the high Verbal Intelligence group (M = 38.68) is 9.23. The standard error is 0.854, and the p-value is .000 (indicating statistical significance). Thus, the mean Verbal Intelligence score of the high group is significantly higher than that of the moderate group. In summary, based on the Scheffé post hoc test, all three pairwise comparisons indicate significant differences in mean Verbal Intelligence scores among the low, moderate, and high Verbal Intelligence groups. Specifically, the moderate group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and moderate groups.

The mean difference between the low Scientific Reasoning group (M = 23.83) and the moderate Scientific Reasoning group (M = 32.54) is 8.72. The standard error is 0.782, and the p-value is .001 (indicating statistical significance). Therefore, the mean Scientific Reasoning score of the moderate group is significantly higher than that of the low group. The mean difference between the low Scientific Reasoning group (M = 23.83) and the high Scientific Reasoning group (M = 38.2) is 14.37. The standard error is 0.930, and the p-value is .001 (indicating statistical significance). This suggests that the mean Scientific Reasoning score of the high group is significantly higher than that of the low group. The mean difference between the moderate Scientific Reasoning group (M = 32.54) and the high Scientific Reasoning group (M = 38.2) is 5.66. The standard error is 0.946, and the p-value is .001 (indicating statistical significance). Thus, the mean Scientific Reasoning score of the high group is significantly higher than that of the moderate group. In summary, based on the statistical analysis, all three pairwise comparisons indicate significant differences in mean Scientific Reasoning scores among the low, moderate, and high Scientific Reasoning groups in the field of chemistry. Specifically, the moderate group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and moderate groups.

Graphical representation of interaction effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for total sample is presented in Figure 14.

Figure 14

Graphical Representation of Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Total Sample



Data and results of analysis of main and interaction effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for subsample male is presented in Table 26.

Table 26

Summary of 3x3 Factorial ANOVA of Main and Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Subsample Male

Source	Sum of Squares	df	Mean Square	F
Verbal Intelligence	7898.206	2	3949.103	29.15**
Scientific Reasoning	6735.245	2	3367.622	24.86**
Verbal Intelligence × Scientific Reasoning	1164.567	4	291.142	2.15
Error	66502.560	491	135.443	

*** Significant at 0.01*

The two-way ANOVA revealed that, there exist significant main effects for Verbal Intelligence (F (2, 491) = 29.15, $p < .001$) and Scientific Reasoning in Chemistry (F (2,491) = 24.86, $p < .01$) on the Achievement in Chemistry. This indicates that both Verbal Intelligence and Scientific Reasoning in Chemistry have individual effects on the Achievement of male students in Chemistry.

In addition the main effect, it is found that there is no significant interaction effect between Verbal Intelligence and Scientific Reasoning in Chemistry on the Achievement in Chemistry (F (4,491) = 2.15, $p > .05$). This indicates that the relationship between Verbal Intelligence and Achievement in Chemistry does not vary depending on the levels of Scientific Reasoning in Chemistry for male students.

To assess the differences between groups in both variables, the Scheffé's post hoc test for comparisons was employed. The corresponding results presented in Table 27.

Table 27

Scheffé's Post hoc Test for Comparisons for Subsample Male

Variable	Group		Mean difference	Std. Error
Verbal Intelligence	Low Verbal Intelligence group (M =22.31)	Moderate Verbal Intelligence group (M= 26.37)	4.06**	1.209
	Low Verbal Intelligence group	High Verbal Intelligence group (M= 36.57)	14.25**	1.32
	Moderate Verbal Intelligence group	High Verbal Intelligence group	10.197**	1.42
Scientific Reasoning in Chemistry	Low Scientific Reasoning group (M= 21.44)	Moderate Scientific Reasoning group (M= 30.15)	8.71**	1.14
	Low Scientific Reasoning group	High Scientific Reasoning group (M= 35.49)	14.05**	1.51
	Moderate Scientific Reasoning group	High Scientific Reasoning group	5.34**	1.564

***Significant at .01 level*

The mean difference between the low Verbal Intelligence group (M = 22.31) and the moderate Verbal Intelligence group (M = 26.37) for male students is 4.06. The standard error is 1.209, and the p-value is .004 (indicating statistical significance). This suggests that the mean Verbal Intelligence score of the moderate group is significantly higher than that of the low group for male students. The mean difference between the low Verbal Intelligence group (M = 22.31) and the high Verbal

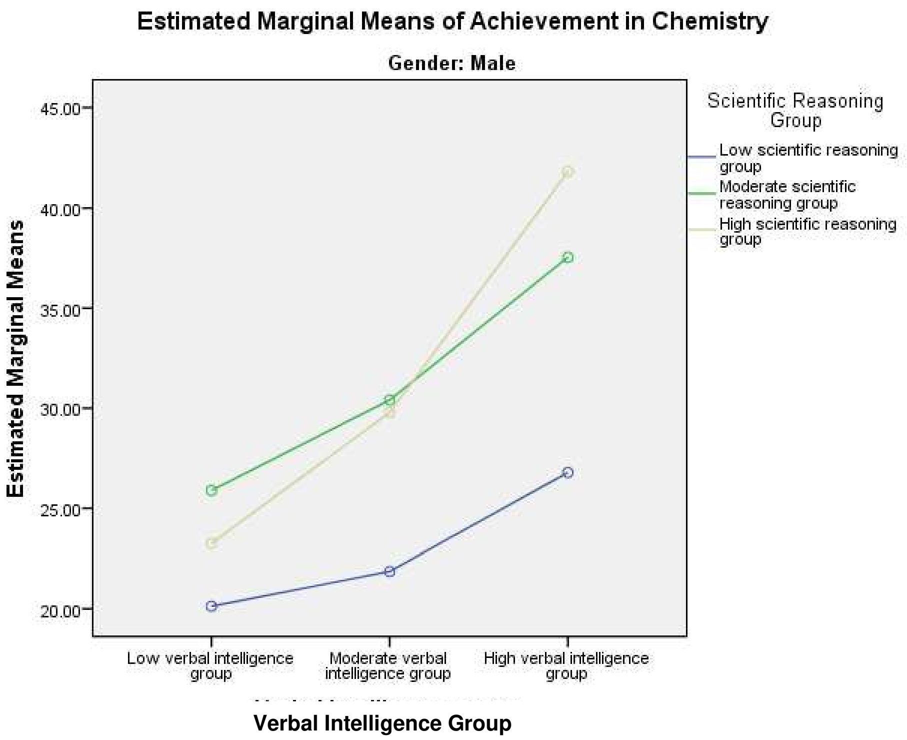
Intelligence group (M = 36.57) for male students is 14.25. The standard error is 1.32, and the p-value is .001 (indicating statistical significance). Thus, the mean Verbal Intelligence score of the high group is significantly higher than that of the low group for male students. The mean difference between the moderate Verbal Intelligence group (M = 26.37) and the high Verbal Intelligence group (M = 36.57) for male students is 10.197. The standard error is 1.42, and the p-value is .001 (indicating statistical significance). Therefore, the mean Verbal Intelligence score of the high group is significantly higher than that of the moderate group for male students. In summary, based on the statistical analysis for male students, all three pairwise comparisons indicate significant differences in mean Verbal Intelligence scores among the low, moderate, and high Verbal Intelligence groups. The moderate group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and moderate groups for male students.

The mean difference between the low Scientific Reasoning group (M = 21.44) and the moderate Scientific Reasoning group (M = 30.15) for male students is 8.71. The standard error is 1.14, and the p-value is .001 (indicating statistical significance). This suggests that the mean Scientific Reasoning score of the moderate group is significantly higher than that of the low group for male students. The mean difference between the low Scientific Reasoning group (M = 21.44) and the high Scientific Reasoning group (M = 35.49) for male students is 14.05. The standard error is 1.51, and the p-value is .001 (indicating statistical significance). Thus, the mean Scientific Reasoning score of the high group is significantly higher than that of the low group for male students. The mean difference between the moderate Scientific Reasoning group (M = 30.15) and the high Scientific Reasoning group (M = 35.49) for male students is 5.34. The standard error is 1.564, and the p-value is 0.003 (indicating statistical significance). Therefore, the mean Scientific Reasoning score of the high group is significantly higher than that of the moderate group for male students. In summary, based on the statistical analysis for male students, all three pairwise comparisons indicate significant differences in mean Scientific Reasoning scores among the low, moderate, and high Scientific Reasoning groups. The moderate group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and moderate groups for male students.

Graphical representation of interaction effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for male sample is presented in Figure 15.

Figure 15

Graphical Representation of Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Male sample



Data and results of analysis of main and interaction effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for subsample female is presented in Table 28.

Table 28

Summary of 3X3 Factorial ANOVA of Main and Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Subsample Female

Source	Sum of Squares	df	Mean Square	F
Verbal Intelligence	14010.459	2	7005.230	55.33**
Scientific Reasoning	6424.703	2	3212.351	25.37**
Verbal Intelligence × Scientific Reasoning	731.563	4	182.891	1.44
Error	74825.245	591	126.608	

*** Significant at 0.01 level*

The two-way ANOVA revealed that there exist significant main effects for Verbal Intelligence ($F(2, 591) = 55.33$, $p < .001$) and Scientific Reasoning in Chemistry ($F(2,591) = 25.37$, $p < .01$) on the Achievement in Chemistry. This indicates that both Verbal Intelligence and Scientific Reasoning in Chemistry have individual effects on the Achievement of female students in Chemistry.

In addition to main effect, it is found that there is no significant interaction effect between Verbal Intelligence and Scientific Reasoning in Chemistry on the Achievement in Chemistry ($F(4,591) = 1.44$, $p > .05$). This indicates that the relationship between Verbal Intelligence and Achievement in Chemistry does not vary depending on the levels of Scientific Reasoning in Chemistry for female students.

To assess the differences between groups in both variables, the Scheffé's post hoc test for comparisons was employed. The corresponding results presented in Table 29.

Table 29

Scheffé's Post hoc Test for Comparisons for Subsample Female

Variable	Group		Mean difference	Std. Error
Verbal Intelligence	Low Verbal Intelligence group (M = 23.02)	Moderate Verbal Intelligence group (M= 31.69)	8.67**	1.211
	Low Verbal Intelligence group	High Verbal Intelligence group (M= 39.70)	16.68**	1.185
	Moderate Verbal Intelligence group	High Verbal Intelligence group	8.01**	1.055
Scientific Reasoning in Chemistry	Low Scientific Reasoning group (M= 26.40)	Moderate Scientific Reasoning group (M= 34.48)	8.08**	1.06
	Low Scientific Reasoning group	High Scientific Reasoning group (M= 39.61)	13.21**	1.187
	Moderate Scientific Reasoning group	High Scientific Reasoning group	5.13**	1.177

*** Significant at .01 level*

The mean difference between the low Verbal Intelligence group (M = 23.02) and the moderate Verbal Intelligence group (M = 31.69) for the female sample is 8.67. The standard error is 1.211, and the p-value is .001 (indicating statistical significance). Therefore, the mean Verbal Intelligence score of the moderate group is significantly higher than that of the low group for the female sample. The mean difference between the low Verbal Intelligence group (M = 23.02) and the high Verbal Intelligence group (M = 39.70) for the female sample is 16.68. The standard error is 1.185, and the p-value is .001 (indicating statistical significance). This suggests that the mean Verbal

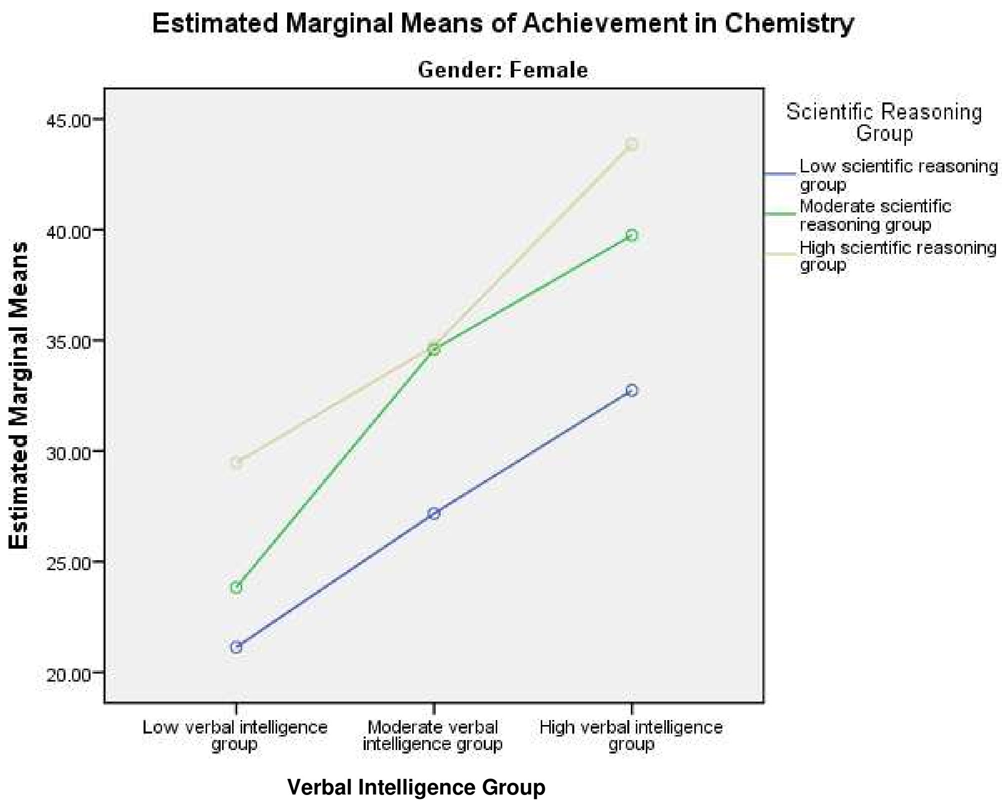
Intelligence score of the high group is significantly higher than that of the low group for the female sample. The mean difference between the moderate Verbal Intelligence group (M = 31.69) and the high Verbal Intelligence group (M = 39.70) for the female sample is 8.01. The standard error is 1.055, and the p-value is 0.001 (indicating statistical significance). Thus, the mean Verbal Intelligence score of the high group is significantly higher than that of the moderate group for the female sample. In summary, based on the statistical analysis for the female sample, all three pairwise comparisons indicate significant differences in mean Verbal Intelligence scores among the low, moderate, and high Verbal Intelligence groups. The moderate group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and moderate groups for the female sample.

The mean difference between the low Scientific Reasoning group (M = 26.40) and the moderate Scientific Reasoning group (M = 34.48) for female students is 8.08. The standard error is 1.06, and the p-value is .001 (indicating statistical significance). This suggests that the mean Scientific Reasoning score of the moderate group is significantly higher than that of the low group for female students. The mean difference between the low Scientific Reasoning group (M = 26.40) and the high Scientific Reasoning group (M = 39.61) for female students is 13.21. The standard error is 1.187, and the p-value is .001 (indicating statistical significance). Thus, the mean Scientific Reasoning score of the high group is significantly higher than that of the low group for female students. The mean difference between the moderate Scientific Reasoning group (M = 34.48) and the high Scientific Reasoning group (M = 39.61) for female students is 5.13. The standard error is 1.177, and the p-value is .001 (indicating statistical significance). Therefore, the mean Scientific Reasoning score of the high group is significantly higher than that of the moderate group for female students. In summary, based on the statistical analysis for female students, all three pairwise comparisons indicate significant differences in mean Scientific Reasoning scores among the low, moderate, and high Scientific Reasoning groups. The moderate group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and moderate groups for female students.

Graphical representation of Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for female sample is presented in figure 16.

Figure 16

Graphical Representation of Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Female Sample



Data and results of analysis of main and interaction effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for subsample rural is presented in table 30.

Table 30

Summary of 3X3 Factorial ANOVA of Main and Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Subsample Rural

Source	Sum of Squares	df	Mean Square	F
Verbal Intelligence	9719.617	2	4859.808	36.53**
Scientific Reasoning	8888.174	2	4444.087	33.40**
Verbal Intelligence × Scientific Reasoning	985.220	4	246.305	1.85
Error	86341.510	649	133.038	

*** Significant at 0.01 level*

The two-way ANOVA revealed that, there exist significant main effects for Verbal Intelligence ($F (2, 649) = 36.53$, $p < .001$) and Scientific Reasoning in Chemistry ($F (2,649) = 33.40$, $p < .01$) on the Achievement in Chemistry. This indicates that both Verbal Intelligence and Scientific Reasoning in Chemistry have individual effects on the Achievement of rural students in Chemistry.

In addition to main effect, it is found that there is no significant interaction effect between Verbal Intelligence group and Scientific Reasoning in Chemistry group on the Achievement in Chemistry ($F (4,649) = 1.85$, $p > .05$). This indicates that the relationship between Verbal Intelligence and Achievement in Chemistry does not vary depending on the levels of Scientific Reasoning in Chemistry for rural students.

To assess the differences between groups in both variables, the Scheffé's post hoc test for comparisons was employed. The corresponding results presented in Table 31.

Table 31

Scheffé's Post hoc Test for Comparisons for Subsample Rural

Variable	Group		Mean difference	Std. Error
Verbal Intelligence	Low Verbal Intelligence group (M =24.64)	Moderate Verbal Intelligence group (M= 30.08)	5.44**	1.08
	Low Verbal Intelligence group	High Verbal Intelligence group (M= 39.17)	14.53**	1.11
	Moderate Verbal Intelligence group	High Verbal Intelligence group	9.09**	1.11
Scientific Reasoning in Chemistry	Low Scientific Reasoning group (M= 24.6)	Moderate Scientific Reasoning group (M= 33.19)	8.57**	.991
	Low Scientific Reasoning group	High Scientific Reasoning group (M= 40.61)	15.99**	1.29 .
	Moderate Scientific Reasoning group	High Scientific Reasoning group	7.42**	1.27 .

*** Significant at 0.01*

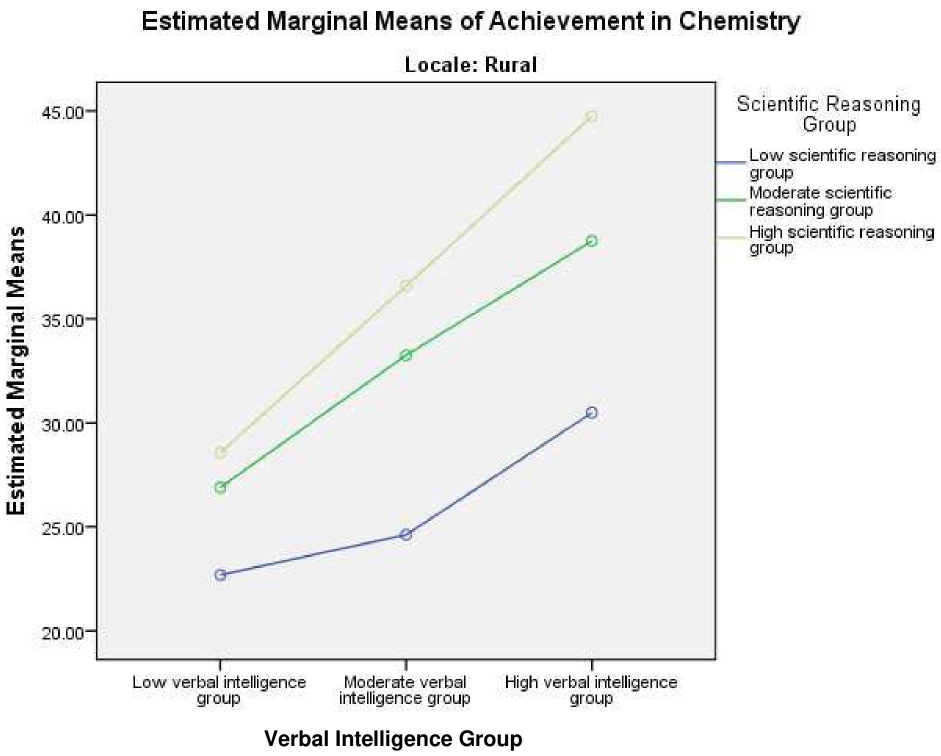
The mean difference between the low Verbal Intelligence group (M = 24.64) and the moderate Verbal Intelligence group (M = 30.08) for rural students is 5.44. The standard error is 1.08, and the p-value is .001 (indicating statistical significance). This suggests that the mean Verbal Intelligence score of the moderate group is significantly higher than that of the low group for rural students. The mean difference between the low Verbal Intelligence group (M = 24.64) and the high Verbal Intelligence group (M = 39.17) for rural students is 14.53. The standard error is 1.11, and the p-value is .001 (indicating statistical significance). Thus, the mean Verbal Intelligence score of the high group is significantly higher than that of the low group for rural students. The mean difference between the moderate Verbal Intelligence group (M = 30.08) and the high Verbal Intelligence group (M = 39.17) for rural students is 9.09. The standard error is 1.11, and the p-value is .001 (indicating statistical significance). Therefore, the mean Verbal Intelligence score of the high group is significantly higher than that of the moderate group for rural students. In summary, based on the statistical analysis for rural students, all three pairwise comparisons indicate significant differences in mean Verbal Intelligence scores among the low, moderate, and high Verbal Intelligence groups. The moderate group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and moderate groups for rural students.

The mean difference between the low Scientific Reasoning group (M = 24.60) and the moderate Scientific Reasoning group (M = 33.19) for rural students is 8.57. The standard error is .991, and the p-value is .001 (indicating statistical significance). This suggests that the mean Scientific Reasoning score of the moderate group is significantly higher than that of the low group for rural students. The mean difference between the low Scientific Reasoning group (M = 24.60) and the high Scientific Reasoning group (M = 40.61) for rural students is 15.99. The standard error is 1.29, and the p-value is .001 (indicating statistical significance). Thus, the mean Scientific Reasoning score of the high group is significantly higher than that of the low group for rural students. The mean difference between the moderate Scientific Reasoning group (M = 33.19) and the high Scientific Reasoning group (M = 40.61) for rural students is 7.42. The standard error is 1.27, and the p-value is .001 (indicating statistical significance). Therefore, the mean Scientific Reasoning score of the high group is significantly higher than that of the moderate group for rural students. In summary, based on the statistical analysis for rural students, all three pairwise comparisons indicate significant differences in mean Scientific Reasoning scores among the low, moderate, and high Scientific Reasoning groups. The moderate group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and moderate groups for rural students.

Graphical representation of interaction effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for rural sample is presented in Figure 17.

Figure 17

Graphical Representation of Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Rural Sample



Data and results of analysis of main and interaction effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for subsample urban is presented in Table 32.

Table 32

Summary of 3x3 Factorial ANOVA of Main and Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Subsample Urban

Source	Sum of Squares	df	Mean Square	F
Verbal Intelligence group	14469.769	2	7234.884	56.94**
Scientific Reasoning group	4945.838	2	2472.919	19.4**
Verbal Intelligence group × Scientific Reasoning group	589.401	4	147.350	1.16
Error	55012.590	433	127.050	

*** Significant at 0.01 level*

The two-way ANOVA revealed that, there exist significant main effects for Verbal Intelligence ($F (2, 433) = 56.94$, $p < .001$) and Scientific Reasoning in Chemistry ($F (2,433) = 19.4$, $p < .01$) on the Achievement in Chemistry. This indicates that both Verbal Intelligence and Scientific Reasoning in Chemistry have individual effects on the Achievement of urban students in Chemistry.

In addition to main effect there is no significant interaction effect between Verbal Intelligence group and Scientific Reasoning in Chemistry group on the Achievement in Chemistry ($F (4,433) = 1.16$, $p > .05$). This indicates that the relationship between Verbal Intelligence and Achievement in Chemistry does not vary depending on the levels of Scientific Reasoning in Chemistry for urban students.

To assess the differences between groups in both variables, the Scheffé's post hoc test for comparisons was employed. The corresponding results presented in Table33.

Table 33

Scheffé's Post hoc Test for Comparisons for Subsample Urban

Variable	Group		Mean difference	Std. Error
Verbal Intelligence	Low Verbal Intelligence group (M =19.5)	Moderate Verbal Intelligence group (M= 28.44)	8.933**	1.32
	Low Verbal Intelligence group	High Verbal Intelligence group (M= 38.02)	18.50**	1.30
	Moderate Verbal Intelligence group	High Verbal Intelligence group	9.57**	1.31
Scientific Reasoning in Chemistry	Low Scientific Reasoning group (M= 22.76)	Moderate Scientific Reasoning group (M= 31.19)	8.43**	1.267
	Low Scientific Reasoning group	High Scientific Reasoning group (M= 35.77)	13.01**	1.32
	Moderate Scientific Reasoning group	High Scientific Reasoning group	4.58**	1.43

*** Significant at 0.01 level*

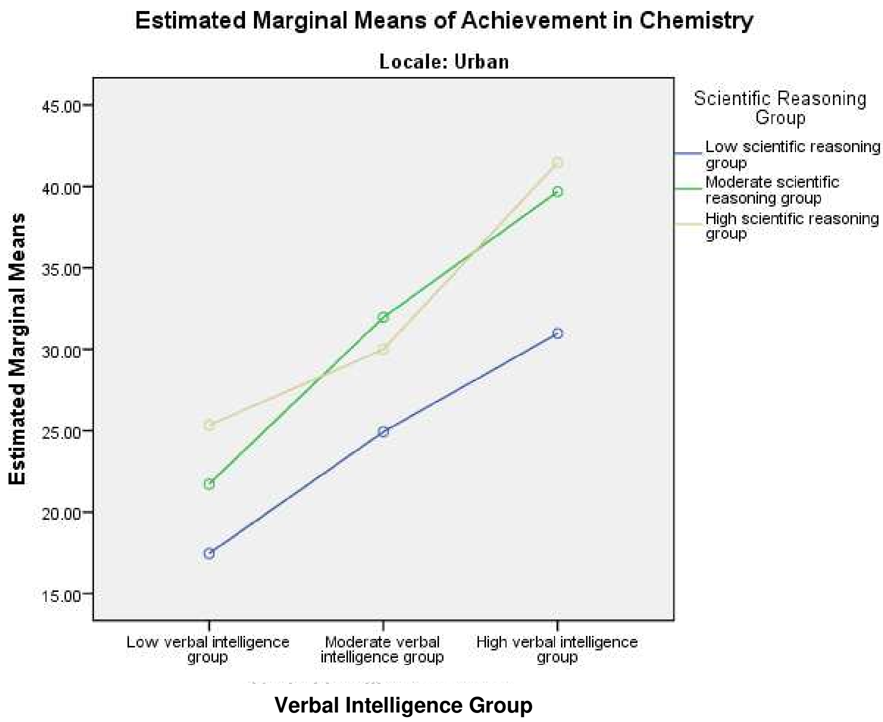
The mean difference between the low Verbal Intelligence group (M = 19.5) and the moderate Verbal Intelligence group (M = 28.44) for urban students is 8.933. The standard error is 1.32, and the p-value is .001 (indicating statistical significance). This suggests that the mean Verbal Intelligence score of the moderate group is significantly higher than that of the low group for urban students. The mean difference between the low Verbal Intelligence group (M = 19.5) and the high Verbal Intelligence group (M = 38.02) for urban students is 18.50. The standard error is 1.30, and the p-value is .001 (indicating statistical significance). Thus, the mean Verbal Intelligence score of the high group is significantly higher than that of the low group for urban students. The mean difference between the moderate Verbal Intelligence group (M = 28.44) and the high Verbal Intelligence group (M = 38.02) for urban students is 9.57. The standard error is 1.31, and the p-value is .001 (indicating statistical significance). Therefore, the mean Verbal Intelligence score of the high group is significantly higher than that of the moderate group for urban students. In summary, based on the statistical analysis for urban students, all three pairwise comparisons indicate significant differences in mean Verbal Intelligence scores among the low, moderate, and high Verbal Intelligence groups. The moderate group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and moderate groups for urban students.

The mean difference between the low Scientific Reasoning group (M = 22.76) and the moderate Scientific Reasoning group (M = 31.19) for urban students is 8.43. The standard error is 1.267, and the p-value is .001 (indicating statistical significance). This suggests that the mean Scientific Reasoning score of the moderate group is significantly higher than that of the low group for urban students. The mean difference between the low Scientific Reasoning group (M = 22.76) and the high Scientific Reasoning group (M = 35.77) for urban students is 13.01. The standard error is 1.32, and the p-value is .001 (indicating statistical significance). Thus, the mean Scientific Reasoning score of the high group is significantly higher than that of the low group for urban students. The mean difference between the moderate Scientific Reasoning group (M = 31.19) and the high Scientific Reasoning group (M = 35.77) for urban students is 4.58. The standard error is 1.43, and the p-value is 0.001 (indicating statistical significance). Therefore, the mean Scientific Reasoning score of the high group is significantly higher than that of the moderate group for urban students. In summary, based on the statistical analysis for urban students, all three pairwise comparisons indicate significant differences in mean Scientific Reasoning scores among the low, moderate, and high Scientific Reasoning groups. The moderate group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and moderate groups for urban students.

Graphical representation of Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for urban sample is presented in Figure 18.

Figure 18

Graphical Representation of Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Urban Sample



Data and results of analysis of Main and Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for subsample government is presented in Table 34.

Table 34

Summary of 3X3 Factorial ANOVA of Main and Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Subsample Government

Source	Sum of Squares	df	Mean Square	F
Verbal Intelligence	14383.674	2	7191.837	47.87**
Scientific Reasoning	8588.654	2	4294.327	28.58**
Verbal Intelligence × Scientific Reasoning	1224.570	4	306.143	2.04
Error	87421.171	582	150.208	

*** Significant at 0.01 level*

The two-way ANOVA revealed that, there exist significant main effects for Verbal Intelligence ($F\ (2,\ 582) = 47.87,\ p < .001$) and Scientific Reasoning in Chemistry ($F\ (2,582) = 28.58,\ p < .01$) on the Achievement in Chemistry. This indicates that both Verbal Intelligence and Scientific Reasoning in Chemistry have individual effects on the Achievement of government students in Chemistry.

In addition to main effect there is no significant interaction effect between Verbal Intelligence group and Scientific Reasoning in Chemistry group on the Achievement in Chemistry ($F\ (4,582) = 2.04,\ p > .05$). This indicates that the relationship between Verbal Intelligence and Achievement in Chemistry does not vary depending on the levels of Scientific Reasoning in Chemistry for government students.

To assess the differences between groups in both variables, the Scheffé's post hoc test for comparisons was employed. The corresponding results presented in Table 35.

Table 35

Scheffé's Post hoc Test for Comparisons for Subsample Government

Variable	Group		Mean difference	Std. Error
Verbal Intelligence	Low Verbal Intelligence group (M =21.49)	Moderate Verbal Intelligence group (M= 31.0)	9.51**	1.28
	Low Verbal Intelligence group	High Verbal Intelligence group (M= 41.25)	19.75**	1.23
	Moderate Verbal Intelligence group	High Verbal Intelligence group	10.245**	1.20
Scientific Reasoning in Chemistry	Low Scientific Reasoning group (M= 23.05)	Moderate Scientific Reasoning group (M= 35.23)	12.17**	1.18
	Low Scientific Reasoning group	High Scientific Reasoning group (M= 39.80)	16.74**	1.28
	Moderate Scientific Reasoning group	High Scientific Reasoning group	4.57**	1.27

*** Significant at 0.01 level*

The mean difference between the low Verbal Intelligence group (M = 21.49) and the moderate Verbal Intelligence group (M = 31.0) for government students is 9.51. The standard error is 1.28, and the p-value is .001 (indicating statistical significance). This suggests that the mean Verbal Intelligence score of the moderate group is significantly higher than that of the low group for government students. The mean difference between the low Verbal Intelligence group (M = 21.49) and the high Verbal Intelligence group (M = 41.25) for government students is 19.75. The standard error is 1.23, and the p-value is 0.001 (indicating statistical significance). Thus, the mean Verbal Intelligence score of the high group is significantly higher than that of the low group for government students. The mean difference between the moderate Verbal Intelligence group (M = 31.0) and the high Verbal Intelligence group (M = 41.25) for government students is 10.245. The standard error is 1.20, and the p-value is 0.001 (indicating statistical significance). Therefore, the mean Verbal Intelligence score of the high group is significantly higher than that of the moderate group for government students. In summary, based on the statistical analysis for government students, all three pairwise comparisons indicate significant differences in mean Verbal Intelligence scores among the low, moderate, and high Verbal Intelligence groups. The moderate group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and moderate groups for government students.

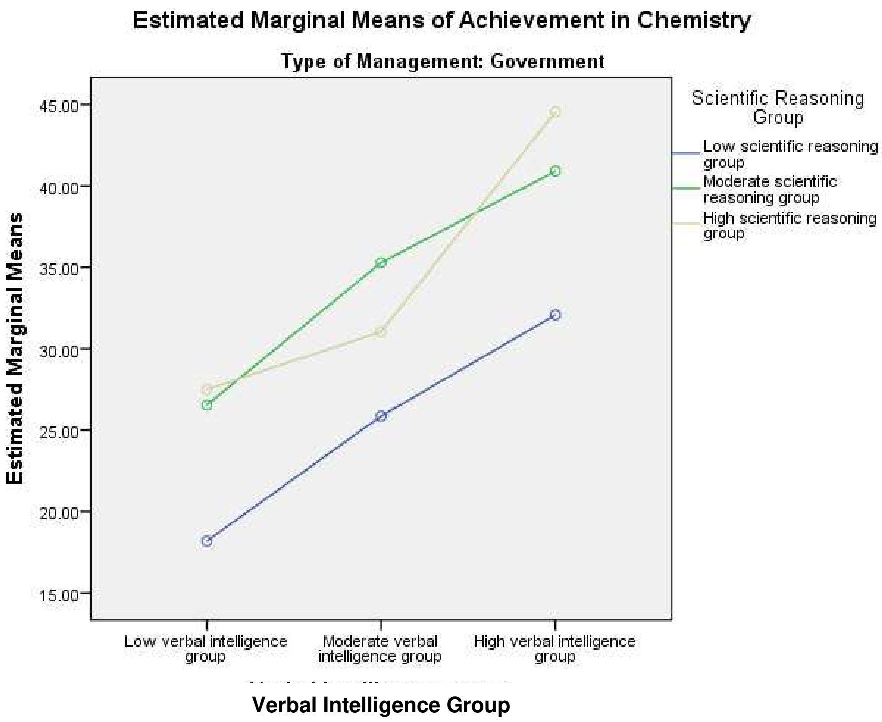
The mean difference between the low Scientific Reasoning group (M = 23.05) and the moderate Scientific Reasoning group (M = 35.23) for government students is 12.17. The standard error is 1.18, and the p-value is .001 (indicating statistical significance). This suggests that the mean Scientific Reasoning score of the moderate group is significantly higher than that of the low group for government students. The mean difference between the low Scientific Reasoning group (M = 23.05) and the high Scientific Reasoning group (M = 39.80) for government students is 16.74. The standard error is 1.28, and the p-value is .001 (indicating statistical significance). Thus, the mean Scientific Reasoning score of the high group is significantly higher than that of the low group for government students. The mean difference between the moderate Scientific Reasoning group (M = 35.23) and the high Scientific Reasoning group (M = 39.80) for government students is 4.57. The standard error is 1.27, and the p-value is 0.001 (indicating statistical significance). Therefore, the mean Scientific

Reasoning score of the high group is significantly higher than that of the moderate group for government students. In summary, based on the statistical analysis for government students, all three pairwise comparisons indicate significant differences in mean Scientific Reasoning scores among the low, moderate, and high Scientific Reasoning groups. The moderate group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and moderate groups for government students.

Graphical representation of interaction effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for government sample is presented in Figure 19.

Figure 19

Graphical Representation of Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Government Sample



Data and results of analysis of Main and Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for subsample aided is presented in Table 36.

Table 36

Summary of 3X3 Factorial ANOVA of Main and Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Subsample Aided

Source	Sum of Squares	df	Mean Square	F
Verbal Intelligence group	5880.350	2	2940.175	27.98**
Scientific Reasoning group	4162.943	2	2081.472	19.80**
Verbal Intelligence group × Scientific Reasoning group	1124.699	4	281.175	2.67*
Error	52540.221	500	105.080	

* *Significant at 0.05 level* ** *Significant at 0.01 level*

The two-way ANOVA revealed that, there exist significant main effects for Verbal Intelligence ($F\ (2,\ 500) = 27.98,\ p < .001$) and Scientific Reasoning in Chemistry ($F\ (2,500) = 19.8,\ p < .01$) on the Achievement in Chemistry. This indicates that both Verbal Intelligence and Scientific Reasoning in Chemistry have individual effects on the Achievement of aided students in Chemistry.

In addition to main effect there exist a significant interaction effect between Verbal Intelligence group and Scientific Reasoning in Chemistry group on the Achievement in Chemistry ($F\ (4,500) = 2.67,\ p < .05$). This indicates that the relationship between Verbal Intelligence and Achievement in Chemistry vary depending on the levels of Scientific Reasoning in Chemistry for aided students.

To assess the differences between groups in both variables, the Scheffé's post hoc test for comparisons was employed. The corresponding results presented in Table 37.

Table 37

Scheffé's Post hoc Test for Comparisons for Subsample Aided

Variable	Group		Mean difference	Std. Error
Verbal Intelligence	Low Verbal Intelligence group (M =23.54)	Moderate Verbal Intelligence group (M= 27.81)	4.27**	1.05
	Low Verbal Intelligence group	High Verbal Intelligence group (M= 34.20)	10.66**	1.16
	Moderate Verbal Intelligence group	High Verbal Intelligence group	6.39**	1.18
Scientific Reasoning in Chemistry	Low Scientific Reasoning group (M= 24.49)	Moderate Scientific Reasoning group (M= 29.53)	5.04**	.983
	Low Scientific Reasoning group	High Scientific Reasoning group (M= 34.46)	9.974**	1.39707
	Moderate Scientific Reasoning group	High Scientific Reasoning group	4.935**	1.435

*** Significant at 0.01 level*

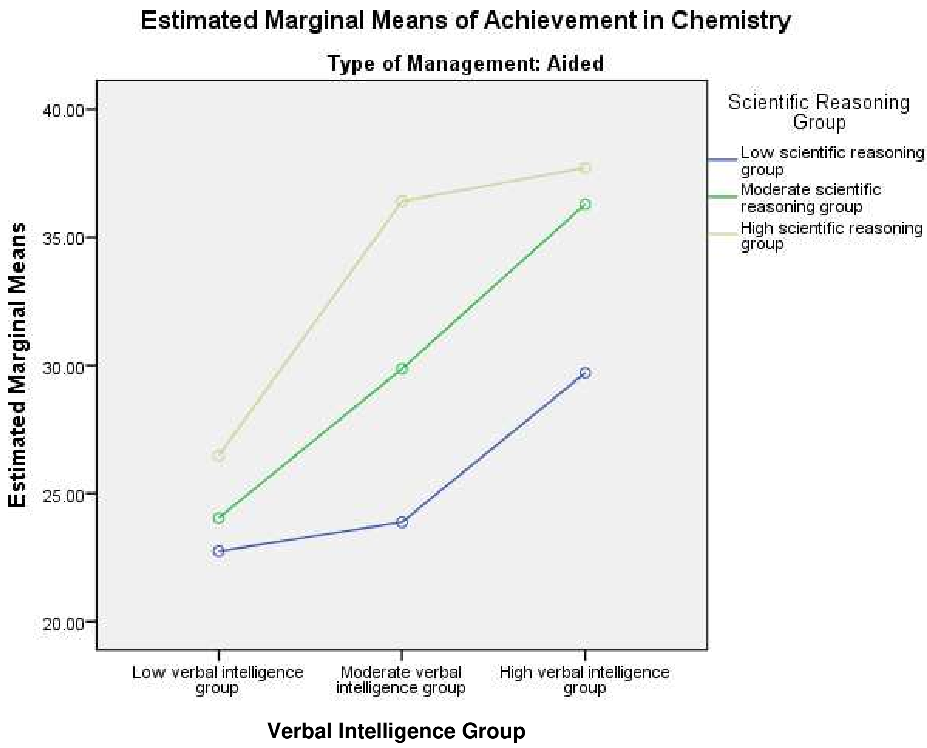
The mean difference between the low Verbal Intelligence group (M = 23.54) and the moderate Verbal Intelligence group (M = 27.81) for aided students is 4.27. The standard error is 1.05, and the p-value is .001 (indicating statistical significance). This suggests that the mean Verbal Intelligence score of the moderate group is significantly higher than that of the low group for aided students. The mean difference between the low Verbal Intelligence group (M = 23.54) and the high Verbal Intelligence group (M = 34.20) for aided students is 10.66. The standard error is 1.16, and the p-value is .001 (indicating statistical significance). Thus, the mean Verbal Intelligence score of the high group is significantly higher than that of the low group for aided students. The mean difference between the moderate Verbal Intelligence group (M = 27.81) and the high Verbal Intelligence group (M = 34.20) for aided students is 6.39. The standard error is 1.18, and the p-value is .001 (indicating statistical significance). Therefore, the mean Verbal Intelligence score of the high group is significantly higher than that of the moderate group for aided students. In summary, based on the statistical analysis for aided students, all three pairwise comparisons indicate significant differences in mean Verbal Intelligence scores among the low, moderate, and high Verbal Intelligence groups. The moderate group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and moderate groups for aided students.

The mean difference between the low Scientific Reasoning group (M = 24.49) and the moderate Scientific Reasoning group (M = 29.53) for aided students is 5.04. The standard error is 0.983, and the p-value is .001 (indicating statistical significance). This suggests that the mean Scientific Reasoning score of the moderate group is significantly higher than that of the low group for aided students. The mean difference between the low Scientific Reasoning group (M = 24.49) and the high Scientific Reasoning group (M = 34.46) for aided students is 9.974. The standard error is 1.39707, and the p-value is 0.001 (indicating statistical significance). Thus, the mean Scientific Reasoning score of the high group is significantly higher than that of the low group for aided students. The mean difference between the moderate Scientific Reasoning group (M = 29.53) and the high Scientific Reasoning group (M = 34.46) for aided students is 4.935. The standard error is 1.435, and the p-value is 0.001 (indicating statistical significance). Therefore, the mean Scientific Reasoning score of the high group is significantly higher than that of the moderate group for aided students. In summary, based on the statistical analysis for aided students, all three pairwise comparisons indicate significant differences in mean Scientific Reasoning scores among the low, moderate, and high Scientific Reasoning groups. The moderate group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and moderate groups for aided students.

Graphical representation of Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for aided sample is presented in Figure 20.

Figure 20

Graphical Representation of Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for Aided Sample



Main and interaction effect of Attitude towards Chemistry and Self-efficacy in Chemistry on Achievement in Chemistry for total sample and subsample.

The main objective was to investigate the influence of independent Noncognitive variables, Attitude towards Chemistry and Self-efficacy in Chemistry, on the dependent variable, Achievement in Chemistry of secondary school students. For this two-way ANOVA with a 3x3 factorial design was used. The analysis was conducted separately for both the total sample and subsamples based on variables such as Gender, Locale, and Type of Management of Schools. Attitude towards Chemistry was categorised into three groups: Low level attitude, Average level attitude, and High-level attitude. Similarly, Self-efficacy in Chemistry was grouped into three categories: Low Self-efficacy group, Moderate Self-efficacy group, and High Self-efficacy group.

Data and results of analysis of Main and Interaction Effect of Attitude towards Chemistry and Self-efficacy in Chemistry on Achievement in Chemistry for Total sample is presented in Table 38.

Table 38

Summary of 3X3 Factorial ANOVA of Main and Interaction Effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for Total Sample

Source	Sum of Squares	df	Mean Square	F
Self-efficacy	3332.796	2	1666.398	9.97**
Attitude towards Chemistry	17899.270	2	8949.635	53.56**
Self-efficacy × Attitude towards Chemistry	1350.111	4	337.528	2.02
Error	182295.733	1091	167.090	

*** Significant at 0.01 level*

The two-way ANOVA revealed that there is significant main effects for Self-efficacy in Chemistry ($F(2, 1091) = 9.97$, $p < .001$) and Attitude towards Chemistry ($F(2,1091) = 53.56$, $p < .01$) on the Achievement in Chemistry. This indicates that both Self-efficacy in Chemistry and Attitude towards Chemistry have individual effects on the Achievement in Chemistry.

In addition to the main effect, there is no significant interaction effect between Self-efficacy group and attitude group on the Achievement in Chemistry ($F(4,1091) = 2.02$, $p > .05$). This indicates that the relationship between Self-efficacy and Achievement in Chemistry does not varies depending on the levels of Attitude towards Chemistry.

To assess the differences between groups in both variables, the Scheffé's post hoc test for comparisons was employed. The corresponding results presented in Table 39.

Table 39

Scheffé's Post hoc Test for Comparisons for Total Sample

Variable	Group		Mean difference	Std. Error
Self-efficacy in Chemistry	Low Self-efficacy group (M =30.17)	Moderate Self-efficacy group (M= 27.76)	2.40*	.946
	Low Self-efficacy group	High Self-efficacy group (M= 33.83)	3.67**	1.046
	Moderate Self-efficacy group	High Self-efficacy group	6.069**	.939
Attitude towards Chemistry	Low level attitude (M= 26.09)	Average level attitude (M= 28.77)	2.68*	.913
	Low level attitude	High level attitude (M= 37.30)	11.20**	.990
	Average level attitude	High level attitude	8.52**	.985

** Significant at 0.05 level ** Significant at 0.01 level*

The mean difference between the low Self-efficacy group (M = 30.17) and the moderate Self-efficacy group (M = 27.76) for the total sample is 2.40. The standard error is 0.946, and the p-value is 0.040 (indicating statistical significance at a significance level of .05). This suggests that the mean Self-efficacy score of the low group is significantly higher than that of the moderate group for the total sample. The mean difference between the low Self-efficacy group (M = 30.17) and the high Self-efficacy group (M = 33.83) for the total sample is 3.67. The standard error is 1.046, and the p-value is 0.002 (indicating statistical significance). Thus, the mean Self-efficacy score of the high group is significantly higher than that of the low group for the total sample. The mean difference between the moderate Self-efficacy group (M = 27.76) and the high Self-efficacy group (M = 33.83) for the total sample is 6.069. The standard error is 0.939, and the p-value is .001 (indicating statistical significance).

Therefore, the mean Self-efficacy score of the high group is significantly higher than that of the moderate group for the total sample. In summary, based on the statistical analysis for the Total Sample, all three pairwise comparisons indicate significant differences in mean Self-efficacy scores among the low, moderate, and high Self-efficacy groups. The low group has significantly higher scores than the moderate group, and the high group has significantly higher scores than both the low and moderate groups for the Total Sample.

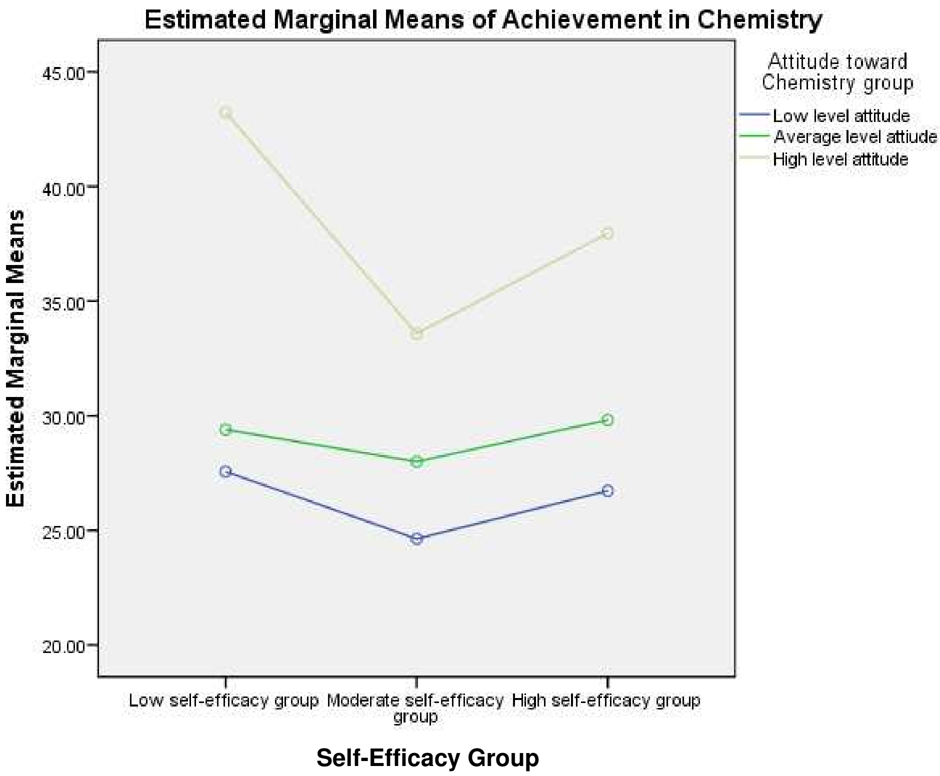
The mean difference between the low level Attitude group (M = 26.09) and the average level Attitude group (M = 28.77) for the total sample is 2.68. The standard error is 0.913, and the p-value is 0.014 (indicating statistical significance at a significance level of 0.05). This suggests that the mean attitude score of the average group is significantly higher than that of the low group for the Total Sample. The mean difference between the low level attitude group (M = 26.09) and the high level Attitude group (M = 37.30) for the total sample is 11.20. The standard error is 0.990, and the p-value is 0.001 (indicating statistical significance). Thus, the mean Attitude score of the high group is significantly higher than that of the low group for the Total Sample. The mean difference between the average level Attitude group (M = 28.77) and the high level Attitude group (M = 37.30) for the Total Sample is 8.52. The standard error is 0.985, and the p-value is .001 (indicating statistical significance). Therefore, the mean Attitude score of the high group is significantly higher than that of the average group for the Total Sample. In summary, based on the statistical analysis for the total sample, all three pairwise comparisons indicate significant differences in mean Attitude scores among the low, average, and high Attitude groups.

The average group has significantly higher scores than the low group, and the high group has significantly higher scores than both the low and average groups for the Total Sample.

Graphical representation of Interaction Effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for Total Sample is presented in Figure 21.

Figure 21

Graphical Representation of Interaction Effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for Total Sample



Data and results of analysis of Main and Interaction Effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for subsample Male is presented in Table 40.

Table 40

Summary of 3X3 Factorial ANOVA of Main and Interaction Effect of Self-efficacy in Chemistry and Attitude Towards Chemistry on Achievement in Chemistry for Subsample Male

Source	Sum of Squares	df	Mean Square	F
Self-efficacy	1400.583	2	700.291	4.29*
Attitude towards Chemistry	7986.212	2	3993.106	24.48**
Self-efficacy × Attitude towards Chemistry	2113.646	4	528.411	3.24*
Error	80062.617	491	163.060	

** Significant at 0.05* *** Significant at 0.01*

The two-way ANOVA revealed that there is significant main effects for Self-efficacy in Chemistry ($F(2, 491) = 4.29$, $p < .005$) and Attitude towards Chemistry ($F(2,491) = 24.48$, $p < .01$) on the Achievement in Chemistry. This indicates that both Self-efficacy in Chemistry and Attitude towards Chemistry have individual effects on the Achievement of male students in Chemistry.

In addition to the interaction effect, it is found that there is significant interaction effect between Self-efficacy group and Attitude group on the Achievement in Chemistry ($F(4,491) = 3.24$, $p < .05$). This indicates that the relationship between Self-efficacy and Achievement in Chemistry varies depending on the levels of Attitude towards Chemistry for male students.

To assess the differences between groups in both variables, the Scheffé's post hoc test for comparisons was employed. The corresponding results presented in Table 41.

Table 41

Scheffé's Post hoc test for Comparisons for Subsample Male

Variable	Group		Mean difference	Std. Error
Self-efficacy in Chemistry	Low Self-efficacy group (M =26.46)	Moderate Self-efficacy group (M= 25.31)	1.14	1.38
	Low Self-efficacy group	High Self-efficacy group (M= 30.41)	3.95*	1.59
	Moderate Self-efficacy group	High Self-efficacy group	5.096**	1.40
Attitude towards Chemistry	Low level attitude (M= 24.12)	Average level attitude (M= 25.63)	.50	1.29
	Low level attitude	High level attitude (M= 34.34)	10.22**	1.51
	Average level attitude	High level attitude	8.715**	1.54

** Significant at .05 level   ** Significant at 0.01 level*

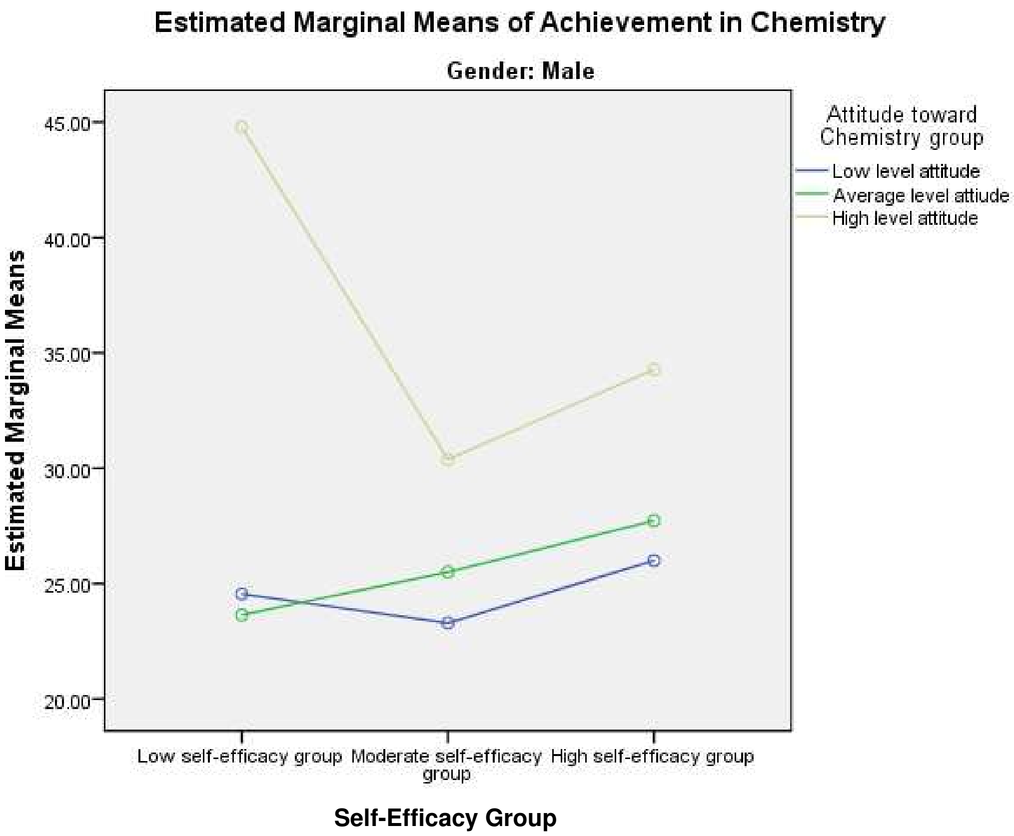
The mean difference between the low Self-efficacy group (M = 26.46) and the moderate Self-efficacy group (M = 25.31) for male students is 1.14. The standard error is 1.38, and the p-value is 0.709 (greater than .05). Therefore, the difference in mean Self-efficacy scores between the low and moderate groups for male students is not statistically significant. The mean difference between the low Self-efficacy group (M = 26.46) and the high Self-efficacy group (M = 30.41) for male students is 3.95. The standard error is 1.59, and the p-value is 0.048 (indicating statistical significance at a significance level of 0.05). This suggests that the mean Self-efficacy score of the high group is significantly higher than that of the low group for male students. The mean difference between the moderate Self-efficacy group (M = 25.31) and the high Self-efficacy group (M = 30.41) for male students is 5.096. The standard error is 1.40, and the p-value is 0.002 (indicating statistical significance). Thus, the mean Self-efficacy score of the high group is significantly higher than that of the moderate group for male students. In summary, based on the statistical analysis for male students, the low Self-efficacy group does not show a significant difference in mean Self-efficacy scores compared to the moderate Self-efficacy group. However, both the low and moderate groups have significantly lower scores compared to the high Self-efficacy group for male students.

The mean difference between the low level attitude group (M = 24.12) and the average level Attitude group (M = 25.63) for male students is 0.50. The standard error is 1.29, and the p-value is 0.507 (greater than 0.05). Therefore, the difference in mean Attitude scores between the low and average groups for male students is not statistically significant. The mean difference between the low level Attitude group (M = 24.12) and the high level Attitude group (M = 34.34) for male students is 10.22. The standard error is 1.51, and the p-value is 0.001 (indicating statistical significance at a significance level of 0.05). This suggests that the mean Attitude score of the high group is significantly higher than that of the low group for male students. The mean difference between the average level Attitude group (M = 25.63) and the high level Attitude group (M = 34.34) for male students is 8.715. The standard error is 1.54, and the p-value is .001 (indicating statistical significance). Thus, the mean Attitude score of the high group is significantly higher than that of the average group for male students. In summary, based on the statistical analysis for male students, there is no significant difference in mean Attitude scores between the low and average Attitude groups. However, both the low and average groups have significantly lower scores compared to the high Attitude group for male students.

Graphical representation of interaction effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for subsample male is presented in Figure 22.

Figure 22

Graphical Representation of Interaction Effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for Subsample Male



Data and results of analysis of Main and Interaction Effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for subsample female is presented in Table 42.

Table 42

Summary of 3X3 Factorial ANOVA of Main and Interaction Effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for Subsample Female

Source	Sum of Squares	df	Mean Square	F
Self-efficacy	1686.131	2	843.066	5.25**
Attitude towards Chemistry	8029.307	2	4014.653	25.01**
Self-efficacy × Attitude towards Chemistry	318.241	4	79.560	.496
Error	94884.796	591	160.550	

*** Significant at 0.01 level*

The two-way ANOVA revealed that there is significant main effects for Self-efficacy in Chemistry ($F(2, 591) = 5.25$, $p < .05$) and Attitude towards Chemistry ($F(2,591) = 25.01$, $p < .01$) on the Achievement in Chemistry. This indicates that both Self-efficacy in Chemistry and Attitude towards Chemistry have individual effects on the Achievement of female students in chemistry.

In addition to the main effect, it is found that there is no significant interaction effect between Self-efficacy group and Attitude group on the Achievement in Chemistry ($F(4,591) = .496$, $p > .05$). This indicates that the relationship between Self-efficacy and Achievement in Chemistry does not varies depending on the levels of Attitude towards Chemistry for female students.

To assess the differences between groups in both variables, the Scheffé's post hoc test for comparisons was employed. The corresponding results presented in Table 43.

Table 43

Scheffé's Post hoc Test for Comparisons for Subsample Female

Variable	Group		Mean difference	Std. Error
Self-efficacy in Chemistry	Low Self-efficacy group (M =33.02)	Moderate Self-efficacy group (M= 30.2)	2.82	1.26
	Low Self-efficacy group	High Self-efficacy group (M= 36.16)	3.14	1.35
	Moderate Self-efficacy group	High Self-efficacy group	5.96**	1.23
Attitude towards Chemistry	Low level attitude (M= 28.26)	Average level attitude (M= 31.42)	3.16*	1.25
	Low level attitude	High level attitude (M= 38.97)	10.71**	1.30
	Average level attitude	High level attitude	7.55**	1.25

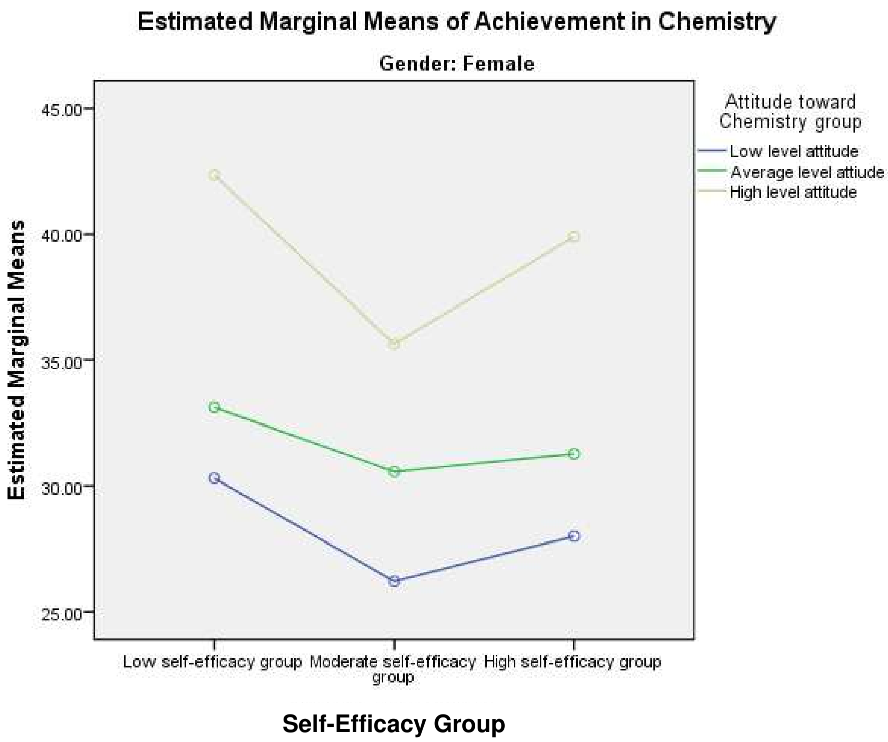
** Significant at 0.05* *** Significant at 0.01*

The mean difference between the low Self-efficacy group (M = 33.02) and the moderate Self-efficacy group (M = 30.2) for female students is 2.82. The standard error is 1.26, and the p-value is 0.083 (greater than .05). Therefore, the difference in mean Self-efficacy scores between the low and moderate groups for female students is not statistically significant. The mean difference between the low Self-efficacy group (M = 33.02) and the high Self-efficacy group (M = 36.16) for female students is 3.14. The standard error is 1.35, and the p-value is 0.067 (slightly greater than 0.05). While the p-value is close to the significance level, it does not meet the criterion for statistical significance at the chosen significance level of 0.05. Therefore, the difference in mean Self-efficacy scores between the low and high groups for female students is not statistically significant. The mean difference between the moderate Self-efficacy group (M = 30.2) and the high Self-efficacy group (M = 36.16) for female students is 5.96. The standard error is 1.23, and the p-value is 0.001 (indicating statistical significance). This suggests that the mean Self-efficacy score of the high group is significantly higher than that of the moderate group for female students. In summary, based on the statistical analysis for female students, there is no significant difference in mean Self-efficacy scores between the low and moderate Self-efficacy groups or between the low and high Self-efficacy groups. However, the high Self-efficacy group has a significantly higher mean Self-efficacy score compared to the moderate Self-efficacy group for female students.

The mean difference between the low level Attitude group (M = 28.26) and the average level Attitude group (M = 31.42) for female students is 3.16. The standard error is 1.25, and the p-value is 0.043 (less than 0.05). Therefore, the difference in mean Attitude scores between the low and average Attitude groups for female students is statistically significant, indicating that the average level Attitude group has a significantly higher mean attitude score compared to the low level Attitude group. The mean difference between the low level Attitude group (M = 28.26) and the high level Attitude group (M = 38.97) for female students is 10.71. The standard error is 1.30, and the p-value is 0.001 (indicating statistical significance at a significance level of 0.05). This suggests that the mean attitude score of the high level attitude group is significantly higher than that of the low level Attitude group for female students. The mean difference between the average level Attitude group (M = 31.42) and the high level Attitude group (M = 38.97) for female students is 7.55. The standard error is 1.25, and the p-value is 0.001 (indicating statistical significance). Thus, the mean attitude score of the high level attitude group is significantly higher than that of the average level Attitude group for female students. In summary, based on the statistical analysis for female students, both the average level Attitude group and the high level attitude group have significantly higher mean Attitude scores compared to the low level Attitude group. Additionally, the high level Attitude group has a significantly higher mean attitude score compared to the average level attitude group for female students is presented in Figure 23.

Figure 23

Graphical Representation of Interaction Effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for Subsample Female



Data and results of analysis of Main and Interaction Effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for rural subsample is presented in Table 44.

Table 44

Summary of 3X3 Factorial ANOVA of Main and Interaction Effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for Rural Subsample

Source	Sum of Squares	df	Mean Square	F
Self-efficacy	1791.316	2	895.658	5.57**
Attitude towards Chemistry	13891.637	2	6945.818	43.21**
Self-efficacy × Attitude towards Chemistry	2049.508	4	512.377	3.19*
Error	104308.447	649	160.722	

** Significant at 0.05 level ** Significant at 0.01 level*

The two-way ANOVA revealed that there exist significant main effects for Self-efficacy in Chemistry ($F(2, 649) = 5.57$, $p < .01$) and Attitude towards Chemistry ($F(2,649) = 43.21$, $p < .01$) on the Achievement in Chemistry. This indicates that both Self-efficacy in Chemistry and Attitude towards Chemistry have individual effects on the achievement of rural students in chemistry.

In addition to the main effect, it is found that there is significant interaction effect between Self-efficacy group and attitude group on the Achievement in Chemistry ($F(4,649) = 3.19$, $p < .05$). This indicates that the relationship between self -efficacy in chemistry and Achievement in Chemistry varies depending on the levels of attitude towards chemistry for rural students.

To assess the differences between groups in both variables, the Scheffé's post hoc test for comparisons was employed. The corresponding results presented in Table 45.

Table 45

Scheffé's Post hoc Test for Comparisons for Rural Subsample

Variable	Group		Mean difference	Std. Error
Self-efficacy in Chemistry	Low Self-efficacy group (M =31.37)	Moderate Self-efficacy group (M= 29.3)	2.07	1.19
	Low Self-efficacy group	High Self-efficacy group (M= 33.50)	2.12	1.31
	Moderate Self-efficacy group	High Self-efficacy group	4.19**	1.194
Attitude towards Chemistry	Low level attitude (M= 26.94)	Average level attitude (M= 29.86)	2.92*	1.16
	Low level attitude	High level attitude (M= 38.26)	11.32**	1.26
	Average level attitude	High level attitude	8.40**	1.25

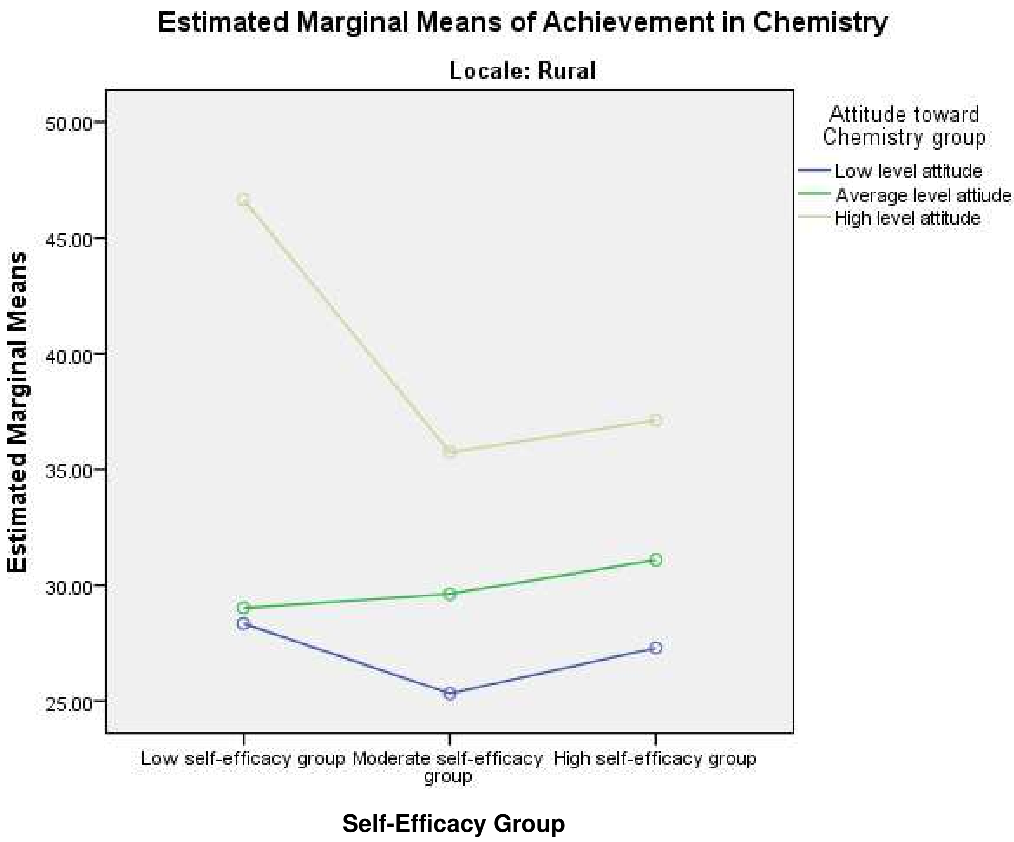
** Significant at 0.05* *** Significant at 0.01*

The mean difference between the low Self-efficacy group (M = 31.37) and the moderate Self-efficacy group (M = 29.3) for rural students is 2.07. The standard error is 1.19, and the p-value is 0.223 (greater than .05). Therefore, the difference in mean Self-efficacy scores between the low and moderate Self-efficacy groups for rural students is not statistically significant. The mean difference between the low Self-efficacy group (M = 31.37) and the high Self-efficacy group (M = 33.50) for rural students is 2.12. The standard error is 1.31, and the p-value is 0.270 (greater than .05). This indicates that the difference in mean Self-efficacy scores between the low and high Self-efficacy groups for rural students is not statistically significant. The mean difference between the moderate Self-efficacy group (M = 29.3) and the high Self-efficacy group (M = 33.50) for rural students is 4.19. The standard error is 1.194, and the p-value is .002 (indicating statistical significance at a significance level of .05). This suggests that the mean Self-efficacy score of the high Self-efficacy group is significantly higher than that of the moderate Self-efficacy group for rural students. In summary, based on the statistical analysis for rural students, there is no significant difference in mean Self-efficacy scores between the low and moderate Self-efficacy groups or between the low and high Self-efficacy groups. However, the high Self-efficacy group has a significantly higher mean Self-efficacy score compared to the moderate Self-efficacy group for rural students.

The mean difference between the low level Attitude group (M = 26.94) and the average level Attitude group (M = 29.86) for rural students is 2.92. The standard error is 1.16, and the p-value is 0.042 (less than .05). Therefore, the difference in mean Attitude scores between the low and average level Attitude groups for rural students is statistically significant. The mean difference between the low level attitude group (M = 26.94) and the high level Attitude group (M = 38.26) for rural students is 11.32. The standard error is 1.26, and the p-value is .001 (indicating statistical significance at a significance level of 0.05). This suggests that the mean Attitude score of the high level Attitude group is significantly higher than that of the low level Attitude group for rural students. The mean difference between the average level Attitude group (M = 29.86) and the high level attitude group (M = 38.26) for rural students is 8.40. The standard error is 1.25, and the p-value is .001 (indicating statistical significance). Thus, the mean Attitude score of the high level Attitude group is significantly higher than that of the average level Attitude group for rural students. In summary, based on the statistical analysis for rural students, there is a significant difference in mean Attitude scores between the low and average level Attitude groups as well as between the low and high level Attitude groups. Additionally, the high level Attitude group has a significantly higher mean Attitude score compared to the average level Attitude group for rural students is presented in Figure 24.

Figure 24

Graphical Representation of Interaction Effect of Self-efficacy in Chemistry and Attitude Towards Chemistry on Achievement in Chemistry for Rural Subsample



Data and results of analysis of Main and Interaction effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for urban subsample is presented in Table 46.

Table 46

Summary of 3X3 Factorial ANOVA of Main and Interaction Effect of Self-efficacy in Chemistry and Attitude Towards Chemistry on Achievement in Chemistry for Urban Subsample

Source	Sum of Squares	df	Mean Square	F
Self-efficacy	1008.370	2	504.185	2.93
Attitude towards Chemistry	3099.741	2	1549.870	9.02**
Self-efficacy × towards chemistry	821.650	4	205.412	1.19
Error	74390.676	433	171.803	

*** Significant at 0.01 level*

The two-way ANOVA revealed that there is no significant main effects for Self-efficacy in Chemistry ($F(2, 433) = 2.93$, $p > .05$) and Attitude towards Chemistry ($F(2,433) = 9.02$, $p < .01$) on the Achievement in Chemistry. This indicates that Self-efficacy in Chemistry does not have individual effects on the achievement of urban students in chemistry and Attitude towards Chemistry have individual effects on the Achievement of urban students in Chemistry.

In addition to the main effect, it is found that there is no significant interaction effect between Self-efficacy group and Attitude group on the Achievement in Chemistry ($F(4,433) = 1.19$, $p > .05$). This indicates that the relationship between Self-efficacy in Chemistry and Achievement in Chemistry does not varies depending on the levels of Attitude towards Chemistry for urban students.

To assess the differences between groups in both variables, the Scheffé's post hoc test for comparisons was employed. The corresponding results presented in Table 47.

Table 47

Scheffé's Post hoc Test for Comparisons for Urban Subsample

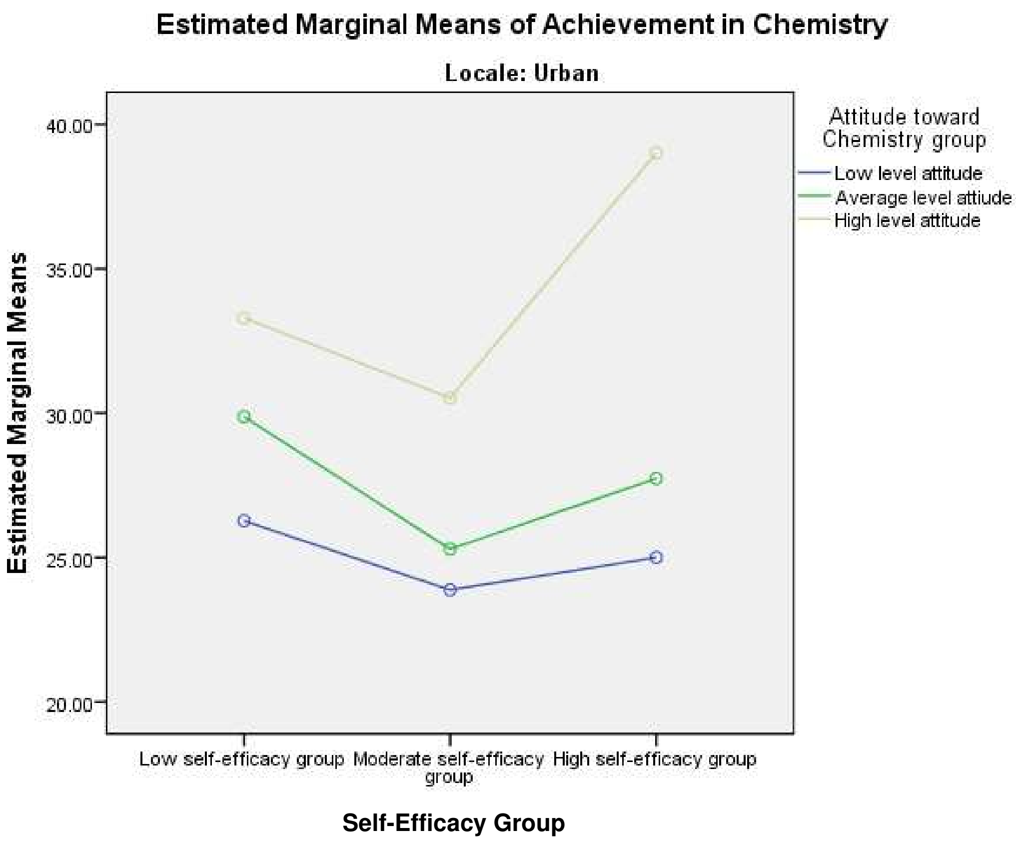
Variable	Group		Mean difference	Std. Error
Attitude towards Chemistry	Low level attitude (M= 24.88)	Average level attitude (M= 27.07)	2.19	1.46
	Low level attitude	High level attitude (M= 35.90)	11.02**	1.57
	Average level attitude	High level attitude	8.83**	1.58

*** Significant at 0.01*

The mean difference between the low level Attitude group (M = 24.88) and the average level Attitude group (M = 27.07) for urban students is 2.19. The standard error is 1.46, and the p-value is 0.327 (greater than .05). Therefore, the difference in mean Attitude scores between the low and average level Attitude groups for urban students is not statistically significant. The mean difference between the low level Attitude group (M = 24.88) and the high level Attitude group (M = 35.90) for urban students is 11.02. The standard error is 1.57, and the p-value is 0.001 (indicating statistical significance at a significance level of .05). This suggests that the mean Attitude score of the high level attitude group is significantly higher than that of the low level Attitude group for urban students. The mean difference between the average level Attitude group (M = 27.07) and the high level Attitude group (M = 35.90) for urban students is 8.83. The standard error is 1.58, and the p-value is 0.001 (indicating statistical significance). Thus, the mean Attitude score of the high level Attitude group is significantly higher than that of the average level Attitude group for urban students. In summary, based on the statistical analysis for urban students, there is no significant difference in mean Attitude scores between the low and average level Attitude groups. However, both the low and average level Attitude groups have significantly lower mean Attitude scores compared to the high level Attitude group for urban students.

Figure 25

Graphical Representation of Interaction Effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for Urban Subsample



Data and results of analysis of Main and Interaction Effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for subsample government school students is presented in Table 48.

Table 48

Summary of 3X3 Factorial ANOVA of Main and Interaction Effect of Self-efficacy in Chemistry and Attitude Towards Chemistry on Achievement in Chemistry for Subsample Government School Students

Source	Sum of Squares	df	Mean Square	F
Self-efficacy	2608.176	2	1304.088	6.63**
Attitude towards science	15156.745	2	7578.372	38.56**
Self-efficacy × Attitude towards science	843.077	4	210.769	1.07
Error	114373.227	582	196.518	

*** Significant at 0.01 level*

The two-way ANOVA revealed that there exist a significant main effects for Self-efficacy in Chemistry (F (2, 582) = 6.63, p <.05) and Attitude towards Chemistry (F (2,582) = 38.56, p < .01) on the Achievement in Chemistry. This indicates that both Self-efficacy in Chemistry and Attitude towards Chemistry have individual effects on the Achievement of government students in Chemistry.

In addition to the main effect, it is found that there is no significant interaction effect between Self-efficacy group and Attitude group on the Achievement in Chemistry (F (4,582) = 1.07, p > .05). This indicates that the relationship between Self-efficacy in Chemistry and Achievement in Chemistry does not varies depending on the levels of Attitude towards Chemistry for government students.

To assess the differences between groups in both variables, the Scheffé's post hoc test for comparisons was employed. The corresponding results presented in Table 49

Table 49

Scheffé's Post hoc Test for Comparisons for Subsample Government School Students

Variable	Group		Mean difference	Std. Error
Self-efficacy in Chemistry	Low Self-efficacy group (M =32.46)	Moderate Self-efficacy group (M=28.97)	3.49*	1.41
	Low Self-efficacy group	High Self-efficacy group (M= 36.48)	4.018*	1.52
	Moderate Self-efficacy group	High Self-efficacy group	7.51**	1.37
Attitude towards Chemistry	Low level attitude (M= 26.22)	Average level attitude (M= 30.38)	4.15*	1.40
	Low level attitude	High level attitude (M= 40.03)	13.81**	1.43
	Average level attitude	High level attitude	9.65**	1.40

** Significant at 0.05 level ** Significant at 0.01 level*

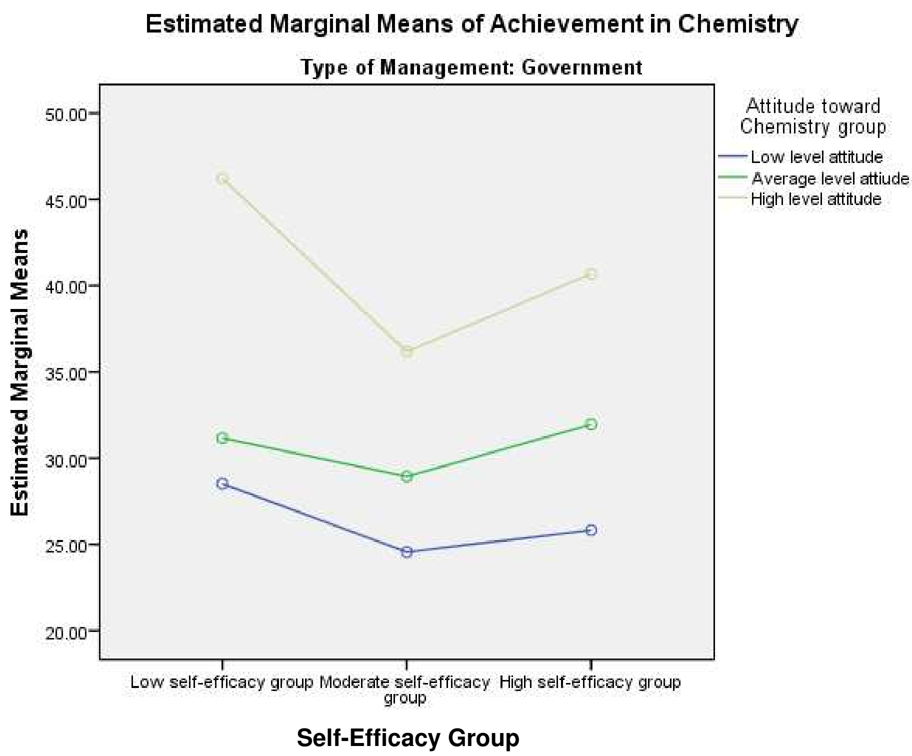
The mean difference between the low Self-efficacy group (M = 32.46) and the moderate Self-efficacy group (M = 28.97) for government school students is 3.49. The standard error is 1.41, and the p-value is 0.048 (indicating statistical significance at a significance level of .05). This suggests that the mean Self-efficacy score of the low Self-efficacy group is significantly higher than that of the moderate Self-efficacy group for government school students. The mean difference between the low Self-efficacy group (M = 32.46) and the high Self-efficacy group (M = 36.48) for government school students is 4.018. The standard error is 1.52, and the p-value is 0.032 (indicating statistical significance). Thus, the mean Self-efficacy score of the high Self-efficacy group is significantly higher than that of the low Self-efficacy group for government school students. The mean difference between the moderate Self-efficacy group (M = 28.97) and the high Self-efficacy group (M = 36.48) for government school students is 7.51. The standard error is 1.37, and the p-value is 0.001 (indicating statistical significance). This suggests that the mean Self-efficacy score of the high Self-efficacy group is significantly higher than that of the moderate Self-efficacy group for government school students. In summary, based on the statistical analysis for government school students, there is a significant difference in mean Self-efficacy scores between the low and moderate Self-efficacy groups, low and high Self-efficacy groups, as well as moderate and high Self-efficacy groups. The high Self-efficacy group has the highest mean Self-efficacy score, followed by the low Self-efficacy group, and the moderate Self-efficacy group has the lowest mean Self-efficacy score.

The mean difference between the low level Attitude group (M = 26.22) and the average level Attitude group (M = 30.38) for government school students is 4.15. The standard error is 1.40, and the p-value is 0.013 (indicating statistical significance at a significance level of .05). This suggests that the mean Attitude score of the average level Attitude group is significantly higher than that of the low level Attitude group for government school students. The mean difference between the low level attitude group (M = 26.22) and the high level Attitude group (M = 40.03) for government school students is 13.81. The standard error is 1.43, and the p-value is 0.001 (indicating statistical significance). Thus, the mean Attitude score of the high level Attitude group is significantly higher than that of the low level Attitude group for government school students. The mean difference between the average level Attitude group (M = 30.38) and the high level Attitude group (M = 40.03) for government school students is 9.65. The standard error is 1.40, and the p-value is .001

(indicating statistical significance). This suggests that the mean Attitude score of the high level attitude group is significantly higher than that of the average level Attitude group for government school students. In summary, based on the statistical analysis for government school students, there is a significant difference in mean Attitude scores between the low and average level Attitude groups, low and high level Attitude groups, as well as average and high level Attitude groups. The high level Attitude group has the highest mean Attitude score, followed by the average level Attitude group, and the low level Attitude group has the lowest mean Attitude score is presented in Figure 26.

Figure 26

Graphical Representation of Interaction Effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for Subsample Government School Students



Data and results of analysis of Main and Interaction Effect of Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry for Subsample Aided School Students is presented in Table 50.

Table 50

Summary of 3X3 Factorial ANOVA of Main and Interaction Effect of Self-efficacy in Chemistry and Attitude Towards Chemistry on Achievement in Chemistry for Subsample Aided School Students

Source	Sum of Squares	df	Mean Square	F
Self-efficacy	692.752	2	346.376	2.77
Attitude towards Chemistry	2203.465	2	1101.732	8.81**
Self-efficacy × Attitude towards Chemistry	663.455	4	165.864	1.33
Error	62551.927	500	125.104	

*** Significant at 0.01 level*

The two-way ANOVA revealed that there is no significant main effects for Self-efficacy in Chemistry ($F(2, 500) = 2.77$, $p > .05$) and Attitude towards Chemistry ($F(2,500) = 8.81$, $p < .01$) on the Achievement in Chemistry. This indicates that both Self-efficacy in Chemistry and Attitude towards Chemistry have individual effects on the Achievement of aided students in Chemistry.

In addition to the main effect, it is found that there is no significant interaction effect between Self-efficacy group and attitude group on the Achievement in Chemistry ($F(4,500) = 1.33$, $p > .05$). This indicates that the relationship between self -efficacy in chemistry and Achievement in Chemistry does not varies depending on the levels of Attitude towards Chemistry for aided students.

To assess the differences between groups in both variables, the Scheffé's post hoc test for comparisons was employed. The corresponding results presented in Table 51

Table 51

Scheffé's Post Hoc Test for Comparisons for Subsample Aided School Students

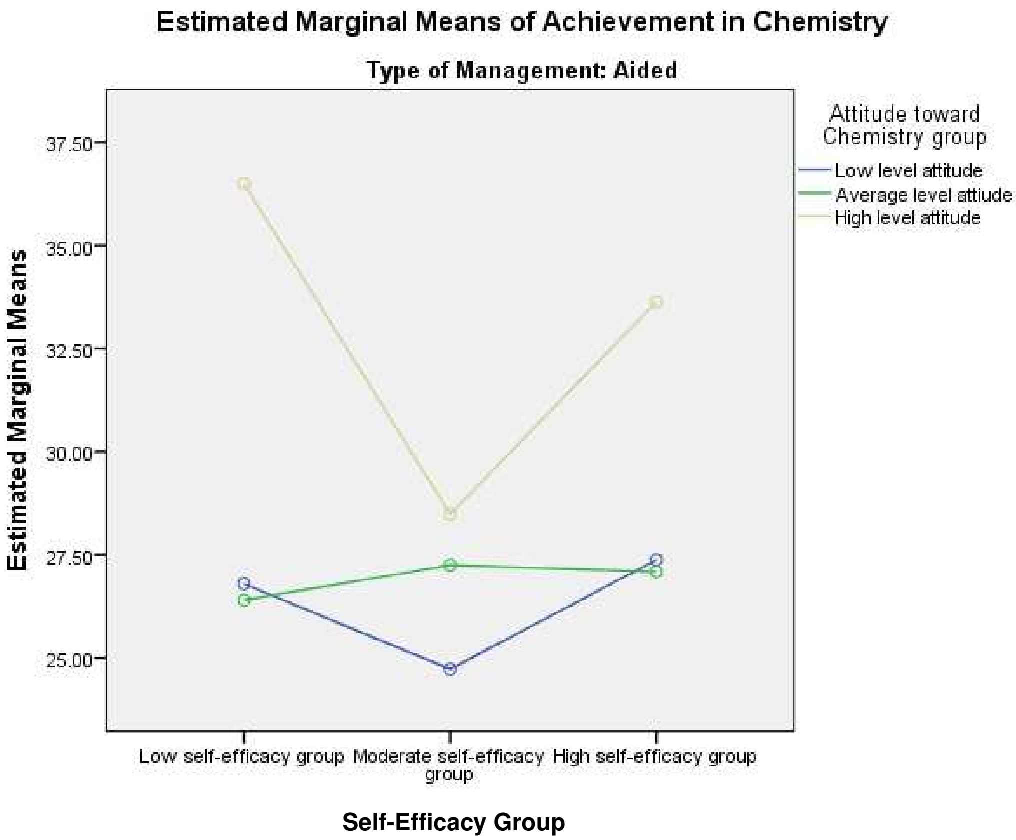
Variable	Group		Mean difference	Std. Error
Attitude towards Chemistry	Low level attitude (M= 25.97)	Average level attitude (M= 27.06)	1.08	1.12
	Low level attitude	High level attitude (M= 32.47)	6.49**	1.33
	Average level attitude	High level attitude	5.41**	1.34

*** Significant at 0.01 Level*

The mean difference between the low level attitude group (M = 25.97) and the average level attitude group (M = 27.06) for aided school students is 1.08. The standard error is 1.12, and the p-value is 0.624 (greater than .05). Therefore, the difference in mean Attitude scores between the low and average level Attitude groups for aided school students is not statistically significant. The mean difference between the low level Attitude group (M = 25.97) and the high level Attitude group (M = 32.47) for aided school students is 6.49. The standard error is 1.33, and the p-value is .001 (indicating statistical significance at a significance level of 0.05). This suggests that the mean Attitude score of the high level Attitude group is significantly higher than that of the low level Attitude group for aided school students. The mean difference between the average level Attitude group (M = 27.06) and the high level Attitude group (M = 32.47) for aided school students is 5.41. The standard error is 1.34, and the p-value is .001 (indicating statistical significance). This suggests that the mean Attitude score of the high level Attitude group is significantly higher than that of the average level Attitude group for aided school students. In summary, based on the statistical analysis for aided school students, there is no significant difference in mean Attitude scores between the low and average level Attitude groups. However, both the low and average level attitude groups have significantly lower scores compared to the high level Attitude group for aided school students is presented in Figure 27.

Figure 27

Graphical Representation of Interaction Effect of Self-efficacy in Chemistry and Attitude Towards Chemistry on Achievement in Chemistry for Subsample Aided School Students



Relationship between Independent Variables, namely Verbal Intelligence, Scientific Reasoning in Chemistry, Attitude towards Chemistry, Self-efficacy in Chemistry, and Dependent Variable Achievement in Chemistry.

To assess the Correlation between the Independent variables (Verbal Intelligence, Scientific Reasoning in Chemistry, Attitude towards Chemistry, Self-efficacy in Chemistry) and Dependent variable (Achievement in Chemistry) Pearson Product-Moment Correlation analysis was conducted. The data and results of this analysis are presented in a Table 52.

Table 52

Correlation Analysis between Independent Variables i.e. Verbal Intelligence, Scientific Reasoning in Chemistry, Self-efficacy in Chemistry, Attitude towards Chemistry, and dependent Variable Achievement in Chemistry

Variable	Verbal Intelligence	Scientific Reasoning in Chemistry	Attitude towards Chemistry	Self-efficacy in Chemistry
r-value	.515**	.423**	.325**	.135**

From the table it is clear that, the Dependent variable "Achievement in Chemistry" is positively correlated with Verbal Intelligence. Scientific Reasoning in Chemistry, Attitude towards Chemistry and Self-efficacy in Chemistry.

The correlation coefficient of .515 indicates a strong positive relationship between Verbal Intelligence and Achievement in Chemistry and it is significant at .01 level of significance. This means that individuals with higher Verbal Intelligence tend to have higher Achievement in Chemistry. The correlation coefficient of .423 suggests a positive and moderate relationship between Scientific Reasoning in Chemistry and

Achievement in Chemistry and it is significant at .01 level of significance. This indicates that individuals with better Scientific Reasoning skills specifically related to chemistry tend to have higher achievement in the subject.

The correlation coefficient of .325 suggests a positive but moderate relationship between Attitude towards Chemistry and Achievement in Chemistry and it is significant at .01 level of significance. This means that individuals with a more positive Attitude towards Chemistry tend to have higher achievement in the subject. The correlation coefficient of .135 indicates a positive but relatively weak relationship between Self-efficacy in Chemistry and Achievement in Chemistry and it is significant at .01 level of significance. This suggests that individuals with higher Self-efficacy in Chemistry may tend to have slightly higher achievement in the subject.

Scatterplot for showing relationship between the dependent variable Achievement in Chemistry and the Independent variables namely. Verbal Intelligence and Scientific Reasoning in Chemistry, Attitude towards Chemistry, Self-efficacy in Chemistry is presented in Figures 28, 29, 30 and 31.

Figure 28

Scatter Plot: Relationship between Achievement in Chemistry and Verbal Intelligence

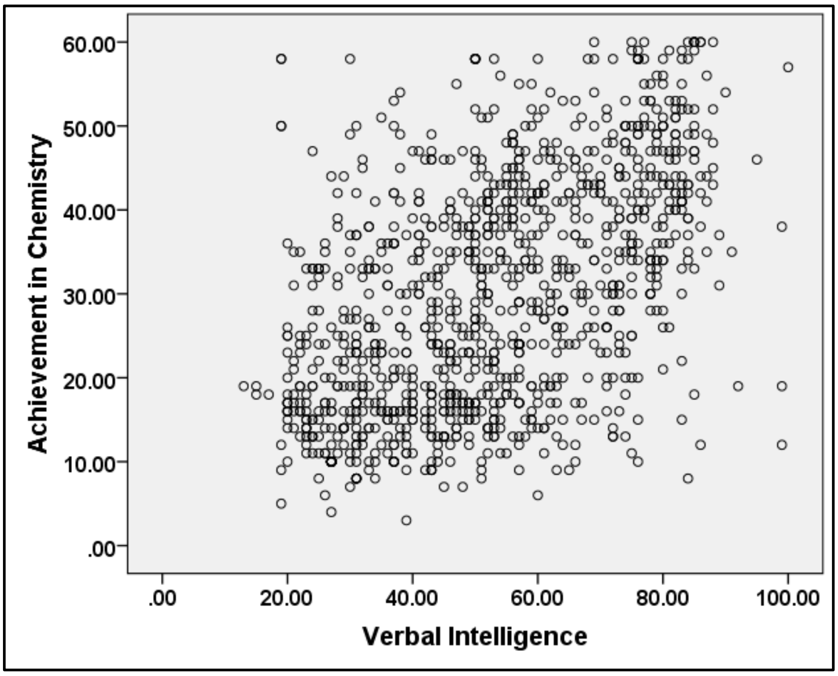


Figure 29

Scatter Plot: Relationship between Achievement in Chemistry and Scientific Reasoning in Chemistry

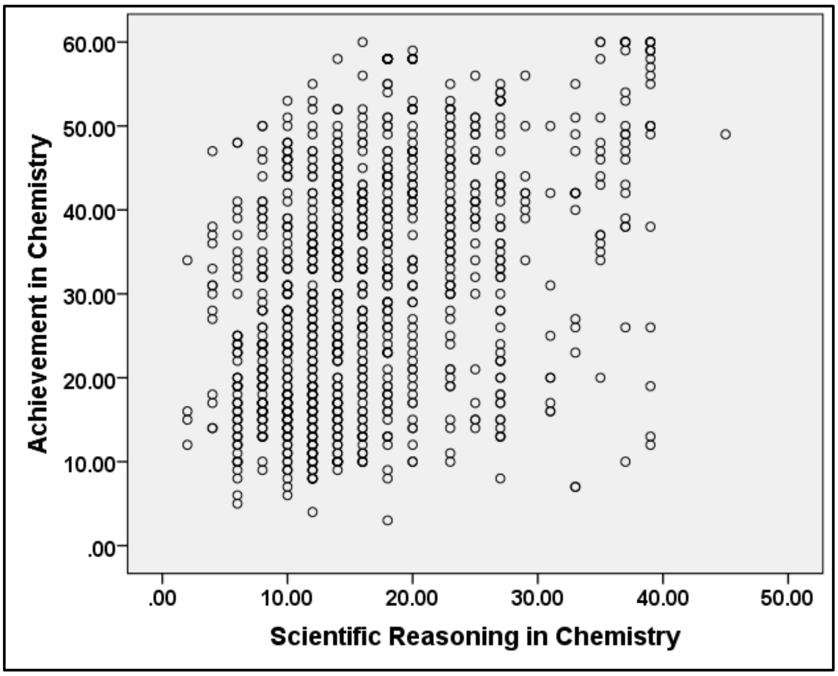


Figure 30

Scatter Plot: Relationship between Achievement in Chemistry and Attitude towards Chemistry

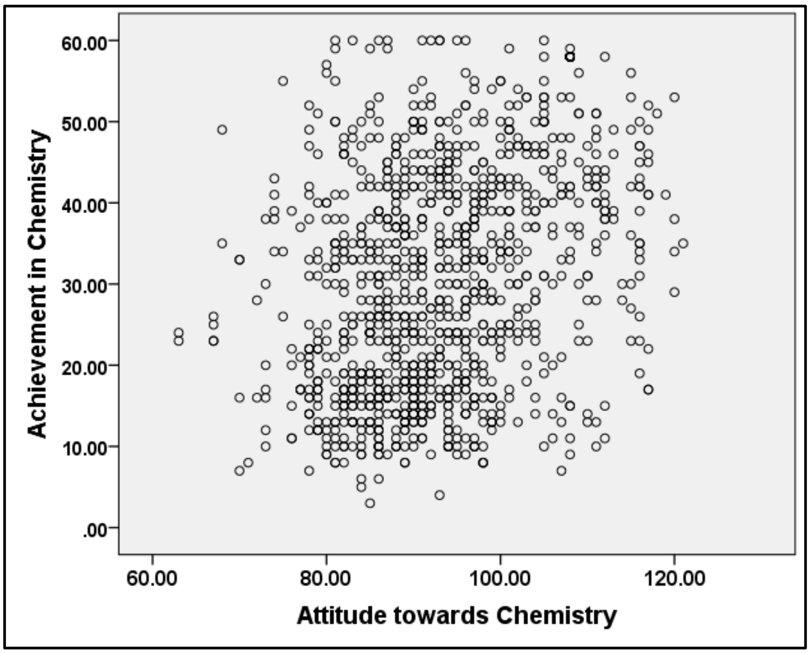
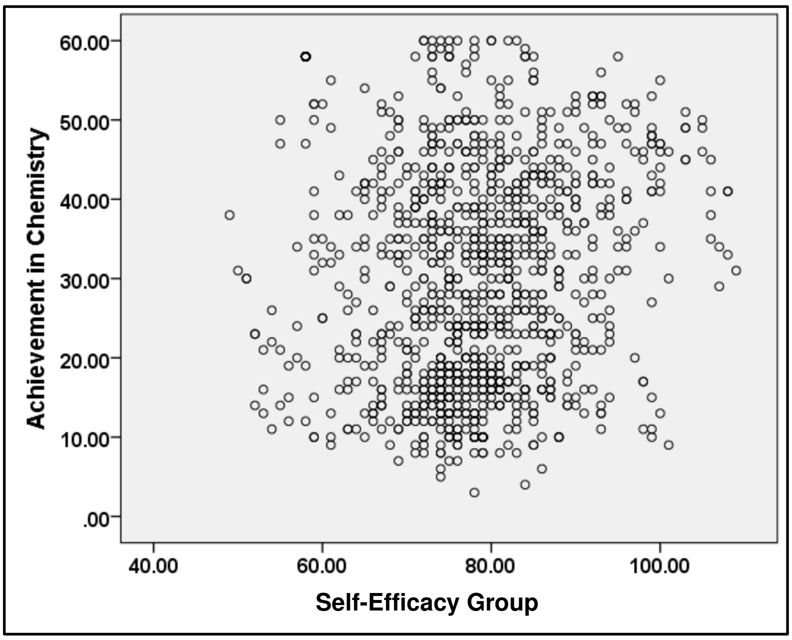


Figure 31

Scatter Plot: Relationship between Achievement in Chemistry and Self-efficacy in Chemistry



The data points on the scatter plot tend to follow an upward trend from left to right, indicating that as the x-values increase, the corresponding y-values also increase. The data points cluster or concentrate around the upward trend line. This suggests a relatively strong relationship between the variables, as the points are closely grouped together and exhibit less variability.

Regression Analysis

The purpose of this study was to examine the relationships between multiple independent variables and a dependent variable using multiple regression analysis. Multiple regression analysis is a statistical technique that allows to explore how multiple predictor variables collectively influence a single outcome variable. In this analysis, researcher aimed to investigate the simultaneous effects of Verbal Intelligence, Scientific Reasoning in Chemistry, Attitude towards Chemistry and Self-efficacy in Chemistry on the Achievement in Chemistry. The details of regression analysis i.e., R, R square are presented in Table 53.

Table 53

R, R^2 and adjusted R^2 for model 1

Model	R	R Square	Adjusted R Square
1	.595	.354	.352

The obtained regression coefficients for the model 1 is presented in Table 54.

Table 54

Regression Coefficients for the Model 1

Model	Predictors	Unstandardized Coefficients (b)	Standardized Coefficients (β)	t	Sig.
1	(Constant)	-13.21		-4.00	.000
	Verbal Intelligence	.270	.373	13.83	.000
	Scientific Reasoning in Chemistry	.417	.239	8.98	.000
	Attitude towards Chemistry	.254	.192	6.686	.000
	Self-efficacy in Chemistry	-.017	-.013	-.455	.649

In this particular model that Verbal Intelligence, Scientific Reasoning in Chemistry, Attitude towards Chemistry and Self-efficacy in Chemistry, as predictors, the unstandardized regression coefficient for the variable Self-efficacy in Chemistry was found to be statistically insignificant, as indicated by a t-value less than 1.96. Consequently, an alternative model (Model 2) was tested, excluding the variable Self-efficacy in Chemistry. The results of the regression analysis with the predictors Attitude towards Chemistry, Verbal Intelligence, and Scientific Reasoning in Chemistry can be found in Table 55

Table 55

R, R^2 and Adjusted R^2 for Model 2

Model	R	R Square	Adjusted R Square
2	.595	.354	.352

The value of R (.595) represents the correlation coefficient, which indicates the strength and direction of the linear relationship between the dependent variable and the combination of independent variables in the model. In this case, the correlation coefficient suggests a moderate positive relationship between the predictors in the model and the dependent variable. The value of R Square (.354) represents the coefficient of determination, which indicates the proportion of variance in the dependent variable that can be explained by the independent variables included in the model. In this instance, approximately 35.4% of the variability in the dependent variable is accounted for by the predictors in Model 2. The value of Adjusted R Square (.352) takes into account the number of predictors in the model and adjusts the R Square value accordingly. It is a more conservative estimate of the proportion of variance explained by the model. In this case, the Adjusted R Square value is very close to the R Square value, suggesting that the model's explanatory power is not significantly affected by the number of predictors.

The Table 56 presents the statistical significance of the Overall Model, which includes all the Independent variables.

Table 56

Statistical Significance of the Overall Model

Model		Sum of Squares	df	Mean Square	F	Sig.
2	Regression	73844.207	3	24614.736	200.161	.001
	Residual	134779.974	1096	122.974		
	Total	208624.182	1099			

The statistical analysis reveals that the overall model (Model 2) is statistically significant at 0.01 level. This means that the independent variables included in the model collectively have a significant impact on explaining the variance in the dependent variable. The F-value of 200.161, with associated significance (p-value) of .001, suggests a highly significant relationship between the predictors and the dependent variable.

The obtained regression coefficients for the model 2 is presented in Table 57.

Table 57

Regression Coefficients for the Model 2

Model	Predictors	Unstandardized Coefficients (b)	Standardized Coefficients (β)	t	Sig.
2	(Constant)	-13.820		-4.581	.001
	Verbal Intelligence	.270	.374	13.850	.001
	Scientific Reasoning in Chemistry	.417	.239	8.990	.001
	Attitude towards Chemistry	.246	.186	7.366	.001

The unstandardized coefficient (b) of 0.246 suggests that for every one-unit increase in Attitude towards Chemistry, the Achievement in Chemistry is expected to increase by 0.246 units. The standardized coefficient (β) of 0.186 indicates that Attitude towards Chemistry has a moderate positive effect on the Achievement in Chemistry after accounting for the scale differences between the variables. The t-value of 7.366 is statistically significant ($p < .001$), indicating that Attitude towards Chemistry has a significant impact on the Achievement in Chemistry.

The unstandardized coefficient (b) of 0.270 indicates that for every one-unit increase in Verbal Intelligence, the Achievement in Chemistry is expected to increase by 0.270 units. The standardized coefficient (β) of 0.374 suggests that Verbal Intelligence has a relatively strong positive effect on the Achievement in Chemistry, even after considering the scale differences. The t-value of 13.85 is highly significant ($p < .001$), indicating that Verbal Intelligence significantly influences the Achievement in Chemistry.

The unstandardized coefficient (b) of 0.417 implies that for every one-unit increase in Scientific Reasoning in Chemistry, the Achievement in Chemistry is expected to increase by 0.417 units. The standardized coefficient (β) of 0.239 indicates that Scientific Reasoning in Chemistry has a moderate positive effect on the Achievement in Chemistry. The t-value of 8.990 is statistically significant ($p < .001$), suggesting that Scientific Reasoning in Chemistry has a significant impact on the Achievement in Chemistry.

In summary, the results show that Attitude towards Chemistry, Verbal Intelligence, and Scientific Reasoning in Chemistry are all significant predictors of the Achievement in Chemistry. This indicates that these variables play important roles in explaining and influencing the variation in the Achievement in Chemistry.

With the values of unstandardized coefficient b, the regression model can be expressed as

$$\mathbf{Y^1 = -13.82 + 0.246\,X_1 + 0.270\,X_2 + 0.417\,X_3}$$

Where,

Y^1 - Predicted value of Achievement in Chemistry

X_1– Score on Attitude towards Chemistry

X_2– Score on Verbal Intelligence

X_3– Score on Scientific Reasoning in Chemistry

Chapter Five

SUMMARY, FINDINGS AND CONCLUSIONS

- Study in Retrospect
- Major Findings
- Tenability of the Hypotheses
- Conclusions

SUMMARY, FINDINGS AND CONCLUSIONS

This chapter provides a concise overview of the study in retrospect, major findings, tenability of hypotheses and conclusions. The present investigation is mainly intended to study the influence of certain Cognitive variables, namely Verbal Intelligence and Scientific Reasoning, and Noncognitive variables, namely Attitude towards Chemistry and Self-efficacy in Chemistry on Achievement in Chemistry among secondary school students. Accordingly, the present study is entitled as "Influence of Certain Cognitive and Noncognitive Variables on Achievement in Chemistry among Secondary School Students". The study was conducted on a sample of 1100 Secondary School Students by using stratified random sampling technique with due representation to gender, locale, and type of management. The sample was selected from three different revenue districts of Kerala. The following tools, namely Verbal Group Test of Intelligence, Scientific Reasoning Test in Chemistry, Scale of Attitude towards Chemistry, Scale of Self-efficacy in Chemistry, Achievement Test in Chemistry, were used for the study. The data collected were classified, tabulated and analysed as per the objectives framed and hypotheses formulated. Appropriate statistical techniques were used for analysis, namely Basic Descriptive Statistics, Independent Sample t-test, Two-way ANOVA (3 × 3 Factorial), Pearson's Product Moment Correlation Coefficient and Multiple Regression Analysis.

Study in Retrospect

Restatement of the Problem

The problem of the present study is restated as "Influence of Certain Cognitive and Non Cognitive Variables on Achievement in Chemistry among Secondary School Students".

Objectives of the Study

1. To find out whether there exists any significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and the dependent variable, Achievement in Chemistry among secondary school students based on subsamples, gender, locale and type of management.

2. To find out the main and interaction effects of selected Cognitive variables, namely Verbal Intelligence and Scientific Reasoning, on Achievement in Chemistry for the total sample and subsamples based on gender, locale and type of management.

3. To find out the main and interaction effects of selected Noncognitive variables, namely Attitude towards Chemistry and Self-efficacy in Chemistry, on Achievement in Chemistry for the total sample and subsamples based on gender, locale and type of management.

4. To find out the extent of relationship between selected Cognitive variables, namely Verbal Intelligence and Scientific Reasoning, and Achievement in Chemistry among secondary school students.

5. To find out the extent of relationship between selected Noncognitive variables, namely Attitude towards Chemistry and Self-efficacy in Chemistry, and Achievement in Chemistry among secondary school students.

6. To develop a regression equation for predicting Achievement in Chemistry based on selected Cognitive and Noncognitive variables.

Hypotheses of the Study

The following are the hypotheses formulated for the study:

1. There exists significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and the dependent variable, Achievement in Chemistry among secondary school students based on subsample, gender.

2. There exists significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and the dependent variable Achievement in Chemistry among secondary school students based on subsample, locale.

3. There exists significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and the dependent variable Achievement in Chemistry among Secondary School students based on subsample, type of management.

4. Selected Cognitive variables have significant main and interaction effects on Achievement in Chemistry for the total sample and the subsamples based on gender, locale and type of management.

5. Selected Noncognitive variables have significant main and interaction effects on Achievement in Chemistry for the total sample and the subsamples based on gender, locale and type of management.

6. There exists significant relationship between selected Cognitive variables and Achievement in Chemistry.

7. There exists significant relationship between selected Noncognitive variables and Achievement in Chemistry.

8. Achievement in Chemistry can be predicted from a combination of selected Cognitive and Non -Cognitive variables.

Variables Selected for the Study

Independent Variables

The investigator selected certain Cognitive and Noncognitive variables as Independent variables.

Cognitive Variables.

Verbal Intelligence

Scientific Reasoning

Noncognitive Variables.

Attitude towards Chemistry

Self-efficacy in Chemistry

Dependent Variables

In the present study, Achievement in Chemistry among Secondary School Students is taken as dependent variable.

Classificatory Variables. The investigator included the following classificatory variables, namely

1. Gender
2. Locale
3. Type of management of the school

Methodology

The present study was intended to find out the Influence of Certain Cognitive and Noncognitive variables on Achievement in Chemistry among Secondary School Students. Survey method was used for the present study.

Sample Selected for the Study. For the present study, stratified random sampling technique was used for the selection of sample. As an Initial sample the investigator selected 1200 secondary school students from Malappuram, Kozhikode and Kannur revenue districts. After discarding the incomplete answer scripts, the investigator selected 1100 secondary school students as final sample for the study.

Tools Used for the Study. In order to measure the variables, the following tools were used for collecting the data.

1. Verbal Group Test of Intelligence (VGTI) (Kumar et al., 1997)
2. Scientific Reasoning Test in Chemistry (Chandran & Jaleel, P, 2017)
3. Scale of Self-efficacy in Chemistry (Rani & Saleem, 2020)
4. Scale of Attitude towards Chemistry (Rani & Saleem, 2020)
5. Achievement Test in Chemistry (Rani & Saleem, 2020)

Statistical Techniques Used. The statistical techniques used for data analysis are as follows:

1. Basic Descriptive Statistics
2. Independent Sample t-test
3. Two-way ANOVA (3 × 3 Factorial)
4. Pearson's Product Moment Correlation Coefficient
5. Multiple Regression Analysis

Major Findings

Findings Regarding the Mean Comparison of Cognitive Variables (Verbal Intelligence and Scientific Reasoning) based on Gender, Locale and Type of Management

1. A Significant difference was observed in the scores of Cognitive variables, between Male and Female secondary school students. Female secondary school students scored significantly higher levels when compared to their male counterparts in Verbal Intelligence, $t = 9.10$, $p < .01$ and in Scientific Reasoning in Chemistry, $t = 3.99$, $p < .01$.

2. There was no statistically significant difference in the mean scores of the Verbal Intelligence between Rural and Urban secondary school students, $t = 0.69$, $p > .05$, nor in their Scientific Reasoning in Chemistry, $t = 0.89$, $p > .05$.

3. A Significant difference was observed in the scores of Cognitive Variables, between government and aided secondary school students. Government secondary school students scored significantly higher score when compared to aided secondary school students in Verbal Intelligence, $t = 5.33$, $p < .01$, and in Scientific Reasoning in Chemistry, $t = 6.28$, $p < .01$.

Findings Regarding the Mean Comparison of Noncognitive Variables (Attitude towards Chemistry and Self-efficacy in Chemistry) Based on Gender, Locale and Type of Management

4. A significant difference was observed in the scores of Attitude toward Chemistry between female and male secondary school students, with female

students showing more positive attitudes, $t = 4.12$, $p < .01$. However no significant difference was found in respect to Self-efficacy in Chemistry between gender groups, $t = 0.80$, $p > .05$.

5. There is no significant difference in the mean scores of the Attitude towards Chemistry between rural and urban secondary school students $t = 0.85$, $p > .05$. Similarly Self-efficacy in Chemistry did not differ significantly between rural and urban secondary school students $t = 0.72$, $p > .05$.

6. There exists a significant difference in the mean scores of Attitudes towards Chemistry between Government and Aided secondary school students with Government secondary school students demonstrating more positive attitude, $t = 4.45$, $p < .01$. However, no significant difference was observed in the variable, Self-efficacy in Chemistry between two types of management groups, $t = 1.01$, $p > .05$.

Findings Regarding the Mean Comparison of Dependent Variable (Achievement in Chemistry) Based on Gender, Locale and Type of Management

7. Female secondary school students exhibited significantly higher levels of Achievement in Chemistry compared to their male counterparts as evidenced by a clear difference in mean achievement scores, $t = 7.29$, $p < .01$.

8. Rural secondary school students exhibited significantly higher levels of Achievement in Chemistry compared to their urban counterparts, $t = 2.82$, $p < .01$.

9. There exists significant difference in the mean scores of the Achievement in Chemistry between Government and Aided secondary school students. Government school students demonstrated significantly higher levels of Achievement in Chemistry compared to their Aided counterparts $t = 5.33$, $p < .01$.

Findings Regarding the Main and Interaction Effect of Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry for the Total Sample and Subsamples Based on Gender, Locale and Type of Management.

10. There exists a significant main effect of Verbal Intelligence, $F(2,1091) = 88.75$, $p < .01$ and Scientific Reasoning $F(2,1091) = 51.99$, $p < .01$ on Achievement in Chemistry for total sample. There exists a significant interaction effect, which indicates and combined influence between Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry, $F(4,1091) = 2.43$, $p < .05$ for total sample.

11. There exists a significant main effect of Verbal Intelligence $F(2,1091) = 29.15$, $p < .01$ and Scientific Reasoning $F(2,1091) = 24.86$, $p < .01$ on Achievement in Chemistry for male sample. There is no significant interaction effect between Verbal Intelligence and Scientific Reasoning in Chemistry on the Achievement in Chemistry $F(4,491) = 2.15$, $p > .05$ for male sample.

12. There exists a significant main effect of Verbal Intelligence $F(2,1091) = 55.33$, $p < .01$ and Scientific Reasoning $F(2,1091) = 25.37$, $p < .01$ on Achievement in Chemistry for female sample. There is no significant interaction effect between Verbal Intelligence and Scientific Reasoning in

Chemistry on the Achievement in Chemistry $F(4,591) = 1.44$, $p > .05$) for female sample.

13. There exists a significant main effect of Verbal Intelligence $F(2,1091) = 36.53$, $p < .01$ and Scientific Reasoning $F(2,1091) = 33.40$, $p < .01$ on Achievement in Chemistry for rural sample. There is no significant interaction effect between Verbal Intelligence and Scientific Reasoning in Chemistry on the Achievement in Chemistry $F(4,649) = 1.85$, $p > 0.05$ for rural sample.

14. There exists a significant main effect of Verbal Intelligence $F(2,1091) = 56.94$, $p < .01$ and Scientific Reasoning $F(2,1091) = 19.4$, $p < .01$ on Achievement in Chemistry for urban sample. There is no significant interaction effect between Verbal Intelligence and Scientific Reasoning in Chemistry on the Achievement in Chemistry $F(4,433) = 1.16$, $p > .05$ for urban sample.

15. There exists a significant main effect of Verbal Intelligence $F(2,1091) = 47.87$, $p < .01$ and Scientific Reasoning $F(2,1091) = 28.58$, $p < .01$ on Achievement in Chemistry for government sample. There is no significant interaction effect between Verbal Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry $F(4,582) = 2.04$, $p > .05$ for government sample.

16. There exists a significant main effect of Verbal Intelligence $F(2,1091) = 27.98$, $p < .01$) and Scientific Reasoning $F(2,1091) = 19.80$, $p < .01$ on Achievement in Chemistry for aided sample. There exists a significant interaction effect, which indicates a combined effect between Verbal

Intelligence and Scientific Reasoning in Chemistry on Achievement in Chemistry $F(4,500) = 2.67$, $p < .05$ for aided sample.

Findings Regarding the Main and Interaction Effect of Self-efficacy and Attitude towards Chemistry on Achievement in Chemistry for the Total Sample and Subsamples Based on Gender, Locale and Type of Management.

17. There exists a significant main effect of Attitude towards Chemistry $F(2,1091) = 53.56$, $p < .01$ and Self-efficacy in Chemistry $F(2,1091) = 9.97$, $p < .01$ on Achievement in Chemistry for total sample. There is no significant interaction effect between Attitude towards Chemistry and Self-efficacy in Chemistry on the Achievement in Chemistry $F(4,1091) = 2.02$, $p > .05$ for total sample.

18. There exists a significant main effect of Attitude towards Chemistry $F(2,1091) = 24.48$, $p < .01$ and Self-efficacy in Chemistry $F(2,1091) = 4.29$, $p < .05$ on Achievement in Chemistry for male sample. There is a significant interaction effect between Attitude towards Chemistry and Self-efficacy in Chemistry on Achievement in Chemistry $F(4,491) = 3.24$, $p < .05$ for male sample.

19. There exists a significant main effect of Attitude towards Chemistry $F(2,1091) = 25.01$, $p < .01$ and Self-efficacy in Chemistry $F(2,1091) = 5.25$, $p < .01$ on Achievement in Chemistry for female sample. There is no significant interaction effect between Attitude towards Chemistry and Self-efficacy in Chemistry on the Achievement in Chemistry $F(4,591) = .496$, $p > .05$ for female sample.

20. There exists a significant main effect of Attitude towards Chemistry $F(2,1091) = 43.21$, $p < .01$ and Self-efficacy in Chemistry $F(2,1091) = 5.57$, $p < .01$ on Achievement in Chemistry for rural sample. There is a significant interaction effect which indicates a combined influence between Attitude towards Chemistry and Self-efficacy in Chemistry on the Achievement in Chemistry $F(4,649) = 3.19$, $p < .05$ for rural sample.

21. There is no significant main effect of Attitude towards Chemistry $F(2,1091) = 9.02$, $p < .01$ and Self-efficacy in Chemistry $F(2,1091) = 2.93$, $p > .05$ on Achievement in Chemistry for urban sample. There is no significant interaction effect between Attitude towards Chemistry and Self-efficacy in Chemistry on Achievement in Chemistry $F(4,433) = 1.19$, $p > .05$ for urban sample.

22. There exists a significant main effect of Attitude towards Chemistry $F(2,1091) = 38.56$, $p < .01$) and Self-efficacy in Chemistry $F(2,1091) = 6.63$, $p < .01$) on Achievement in Chemistry for government sample. There is no significant interaction effect between Attitude towards Chemistry and Self-efficacy in Chemistry on Achievement in Chemistry $F(4,582) = 1.07$, $p > .05$) for government sample.

23. There exists a significant main effect of Attitude towards Chemistry $F(2,1091) = 8.81$, $p < .01$ and Self-efficacy in Chemistry $F(2,1091) = 2.77$, $p >.05$ on Achievement in Chemistry for aided sample. There is no significant interaction effect between Attitude towards Chemistry and Self-efficacy in

Chemistry on Achievement in Chemistry $F(4,500) = 1.33$, $p > .05$ for aided sample.

Findings Regarding the Extent of Relationship Between Cognitive and Noncognitive Variables and Achievement in Chemistry.

24. There exists a significant strong positive relationship between Verbal Intelligence and Achievement in Chemistry, $r = 0.515$, $p < .01$.

25. There exists a significant moderate positive relationship between Scientific Reasoning in Chemistry and Achievement in Chemistry, $r = 0.423$, $p < .01$.

26. There exists a significant moderate positive relationship between Attitude towards Chemistry and Achievement in Chemistry, $r = 0.325$, $p < .01$.

27. There exists a significant weak positive relationship between Self-efficacy in Chemistry and Achievement in Chemistry, $r = .135$, $p < .01$.

Findings Regarding the Multiple Regression Analysis

28. Regression analysis revealed that Verbal Intelligence, Scientific Reasoning in Chemistry and Attitude towards Chemistry were the significant predictors of Achievement in Chemistry whereas Self-efficacy in Chemistry is not a significant predictor of Achievement in Chemistry.

29. Approximately 35.4% of the variability in the Achievement in Chemistry was accounted by the combined predictors: Verbal Intelligence, Scientific Reasoning in Chemistry and Attitude towards Chemistry.

30. The Regression Model for Predicting Achievement in Chemistry is:

$$Y_1 = -13.82+0.246\ X_1+ 0.270\ X_2+ 0.417\ X_3$$

Where,

Y_1 – predicted value of Achievement in Chemistry

X_1 – score on Attitude towards Chemistry

X_2 – score on Verbal Intelligence

X_3 – score on Scientific Reasoning in Chemistry

Tenability of the Hypotheses

The tenability of the hypotheses were examined on the basis of analysis and its findings.

Hypothesis 1: There exists significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and the dependent variable, Achievement in Chemistry among secondary school students based on subsamples, gender

The study found that there exists significant difference between the mean scores of the variables, namely Achievement in Chemistry, Attitude towards Chemistry, Verbal Intelligence and Scientific Reasoning in Chemistry between male and female secondary school students. Study also revealed that there is no significant difference between the mean scores of the variable Self-efficacy in Chemistry between male and female secondary school students. Hence, the hypothesis 1 is partially substantiated.

Hypothesis 2: There exists significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and the dependent variable, Achievement in Chemistry among secondary school students based on subsample, locale.

The study revealed that there exists significant difference between the mean scores of the variable Achievement in Chemistry between urban and rural secondary school students. The study also found that there is no significant difference between the mean scores of the variables Attitude towards Chemistry, Verbal Intelligence, Self-efficacy in Chemistry and Scientific Reasoning in Chemistry between urban and rural secondary school students. Hence, the hypothesis 2 is partially substantiated.

Hypothesis 3: There exists significant difference in the mean scores of selected independent variables, namely Verbal Intelligence, Scientific Reasoning, Attitude towards Chemistry and Self-efficacy in Chemistry, and the dependent variable, Achievement in Chemistry among secondary school students based on subsample, type of management.

The study found that there exists significant difference between the mean scores of the variables Achievements in Chemistry, Attitude towards Chemistry, Verbal Intelligence and Scientific Reasoning in Chemistry between Government and Aided secondary school students. Study also revealed that there is no significant difference between the mean scores of the variable Self-efficacy in Chemistry between Government and Aided secondary school students. Hence, the hypothesis 3 is partially substantiated.

Hypothesis 4: Select Cognitive variables have significant main effect on Achievement in Chemistry in the total sample and the relevant subsamples.

The study revealed that there exists a significant main effect of select Cognitive variables, namely Verbal Intelligence and Scientific Reasoning on Achievement in Chemistry among secondary school students in total sample and relevant subsamples. Hence the hypothesis 4 is substantiated.

Hypothesis 5: Select Noncognitive variables have significant main effect on Achievement in Chemistry in the total sample and the relevant sub- samples.

The study revealed that there exists a significant main effect of select Noncognitive variables, namely, Self-efficacy in Chemistry and Attitude towards Chemistry on Achievement in Chemistry among secondary school students in total sample and relevant subsamples except main effect of Self-efficacy in Chemistry on Achievement in Chemistry for urban and Aided subsamples. Hence the hypothesis 5 is partially substantiated.

Hypothesis 6: There exists significant relationship between each of the select Cognitive variables and Achievement in Chemistry.

The study found that there exists strong positive relationship between Verbal Intelligence and Achievement in Chemistry and positive moderate relationship between Scientific Reasoning in Chemistry and Achievement in Chemistry. Hence the hypothesis 6 is substantiated.

Hypothesis 7: There exists significant relationship between each of the select Noncognitive Variables and Achievement in Chemistry.

The study found that there exist a positive but moderate relationship between Attitude towards Chemistry and Achievement in Chemistry and a positive but relatively weak relationship between Self-efficacy in Chemistry and Achievement in Chemistry. Hence the hypothesis 7 is substantiated.

Hypothesis 8: Achievement in Chemistry can be predicted from a combination of select Cognitive and Noncognitive variables.

The study revealed that Verbal Intelligence, Scientific Reasoning in Chemistry and Attitude towards Chemistry are significant predictors of Achievement in Chemistry among secondary school students. But Self-efficacy is found to be not significantly contributing to predict Achievement in Chemistry among secondary school students. Hence hypothesis 8 is partially substantiated.

Conclusions

The findings of the study prompted the investigator to arrive at the following conclusions:

The present study gives substantial evidence that Achievement in Chemistry is influenced by a combination of Cognitive, Noncognitive and contextual factors such as gender, locale and type of management. Female students outperforming male students both in achievement and in demonstrating a more positive Attitude towards Chemistry. Students from rural backgrounds exhibited better performance compared to their urban counterparts. Government schools students shows better performance than students in aided schools.

The study revealed that Verbal Intelligence, Scientific Reasoning, and Attitude towards Chemistry are significant predictors of Achievement in the subject. The presence of significant interaction effects – particularly between Verbal Intelligence and Scientific Reasoning, as well as between Self-efficacy and Attitude – indicates that these variables have combined influence on Achievement in Chemistry among secondary school students.

The study provides strong positive correlation between Verbal Intelligence and Achievement in Chemistry which shows the basic role of cognitive ability in mastering scientific content. The moderate relationship with Scientific Reasoning, along with the positive contributions of Self-efficacy and Attitude, is a clear indication to the importance of nurturing both cognitive skills and affective dispositions in students.

The Regression findings support a holistic educational model, where fostering Verbal and Scientific Reasoning abilities, building students' confidence, and nurturing positive Attitudes are all integral to improving Achievement in Chemistry. These insights have meaningful implications for curriculum design, teacher training, and policy interventions aimed at enhancing science education at the secondary school level.

Chapter Six

RECOMMENDATIONS AND SUGGESTIONS

- Educational Implications and Recommendations
- Suggestions for Further Research

RECOMMENDATIONS AND SUGGESTIONS

The results and findings of the study have many implications in educational theory and practice at school level education. They are useful for curriculum experts, educational planners, teachers and researchers as well.

Educational Implications and Recommendations

Some of the possible educational implications and recommendations of the study are presented below:

1. A significant gender difference was observed in Cognitive Variables, Verbal Intelligence and Scientific Reasoning which are crucial for success in Chemistry. This shows the importance of gender-sensitize curricular activities, especially in chemistry. To encourage varied cognitive strengths and close the performance gap, gender-responsive teaching and learning methods may be adopted.

   Workshops for teachers on integrating cognitive skill-building strategies, modules to improve Verbal Intelligence and Scientific Reasoning in boys, such as debate, peer tutoring, or inquiry-based activities, inclusive classroom environments that promote confidence in both boys and girls and cooperative learning strategies where students benefit from each other's cognitive strengths are some of the strategies may plan and implement effectively in our schools.

2. No statistically significant locale difference was observed in Cognitive variables. Hence geographic location (rural vs. urban) may not inherently affect students' Verbal Intelligence or Scientific Reasoning. This is a positive indicator of equity and reflects the equalising impact of educational access across Kerala's school systems.

3. Government secondary school students scored significantly higher than aided school students in Cognitive variables. It shows government schools may be fostering better cognitive development in key academic areas with more effective teaching learning strategies. This reflect greater academic accountability and monitoring, suggesting the need to evaluate internal systems and practices in aided schools. Capacity-building programmes for teachers in aided schools to improve classroom strategies may be organised. Inter-school collaborations or "twinning programmes" between aided and government schools to share best practices also may be encouraged.

4. In Noncognitive variables, Female students showed significantly more positive Attitudes toward Chemistry than male students, whereas no significant gender difference was found in Self-efficacy in Chemistry. This is the indication of girl's students in respect to their significant emotional attachment towards science learning especially the subject of chemistry. But genders perceive themselves equally capable in Self-efficacy, which shows the self-confidence of students irrespective of their gender in learning chemistry.

Gender-neutral encouragement programmes may be organised in schools, for both boys and girls to perform equally well in Chemistry and Utilize the girls' positive attitudes by motivating them to take up leadership roles in science related co-curricular activities inside and outside the school.

5. No significant locale difference was found in Noncognitive variables, among secondary school students. This reflects Kerala’s inclusive educational ecosystem where the ICT-enabled uniform implementation of curriculum and its transaction.

   Measures to be taken to empower ongoing programmes like Little Kites, Science Clubs, and Lab Improvement Schemes equally to both urban and rural schools. State-wide competitions, collaborative projects, and mobile science labs that blend rural and urban student participation may also provided.

6. Government school students showed more positive attitudes than aided school students towards chemistry but, no significant difference was found in Self-efficacy in Chemistry between the two groups. The result challenges the traditional assumptions that aided/private schools are better performers than Govt. School and it is a clear positive indication in respect to the Govt. Initiatives to strengthen the public education system of Kerala.

   Teacher empowerment programmes for aided school teachers should be organised with ensured participation, focusing on fostering student interest and building positive emotional engagement with science.

7. The study reveals that Cognitive variables, particularly Verbal Intelligence and Scientific Reasoning, independently influence Achievement in Chemistry. Therefore, the science curriculum should incorporate a cross-disciplinary approach from the school level onwards, promoting the integration of language and science. Interdisciplinary modules that combine language and scientific skills should be developed, and teachers must be equipped for effective implementation through targeted faculty development programmes.

8. A positive attitude is strongly correlated with higher achievement across all student subgroups. The significant interaction observed among male and rural students suggests that the combined influence of Attitude and Self-efficacy substantially enhances academic performance. Therefore, the curriculum should include provisions for inquiry-based learning, contextualising Chemistry concepts within everyday experiences, and fostering curiosity in the subject.

9. Verbal Intelligence, Scientific Reasoning in Chemistry, and Attitude towards the subject collectively serve as significant predictors of Achievement in Chemistry. Accordingly, curriculum design and pedagogical strategies should aim to strengthen these dimensions by incorporating scientific communication exercises within Chemistry instruction, engaging students in inquiry-based laboratories, problem-solving tasks, and critical thinking activities. Furthermore, Chemistry should be made relevant and engaging through real-world applications and student-centered learning approaches.

Suggestions for Further Research

The present research was undertaken to study the influence of certain Cognitive and Noncognitive Variables on Achievement in Chemistry among Secondary School Students. By considering the findings of the study and scope and limitations of the study the investigator suggests a few areas related to the study for further research.

1. A Longitudinal study on how cognitive development in boys and girls influences long-term achievement in Science Subjects.
2. A study can be conducted taking multiple intelligences as predictors of Achievement in Chemistry at secondary level.
3. Study the impact of attitude differences on subject selection and career aspirations in science.
4. The study can be extended by incorporating more suitable variables like Scientific Attitude, Scientific Literacy and Linguistic Creativity among Secondary School Students.
5. A study may be conducted to explore the underlying causes of gender differences in Verbal Intelligence and Scientific Reasoning.
6. Investigate how extra-curricular and co-curricular science activities contribute to student Attitudes towards Chemistry.

7. Explore how Cognitive and Noncognitive variables together predict Chemistry achievement.

8. A study may be conducted selecting sociological determinants of Chemistry achievements among secondary school students.

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APPENDICES

Appendix I

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

VERBAL GROUP TEST OF INTELLIGENCE
(Malayalam Version)

Dr. P.K. Sudheesh Kumar
Hameed. A & Prasanna.A

വിദ്യാർത്ഥികളുടെ മാനസികമായ കഴിവുകൾ പരിശോധിക്കുന്നതിനുവേണ്ടി തയ്യാറാക്കിയിട്ടുള്ളതാണ് ഈ ടെസ്റ്റ്. വിവിധ തരത്തിലുള്ള 5 ടെസ്റ്റുകൾ ഇതിൽ ഉൾക്കൊള്ളിച്ചിരിക്കുന്നു. ഓരോ ടെസ്റ്റിന്റെയും ആരംഭത്തിൽ കൊടുത്തിട്ടുള്ള നിർദ്ദേശങ്ങൾ എഴുതിത്തുടങ്ങുന്നതിനുമുമ്പ് ശ്രദ്ധിച്ചു വായിക്കുക. ഉത്തരം എഴുതേണ്ട രീതി ഉദാഹരണ സഹിതം വ്യക്തമാക്കിയിട്ടുണ്ട്. നിർദ്ധിഷ്ട സമയത്തിനുള്ളിൽ ഉത്തരം എഴുതിത്തീർക്കാൻ ശ്രദ്ധിക്കുകയും, പറഞ്ഞതിനുശേഷം മാത്രം എഴുതിത്തുടങ്ങുകയും, ഏറ്റവും വേഗത്തിൽ എഴുതിത്തീർക്കാൻ ശ്രമിക്കുകയും ചെയ്യേണ്ടതാണ്. തന്നിരിക്കുന്ന ഈ ചോദ്യക്കടലാസ്സിൽ എന്തെങ്കിലും എഴുതുകയോ, അടയാളപ്പെടുത്തുകയോ ചെയ്യരുത്. പ്രത്യേകം തന്നിട്ടുള്ള ഉത്തരക്കടലാസ്സിൽ മാത്രമേ ഉത്തരം എഴുതാവൂ.

TEST - I VERBAL ANALOGY

ഈ വിഭാഗത്തിൽ കൊടുത്തിട്ടുള്ള ചോദ്യങ്ങളിൽ മൂന്നു വാക്കുകൾ വീതം തന്നിട്ടുണ്ട്. നാലാമത്തെ വാക്ക് നിങ്ങൾ എഴുതേണ്ടതാണ്. തന്നിരിക്കുന്ന മൂന്നു വാക്കുകളിൽ ആദ്യത്തെ രണ്ടു വാക്കുകൾ തമ്മിലുള്ള ബന്ധം മനസ്സിലാക്കി മൂന്നാമത്തെ വാക്കിനോട് യോജിക്കുന്ന വാക്ക് A, B, C, D എന്നീ ക്രമത്തിൽ കൊടുത്തിരിക്കുന്ന നാലു വാക്കുകളിൽ നിന്നും തെരഞ്ഞെടുത്ത് ഉത്തരക്കടലാസ്സിൽ അടയാളപ്പെടുത്തുക.

ഉദാഹരണം:

ദാഹം:	വെള്ളം::	വിശപ്പ്:	... ...
A. മാംസം	B. വിശ്രമം	C. ആഹാരം	D. ക്ഷീണം

ദാഹം വരുമ്പോൾ വെള്ളം കുടിയ്ക്കുന്നു. അതുപോലെ വിശപ്പുവരുമ്പോൾ ആഹാരം കഴിക്കുന്നു. അതുകൊണ്ട് 'C' യാണ് ശരിയായ ഉത്തരം

A.	B.	C.✓	D.

1. കൗശലം: കുറുക്കൻ:: വിഡ്ഢിത്തം: ... ...
   A. കുരങ്ങൻ B. കരടി C. മാൻ D. കഴുത
2. ദയ : ക്രൂരത:: നിശബ്ദത: ... ...
   A. നിശ്ചലം B. ശബ്ദം C. ശാന്തത D. ധ്യാനം
3. നാടകം: സംവിധായകൻ:: ന്യൂസ്പേപ്പർ: ... ...
   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. സമാധാനം
6. ഷർട്ട്: തുണി:: ചെരുപ്പ്: ... ...
   A. ഉളി B. തുകൽ C. ചെരുപ്പ്കുത്തി D. തയ്യൽക്കാരൻ
7. കാക്ക: കറുപ്പ്:: ഹൗസം: ... ...
   A. പക്ഷി B. വെള്ളം C. വെളുപ്പ് D. തവിട്ട്
8. മാസിക: വായനക്കാരൻ:: റേഡിയോ: ... ...
   A. പരസ്യക്കാർ 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:	മേൽക്കൂര::	ഭൂമി:	... ...
A. വായു	B. ആകാശം	C. അന്തരീക്ഷം	D. ധ്രുവങ്ങൾ
12. കുട്ടി:	മാതാപിതാക്കൾ::	ബുക്ക്:	... ...
A. അധ്യാപകൻ	B. പ്രസാധകൻ	C. പ്രസ്സ്	D.ഗ്രന്ഥകർത്താവ്
13. വർഷം:	മാസം::	ആഴ്ച:	... ...
A. മണിക്കൂർ	B. മിനിറ്റ്	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. കണ്ടക്ടർ
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::	സ്കേറ്റിംഗ്:	... ...
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 നാലു വാക്കുകൾ വീതം തന്നിട്ടുണ്ട്. അതിൽ ഒരെണ്ണം മറ്റു മൂന്നു വാക്കുകളോടും യോജിക്കാതെ നിൽക്കുന്നു. അത് ഏതെന്ന് കണ്ടുപിടിച്ച് ഉത്തരക്കടലാസിൽ അടയാളപ്പെടുത്തുക.

ഉദാഹരണം:

1.	A. മധുരം	B. മുളക്	C. എരിവ്	D. കയ്പ്

ഇതിൽ A, C, D എന്നിവ വിവിധ രുചികളെ കാണിക്കുന്നു. B(മുളക്) രുചികളിൽ ഉൾപ്പെടുന്നതല്ല. അതുകൊണ്ട് ശരി ഉത്തരം 'B' ആണ്.

A.	B.✓	C.	D.

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. മാസം	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. പെയിന്റിംഗ്	D. ക്യാൻവാസ്
15.	A. മാവ്	B. പ്ലാവ്	C. തെങ്ങ്	D. തേക്ക്
16.	A. മാങ്ങ	B. ആപ്പിൾ	C. തക്കാളി	D. ഉരുളക്കിഴങ്ങ്
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 ശരിയുത്തരം കണ്ടെത്തി അടയാളപ്പെടുത്തുക

ഉദാഹരണം:

1. 2, 4, 6, __, 10

A. 5 B. 8 C. 7 D. 11

A.	B.✓	C.	D.

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. 0, 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 മറ്റു മൂന്നു സംഖ്യകളോടും യോജിക്കാതെ നിൽക്കുന്നു. അത് ഏതെന്ന് കണ്ടുപിടിച്ച് ഉത്തരക്കടലാസ്സിൽ അടയാളപ്പെടുത്തുക

ഉദാഹരണം:

A. 1 B. 3 C. 6 D. 7

ഇതിൽ A, B, D എന്നിവ ഒറ്റ സംഖ്യകളെ സൂചിപ്പിക്കുന്നു. എന്നാൽ 'C' ഒറ്റസംഖ്യയല്ല അതുകൊണ്ട് ഉത്തരം 'C' യാകുന്നു.

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 മൂന്നുസംഖ്യകളിൽ ആദ്യത്തെ രണ്ടു സംഖ്യകൾ തമ്മിലുള്ള ബന്ധം മനസ്സിലാക്കി മൂന്നാമത്തെ സംഖ്യയോട് യോജിക്കുന്ന സംഖ്യ A, B, C, D എന്നീക്രമത്തിൽ കൊടുത്തിരിക്കുന്ന സംഖ്യകളിൽ നിന്നും തെരഞ്ഞെടുത്ത് ഉത്തരക്കടലാസ്സിൽ അടയാളപ്പെടുത്തുക.

ഉദാഹരണം:

1. 1:2 :: 2: ___

A. 1 B. 4 C. 6 D. 7

ഒന്നിന്റെ ഇരട്ടിയാണ് രണ്ട്. അതുപോലെ രണ്ടിന്റെ ഇരട്ടിയാണ് നാല് അത്കൊണ്ട് ഉത്തരം ‘B’ ആണ്.

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. 52

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:

1. ബിന്ദുവിന് സിന്ദുവിനേക്കാൾ വണ്ണം കൂടുതലാണ്. മഞ്ചുവിനു ബിന്ദുവിനേക്കാൾ വണ്ണം കുറവാണ്. മഞ്ചുവിനും സന്ധ്യയ്ക്കും തുല്യ വണ്ണമാണുള്ളത്. എന്നാൽ ഇവ രിലാർക്കാണ് ഏറ്റവും വണ്ണം കൂടുതൽ?

   A. മഞ്ചു B. ബിന്ദു C. സിന്ധു D. സന്ധ്യ

A.	B.✓	C.	D.

1. അപ്പു ചിപ്പുവിനേക്കാൾ നന്നായി പാടും. ദേവന് കണ്ണനേക്കാളും 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 രാമ നേക്കാൾ മുന്നിലുമാണ് നടക്കുന്നത്. രാജു രമണിയേക്കാൾ മുൻപിലാണ് നടക്കു ന്നത് എങ്കിൽ ഏറ്റവും പുറകിൽ നടക്കുന്നതാര്?

   A. രാമൻ B. രമണി C. രമ D. രാജു

3. അജയ് വിജയ്നേക്കാൾ ജോലി ചെയ്യും. അശോകും അജിത്തും ജോലി ചെയ്യുന്ന തിൽ തൃപ്തരാണ്. വിജയ് അശോകിനേക്കാൾ നന്നായി ജോലി ചെയ്യും. ഇവരിൽ ഏറ്റവും കൂടുതൽ ജോലി ചെയ്യുന്നതാര്?

   A. അശോക് B. അജിത്ത് C. വിജയ് D. അജയ്

4. രമ്യ ഭവ്യയോളം നൃത്തം ചെയ്യില്ല. ദിവ്യ ഭവ്യയേക്കാൾ നന്നായി നൃത്തം ചെയ്യും. വിദ്യ ദിവ്യയേക്കാൾ നൃത്തത്തിൽ മിടുക്കിയാണ് എങ്കിൽ ഇവരിലാരാണ് നൃത്ത ത്തിൽ മിടുമിടുക്കി?

   A. ദിവ്യ B. ഭവ്യ C. രമ്യ D. വിദ്യ

5. ദീപകിന്റെ അച്ഛനാണ് മോഹനന്റെ മകൻ എങ്കിൽ ദീപകും മോഹനനും തമ്മിലുള്ള ബന്ധമെന്ത്?

   A. മകൻ B.സഹോദരൻ C. അനന്തരവൻ D. കൊച്ചുമകൻ

6. റഫീക്കിന് മുനീറിനേക്കാൾ കാഴ്ചയുണ്ട്. ഷമീറിന് സുധീറിനേക്കാൾ കാഴ്ചകുറ വാണ്. സുധീറിന് റഫീക്കിനോളം കാഴ്ചശക്തിയില്ല. ഇവരിൽ ആർക്കാണ് കാഴ്ച ഏറ്റവും കൂടുതൽ?

   A. സുധീറിന് B. ഷമീറിന് C. റഫീക്കിന് D. മുനീറിന്

7. രണ്ടുപേർ ചേർന്ന് പത്ത് ദിവസം കൊണ്ട് ഒരു ജോലി ചെയ്തുതീർത്തു. എങ്കിൽ ഒരാൾക്ക് ഒരു ദിവസം കൊണ്ട് എത്ര ജോലി ചെയ്യാൻ കഴിയും?

A. 1/2 B. 1/5 C. 1/10 D. 1/20

8. ഒരു വെടിയൊച്ച A എന്ന സ്ഥലത്തു നിന്നും B എന്ന സ്ഥലത്തെത്താൻ എടുക്കുന്ന സമയം 2 മിനിറ്റ്. 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 തുല്യപ്രായമാണുള്ളത്. സുധീഷിന് നന്ദയേക്കാൾ പ്രായം കുറവാണ്. സുധീഷിന് ഷർമിളയേക്കാൾ പ്രായം കൂടുതലാണ്. മാലയ്ക്ക് സുധീഷിനോളം പ്രായം ഇല്ല. എന്നാൽ ഏറ്റവും കൂടുതൽ പ്രായമാർക്ക്?

A. സുധീഷ് B. 2 മാല C. 4 ഷർമിള D. കുഞ്ചൻ

10. ഒരു കോളേജിലെ ഫീസടയ്ക്കാൻ 'ക്യൂ' വിലെ കുട്ടികളുടെ എണ്ണം 70 ആകുന്നു. അതിൽ മോഹനന്റെ സ്ഥലം ജനലിന്റെ അടുത്തുനിന്നും 54-മത്തേതാണെങ്കിൽ അവന്റെ പുറകിൽ എത്ര പേരുകാണും?

A. 15 B. 16 C. 17 D. 18

11. തെക്കുപടിഞ്ഞാറ് വടക്കാണെങ്കിൽ വടക്കുകിഴക്ക് 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. A യുടെ അമ്മയുടെ സഹോദരിയാണ് E

B. C യും E യും സഹോദരിസഹോദരന്മാരാണ്.

C. C, A യുടെ അമ്മൂമ്മയാണ്.

D. A യും E യും സഹോദരന്മാരാണ്.

13. ഒരു കമ്പനിയിലെ തൊഴിലാളികളുടെ എണ്ണം 60 ആകുന്നു. അതിൽ 1/4 പേർക്ക് കാറും 1/2 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. 37 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 നടന്നു. എങ്കിൽ അയാൾ ഇപ്പോൾ നടക്കുന്ന ദിശയേത്?

A. വടക്ക് B. പടിഞ്ഞാറ് C. കിഴക്ക് D. തെക്ക്

12. F, A യുടെ 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 രണ്ടുവയസ്സുള്ള ജിനുവിന് മിനുവിനേക്കാൾ മൂന്നുമടങ്ങ് പ്രായമുണ്ട്. മൂന്നുപേരുടെയും വയസ്സുകൂട്ടിയാൽ 19 കിട്ടും എങ്കിൽ ജിനുവിന്റെ വയസ്സ് എത്ര?

A. 5 B. 3 C. 9 D. 10

18. ഒരു മാവേലിസ്റ്റോറിന്റെ മുന്നിലുള്ള ക്യൂവിൽ നിൽക്കുന്ന X എന്നയാളിന്റെ സ്ഥാനം മുന്നിൽ നിന്നും 22-മത്തേയും പിന്നിൽ നിന്നും 28-മത്തേതുമാണെങ്കിൽ ആകെ ക്യൂവിലുള്ള ആളുകളുടെ എണ്ണമെത്ര?

A. 49 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 ബന്ധം എന്ത്?

A. മകൻ B. കൊച്ചുമകൻ C. സഹോദരൻ D. അനന്തരവൻ

TEST - V COMPREHENSION

ഈ വിഭാഗത്തിലുള്ള ചോദ്യങ്ങളിൽ ഓരോന്നിലും ഏതാനും ചില പ്രസ്താവനകൾ കൊടുത്തിട്ടുണ്ട്. ഇവ ശ്രദ്ധാപൂർവ്വം വായിച്ച് അതിനുതാഴെ കൊടുത്തിരിക്കുന്ന ചോദ്യങ്ങൾക്ക് ഉത്തരം കണ്ടെത്തുക. A, B, C, D എന്നീ ക്രമത്തിൽ നാലു ഉത്തരങ്ങൾ കൊടുത്തിരിക്കുന്നു. ശരി ഉത്തരം കണ്ടെത്തി ഉത്തരക്കടലാസിൽ അടയാളപ്പെടുത്തുക.

ഉദാഹരണം:

സതീഷിന്റെ പുത്രന്മാരാണ് A യും B യും, പുത്രിമാരാണ് C യും D യും ശ്യാമയുടെ മക്കളാണ് X ഉം Y യും മനോജിന്റെ മക്കളായ E യും F ഉം ഒരു കമ്പനിയിൽ ജോലിയുള്ളവരാണ്. A യും D യും വിവാഹിതരാണ്. X വിവാഹം ചെയ്തിരിക്കുന്നത് C യെയും F വിവാഹം ചെയ്തിരിക്കുന്നത് A യെയും ആണ്. മനോജിനും ശ്യാമയ്ക്കും തമ്മിൽ സഹോദരിസഹോദര ബന്ധമാണ്.

ചോദ്യങ്ങൾ

1. X ഉം Y യും തമ്മിലുള്ള ബന്ധമെന്ത്?

A. മകനും അച്ഛനും B. സഹോദരിസഹോദരന്മാർ

C. സഹോദരിസഹോദരന്മാരുടെ മക്കൾ D. മകളും അച്ഛനും

A.	B.	C.✓	D.

(1) 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, വിദ്യാഭ്യാസവും സത്യസന്ധയും ഉള്ളതാർക്കാണ്?

A. W B. X C. Y D. Z

3. ആർക്കാണ് ജോലിയും സത്യസന്ധയുമുള്ളതും എന്നാൽ വിദ്യാഭ്യാസമില്ലാത്തതും?

A. W B. X C. Y D. Z

4. വിദ്യാഭ്യാസവും വിനയവും ഉണ്ടെങ്കിലും സത്യസന്ധയും ജോലിയും ഇല്ലാത്തതാർക്ക്?

A. W B. X C. Y D. Z

5. സത്യസന്ധയും, ജോലിയും, വിനയവും ഉണ്ടായിട്ടും വിദ്യാഭ്യാസമില്ലാത്തതാർക്കാണ്?

A. W B. X C. Y D. Z

(2) ദിനേശിന് A എന്ന പുത്രിയും B, C എന്ന പുത്രന്മാരുമുണ്ട്. 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 ബന്ധമെന്ത്?

A. അച്ഛൻ B. മുത്തച്ഛൻ C. അമ്മാവൻ D. പുത്രൻ

7. ദിനേശിന് E യുമായുള്ള ബന്ധമെന്ത്?

A. മുത്തച്ഛൻ B. അമ്മാവൻ C. അച്ഛൻ D. പുത്രൻ

8. M ന് R നോടുള്ള ബന്ധമെന്ത്?

A. അമ്മ B. മകൾ C. അനന്തിരവൾ D. അമ്മായി

9. B യ്ക്ക് G യോടുള്ള ബന്ധമെന്ത്?

A. മകൻ B. അമ്മ C. അമ്മായി D. അനന്തിരവൾ

10. E യ്ക്ക് S നോടുള്ള ബന്ധമെന്ത്?

A. പേരക്കിടാവ് B. അമ്മാവൻ C. സഹോദരിപുത്രി D. അച്ഛൻ

(3) $5 \text{ PQ } 8 = 5^2 + 8 = 25 + 8 = 33$ ആയാൽ?

11. 4 PQ 4 = ?

A. 16 B. 20 C. 24 D. 12

12. 4 PQ 1 = ?

A. 17 B. 12 C. 8 D. 9

13. 5 PQ 5 = ?

A. 20 B. 30 C. 15 D. 25

14. 6 PQ ? = 108

A. 72 B. 82 C. 52 D. 42

15. ? PQ 9 = 109

A. 50 B. 25 C. 20 D. 10

(5) ഒരു വീട്ടിലെ ആറ് അംഗങ്ങളാണ് U, V,W, X, Y, Z ഇവരിൽ ഒരാൾ ഫുഡ്ബോൾ കളിക്കാരനും മറ്റൊരാൾ ചെസ്സ് കളിക്കാരനും, ഇനിയുമൊരാൾ ക്രിക്കറ്റുകളിക്കാരനുമാണ്. അവിവാഹിതകളായ U ഉം X ഉം ഒരു കളിയിലും പങ്കെടുക്കുന്നില്ല. ഒറ്റ സ്ത്രീകളും

ഫുഡ്ബോൾ കളിയിലോ ക്രിക്കറ്റ് കളിയിലോ ഏർപ്പെടുന്നില്ല. ഇവരിൽ ഒരു വിവാഹ ജോടിയിലെ ഭർത്താവാണ് Z. W ന്റെ സഹോദരനായ V ഒരു ചെസ്സ് കളിക്കാരനോ ക്രിക്കറ്റുകളിക്കാരനോ അല്ല. Y, V യുടെ കൂട്ടുകാരനും ക്രിക്കറ്റുകളിക്കാരനുമാണ്.

16. ആരാണ് ഫുഡ്ബോൾ കളിക്കാരൻ?

A. X B. U C. Y D. Z

17. ആരാണ് ചെസ്സ് 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 II

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

VERBAL GROUP TEST OF INTELLIGENCE
(English Version)

Dr. P.K. Sudheesh Kumar
Hameed. A & Prasanna.A

This test is prepared to test the mental abilities of children. The test includes 5 sub tests. Before writing the answer, read the instructions carefully given in the beginning of each sub test. The mode of answering is explained with example. You should start answering only after the instruction is given, and try to complete within the stipulated time. Don't write or mark anything on this question booklet. Mark your response only in the Response sheet provided.

TEST- 1 VERBAL ANALOGY

In this section, for each question, three words are given. You have to write the fourth word. By understanding the relationship between the first word and second word from the given three words; select the fourth word from the alternatives A, B, C and D and mark it on the response sheet provided.

Example:

Thirst : Water:: Hunger: ....

A. Meat B. Leisure C. Food D. Weariness

We drink water when we have thirst. Likewise we take food when we are hungry. Hence the correct answer is "C"

A.	B.	C.✓	D.

1. Clever : Fox :: Foolishness: ....
   A. Monkey B. Bear C. Deer D. Ass

2. Mercy : Cruelty:: Silence: ....
   A. Serene B. Noise C. Calmness D. Meditation

3. Drama : Director:: Newspaper: ....
   A. Manager B. Editor C. Owner D. Press

4. Ship : Captain:: Aero plane: ....
   A. Sea B. Airport C. Driver D. Pilot

5. Cry : Laugh:: Sadness: ....
   A. Happiness B. Energetic C. Harmony D. Peace

6. Shirt : Cloth:: Chappals: ....
   A. Chissel B. Leather C. Cobbler D. Tailor

7. Crow : Black:: Swan: ....
   A. Bird B. Water C. White D. Grey

8. Magazine : Reader:: Radio: ....
   A. Advertisers B. Announcers C. Spectators D. Listeners

9. Firewood : Axe:: Cloth: ....
   A. Machine B. Needle C. Scissors D. Thread

10. Student : Classroom:: Player: ....
    A. Stadium B. Competition C. Coach D. Game

11. House : Roof :: Earth: ....
    A. Air B. Sky C. Atmosphere D. Poles

12. Child : Parents:: Book: ....
    A. Teacher B. Publisher C. Press D. Author

13. Year : Month :: Week: ....
    A. Hour B. Minute C. Two weeks D. Day

14. Night : Day :: Hatred: ....
    A. Help B. Mercy C. Love D. Failure

15. Poet : Poem :: Music: ....
    A. Composer B. Writer C. Producer D. Conductor

16. Snow : White :: Coal: ....
    A. Smoke B. Red C. Black D. Yellow

17. Cow : Animal:: Hen: ....
    A. House B. Bird C. Egg D. Nest

18. Swimming : Water :: Skating: ....
    A. Ice B. Sky C. Mountain D. Space

19. Man : Autobiography :: Nation: ....
    A. People B. Population C. Geography D. History

20. Medicine : Disease :: Book: ....
    A. Knowledge B. Teacher C. Author D. Publisher

TEST - II VERBAL CLASSIFICATION

In this section, for each question, for words are given, of which, three can be grouped together find out the fourth word, and mark it on the response sheet.

Example:

1.	A. Sweetness	B. Chilly	C. Hotness	D. Bitterness

Among these words, A, C and D denote different tastes. B (chilly) is not included in this category. so the right answer is 'B'.

A.	B.✓	C.	D.

1.	A. Teacher	B. Principal	C. Student	D. Professor
2.	A. Bus	B. Aero plane	C. Bicycle	D. Lorry
3.	A. Walking	B. Thinking	C. Swimming	D. Jumping
4.	A. Circle	B. Square	C. Triangle	D. Hexagon
5.	A. Beauty	B. Senility	C. Chap	D. Youth
6.	A. Gram	B. Kilogram	C. Metre	D. Quintal
7.	A. Peace	B. Sound	C. Medication	D. Stillness
8.	A. Director	B. Actor	C. Singer	D. Orator
9.	A. Day	B. Calender	C. Month	D. Week
10.	A. Quintal	B. Inch	C. Mile	D. Feet
11.	A. Tongue	B. Eye	C. Teeth	D. Nose
12.	A. Wheat	B. Raggy	C. Paddy	D. Pie
13.	A. Snake	B. Whale	C. Chameleon	D. Tortoise
14.	A. Pencil	B. Umbrella	C. Paint	D. Canvas
15.	A. Mango tree	B. Jack fruit tree	C. Coconut tree	D. Teak
16.	A. Mango	B. Apple	C. Tomato	D. Potato
17.	A. Ear	B.Finger	C. Hand	D. Leg
18.	A. Hen	B. Goat	C. Cow	D. Crow
19.	A. Office	B. House	C. Bungalow	D. Hut
20.	A. Announcers	B. Spectators	C. Lyricist	D. Listeners

TEST - III NUMERICAL REASONING

For the 6 items given below, certain numbers are given in particular orders. For each item four alternatives are given as a, B, C and D. Find out the right answer and mark it on the answer sheet.

Example:

1. 2, 4, 6, __, 10

A. 5 B. 8 C. 7 D. 11

A.	B.✓	C.	D.

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. 0, 2, 4, 6, __, 10
   A. 7 B. 5 C. 8 D. 9

For the questions 7 to 10, four numerals are given. Find out the numeral that is not related to the other three and mark it on the response sheet provided.

Example:

A. 1 B. 3 C. 6 D. 7

A, B and D are the odd numbers whereas C is not an odd number. Therefore the answer is ‘C’.

A.	B.	C.✓	D.

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

For the questions 11 to 20 three numbers are given. You have to find out the fourth number from the given three numerals. There is a relationship between the first two. Select the most appropriate numeral to the third one from the numerals A, B, C and D.

Example:

1. 1:2 :: 2: ___

   A. 1 B. 4 C. 6 D. 7

One id multiple of two. Similarly two is the multiple of four. Therefore the answer is 'B'.

A.	B.✓	C.	D.

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. 52
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

For each question in this section four alternatives are given as A, B, C and D. Read the questions carefully and mark the answers on the response sheet provided.

Example:

1. Bindu is fatter than Sindhu. Manju is not so fatter than Bindu. Manju and Sandhya are equally fat. Then who among them is the fattest?

   A. Manju B. Bindu C. Sindu D. Sandhya

A.	B.✓	C.	D.

1. Appu sings better than Chippu. Devan can't sing as good as Kannan. Kannan can sing better than Appu. Who is the singer among them?

   A. Appu B. Kannan C. Chippu D. Devan

2. Raman is walking behind Rama. Ramani is walking behind Rama but infront of Raman. Raju is walking in front of Ramani. Then who is walking behind everybody?

   A. Raman B. Ramani C. Rama D. Raju

3. Ajay works more than Vijay. Asok and Ajith has the same capacity to work. Vijay works better than Asok. Who is the hard worker?

   A. Asok B. Ajith C. Vijay D. Ajay

4. Ramya cannot dance as Bhavya. Divya can dance, better than Bhavya. Vindhya's performance in dance is better than Divya. Then who is the top dancer?

   A. Divya B. Bhavya C. Ramya D. Vidya

5. If son of Mohanan is the father of Deepak. What is the relationship between Deepak and Mohanan?

   A. Son B. Brother C. Nephew D. Grandson

6. Rafeeq has better sight power than Muneer. Shameer have less sight to that of Sudheer. Sudheer doesn't have sight as that of Rafeeq. Who among these have more power of sight?

   A. Sudheer B. Shameer C. Rafeeq D. Muneer

7. If two persons have completed a job within 10 days. What amount of job one can do in one day?

   A. 1/2   B. 1/5   C. 1/10   D. 1/20

8. If the sound of a gunfire takes 2 minutes to reach from place A to place B, how much time the sounds of five gunfire will take to reach from place A to B?

   A. 10 minutes   B. 2 minutes   C. 4 minutes   D. 5 minutes

9. Sharmila is younger than Mala. Kunjan and Nanda are of the same age. Sudheesh is younger than Nanda and elder than Sharmila. Mala is not as old as Sudheesh. Then who is the eldest one?

   A. Sudheesh   B. Mala   C. Sharmila   D. Kunjan

10. There are 70 students in a quene for remitting the fees. If the place of Mohan is 54th from the window how many students are there behind Mohanan?

    A. 15   B. 16   C. 17   D. 18

11. If South-West is North, What will be the North-East?

    A. West   B. South west   C. East west   D. South

12. A is the son of B. B and C are sisters. D is the mother of C and E is the son of D. Then, which is right among the following?

    A. E is the uncle of A   B. C and E are brother and sister

    C. C is the grandmother of A   D. A and E are brothers.

13. There are 80 employees in a company in which 1/4 of them have a car 1/2 of them have scooter and 1/10 of them have both car and scooter. Then how many of them are there without a car or scooter?

    A. 12   B. 32   C. 30   D. 28

14. In a class having a strength of 51 students, the rank of Akhil is 21st. When count from the least ranked student, which will be the rank of Akhil?

    A. 12   B. 30   C. 31   D. 35

15. A person started his journey from the place, X. After walking 4 miles towards east he turned left and again walked 5 miles. Then he turned left and walked two miles. Then, to which direction now he is walking?

    A. North   B. West   C. East   D. South

16. F is the brother of A and C is the daughter of A. K is the sister of F and G is the brother of C. Among them who is uncle of 'G'?

    A. F   B. C   C. K   D. A

17. Jinu is two years elder than Vinu and have three times the age of Minu? If, the; sum of the age of 3 persons is 27, what is the age of Jinu?

    A. 5 B. 3 C. 9 D. 10

18. If the place of x, who is standing in a quene in front of a Maveli store, from the front is 22 and from the back is 28. How many persons are there in the quene?

    A. 49 B. 52 C. 50 D. 54

19. A is longer than B and B is shorter than X. X and Y are of the same length. If Z is longer than A, who is the shortest one?

    A. X B. Y C. A D. B

20. If father of Syam is the son of Sajjay, what is the relationship; between Syam and Sajjay.?

    A. Son B. Grandson C. Brother D. Nephew

TEST - V COMPREHENSION

In this section, for every question, some statements are given. Four alternatives are given for every question as A, B, C and D. Read the statements carefully and find out the answers and mark it on the answer sheet provided.

Example:

Satheesh have two sons. A and B and two daughters C and D. Shyama have two children X and Y. Manoj have two children namely E and F and they are employed in a company. A and D are married. X married C and F married A. Manoj is the brother of Shyama.

Question:

1. What is the relationship between X and E?

   A. Father and Son B. Brother and Sister

   C. Cousins D. Father and daughter

A.	B.	C.✓	D.

(1) W,X,Y and Z are the members of a home. Among them W, X and Y are educated and W,Y and Z are honest. Y and Z are employed and W, X and Z have humility.

1. Who have education and honesty, but is not employmed?

   A. W B. X C. Y D. Z

2. Who is honest, educated and employed?

   A. W B. X C. Y D. Z

3. Who is honest and employed but does not have education?

   A. W B. X C. Y D. Z

4. Who have education and humility, yet not with honesty and employment?

   A. W B. X C. Y D. Z

5. Who doesn't have education, even if he is humble, honest and employed?

   A. W B. X C. Y D. Z

(2) Dinesh have a daughter namely A and two sons namely B and C. Shyam have two sons namely P and Q and a daughter R. P and C are married and they have two sons, M and N. Rohit is the father of both S and T. T and B are married and they have two daughters D and E and a son G

6. What is the relationship between Q and N?

   A. Father B. Grand father C. Uncle D. Son

7. What is the relationship between Dinesh and E?

   A. Grandfather B. Uncle C. Father D. Son

8. What is the relationship between M and R?

   A. Mother B. Daughter C. Niece D. Aunt

9. What is the relationship between B and G ?

   A. Daughter B. Mother C. Aunt D. Niece

10. What is the relationship between E and S?

    A. Grandson B. Uncle C. Niece D. Father

(3) If 5 PQ 8 = 5^2 + 8 = 25 + 8 = 33

11. 4 PQ 4 = ?

    A. 16 B. 20 C. 24 D. 12

12. 4 PQ 1 = ?

    A. 17 B. 12 C. 8 D. 9

13. 5 PQ 5 = ?

    A. 20 B. 30 C. 15 D. 25

14. 6 PQ ? = 108

    A. 72 B. 82 C. 52 D. 42

15. ? PQ 9 = 109

    A. 50 B. 25 C. 20 D. 10

(5) U, V,W, X, Y and Z are the members of a home. One among them is a foot ball player and another one, a chess player. The third person is a cricket player. U and X are unmarried women and they do not participate in any game. No women are engaged in playing football or in cricket. Z is the husband of a married couple. V, the brother of W is not a chess player or a cricket player. Y, is the friend of 'V' and a cricket player.

16. Who is the football player?

    A. X B. U C. Y D. Z

17. Who is the chess player?

    A. U B. V C. W D. X

18. Who is the wife of 'Z'?

    A. W B. V C. U D. Y

19. Who are the ladies?

    A. UXV B. VYX C. XZY D. UXW

20. Who are the gents?

    A. XUY B. UXV C. VYZ D. WXZ

Appendix III

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

VERBAL GROUP OF INTELLIGENCE

RESPOSE SHEET

Name: Class: Age:

School:

Boy/Girl:

Sl.No	Answers				Sl.No	Answers				Sl.No	Answers				Sl.No	Answers				Sl.No	Answers			
1	A	B	C	D	1	A	B	C	D	1	A	B	C	D	1	A	B	C	D	1	A	B	C	D
2	A	B	C	D	2	A	B	C	D	2	A	B	C	D	2	A	B	C	D	2	A	B	C	D
3	A	B	C	D	3	A	B	C	D	3	A	B	C	D	3	A	B	C	D	3	A	B	C	D
4	A	B	C	D	4	A	B	C	D	4	A	B	C	D	4	A	B	C	D	4	A	B	C	D
5	A	B	C	D	5	A	B	C	D	5	A	B	C	D	5	A	B	C	D	5	A	B	C	D
6	A	B	C	D	6	A	B	C	D	6	A	B	C	D	6	A	B	C	D	6	A	B	C	D
7	A	B	C	D	7	A	B	C	D	7	A	B	C	D	7	A	B	C	D	7	A	B	C	D
8	A	B	C	D	8	A	B	C	D	8	A	B	C	D	8	A	B	C	D	8	A	B	C	D
9	A	B	C	D	9	A	B	C	D	9	A	B	C	D	9	A	B	C	D	9	A	B	C	D
10	A	B	C	D	10	A	B	C	D	10	A	B	C	D	10	A	B	C	D	10	A	B	C	D
11	A	B	C	D	11	A	B	C	D	11	A	B	C	D	11	A	B	C	D	11	A	B	C	D
12	A	B	C	D	12	A	B	C	D	12	A	B	C	D	12	A	B	C	D	12	A	B	C	D
13	A	B	C	D	13	A	B	C	D	13	A	B	C	D	13	A	B	C	D	13	A	B	C	D
14	A	B	C	D	14	A	B	C	D	14	A	B	C	D	14	A	B	C	D	14	A	B	C	D
15	A	B	C	D	15	A	B	C	D	15	A	B	C	D	15	A	B	C	D	15	A	B	C	D
16	A	B	C	D	16	A	B	C	D	16	A	B	C	D	16	A	B	C	D	16	A	B	C	D
17	A	B	C	D	17	A	B	C	D	17	A	B	C	D	17	A	B	C	D	17	A	B	C	D
18	A	B	C	D	18	A	B	C	D	18	A	B	C	D	18	A	B	C	D	18	A	B	C	D
19	A	B	C	D	19	A	B	C	D	19	A	B	C	D	19	A	B	C	D	19	A	B	C	D
20	A	B	C	D	20	A	B	C	D	20	A	B	C	D	20	A	B	C	D	20	A	B	C	D

Appendix IV

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

VERBAL GROUP TEST OF INTELLIGENCE

SCORING KERY

TEST 1		TEST 2		TEST 3		TEST 4		TEST 5	
Sl.No	Answers	Sl.No	Answers	Sl.No	Answers	Sl.No	Answers	Sl.No	Answers
1	D	1	C	1	C	1	B	1	A
2	B	2	B	2	A	2	A	2	C
3	B	3	B	3	D	3	D	3	D
4	D	4	A	4	A	4	B	4	B
5	A	5	C	5	C	5	D	5	D
6	B	6	C	6	C	6	C	6	C
7	C	7	B	7	A	7	D	7	A
8	D	8	A	8	B	8	B	8	D
9	C	9	B	9	C	9	D	9	A
10	A	10	A	10	A	10	B	10	B
11	B	11	C	11	B	11	D	11	B
12	D	12	D	12	D	12	B	12	A
13	D	13	B	13	A	13	A	13	B
14	C	14	B	14	B	14	C	14	A
15	A	15	D	15	D	15	B	15	D
16	C	16	D	16	B	16	A	16	D
17	B	17	A	17	C	17	C	17	C
18	A	18	D	18	A	18	A	18	A
19	D	19	A	19	C	19	D	19	D
20	A	20	C	20	D	20	B	20	C

Appendix V

SCIENTIFIC REASONING TEST IN CHEMISTRY
(Malayalam Version)

School of Pedagogical Sciences

Mahatma Gandhi University Kottayam

Standard: IX (Time: 45 minutes) Maximum Marks: 45

Premachandran P.
UGC-Senior Research Fellow
School of Pedagogical Sciences
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പൊതു നിർദ്ദേശങ്ങൾ

- എല്ലാ ചോദ്യങ്ങളും ശ്രദ്ധാപൂർവ്വം വായിക്കുക
- എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരമെഴുതുക
- ഉത്തരകടലാസിൽ തന്നിരിക്കുന്ന നിർദ്ദേശങ്ങൾക്ക് അനുസൃതമായി ഉത്തരം അട യാളപ്പെടുത്തുക

1. സൈക്ലോഹെക്സെയ്നിലെ ഹൈഡ്രജൻ ആറ്റങ്ങളുടെ എണ്ണം എത്ര?

a)6 b) 10 c) 12 d)8

Q. തന്നിരിക്കുന്ന പട്ടികയെ ആസ്പദമാക്കി ചോദ്യങ്ങൾക്ക് (2 – 3) ഉത്തരമെഴുതുക

മൂലകം	ജലവുമായുള്ള പ്രവർത്തനം	നേർപ്പിച്ച ആസിഡുമായുള്ള പ്രവർത്തനം	ദ്രവണാങ്കം	സാന്ദ്രത
Na	തീവ്രമായ പ്രവർത്തനം	തീവ്രമായ പ്രവർത്തനം സാവധാനത്തിലുള്ള പ്രവർത്തനം	98°C	0.97
Fe	പ്രവർത്തനമില്ല	തീവ്ര പ്രവർത്തനത്തിലൂടെ ഹൈഡ്രജൻ ഉണ്ടാകുന്നു.	1537°C	7.87
K	തീവ്രപ്രവർത്തനത്തിലൂടെ ഹൈഡ്രജൻ വാതകം ഉണ്ടാകുന്നു.	തീവ്രപ്രവർത്തനത്തിലൂടെ ഹൈഡ്രജൻ ഉണ്ടാകുന്നു.	64°C	0.86
Zn	പ്രവർത്തനമില്ല	ഹൈഡ്രജൻ വാതകം ഉണ്ടാകുന്നു.	419°C	7.1
Ag	പ്രവർത്തനമില്ല	പ്രവർത്തനമില്ല	962°C	10.5

2. ജലവുമായും നേർപ്പിച്ച ആസിഡുമായും ക്രിയാശേഷി കൂടുതൽ കാണിക്കുന്ന മൂലക ങ്ങൾ ഏവ?

a) Fe & K   b) Na & K   c) K & Zn   d) Na & Zn

3. ആഭരണ നിർമ്മാണത്തിന് അനുയോജ്യമായ മൂലകം ഏത്?

a) Na   b) Fe   c) Ag   d) Zn

4. പൊട്ടാസ്യം പെർമാംഗനേറ്റ് ചൂടാക്കുമ്പോൾ ലഭിക്കുന്ന വാതകം?

a) MnO_2 b) O_2 c) N_2 d) O_3

5. ചുുവടെ തന്നിരിക്കുന്ന പട്ടിക പൂർത്തീകരിക്കുക.

അറ്റോമിക നമ്പർ	രാസസൂത്രം	നാമം	ഗ്രൂപ്പ്	പിരിയഡ്
4	----	കാർബൺ	-----	2
8	O	----	16	-----
18	----	ആർഗൺ	---	3
20	Ca	കാൽസ്യം	---	----
13	-----	----	13	3

6. കാർബൺഡൈ ഓക്സൈഡിന്റെ ഏത് രൂപമാണ് ശീതികാരിയായി ഉപയോഗിക്കു ന്നത്?

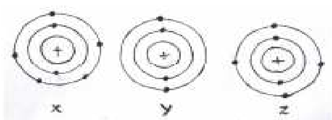
a) ഗ്രാഫൈറ്റ്   b) കാർബൊറണ്ടം   c) ഡ്രൈ ഐസ്   d) ചാർക്കോൾ

7. തന്നിരിക്കുന്ന ചിത്രീകരണത്തിൽ നിന്നും ഇവയുടെ സ്ഥിരതയുടെ ശരിയായ ആരോ ഹണക്രമം കണ്ടെത്തുക?

:N⁝⁝N: , :Ö::Ö: , :C̤̈l..C̤̈l:

a) $Cl_2<O_2<N_2$ b) $Cl_2< N_2<O_2$ c) $O_2< N_2<Cl_2$ d) $N_2<O_2<Cl_2$

8. തന്നിരിക്കുന്ന മൂലകങ്ങളുടെ ഇലക്ട്രോനെഗറ്റിവിറ്റിയുടെ അവരോഹണക്രമം ഏത്?



a) X>Y>Z   b) Z>Y>X   c)Y>Z>X   d)X>Z>Y

9. C_8H_{14} എന്ന കാർബണിക സംയുക്തത്തിന്റെ പൊതു തന്മാത്രാവാക്യം?

a) C_nH_{2n} b) C_nH_{2n+2} c)C_nH_{2n-1} d) C_nH_{2n-2}

10. ചുവടെ തന്നിരിക്കുന്ന രാസസമവാക്യത്തിലെ വിട്ടുപോയ ഭാഗം പൂരിപ്പിക്കുക.

$$16HCl+2KMnO_4 \rightarrow 2KCl+2MnCl_2+8H_2O+.....Cl_2$$

a)1 b)5 c) 4 d 3

11. കുടിവെള്ളം ശുദ്ധീകരിക്കാൻ ക്ലോറിൻ ഉപയോഗിക്കുന്നതിനുള്ള കാരണം:

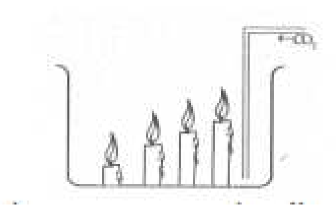
a) ക്ലോറിന്റെ ഓക്സീകരണ ഗുണം b) ക്ലോറിന്റെ നിരോക്സീകരണ ഗുണം

c) ക്ലോറിന്റെ ഉയർന്ന സാന്ദ്രത d) ക്ലോറിന്റെ നിർജ്ജലീകരണഗുണം

12. ക്ലോറിന്റെ ഇലക്ട്രോൺ വിന്യാസം 2, 8, 7 ആണ് ക്ലോറിൻ സ്ഥിരത നേടുന്നതിനു വേണ്ടി കൈവരിക്കേണ്ട ചാർജ്ജ് താഴെ തന്നിരിക്കുന്നവയിൽ ഏതാണ്?

a) -2 b) - 1 c) +1 d) +2

13.



മുകളിൽ തന്നിരിക്കുന്ന ക്രമീകരണത്തിൽ ഉയരമുള്ള മെഴുകുതിരി അവസാനം അണയുന്നു ഇതിനു കാരണം?

a) CO_2 ജ്വലനസഹായിയല്ലb) CO_2 ന്റെ ഉയർന്ന തിളനില

c) CO_2 വിന്റെ ഉയർന്ന സാന്ദ്രത d) CO_2 ന്റെ താഴ്ന്ന സാന്ദ്രത

14. ഗ്രൂപ്പിൽ ഉൾപ്പെടാത്തത് തെരഞ്ഞെടുക്കുക?

a) C_3H_8 b) C_4H_8 c) C_5H_{12} d) C_4H_{10}

15.

```
      H    H    H    H    H
      |    |    |    |    |
H  -  C -  C -  C -  C  = C -  H
      |    |    |
      H    H    H
```

തന്നിരിക്കുന്ന സംയുക്തത്തിന്റെ പേര് എന്ത്?

a) ബ്യൂട്ടീൻ b) ഹെക്സെയ്ൻ c) പെന്റീൻ d) പെന്റൈൻ

16. ഹൈഡ്രജൻ വാതകം സിലിണ്ടറുകളിലാക്കി തറയിലൂടെ ഉരുട്ടികൊണ്ടുപോകുന്നത് പ്രയോഗികമല്ല എന്ന് പറയുന്നു. ഇതിനു കാരണം എന്ത്?

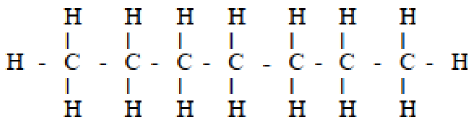
a) ഹൈഡ്രജൻ വാതകത്തിന് ഭാരം കൂടുതലാണ്

b) ഹൈഡ്രജനെ ദ്രാവകമാക്കാൻ സാധിക്കില്ല

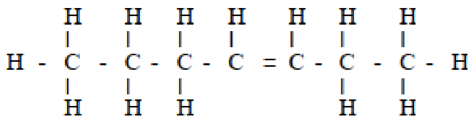
c) ഹൈഡ്രജന് സാന്ദ്രത കുറവാണ് d) ഹൈഡ്രജന് സ്ഫോടനശേഷി ഉണ്ട്.

17. ഹെപ്റ്റൈനിന്റെ ഘടനാവാക്യം താഴെതന്നിരിക്കുന്നവയിൽ ഏതാണ്?

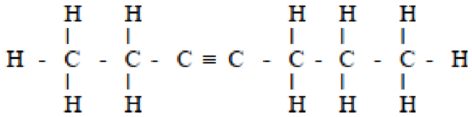
a



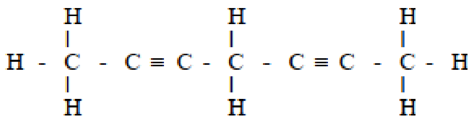
b



c



d



Q. ചില മൂലകങ്ങളും അവയുടെ ഇലക്ട്രോൺ വിന്യാസവും തന്നിരിക്കുന്നു. പട്ടികയെ ആസ്പദമാക്കിയുള്ള ചോദ്യത്തിന് (18) ഉത്തരമെഴുതുക

മൂലകം	ഇലക്ട്രോൺ വിന്യാസം
Li	2, 1
Be	2, 2
B	2, 3
C	2, 4
N	2, 5
O	2, 6
F	2, 7

18. തന്നിരിക്കുന്ന പട്ടികയിൽ നിന്നും വ്യക്തമാകുന്ന ആശയം എന്ത്?

a) മൂലകങ്ങൾ സമാനസ്വഭാവം കാണിക്കുന്നു

b) മൂലകങ്ങൾ ഒരേ ഗ്രൂപ്പിൽ ഉൾപ്പെടുന്നു

c) മൂലകങ്ങൾ ഒരേ പീരിയഡിൽ കാണപ്പെടുന്നു.

d) മൂലകങ്ങൾ എല്ലാം ലോഹങ്ങളാണ്

Q. ചുവടെ തന്നിരിക്കുന്ന വിവരണം ശ്രദ്ധാപൂർവ്വം വായിച്ചതിനുശേഷം തന്നിരിക്കുന്ന

ചോദ്യങ്ങൾക്ക് (19-20) ഉത്തരമെഴുതുക.

അന്തരീക്ഷവായുവിന്റെ ഏകദേശം 70% നൈട്രജൻ വാതകമാണ്. ഇടിയും മിന്നലും ഉണ്ടാകുമ്പോൾ അന്തരീക്ഷത്തിൽ ഇലക്ട്രിക് ഡിസ്ചാർജുകൾ പ്രവഹിക്കപ്പെടുകയും അന്തരീക്ഷവായുവിലെ സ്വതന്ത്ര നൈട്രജൻ ഓക്സിജനുമായി ചേർന്ന് നൈട്രിക് ഓക്സൈഡ് വാതകം, (NO) ഉണ്ടാവുകയും ചെയ്യുന്നു. ഈ നൈട്രിക് ഓക്സൈഡ് വാതകം കൂടുതൽ ഓക്സിജനുമായി ചേർന്ന് നൈട്രജൻ ഡൈഓക്സൈഡ് (NO_2) ആയി മാറുന്നു. നൈട്രജൻ ഡൈഓക്സൈഡ് മഴമേഘങ്ങളിൽ ലയിച്ച് നൈട്രിക് ആസിഡായി ഭൂമിയിലെത്തുന്നു. ഇവ മണ്ണിലെ ലവണങ്ങളുമായി ചേർന്ന് നൈട്രേറ്റുകൾ രൂപപ്പെടുത്തുകയും വേരുകൾ വലിച്ചെറിയുക വഴി സസ്യങ്ങളിൽ എത്തിച്ചേരുകയും ചെയ്യുന്നു. ഇവ സസ്യങ്ങൾക്കുള്ളിൽ വച്ച് അമിനോ അസിഡുകളായി മാറി കൂടിചേർന്ന് പ്രോട്ടീനുകൾ രൂപം കൊള്ളുന്നു. അന്തരീക്ഷത്തിലെ നൈട്രജൻ ഇപ്രകാരം തുടർച്ചയായി ഉപയോഗിക്കപ്പെടുന്നുവെങ്കിലും അവയുടെ അളവിന് വ്യത്യാസം സംഭവിക്കുന്നില്ല. ഇതിനു കാരണം സസ്യങ്ങളുടെയും ജന്തുക്കളുടെയും മരണശേഷം അവയുടെ അവശിഷ്ടങ്ങൾ വിഘടിക്കപ്പെടുന്നതിന്റെ ഫലമായി സംയുക്താവസ്ഥയിലുള്ള നൈട്രജൻ സ്വതന്ത്രാവസ്ഥയിലേക്കു മാറുന്നു എന്നുള്ളതാണ്.

19. നൈട്രിക് ഓക്സൈഡ് രൂപം കൊള്ളുന്നതിന്റെ രാസസമവാക്യം ഏത്?

a) $N + O \rightarrow NO$ b) $2N + O_2 \rightarrow 2NO$

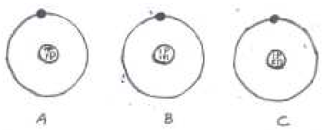
c) $2N_2 + O_2 \rightarrow 2NO$ d) $N_2 + O_2 \rightarrow 2NO$

20. പ്രോട്ടീനുകൾ നിർമ്മിക്കപ്പെട്ടിരിക്കുന്നത് എന്ത് ഘടകങ്ങൾ ചേർന്നാണ്?

a) ന്യൂക്ലിക് ആസിഡ് b) നൈട്രേറ്റുകൾ

c) അമിനോ ആസിഡ് d) നൈട്രിക് ആസിഡ്

Q. തന്നിരിക്കുന്ന ഹൈഡ്രജന്റെ വിവിധ ആറ്റം ഘടനകളെ ആസ്പദമാക്കി ചോദ്യത്തിന് (21) ഉത്തരമെഴുതുക



21. തന്നിരിക്കുന്നവയിൽ ന്യൂട്രോണില്ലാത്ത ഐസോടോപ്പിന്റെ പേരെന്ത്?

a) ഡ്യൂട്ടീരിയം b) പ്രോട്ടിയം c) ട്രിഷിയം d) ഹൈഡ്രോണിയം

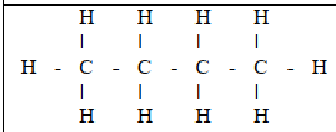
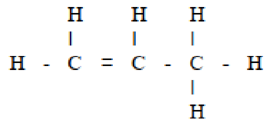
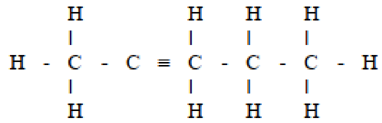
22. ചുവടെ തന്നിരിക്കുന്നവയിൽ വിട്ടുപോയ ഭാഗം ശരിയായ ബന്ധം കണ്ടെത്തി പൂരിപ്പിക്കുക

വജ്രം :ആഭരണങ്ങൾ നിർമ്മിക്കാൻ ഉപയോഗിക്കുന്നു

.... : നാനോ സാങ്കേതിക വിദ്യയിൽ ഉപയോഗിക്കുന്നു.

ഗ്രാഫൈറ്റ് : സ്നേഹകമായി ഉപയോഗിക്കുന്നു

22. ചേരുംപടി ചേർക്കുക.

A	B	C
	Pentyne	C_3H_6
	Butane	C_5H_8
	Propene	C_4H_{10}

24. ആഗോളതാപനത്തെ അസ്പദമാക്കിയുള്ള നാല് പ്രസ്താവനകൾ ചുവടെ തന്നിരിക്കുന്നു. ഇവയിൽ തെറ്റായ പ്രസ്താവന ഏത്?

a) ആഗോളതാപനം ധ്രുവങ്ങളിലെ മഞ്ഞുരുകുന്നതിന് കാരണമാകുന്നു.

b) ആഗോളതാപനം കാലാവസ്ഥ മാറുന്നതിന് കാരണമാകുന്നു.

c) ആഗോളതാപനം ഹരിതസസ്യങ്ങളുടെ വളർച്ചയെ ത്വരിതപ്പെടുത്തുന്നു.

d) ആഗോളതാപനം ആവാസ വ്യവസ്ഥയുടെ നാശത്തിന് കാരണമാകുന്നു.

25. പീരിയോഡിക് ടേബിളിന്റെ അപൂർണ്ണരൂപം താഴെ നൽകിയിരിക്കുന്നു. സെല്ലുകളിൽ നൽകിയിരിക്കുന്നത് മൂലകങ്ങളുടെ യതാർത്ഥ പ്രതീകങ്ങളല്ല. ടേബിളിനെ ആസ്പദമാക്കി നൽകിയിരുക്കുന്ന ചോദ്യങ്ങൾക്ക് (65-70) ഉത്തരം എഴുതുക.

1	2											13	14	15	16	17
A																
B												G	H			J
C																K
D							E			F				I		

a) രണ്ടാം പീരിയഡിലെ ഏറ്റവും ചെറിയ മൂലകം ഏത്?

b) ഇലക്ട്രോ പോസിറ്റിവിറ്റി ഏറ്റവും കൂടിയ മൂലകം ഏത്?

c) സംക്രമണ മുലകങ്ങൾ ഏതെല്ലാമാണ്?

d) ഇലക്ട്രോ നെഗറ്റിവിറ്റി കൂടിയ മൂലകം ഏത്?

e) ഉയർന്ന ലോഹഗുണം പ്രദർശിപ്പിക്കുന്ന മൂലകം ഏത്?

f) 5 സംയോജക ഇലക്ട്രോണുകൾ ഉള്ള മൂലകം ഏത്?

26. താഴെപ്പറയുന്നവയിൽ ക്ലോറിന്റെ ഉപയോഗങ്ങളിൽ ഉൾപ്പെടാത്തത് ഏത്?

a) ബ്ലീച്ചിങ്ങ് പൗഡറിന്റെ നിർമ്മാണം

b) പോളിവിനൈൽ ക്ലോറൈഡിന്റെ നിർമ്മാണം

c) സൾഫ്യൂറിക്കാസിഡിന്റെ നിർമ്മാണം

d) കുടിവെള്ള ശുദ്ധീകരണം

Appendix VI

SCIENTIFIC REASONING TEST IN CHEMISTRY
(English Version)

School of Pedagogical Sciences

Mahatma Gandhi University Kottayam

Standard: IX (Time: 45 minutes) Maximum Marks: 45

Premachandran P.
UGC-Senior Research Fellow
School of Pedagogical Sciences
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Dr.Sajna Jaleel
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General Instruction

- Read all the questions carefully
- Answer all the questions
- Answer as per the Instructions given in the answer sheet

1. What is the total number of hydrogen atoms in Cyclohexane?

   a)6 b) 10 c) 12 d)8

Q:Answer the questions (2-3) based on the following table.

Element	Reaction with water	Reaction with Dilute Acid	Melting Point	Density
Na	Vigorous Reaction	Vigorous Reaction	98°C	0.97
Fe	No Reaction	Slow Reaction	1537°C	7.87
K	Produces Hydrogen through Vigorous reaction	Produces Hydrogen through Vigorous reaction	64°C	0.86
Zn	No Reaction	Produces Hydrogen Gas	419°C	7.1
Ag	No Reaction	No Reaction	962°C	10.5

Appendix

2. Which are the elements giving high reactivity towards acid and water?

   a) Fe & K   b) Na & K   c) K & Zn   d) Na & Zn

3. Which is the element most suitable for making ornaments?

   a) Na   b) Fe   c) Ag   d) Zn

4. Which is the gas produced on heating Potassium Permanganate?

   a) MnO_2 b) O_2 c) N_2 d) O_3

5. Complete the following Table.

Atomic Number	Symbol	Name	Group	Period
4	----	Carbon	-----	2
8	O	----	16	-----
18	----	Argon	---	3
20	Ca	Calcium	---	----
13	-----	------	13	3

6. Which form of carbon dioxide is using as freezing agent?

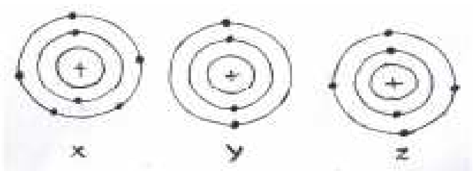
   a) Graphite   b) Carborandum   c) Dry Ice   d) Charcoal

7. Find out the correct ascending order of the stability of the following representations?

   :N⁝⁝N: , :Ö::Ö: , :C̤̈l..C̤̈l:

   a) $Cl_2<O_2<N_2$ b) $Cl_2< N_2<O_2$ c) $O_2< N_2<Cl_2$ d) $N_2<O_2<Cl_2$

8. Which is the descending order of electro negativity of the given elements?



   a) X>Y>Z   b) Z>Y>X   c)Y>Z>X   d)X>Z>Y

9. What is the general equation for the hydrocarbon C_8H_{14}?

   a) C_nH_{2n} b) C_nH_{2n+2} c)C_nH_{2n-1} d) C_nH_{2n-2}

10. Fill the following blank of the given chemical equation:

$$16HCl + 2KMnO_4 \rightarrow 2KCl + 2MnCl_2 + 8H_2O + ...Cl_2$$

a)1 b)5 c) 4 d 3

11. The reason behind the use of chlorine for drinking water purification:

a) The oxidizing property of chlorine b) The reducing property of chlorine

c) High density of chlorine d) The dehydrating nature of chlorine

12. The electronic configuration of chlorine is 2, 8, 7. Which of the following charges should be acquired by chlorine in order to get stability?

a) -2 b) - 1 c) +1 d) +2

13.

In the above shown arrangement the tallest candle flame extinguishes lastly. The reason is;

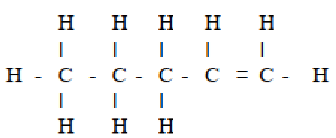
a) CO_2 is not favoring combustion b) High Boiling Point of CO_2

c) High Density of CO_2 d) Low Density of CO_2

14. Find out the odd one?

a) C_3H_8 b) C_4H_8 c) C_5H_{12} d) C_4H_{10}

15.



What is the name of the above shown compound?

a) Butene b) Hexane c) Pentene d) Pentyne

16. It is said that is not practical to roll hydrogen contained cylinders through the ground. What is the reason?

    a) Hydrogen gas has high weight b) Hydrogen cannot be liquefied

    c) Hydrogen has low density d) Hydrogen has Exploding Nature

Q. Some elements and their electronic configuration are given in the following table.

Answer the questions (17) based on the table.

Element	Electronic Configuration
Li	2, 1
Be	2, 2
B	2, 3
C	2, 4
N	2, 5
O	2, 6
F	2, 7

17. What is the idea getting clear from the above Table?

    a) Elements show similar properties b) Elements belong to same group

    c) Elements lie in the same period d) Elements are all metals

Q. Read carefully the following passage and answer the following questions (18).

70% of atmosphere is Nitrogen gas. When lightning occurs, electric discharges are generated in the atmosphere and free Nitrogen present in the atmosphere combines with oxygen to form Nitric Oxide (NO). This Nitric oxide combines with more oxygen to form Nitrogen dioxide (NO_2). Nitrogen dioxide dissolves in rainy clouds to form Nitric Acid and reaches earth. They combines with minerals present in soil to form Nitrates and through the absorption by roots, they reaches the plant body. They form amino acids inside the plants and get combined to form proteins. Even though nitrogen is getting consumed continuously through these processes, no change occurs to the amount of nitrogen. This is because by the decomposition of dead remains of plants and animals, Free Nitrogen gets liberated into the atmosphere from its compounds.

18. Which is the chemical equation for the formation of Nitric oxide?

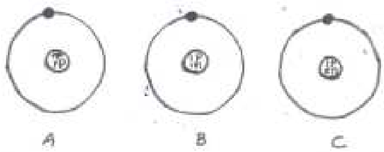
    a) $N + O \rightarrow NO$ b) $2N + O_2 \rightarrow 2NO$

    c) $2N_2 + O_2 \rightarrow 2NO$ d) $N_2 + O_2 \rightarrow 2NO$

19. From which components, proteins are made up of?

    a) Nucleic acid b) Nitrates c) Amino Acids d) Nitric Acid

Q. Answer the following questions (20) based on the various Hydrogen atom models



20. Which of the above is the isotope without neutrons?

    a) Deuterium b) Protium c) Tritium d) Hydronium

21. Fill in the blank given below by finding out the appropriate relation.

    Diamond: Used to make ornaments

    ....: Used in Nano technology

    Graphite: Used as solid lubricant

22. Match the following.

<table>
<tr><th>A</th><th>B</th><th>C</th></tr>
<tr><td>H H H H
I I I I
H - C - C - C - C - H
I I I I
H H H H</td><td>Pentyne</td><td>C_3H_6</td></tr>
<tr><td>H H H
I I I
H - C = C - C - H
I
H</td><td>Butane</td><td>C_5H_8</td></tr>
<tr><td>H H H H
I I I I
H - C - C ≡ C - C - C - H
I I I I
H H H H</td><td>Propene</td><td>C_4H_{10}</td></tr>
</table>

23. Four statements regarding global warming is given below. Which one of them is wrong?

    a) Global warming is responsible for the melting of polar ice caps

    b) Global warming is responsible for the weather changes

    c) Global warming promotes the growth of green plants.

d) Global warming is responsible for the destruction of eco system.

24. An incomplete form of periodic table is given below. The symbols which are given in cells are not real. Answer the following questions (a-f) based on the table.

1	2											13	14	15	16	17
A																
B												G	H			J
C																K
D							E			F				I		

a) Which is the smallest element of second period?

b) Which is the element having highest electro positivity?

c) Which are the transition elements?

d) Which is the element having higher electro negativity?

e) Which is the element showing high metallic character?

f) Which is the element having 5 valence electrons?

25. Which of the following is not a use of chlorine?

a) Preparation of bleaching powder

b) Preparation of poly vinyl chloride

c) Preparation of sulphuric acid

d) Drinking water purification

Appendix VII

SCIENTIFIC REASONING TEST IN CHEMISTRY
School of Pedagogical Sciences
Mahatma Gandhi University Kottayam

RESPONSE SHEET

Name of student: Class:

Division: Name of school:

No.	A	B	C	D	No.	A	B	C	D
1					3				
2					4				

5

Atomic Number	Symbol	Name	Group	Period
4	---	കാർബൺ	---	2
8	O	-------	16	---
18	----	ആർഗൺ	---	3
20	Ca	കാൽത്സ്യം	---	---
13	-----	-------	13	3

No.	A	B	C	D	No.	A	B	C	D
6					14				
7					15				
8					16				
9					17				
10					18				
11					19				
12					20				
13					21				
22 ....: നാനോ സാങ്കേതിക വിദ്യയിൽ ഉപയോഗിക്കുന്നു.									

23

A	B	C

Appendix

No.	A	B	C	D	No.	A	B	C	D
24									
25 a									
b									
c									
d									
e									
f									
No.	A	B	C	D	No.	A	B	C	D
26									

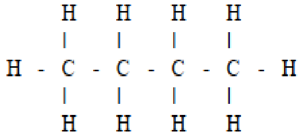
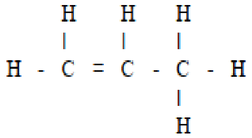
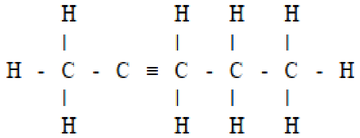
Appendix VIII

SCIENTIFIC REASONING TEST IN CHEMISTRY
School of Pedagogical Sciences
Mahatma Gandhi University Kottayam

ANSWER KEY

<table>
<tr><th>Qn.No</th><th colspan="3">Answer</th><th>Marks</th></tr>
<tr><td>1</td><td colspan="3">12</td><td>1</td></tr>
<tr><td>2</td><td colspan="3">Na &K</td><td>1</td></tr>
<tr><td>3</td><td colspan="3">Ag</td><td>1</td></tr>
<tr><td>4</td><td colspan="3">O_2</td><td>1</td></tr>
<tr><td>5</td><td colspan="3"></td><td>10</td></tr>
<tr><td>ആറ്റോമിക നമ്പർ</td><td>രാസസൂത്രം</td><td>നാമം</td><td>ഗ്രൂപ്പ്</td><td>പിരീഡ്</td></tr>
<tr><td>4</td><td>C</td><td>കാർബൺ</td><td>14</td><td>2</td></tr>
<tr><td>8</td><td>O</td><td>ഓക്സിജൻ</td><td>16</td><td>2</td></tr>
<tr><td>18</td><td>Ar</td><td>ആർഗൺ</td><td>18</td><td>3</td></tr>
<tr><td>20</td><td>Ca</td><td>കാൽസ്യം</td><td>2</td><td>4</td></tr>
<tr><td>13</td><td>Al</td><td>അലൂമിനിയം</td><td>13</td><td>3</td></tr>
<tr><td>6</td><td colspan="3">ഡ്രൈ ഐസ്</td><td>1</td></tr>
<tr><td>7</td><td colspan="3">$Cl_2<O_2<N_2$</td><td>1</td></tr>
<tr><td>8</td><td colspan="3">$X<Z<Y$</td><td>1</td></tr>
<tr><td>9</td><td colspan="3">C_nH_{2n-2}</td><td>1</td></tr>
<tr><td>10</td><td colspan="3">5</td><td>1</td></tr>
<tr><td>11</td><td colspan="3">ക്ലോറിന്റെ ഓക്സീകരണ ഗുണം</td><td>1</td></tr>
<tr><td>12</td><td colspan="3">-1</td><td>1</td></tr>
<tr><td>13</td><td colspan="3">CO_2 വിന്റെ ഉയർന്ന സാന്ദ്രത</td><td>1</td></tr>
<tr><td>14</td><td colspan="3">C_4H_8</td><td>1</td></tr>
<tr><td>15</td><td colspan="3">പെന്റീൻ</td><td>1</td></tr>
<tr><td>16</td><td colspan="3">ഹൈഡ്രജന് സ്ഫോടനശേഷി ഉണ്ട്</td><td>1</td></tr>
<tr><td>17</td><td colspan="3">$\begin{array}{ccccccccccccccccc} & & H & & H & & & & & & H & & H & & H & & \\ & & \vert & & \vert & & & & & & \vert & & \vert & & \vert & & \\ H & - & C & - & C & - & C & \equiv & C & - & C & - & C & - & C & - & H \\ & & \vert & & \vert & & & & & & \vert & & \vert & & \vert & & \\ & & H & & H & & & & & & H & & H & & H & & \end{array}$</td><td>1</td></tr>
<tr><td>18</td><td colspan="3">മൂലകങ്ങൾ ഓരേ പിരിയഡിൽ കാണപ്പെടുന്നു</td><td>1</td></tr>
<tr><td>19</td><td colspan="3">$N_2+O_2 \longrightarrow 2NO$</td><td>1</td></tr>
<tr><td>20</td><td colspan="3">അമിനോ ആസിഡ്</td><td>1</td></tr>
<tr><td>21</td><td colspan="3">പ്രോട്ടിയം</td><td>1</td></tr>
<tr><td>22</td><td colspan="3">ഫ്ളൂറിൻ</td><td>1</td></tr>
<tr><td>23</td><td colspan="3"></td><td></td></tr>
<tr><td colspan="2">A</td><td>B</td><td>C</td><td></td></tr>
</table>

Appendix

	ബ്യൂട്ടെയ്ൻ	$C_4 H_{10}$	2
	പ്രൊപ്പീൻ	$C_3 H_6$	2
	പെന്റൈൻ	$C_5 H_8$	2

24	ആഗോളതാപനം ഹരിതസസ്യങ്ങളുടെ വളർച്ചയെ ത്വരിതപ്പെടുത്തുന്നു	1
25a	J	
b	D	
c	J	
d	E,F	
e	D	
f	I	
26	സൾഫ്യൂറിക്കാസിഡിന്റെ നിർമ്മാണം	1
	Total Marks	45

Appendix IX

FAROOK TRAINING COLLEGE, KOZHIKODE

Research Centre in Education, University of Calicut

SCALE OF ATTITUDE TOWARDS CHEMISTRY (Malayalam Version)

Prof. (Dr.) T. Mohamed Saleem
Principal & Professor
Farook Training College

Sukanya Rani P
Research Scholar

നിർദ്ദേശങ്ങൾ

രസതന്ത്രവിഷയത്തിൽ നിങ്ങളുടെ പഠനവുമായി ബന്ധപ്പെട്ട ഏതാനും പ്രസ്താവനകളാണ് താഴെ കൊടുത്തിട്ടുള്ളത്. ഓരോ പ്രസ്താവനയോടും മൂന്ന് രീതിയിൽ പ്രതികരിക്കാം. 1) യോജിക്കുന്നു 2) അഭിപ്രായമില്ല 3) വിയോജിക്കുന്നു. ഓരോ പ്രസ്താവനയും ശ്രദ്ധാപൂർവ്വം വായിക്കുകയും നിങ്ങളെ സംബന്ധിച്ച് എത്രമാത്രം ശരിയാണെന്ന് തീരുമാനിക്കുകയും ചെയ്ത ശേഷം പ്രത്യേകം തന്നിരിക്കുന്ന ഉത്തരക്കടലാസ്സിൽ അതാത് പ്രസ്താവനയുടെ നമ്പറിന് നേരെ അനുയോജ്യമായ കോളത്തിൽ ശരി (✓) ചിഹ്നം കൊണ്ട് രേഖപ്പെടുത്തുക.

1) ശാസ്ത്ര വിഷയങ്ങൾ പഠിക്കാൻ എനിക്കു കൂടുതൽ ഇഷ്ടമാണ്.
2) രസതന്ത്രപഠനം എനിക്കു വളരെ സന്തോഷം നൽകാറുണ്ട്.
3) മാനവരാശിയുടെ വികാസ പരിണാമങ്ങളിൽ രസതന്ത്രത്തിന് മുഖ്യമായ പങ്കാണുള്ളത്.
4) ശാസ്ത്ര വിഷയങ്ങളിൽ ഏറ്റവും ബുദ്ധിമുട്ടുള്ള വിഷയമാണ് രസതന്ത്രം.
5) രസതന്ത്ര സിദ്ധാന്തങ്ങൾ നന്നായി പഠിക്കണമെന്നു എനിക്ക് ആഗ്രഹമുണ്ട്.
6) രസതന്ത്രം എന്ന വിഷയം പലപ്പോഴും വളരെ സങ്കീർണ്ണമായി തോന്നാറുണ്ട്.
7) രസതന്ത്രം എന്ന വിഷയത്തോടുതന്നെ പൊതുവെ താൽപര്യകുറവാണ്.
8) ശാസ്ത്രമേളകളിൽ രസതന്ത്രവുമായി ബന്ധപ്പെട്ട പരിപാടികൾ അവതരിപ്പിക്കാറുണ്ട്.
9) രസതന്ത്രത്തെ സംബന്ധിച്ച് ക്വിസ് പരിപാടികളിൽ പങ്കെടുക്കാറുണ്ട്.
10) ആഗോള താപനം പോലെയുള്ള പ്രതിഭാസങ്ങളിൽ രസതന്ത്രത്തിന് കൂടുതൽ സംഭാവനകൾ ചെയ്യാൻ കഴിയും.
11) പച്ചക്കറികളിലും മറ്റു നിത്യോപയോഗ സാധനങ്ങളിൽ മായം ചേർക്കുന്നത് സമൂഹത്തിന് ഹാനികരമാണെന്നതിനാൽ അവയ്ക്കെതിരെ പ്രതികരിക്കാൻ തോന്നാറുണ്ട്.
12) രസതന്ത്ര വിഷയം അതിവേഗം വികസിക്കുന്ന പശ്ചാത്തലത്തിൽ നമ്മുടെ പാഠപുസ്തകങ്ങളും അതിനനുയോജ്യമായി പരിഷ്കരിക്കേണ്ടതുണ്ട്.
13) രസതന്ത്രത്തിലെ സിദ്ധാന്തങ്ങൾ വെറുതെ കാണാതെ പഠിക്കുന്നതിൽ എനിക്ക് താല്പര്യമില്ല.

14) ജീവിതവുമായി കൂടുതൽ ബന്ധമുള്ള വിഷയം എന്ന നിലയിൽ എനിക്ക് രസതന്ത്ര വിഷയത്തോടു കൂടുതൽ താത്പര്യം തോന്നാറുണ്ട്.

15) ജീവിതത്തിന്റെ സർവ്വമേഖലകളും രസതന്ത്രവുമായി ബന്ധിപ്പിക്കാൻ കഴിയും.

16) രസതന്ത്രത്തിലെ പല സിദ്ധാന്തങ്ങളും പഠിക്കാൻ എനിക്കു ബുദ്ധിമുട്ടാണ്.

17) പരീക്ഷണശാലാ പ്രവർത്തന പരിപാടികൾ കൃത്യമായും ചിട്ടയായും ഞാൻ ചെയ്തു തീർക്കാറുണ്ട്.

18) രസതന്ത്രലാബിൽ പോകാൻ തന്നെ എനിക്ക് ഭയമാണ്.

19) രസതന്ത്രലാബിലെ പരീക്ഷണങ്ങൾ ചെയ്യാൻ വളരെ ബുദ്ധിമുട്ടനുഭവിക്കുന്നു.

20) ലൈബ്രറിയിൽ നിന്നും രസതന്ത്രവുമായി ബന്ധപ്പെട്ട പുസ്തകങ്ങൾ വായിക്കാൻ എടുക്കാറുണ്ട്.

21) രസതന്ത്രാധ്യപകന്റെ ക്ലാസുകൾ വളരെയധികം അറിവുകൾ നൽകുന്നതായി അനുഭവപ്പെടാറുണ്ട്.

22) രസതന്ത്രവുമായി ബന്ധപ്പെട്ടുള്ള പ്രൊജക്റ്റുകൾ ചെയ്യാൻ വളരെ താത്പര്യമണ്.

23) രസതന്ത്രത്തെക്കുറിച്ച് കൂടുതൽ അറിയാൻ ഇന്റർനെറ്റ് ഉൾപ്പെടെയുള്ള പുതിയ സങ്കേതങ്ങൾ ഉൾപ്പെടുത്താറുണ്ട്.

24) രസതന്ത്രത്തിലെ നൂതനമായ കണ്ടെത്തലുകളെക്കുറിച്ച് അറിയാൻ എനിക്കു അതിയായ താല്പര്യമാണ്.

25) രസതന്ത്രത്തെക്കുറിച്ചു കൂടുതൽ അറിയാൻ സയൻസ് മാഗസിനുകളും പുസ്തകങ്ങളും വാങ്ങിക്കാറുണ്ട്.

26) സമൂഹത്തിന് ഉപകാരപ്രദമാകുന്ന രസതന്ത്ര പ്രൊജക്റ്റുകൾ ഏറ്റെടുക്കണമെന്ന് എനിക്കാഗ്രഹമുണ്ട്.

27) രസതന്ത്രത്തിൽ പിന്നോക്കം നിൽക്കുന്ന കുട്ടികളെ അവരുടെ പഠനത്തിൽ സഹായിക്കാറുണ്ട്.

28) ടെക്നോളജിയുടെ ഉപയോഗം വഴി രസതന്ത്രക്ലാസുകൾ ആസ്വാദ്യകരമാക്കാൻ കഴിയും.

29) ടെലിവിഷൻ ചാനലുകളിലെ രസതന്ത്രപഠന ക്ലാസുകൾ പരമാവധി ഉപയോഗപ്പെടുത്താറുണ്ട്.

30) രസതന്ത്രപഠനവുമായി ബന്ധപ്പെട്ടുണ്ടാകുന്ന ഏതു സംശയങ്ങളും രസതന്ത്രാധ്യപകനുമായി ചർച്ചചെയ്യാറുണ്ട്.

31) പരിസ്ഥിതി സംരക്ഷണ പരിപാടികളിൽ രസതന്ത്ര വിദ്യാർത്ഥികൾക്കു കൂടുതൽ സംഭാവന ചെയ്യാൻ കഴിയും എന്ന് എനിക്കുറപ്പുണ്ട്.

32) കാലാവസ്ഥ വ്യതിയാനങ്ങൾ പോലുള്ള കാര്യങ്ങളിൽ ഇടപെട്ടു രസതന്ത്ര വിദ്യാർത്ഥികൾക്കു സമൂഹത്തോട് സംവദിക്കാൻ കഴിയും.

33) രസതന്ത്ര പരീക്ഷയിൽ മാർക്കു കുറയുമ്പോൾ എനിക്ക് അതിയായ ദുഃഖം തോന്നാറുണ്ട്.

34) രാസവസ്തുക്കളെക്കുറിച്ചൊന്നും പഠിച്ചിട്ട് ജീവിതത്തിൽ യാതൊരു പ്രയോജനവുമില്ല.

35) ഐൻസ്റ്റീൻ പോലെയുള്ള ശാസ്ത്രജ്ഞന്മാരുടെ ആത്മകഥകൾ എന്നെ വളരെയധികം സ്വാധീനിച്ചിട്ടുണ്ട്.

36) ഹൈസ്കൂൾ തലത്തിൽ രസതന്ത്രം ഒരു നിർബന്ധിത വിഷയമാക്കിയതുകൊണ്ട് പ്രത്യേകിച്ച് ഒരു ഗുണവുമില്ല.

37) രസതന്ത്ര ക്ലാസ്സിൽ മറ്റെന്തെങ്കിലും വായിക്കാനോ എഴുതാനോ ആണ് എനിക്ക് കൂടുതൽ ഇഷ്ടം.

38) രസതന്ത്ര വിഷയത്തെ സംബന്ധിച്ചുള്ള ക്വിസ് മത്സരങ്ങളിൽ പങ്കെടുക്കുന്നതു കൊണ്ട് പ്രത്യേകിച്ചൊന്നും നേടാനില്ല.

39) രസതതന്ത്രവുമായി ബന്ധപ്പെട്ടുള്ള ദിനാചരണങ്ങൾ നിത്യജീവിതത്തിന് പ്രത്യേകിച്ചൊരു ഗുണവുമില്ലാത്തതാണ്.

40) യൂറിക്ക പോലെയുള്ള വിജ്ഞാനോത്സവ പരിപാടികളിൽ പങ്കെടുക്കാൻ എനിക്ക് താല്പര്യമില്ല.

41) രസതന്ത്രത്തിലെ ഓർഗാനിക് കെമിസ്ട്രി പോലെയുള്ള ഭാഗങ്ങൾ പഠിച്ച് മാർക്ക് നേടുക എന്നത് വളരെ ബുദ്ധിമുട്ടുള്ള കാര്യമാണ്.

42) വിക്ടേഴ്സ് ചാനലിൽ രസതന്ത്രവുമായി ബന്ധപ്പെട്ടുള്ള ക്ലാസുകൾ കാണാൻ എനിക്ക് ഏറെ താല്പര്യമാണ്.

Appendix X

FAROOK TRAINING COLLEGE, KOZHIKODE

Research Centre in Education, University of Calicut

SCALE OF ATTITUDE TOWARDS CHEMISTRY
(English Version)

Prof. (Dr.) T. Mohamed Saleem
Principal & Professor
Farook Training College

Sukanya Rani P
Research Scholar

Instructions:

Below are 42 statements related to your study in Chemistry. Each statement can be responded to in there ways. 1) Agree 2) No Comments 3) Disagree. After reading each statement carefully and deciding how many are true to you, mark Yes (✓) in the appropriate column against the number of the respective statement in the separate answer sheet provided.

1. I like to study Science subjects more.
2. I enjoy studying Chemistry very much.
3. Chemistry has played a major role in the progress of mankind.
4. Chemistry is one of the most difficult subjects in Science.
5. I want to study Chemistry theories well.
6. Chemistry as a subject often seems very complicated.
7. There is generally little interest in the subject of Chemistry.
8. Programmes related to Chemistry are presented in Science fairs.
9. I used to participate in quiz programmes related to Chemistry.
10. Chemistry can contribute more to phenomena such as global warming.
11. Adulteration of vegetables and other daily commodities is considered to be harmful to the society.
12. As the subject of Chemistry evolves rapidly, our text books also need to be revised accordingly.
13. I am not interested in just learning the theories of Chemistry.
14. I tend to be more interested in Chemistry as it is more related to life.
15. All areas of life can be connected to Chemistry.
16. I find it difficult to learn many theories in Chemistry.

17. I carry out laboratory work programmes in a precise and orderly manner.
18. I am afraid to go to Chemistry lab.
19. Experiments in the Chemistry lab are very difficult to do.
20. I used to take books related to Chemistry from the library.
21. Chemistry classes often sounds very informative.
22. I am very much interested in doing Chemistry related projects.
23. New techniques along with internet should be adopted to learn more Chemistry.
24. I am very interested in learning about the latest discoveries in Chemistry.
25. Science magazines and books are bought to learn more about Chemistry.
26. I want to take up Chemistry projects that will benefit the society.
27. I used to help the children who are backward in Chemistry.
28. Chemistry classes can be made more enjoyable through the use of technology.
29. Chemistry classes on television channels are utilized to the maximum extent.
30. Any doubts regarding the study of Chemistry are discussed with the Chemistry teacher.
31. I am sure that Chemistry students can contribute more in environmental protection programmes.
32. Chemistry students can interact with society by intervening on issues such as climate change.
33. I feel very sad when I fail in Chemistry exams.
34. Learning about chemicals is of no use is life.
35. Autobiographies of scientists like Einstein have influenced me greatly.
36. Making Chemistry a compulsory subject at the high school level does not do much good.
37. I prefer to read or write something else in Chemistry class.
38. There is nothing special to be gained by participating in Chemistry quiz competitions.
39. Chemistry related day celebrations are of no particular use in everyday life.
40. I am not interested in participating science fairs like Eureka.
41. It is very difficult to get marks in the areas like Organic Chemistry.
42. I am very interested to watch Chemistry classes on Victors channel.

Appendix XI

FAROOK TRAINING COLLEGE, KOZHIKODE

Research Centre in Education, University of Calicut

SCALE OF ATTITUDE TOWARDS CHEMISTRY

RESPONSE SHEET

Name of student: Class:

Division: Name of school:

Type of School: Aided/Govt. Gender:

Qn.No.	എല്ലായ്പ്പോഴും	ചിലപ്പോഴൊക്കെ	ഒരിക്കലുമില്ല
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Qn.No.	എല്ലായ്പ്പോഴും	ചിലപ്പോഴൊക്കെ	ഒരിക്കലുമില്ല
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			

Qn.No.	എല്ലായ്പ്പോഴും	ചിലപ്പോഴൊക്കെ	ഒരിക്കലുമില്ല
31			
32			
33			
34			
35			
36			
37			
38			
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40			
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42			

Appendix XII

FAROOK TRAINING COLLEGE, KOZHIKODE
Research Centre in Education, University of Calicut

SCALE OF SELF-EFFICACY IN CHEMISTRY
(Malayalam Version)

Prof. (Dr.) T. Mohamed Saleem
Principal & Professor
Farook Training College

Sukanya Rani P
Research Scholar

നിർദ്ദേശങ്ങൾ

രസതന്ത്രവിഷയത്തിൽ നിങ്ങളുടെ പഠനവുമായി ബന്ധപ്പെട്ട ഏതാനും പ്രസ്താവനകളാണ് താഴെ കൊടുത്തിട്ടുള്ളത്. ഓരോ പ്രസ്താവനയോടും മൂന്ന് രീതിയിൽ പ്രതികരിക്കാം. 1) എല്ലായ്പ്പോഴും 2) ചിലപ്പോഴൊക്കെ 3) ഒരിക്കലുമില്ല. ഓരോ പ്രസ്താവനയും ശ്രദ്ധാപൂർവ്വം വായിക്കുകയും നിങ്ങളെ സംബന്ധിച്ച് എത്രമാത്രം ശരിയാണെന്ന് തീരുമാനിക്കുകയും ചെയ്ത ശേഷം പ്രത്യേകം തന്നിരിക്കുന്ന ഉത്തരക്കടലാസ്സിൽ അതാത് പ്രസ്താവനയുടെ നമ്പറിന് നേരെ അനുയോജ്യമായ കോളത്തിൽ ശരി (✓) ചിഹ്നം കൊണ്ട് രേഖപ്പെടുത്തുക.

1) രസതന്ത്രവുമായി ബന്ധപ്പെട്ടിട്ടുള്ള വിഷയങ്ങൾ ക്ലാസിൽ അവതരിപ്പിക്കുവാൻ കഴിയുമെന്ന വിശ്വാസം എനിക്കുണ്ട്.

2) രസതന്ത്രവുമായി ബന്ധപ്പെട്ടു സെമിനാറുകളിൽ പേപ്പറുകൾ അവതരിപ്പിക്കാൻ എനിക്ക് കഴിയും.

3) രസതന്ത്രപാഠങ്ങളുമായി ബന്ധപ്പെട്ടിട്ടുള്ള സംശയങ്ങൾ ഞാൻ സുഹൃത്തുക്കളുമായി ചർച്ചചെയ്യാറുണ്ട്.

4) രസതന്ത്രാധ്യാപകനോട് സംശയങ്ങൾ ചോദിക്കാൻ ഞാൻ മടി കാണിക്കാറില്ല.

5) രസതന്ത്രത്തിന്റെ വികസന ചരിത്രം പഠിക്കാൻ എനിക്കു വളരെയധികം താൽപര്യമാണ്.

6) ഗൈഡുകളുടെയോ, സുഹൃത്തുക്കളുടെയോ സഹായത്തോടെ മാത്രമേ ഗൃഹപാഠങ്ങൾ ചെയ്യാൻ എനിക്ക് കഴിയാറുള്ളു.

7) ഗൃഹാവശ്യത്തിനായി കടകളിൽ നിന്ന് സോപ്പ്, ഡിറ്റർജന്റ് തുടങ്ങിയ സാധനങ്ങൾ വാങ്ങുമ്പോൾ രസതന്ത്രത്തിലൂടെ നേടിയ അറിവ് ഞാൻ ഉപയോഗപ്പെടുത്താറുണ്ട്.

8) ഒരു രസതന്ത്രജ്ഞൻ ആവാൻ വേണ്ടുന്ന വൈദഗ്ധ്യത്തെ കുറിച്ചോർക്കുമ്പോൾ എനിക്ക് അതിയായ പ്രതീക്ഷയാണ് അനുഭവപ്പെടുന്നത്.

9) രസതന്ത്ര പാഠങ്ങൾ സ്വയം വായിച്ചു മനസ്സിലാക്കാൻ എനിക്കു ബുദ്ധിമുട്ടാണ്.

10) രസതന്ത്രത്തിലെ പല ആശയങ്ങളും വസ്തുതകളും പൂർണ്ണമായി ഉൾക്കൊള്ളാൻ എനിക്ക് പ്രയാസമാണ്.

11) രസതന്ത്രവുമായി ബന്ധപ്പെട്ടുള്ള ലാബ് പരീക്ഷണങ്ങൾ ചെയ്യാൻ എനിക്കു സാധിക്കാറുണ്ട്.

12) രസതന്ത്രപഠനവുമായി ബന്ധപ്പെട്ട് സഹപാഠികൾക്കുണ്ടാകുന്ന ബുദ്ധിമുട്ടുകൾ ദൂരീകരിക്കാൻ ഞാൻ ശ്രമിക്കാറുണ്ട്.

13) രസതന്ത്ര പഠനവുമായി ബന്ധപ്പെട്ടുള്ള ഏതു കാര്യങ്ങൾ ചെയ്യുമ്പോഴും അതിന്റെ ആശയവും ആവശ്യകതയും ഉൾക്കൊള്ളാനായി ഞാൻ കൂടുതൽ ശ്രദ്ധ പുലർത്താറുണ്ട്.

14) പരീക്ഷഫലം വരുന്നതിന് മുൻപുതന്നെ ഉയർന്ന വിജയം നേടാനാവുമെന്ന വിശ്വാസം എനിക്കുണ്ടാകാറുണ്ട്.

15) രസതന്ത്ര പരീക്ഷയുമായി ബന്ധപ്പെട്ടുണ്ടാകുന്ന പ്രയാസങ്ങൾ പലപ്പോഴും എന്നെ കൂടുതൽ അലോസരപ്പെടുത്താറുണ്ട്.

16) രസതന്ത്ര പാഠങ്ങളിലെ ആശയങ്ങൾ വ്യക്തമായി ഉൾക്കൊള്ളാൻ പലപ്പോഴും എനിക്കു കഴിയാറില്ല.

17) രസതന്ത്ര അധ്യാപകരോട് എനിക്കു മാനസികമായി അടുപ്പം കുറവാണ്.

18) രസതന്ത്രത്തിലെ അസൈൻമെന്റുകൾ എഴുതാൻ എനിക്ക് പൊതുവെ മടുപ്പാണ്.

19) രസതന്ത്രം എന്ന വിഷയം സ്വയം പഠിക്കാനുള്ള കഴിവ് എനിക്കുണ്ട്.

20) രസതന്ത്ര ലാബിലെ വിവിധ രാസവസ്തുക്കൾ ഏതെല്ലാമാണെന്ന് കൃത്യമായി തിരിച്ചറിയാൻ എനിക്കുകഴിയും.

21) രസതന്ത്രവുമായി ബന്ധപ്പെട്ടുള്ള പ്രൊജക്ടുകൾ ഏറ്റെടുത്ത് നടത്താനുള്ള പ്രാപ്തി എനിക്കുണ്ട്.

22) രസതന്ത്ര പാഠങ്ങളുമായി ബന്ധപ്പെട്ട ആശയങ്ങൾ പൂർണ്ണമായും ഉൾക്കൊള്ളാൻ എനിക്ക് കഴിയാറുണ്ട്.

23) രസതന്ത്രവുമായി ബന്ധപ്പെട്ടുള്ള കാര്യങ്ങൾ താൽപര്യമുള്ളവർക്ക് പറഞ്ഞുകൊടുക്കുന്നതിൽ എനിക്ക് അതിയായ സന്തോഷമണുള്ളത്.

24) രസതന്ത്രലാബിൽ നടത്തുന്ന നിരീക്ഷണ പരീക്ഷണ പ്രവർത്തനങ്ങളിൽ സഹപാഠികളെ സഹായിക്കാൻ എനിക്ക് കഴിയാറുണ്ട്.

25) രസതന്ത്ര പരീക്ഷകളും, ക്ലാസുകളിലെ മറ്റു പ്രവർത്തന പരിപാടികളും അഭിമുഖീകരിക്കേണ്ടിവരുമ്പോൾ എനിക്കു ഭയം തോന്നാറില്ല.

26) രസതന്ത്രവുമായി ബന്ധപ്പെട്ടുള്ള ഏതു അറിവുകളും പരമാവധി ശേഖരിക്കാൻ ഞാൻ ശ്രമിക്കാറുണ്ട്.

27) രസതന്ത്രത്തിലെ പുതിയ സാധ്യതകളെക്കുറിച്ച് ഞാൻ ബോധവാനാണ്.

28) രസതന്ത്രപാഠപുസ്തകത്തിലെ കാര്യങ്ങൾ എന്റെ സഹപാഠികളെക്കൂടി പഠിപ്പിക്കാൻ മാത്രം കഴിവെനിക്കുണ്ട്.

29) രസതന്ത്രപഠനവുമായി ബന്ധപ്പെട്ട ലാബിൽ ഏതു രാസവസ്തുക്കൾ കൈകാര്യം ചെയ്യാനും എനിക്കു കഴിയുമെന്ന വിശ്വാസമെനിക്കുണ്ട്.

30) രസതന്ത്രത്തിലെ പ്രയാസമേറിയ ലാബ് പ്രവർത്തനങ്ങൾപോലും പൂർത്തിയാക്കാൻ എനിക്ക് സാധിക്കാറുണ്ട്.

31) ഉചിതമായ രീതിയിൽ പഠനപ്രവർത്തനങ്ങൾ ചെയ്തുതീർക്കാൻ എനിക്കു കഴിയാറുണ്ട്.

32) രസതന്ത്ര സംബന്ധമായ ചർച്ചകളിൽ സുഹൃത്തുക്കളോടൊപ്പം ആത്മവിശ്വാസത്തോടെ ഞാനും പങ്കെടുക്കാറുണ്ട്.

33) മറ്റു കുട്ടികൾക്ക് രസതന്ത്ര ഗൃഹപാഠങ്ങൾ ചെയ്യേണ്ട രീതികൾ ഞാൻ പറഞ്ഞുകൊടുക്കാറുണ്ട്.

34) രസതന്ത്രത്തിലെ ലാബിലെ വിവിധ ഉപകരണങ്ങളെ എനിക്കു തിരിച്ചറിയാൻ കഴിയാറുണ്ട്.

35) രസതന്ത്രവുമായി ബന്ധമുള്ള ഏത്തരം ജോലിയും ചെയ്യാൻ എനിക്ക് കഴിയും.

36) രസതന്ത്രത്തിൽ ഞാൻ ചെയ്യുന്ന പ്രൊജക്റ്റുകൾക്ക് നല്ല അഭിപ്രായം കിട്ടാറുണ്ട്.

37) പരീക്ഷാസമയത്ത് രസതന്ത്ര സമവാക്യങ്ങൾ ഓർത്തെടുക്കാൻ എനിക്കു സാധിക്കാറുണ്ട്.

Appendix XIII

FAROOK TRAINING COLLEGE, KOZHIKODE

Research Centre in Education, University of Calicut

SCALE OF SELF-EFFICACY IN CHEMISTRY
(English Version)

Prof. (Dr.) T. Mohamed Saleem
Principal & Professor
Farook Training College

Sukanya Rani P
Research Scholar

Instructions:

Below are 37 statements related to your study in Chemistry. Each statement can be responded to in there ways. 1) Always 2) Sometimes 3) Never. After reading each statement carefully and deciding how many are true to you, mark Yes (✓) in the appropriate column against the number of the respective statement in the separate answer sheet provided.

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1. I believe that topics related to Chemistry can be presented in class.
2. I can present papers in Chemistry related seminars.
3. I used to discuss doubts related to Chemistry lessons with my friends.
4. I don't hesitate to ask questions to Chemistry teacher.
5. I am very interested in studying the history of the development of Chemistry.
6. I can do homework only with the help of guides or friends.
7. I use the knowledge gained through Chemistry when I buy things like soap, detergent, etc. from the shops for household purposes.
8. I feel a sense of hope when I think about the skills it takes to become a chemist.
9. I find it difficult to read and understand Chemistry.
10. I find it difficult to fully grasp many concepts and facts in Chemistry.
11. I can do lab experiments related to Chemistry.
12. I try to remove the difficulties faced by my classmates regarding the study of Chemistry.
13. Whenever I do anything related to the study of Chemistry, I take extra care to understand its concept and requirements.

14. I have the belief that I can achieve high success even before the exam result comes.
15. Difficulties associated with Chemistry exams often annoy me more.
16. Often I am not able to grasp concepts clearly in Chemistry lessons.
17. I have little emotional attachment to Chemistry teachers.
18. I am generally tired of writing assignments in Chemistry.
19. I have the ability to study Chemistry on my own.
20. I can identify each and every chemicals in a Chemistry lab.
21. I have the ability to undertake and carry out Chemistry related projects.
22. I can fully grasp the concepts related to Chemistry.
23. I am very happy to share Chemistry related topics with those who are interested.
24. I am able to help my classmates in observational experiments in Chemistry Lab.
25. I don't feel scared when I have to face Chemistry tests and other activities in class.
26. I try to gather as much knowledge as I can in Chemistry.
27. I am aware of new possibilities or opportunities in Chemistry.
28. I have the ability to teach my classmates what is in the Chemistry text book.
29. I am confident that I can handle any chemical in the Chemistry lab.
30. I am able to complete even the most difficult lab activities in Chemistry.
31. I am able to complete learning activities appropriately.
32. I confidently participate in the discussions related to Chemistry with my friends.
33. I help other children to study Chemistry lessons.
34. I can identify different equipments in the Chemistry lab.
35. I can do any type of work related to Chemistry.
36. My projects in Chemistry get good feedback from my teachers and friends.
37. I can memorize Chemistry equations during examinations.

Appendix XIV

FAROOK TRAINING COLLEGE, KOZHIKODE

Research Centre in Education, University of Calicut

SCALE OF SELF-EFFICACY IN CHEMISTRY

RESPONSE SHEET

Name of student: Class:

Division: Name of school:

Type of School: Aided/Govt. Gender:

Qn.No.	എല്ലായ്പ്പോഴും	ചിലപ്പോഴൊക്കെ	ഒരിക്കലുമില്ല
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Qn.No.	എല്ലായ്പ്പോഴും	ചിലപ്പോഴൊക്കെ	ഒരിക്കലുമില്ല
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			

Qn.No.	എല്ലായ്പ്പോഴും	ചിലപ്പോഴൊക്കെ	ഒരിക്കലുമില്ല
31			
32			
33			
34			
35			
36			
37			

Appendix XV

FARROOK TRAINING COLLEGE, KOZHIKODE

Research Centre in Education, University of Calicut

ACHIEVEMENT TEST IN CHEMISTRY FOR IX STANDARD PUPILS OF KERALA (Malayalam Version)

Prof. (Dr.) T. Mohamed Saleem
Principal & Professor
Farook Training College

Sukanya Rani P
Research Scholar

നിർദ്ദേശങ്ങൾ

9-ാം ക്ലാസ്സ് വിദ്യാർത്ഥികളുടെ രസതന്ത്രവിഷയത്തിലുള്ള പരിജ്ഞാനം എത്ര ത്തോളമുണ്ട് എന്ന് വിലയിരുത്തുന്നതിനുള്ള ഒരു ടെസ്റ്റാണ് ഇത്. ഈ ടെസ്റ്റിൽ ആകെ 60 ചേദ്യങ്ങളാണുള്ളത്. ഓരോ ചോദ്യത്തിന് നേരെയും നാല് ഉത്തരങ്ങൾ കൊടുത്തിട്ടുണ്ട്. ഓരോ ചോദ്യവും വായിച്ച് ഇവയിൽ ഏറ്റവും അനുയോജ്യമായ ഉത്തരം ശരി ചിഹ്നം (✓) ഉപയോഗിച്ച് രേഖപ്പെടുത്തുക. ശരിയായ ഓരോ ഉത്തരത്തിനും ഒരു മാർക്ക് വീതം

1. രണ്ടോ അതിലധികമോ മൂലകങ്ങളുടെ ആറ്റങ്ങൾ സംയോജിച്ചാണ് ഉണ്ടാകുന്നത്.

   A. സംയുക്തങ്ങൾ B. ആറ്റങ്ങൾ C. മൂലകങ്ങൾ D. തന്മാത്രകൾ

2. ആറ്റത്തിന്റെ നെഗറ്റീവ് ചാർജ്ജുള്ള കണത്തെ പറയുന്ന പേരെന്താണ്?

   A. പ്രോട്ടോൺ B. ന്യൂട്രോൺ C. ഇലക്ട്രോൺ D. ന്യൂക്ലിയസ്

3. ആറ്റത്തിന്റെ സൗരയൂഥ മാതൃക കൊണ്ടുവന്നതാര്?

   A. റൂഥർഫോർഡ് B. ജെയിംസ് ചാഡ്‌വിക്ക

   C. ജെ.ജെ തോംസൺ D. വില്യം കുക്സ്

4. ഒരു ആറ്റത്തിലുള്ള പ്രോട്ടോണുകളുടെ ആകെ എണ്ണത്തെ ആ ആറ്റത്തിന്റെ ---- എന്നു സൂചിപ്പിക്കുന്നു.

   A. ആറ്റോമിക നമ്പർ B. ao meud

   C. ആറ്റോമിക മാസ്സ് D. മോളിക്കുലാർ മാസ്സ്

5. ഏതൊരു ആറ്റത്തിൻറെയും ബാഹ്യതമല്ലിൽ ഉൾക്കൊള്ളാവുന്ന പരമാവധി ഇലക്ട്രോണുകളുടെ എണ്ണം എത്രയാണ്?

   A. 6 B. 8 C. 10 D. 14

6. രണ്ടു ജോഡി ഇലക്ട്രോൺ പങ്കുവെച്ചുണ്ടാകുന്ന സഹസംയോജക ബന്ധം

   A. ദ്വിബന്ധനം B. ത്രിബന്ധനം C. രാസബന്ധനം D. അയോണികബന്ധനം

7. മഗ്നീഷ്യം ക്ലോറോഡിന്റെ മാസസത്രം ഏതായിരിക്കും?

   A. $MgCl_2$ B. MgCL C. Mg_2Cl_2 D. $MnCl_2$

8. സ്വയം സ്ഥിരമായ രാസമാറ്റത്തിന വിധേയമാകാതെ രാസപ്രവർത്തനത്തെ വേഗത്തിൽ മാറ്റമുണ്ടാകുന്ന പദാർത്ഥങ്ങളാണ്

A. ഉൽപ്രേരകം B. രാസബന്ധനം C. സംയോജകത D. അയോണിക ബന്ധനം

9. സംഗീതത്തിലെ സപ്തസ്വരങ്ങളുമായി ബന്ധപ്പെട്ട് കൊണ്ടുവന്ന നിയമം ഏതാണ്?

A. പീരിയോഡിക് നിയമം B. അഷ്ടകനിയമരം

C. ആധുനിക പീരിയോഡിക് നിയമം D. ത്രികങ്ങൾ

10. ഇലക്ട്രോൺ വിട്ടുകൊടുത്ത് പോസിറ്റീവ് അയോണുമായി മാറുന്നതിനാൽ ലോഹങ്ങളെ ഏതുപേരിൽ അറിയപ്പെടുന്നു.

A. ഇലക്ട്രോ പോസിറ്റീവ് B. ഇലക്ട്രോ നെഗറ്റീവ്

C. സംക്രമണമൂലകങ്ങൾ D. ഉൽകൃഷ്ട വാതകങ്ങൾ

11. ആസിഡുകൾ കാർബണേറ്റുകളുമായി പ്രവർത്തിക്കുമ്പോൾ -- വാതകം സ്വ തന്ത്രമാകുന്നു.

A. കാർബൺഡൈ ഓക്സൈഡ് B. ക്ലോറിൻ

C. ഓക്സിജൻ D. ഹൈഡ്രജൻ

12. കറിയുപ്പിന്റെ രാസനാമം എഴുതുക

A. NaCl B. NaOH C. $NaCo_3$ D. Na_2CO_3

13. കത്തുന്ന വായു എന്നറിയപ്പെടുന്ന മൂലകം ഏതാണ്?

A. ഹൈഡ്രജൻ B. ഓക്സിജൻ

C. കാർബൺ D. ക്ലോറിൻ

14. പ്രകൃതിയിൽ മൂലകാവസ്ഥയിലും സംയുക്ത രൂപത്തിലും കാണപ്പെടുന്ന ഒരു മൂലകത്തിന്റെ പേരെന്താണ്?

A. കാർബൺ B. നൈട്രജൻ

C. ഓക്സിജൻ D. ക്ലോറിൻ

15. കോക്ക്, കൽക്കരി, മരക്കരി, എല്ലുകരി തുടങ്ങിയ ഏതിന്റെ രൂപാന്തരങ്ങളാണ്

A. കാർബൺ B. നൈട്രജൻ

C. ഓക്സിജൻ D. ഹൈഡ്രജൻ

16. ....ആണവനിലയങ്ങളിൽ ഇന്ധനമായി ഉപയോഗിക്കുന്നു.

A. യുറേനിയം 235 B. അയഡിൻ 131

C. കോബാൾട്ട് 60 D. ഹൈഡ്രജൻ

17. വൈദ്യുതിയുടെ പിതാവ് എന്നറിയപ്പെടുന്ന ആരെയാണ്

A. മൈക്കൽ ഫാരഡെ B. സർ ഹംഫ്രിഡേവി

C. ഹെന്റിച്ച് ഗ്ലിസ്റ്റർ D. ജ്യൂലിയാസ് ഫ്ളക്കർ

18. ഓരോ ഷെല്ലിലും ഇലക്ട്രോണുകൾക്ക് ഒരു നിശ്ചിത ഊർജമുണ്ട്. അതിനാൽ ആ ഷെല്ലുകളെ പറയുന്ന പേരെന്താണ്?

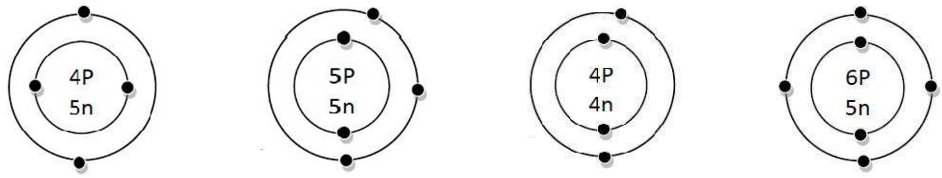
A. ഊർജനിലകൾ B. ആറ്റോമിക നമ്പർ

C. മാസ്സ് നമ്പർ D. ന്യൂക്ലിയസ്

19. K-ഷെല്ലിൽ ഉൾക്കൊള്ളുന്ന പരമാവധി ഇലക്ട്രോണുകളുടെ എണ്ണം എത്രയാണ്?

A. 2 B. 6 C. 8 D. 10

20. ബെറിലിയം മൂലകത്തിന്റെ ബോർ മാതൃക ഏതെന്ന് കണ്ടെത്തുക.



A. B. C. D.

21. കാർബണിക ഐസോടോപ്പായ.............. ഫോസിലുകളുടെയും ചരിത്രാതീത കാലത്തെ വസ്തുക്കളുടെയും കാലപ്പഴക്കം നിർണയിക്കാൻ ഉപയോഗിക്കുന്നു.

A. ഡ്യൂട്ടീരിയം B. കാർബൺ-14

C. ട്രിഷിയം D. പ്രോട്ടിയം

22. ബാഹ്യമത ഷെല്ലിൽ 8 ഇലക്ട്രോൺ വരുന്ന ക്രമീകരണം ......എന്നറിയപ്പെടുന്നു

A. അയോണിക സംയുക്തങ്ങൾ B. സഹസംയോജക ബന്ധനം

C. അഷ്ടക ഇലക്ട്രോൺ വിന്യാസം D. അയോണ്ക ബന്ധനം

23. മൂന്ന് ജോഡി ഇലക്ട്രോൺ പങ്കുവെച്ചുണ്ടാകുന്ന സഹസംയോജക ബന്ധനം ....എന്നറിയപ്പെടുന്നു.

A. ദ്വിബന്ധനം B. ത്രിബന്ധനം C. ഏകബന്ധനം D. രാസബന്ധനം

24. രാസപ്രവർത്തനവേഗം വർദ്ധിപ്പിക്കുന്ന ഉൽപ്രേരകത്തെ പറയുന്നതെന്താണ്?.

A. പോസിറ്റീവ് ഉൽപ്രേരകം B. നെഗറ്റീവ് ഉൽപ്രേരകം

C. അഭികാരകം D. ഉൽപ്രേരകം

25. പീരിയോഡിക് ടേബിളിൽ 3 മുതൽ 12 വരെയുള്ള ഗ്രൂപ്പുകളിൽ ഉൾപ്പെടുന്ന മൂലകങ്ങളുടെ പേരെന്താണ്?

A. സംക്രമണമൂലകങ്ങൾ B. ഉൽകൃഷ്ടമൂലകങ്ങൾ

C. ലാൻഥനോയ്ഡുകൾ D. ആക്റ്റിനൈഡുകൾ

26. കാസ്റ്റിക് സോഡയുടെ രാസനാമം എന്താണ്?

A. NAOH B. $NaCO_3$ C. $NaHCO_3$ D. Na_2CO_3

27. കാർബണിന്റെ ഏറ്റവും കാഠിന്യമുള്ള രൂപാന്തരമാണ്…………

A. വജ്രം B. ഗ്രാഫൈറ്റ് C. കാർബൺ D. Co2

28. താഴെ പറയുന്നവയിൽ വജ്രത്തിന്റെ സവിശേഷത അല്ലാത്തത് ഏത്

A. കാഠിന്യം വളരെ കൂടുതൽ B. സുതാര്യം

C. കുറഞ്ഞ താപ ചാലകത D. വൈദ്യുത ചാലകമല്ല

29. കാർബണും ഹൈഡ്രജനും മാത്രം അടങ്ങിയ സംയുക്തങ്ങളാണ്……… എന്നറിയപ്പെടുന്നു.

A. ഹൈഡ്രോ കാർബൺ B. മീഥൈൻ C. ഈഥൈൻ D. പ്രൊപൈൻ

30. വൈദ്യുതി കടത്തിവിട്ട് ദ്രാവക പദാർത്ഥങ്ങളെ അവയുടെ ഘടകങ്ങളാക്കി മാറ്റുന്ന പ്രക്രിയയാണ്……………

A. വൈദ്യുതവിശ്ലേഷണം B. വൈദ്യുത ലേപനം

C. രാസബന്ധനം D. സംയോജകത

31. L ഷെല്ലിൽ ഉൾക്കൊള്ളുന്ന പരമാവധി ഇലക്ട്രോണുകളുടെ എണ്ണം എത്രയാണ്?.

A. 2 B. 6 C. 8 D. 10

32. ഒരേ ആറ്റോമിക നമ്പറും വ്യത്യസ്ത മാസ്സ് നമ്പറുമുള്ള ഒരു മൂലകത്തിന്റെ വ്യത്യസ്ത ആറ്റങ്ങളെ പറയുന്ന പേരെന്താണ്?

A. ഐസോബാറുകൾ B. ഐസോടോണുകൾ

C. ഐസോടോപ്പുകൾ D. രാസബന്ധനം

33. അയോണിക ബന്ധനം വഴിയുണ്ടാകുന്ന സംയുക്തങ്ങൾ……… എന്നറിയപ്പെടുന്നു

A. അയോണിക സംയുക്തങ്ങൾ B. അയോണിക ബന്ധനം

C. രാസബന്ധനം D. സംയോജകത

34. സംയോജകത ബന്ധനം വഴി ഉണ്ടാകുന്ന സംയുക്തങ്ങളാണ്

A. അയോണിക സംയുക്തങ്ങൾ B. സഹസംയോജക സംയുക്തങ്ങൾ

C. സഹസംയോജക ബന്ധനം D. രാസബന്ധനം

35. ഇലക്ട്രോണിനെ സ്വീകരിക്കുന്ന പ്രവർത്തനമാണ്

A. ഓക്സീകരണം B. നിരോക്സീകരണം

C. സംയോജകത D. രാസബന്ധനം

36. ആധുനിക പീരിയോഡിക് നിയമപ്രകാരം മൂലകങ്ങളുടെ രാസഗുണങ്ങളും, ഭൗതികഗുണങ്ങളും അവയുടെ ……………..ആവർത്തന ഫലമാണ്

A. അറ്റോമിക നമ്പർ B. അറ്റോമിക മാസ്സ്

C. അഷ്ടക നിയമം D. മാസ്സ് നമ്പർ

37. ലാൻഥനോയഡുകൾ എന്ത് പേരിലറിയപ്പെടുന്നു?

A. റെയർ എർത്ത്സ് B. സംക്രമണ മൂലകങ്ങൾ

C. ഉൽകൃഷ്ട വാതകങ്ങൾ D. ത്രികങ്ങൾ

38. ലോഹങ്ങളുടെയും, അലോഹങ്ങളുടെയും സ്വഭാവങ്ങൾ പ്രദർശിപ്പിക്കുന്ന മൂലകങ്ങളാണ്

A. ഉപലോഹങ്ങൾ B. സംക്രമണ മൂലകങ്ങൾ

C. ഉൽകൃഷ്ട വാതകങ്ങൾ D. ത്രികങ്ങൾ

39. ബേസികത........ ആണെങ്കിൽ അതിനെ ഏകബേസിക ആസിഡ് എന്നുപറയുന്നു.

A. 1 B. 2 C. 3 D. 4

40. അന്തരീക്ഷവായുവിൽ ഏറ്റവും കൂടുതൽ അടങ്ങിയിരക്കുന്ന വാതകം എതാണ്?

A. നൈട്രജൻ B. ഓക്സിജൻ

C. ഹൈഡ്രജൻ D. കാർബൺ

41. മൂന്ന് ഓക്സിജൻ ആറ്റങ്ങൾ ചേർന്ന ത്രയാറ്റോമിക തന്മാത്രയാണ്.............

A. ഓസോൺ B. നിയോൺ

C. ഹീലിയം D. ഓക്സിജൻ

42. ഒരേ മൂലകത്തിന്റെ ആറ്റങ്ങൾക്ക് പരസ്പരം സംയോജിക്കുവാനുള്ള കഴിവിനെയാണ്.........

A. കാറ്റിനേഷൻ B. റിഡോക്സ് റിയാക്ഷൻ

C. വിഘടനം D. വൈദ്യുതലേപനം

43. ഏതൊരു മൂലകത്തിന്റെയും ആറ്റങ്ങൾ നിർമ്മിച്ചിരിക്കുന്നത് പ്രധാനമായും ഇലക്ട്രോൺ .... ന്യൂട്രോൺ എന്നീ കണങ്ങൾ കൊണ്ടാണ്.

A. പ്രോട്ടോൺ B. ഹൈഡ്രജൻ

C. ന്യൂക്ലിയസ് D. നൈട്രജൻ

44. പ്രോട്ടിയം, ഡ്യൂട്ടീരിയം, ട്രിഷിയം എന്നിവ ....ന്റെ ഐസോടോപ്പുകൾ ആണ്

A. ഹൈഡ്രജൻ B. നൈട്രജൻ

C. ഓക്സിജൻ D. കാർബൺ

45. വീട്ടിൽ അഗ്നിബാധ സംഭവിക്കുകയാണെങ്കിൽ ഉപയോഗിക്കുവാനായി ഒരു അഗ്നിശമനി തയ്യാറാക്കുവാൻ അധ്യാപകൻ നിർദ്ദേശിക്കുന്നു. നിങ്ങൾ ഏതൊക്കെ ഘടകങ്ങൾ ഇതിനായി ഉപയോഗിക്കും

A. അലക്കുകാരവും സോഡാവാട്ടറും

B. അലക്കുകാരവും ജലവും

C. അപ്പക്കാരവും വിനാഗിരിയും

D. അപ്പക്കാരവും നേർപ്പിച്ച ഹൈഡ്രോക്ലോറിക് ആസിഡും

46. മാസ ബന്ധനത്തിലൂടെ ആറ്റങ്ങൾ ബാഹ്യ ഷെല്ലിൽ ……….. ഇലക്ട്രോൺ നേടി സ്ഥിരത കൈവരിക്കുന്നു.

A. 2 B. 6 C. 8 D. 10

47. ജലത്തിന്റെ വിഭിന്ന സവിശേഷതകൾക്ക് അടിസ്ഥാനം……………സ്വാഭാവമാണ്

A. പോളാർ B. അയോണിക സ്വാഭാവം

C. സംയോജകത D. അഷ്ടക വിന്യാസം

48. മൂലകങ്ങളെ ലോഹങ്ങൾ, അലോഹങ്ങൾ എന്നും വർഗീകരിച്ച ശാസ്ത്രീകരിച്ച ശാസ്ത്രജ്ഞൻ ആരാണ്?

A. ലാവോസിയ B. ഡൊബെറെയ്നർ

C. ന്യൂലാൻസ് D. മെൻഡലിയഫ്

49. പീരിയോഡിക് ടേബിളിൽ ഒരു ഗ്രൂപ്പിൽ രുകളിൽ നിന്ന് താഴോട്ട് പോകുന്തോറും ഷെല്ലുകളുടെ എണ്ണം വർദ്ധിക്കുന്നതിനാൽ മൂലകങ്ങളുടെ അതിന്റെ………….. വർദ്ധിച്ചുവരുന്നു.

A. വലുപ്പം B. ആറ്റോമിക നമ്പർ

C. ആറ്റോമിക മാസ്സ് D. മാസ്സ് നമ്പർ

50. ചുവടെ തന്നിരിക്കുന്നവയിൽ അന്തരീക്ഷ മലിനീകരണത്തിനുള്ള പരിഹാരമാർഗങ്ങളിൽ ഉൾപ്പെടാത്തത് ഏത്?

A. വൃക്ഷലതാതികൾ നട്ടുവളർത്തുക

B. വാഹനങ്ങളുടെ അമിത ഉപയോഗം കുറയ്ക്കുക

C. വിറക് കൽക്കരി തുടങ്ങിയ പ്രകൃതിദത്ത ഇന്ധനങ്ങൾ ഉപയോഗിക്കുക

D. വ്യവസായശാലകളുടെ എണ്ണം നിയന്ത്രിക്കുക.

51. പുളിശ്ശേരി അലൂമിനിയം പാത്രത്തിൽ പാകം ചെയ്യാൻ പാടില്ലെന്ന് ദാമു അമ്മയോടു പറഞ്ഞു. എന്തായിരിക്കും ദാമു ഇങ്ങനെ പറയാൻ കാരണം?

A. അലൂമിനിയം പാത്രത്തിൽ വെക്കുമ്പോൾ പുളിശ്ശേരിയുടെ രുചി കുറയും

B. ആസിഡും ലോഹവുമായി പ്രവർത്തിച്ച് വിഷവസ്തു ഉല്പ്പാദിപ്പിക്കപ്പെടുന്നു

C. അലൂമിനിയം പാത്രത്തേക്കാൾ നല്ലത് ചെമ്പ് പാത്രമായതുകൊണ്ട്.

D. കൂടുതൽ ഇന്ധനചെലവ് ഉണ്ടാകുന്നു.

52. നിങ്ങളുടെ വീട്ടിൽ പാചകം ചെയ്തതിനുശേഷം ബാക്കിവരുന്ന പച്ചക്കറിയുടെയും മാംസോൽപന്നങ്ങളുടെയും അവശിഷ്ടങ്ങൾ താഴെ പറയുന്ന ഏതുരീതിയിൽ നിങ്ങൾ കൈകാര്യം ചെയ്യും.

A. അവശിഷ്ടങ്ങൾ സഞ്ചിയിലാക്കി പൊതുസ്ഥലങ്ങളിൽ നിക്ഷേപിക്കും

B. അവശിഷ്ടങ്ങൾ പഞ്ചായത്തുകൾ സ്ഥാപിച്ചിട്ടുള്ള മാലിന്യ സംഭരണ ബോക്സുകളിൽ നിക്ഷേപിക്കും

C. അവശിഷ്ടങ്ങൾ സംസ്കരിച്ച് പ്രകൃതിദത്ത വളങ്ങളാക്കി വീട്ടിലേക്ക് പച്ചക്കറി കൃഷിക്കും ചെടികളുടെ പരിപാലനത്തിനും ഉപയോഗിക്കുന്നു.

D. വീട്ടിലെ പറമ്പിൽ ഒഴിഞ്ഞ സ്ഥലത്ത് അവശിഷ്ടങ്ങൾ നിക്ഷേപിക്കും.

53. ആസിഡുകൾ പ്രവർത്തനശേഷി കൂടിയ ലോഹങ്ങളുമായി പ്രവർത്തിക്കുമ്പോൾ....... വാതകം ഉണ്ടാകുന്നു.

A. ഹൈഡ്രജൻ B. ഓക്സിജൻ

C. നൈട്രജൻ D. കാർബൺ

54. പി വി സിയുടെ ഘടകമൂലകങ്ങൾ ഏതൊക്കെയാണ്?

A. കാർബൺ, ഹൈഡ്രജൻ, ഓക്സിജൻ

B. കാർബൺ, നൈട്രജൻ, ഓക്സിജൻ

C. കാർബൺ, ഓക്സിജൻ, ബോറോൺ

D. കാർബൺ, നൈട്രജൻ, ബോറോൺ

55. റഫ്രിജറേറ്റർ. എ.സി മുതലായവയിൽ ഉപയോഗിക്കുന്ന സംയുക്തം ഏതാണ്?

A. ക്ലോറോഫ്ളൂറോ കാർബൺ

B. കാർബൺ ഡൈ ഓക്സൈഡ്

C. നൈട്രസ് ഓക്സൈഡ്

D. കാർബൺ ടെട്രാക്ലോറൈഡ്

56. അന്തരീക്ഷവായുവിൽ CO, ന്റെ അളവ് വർദ്ധിക്കുന്നതുമൂലം അന്തരിക്ഷ താപനില ഉയരുന്നതിനെ .... എന്നുപറയുന്നു

A. ഹരിതാലയ പ്രഭാവം

B. കാറ്റിനേഷൻ

C. ഓക്സിഡേഷൻ

D. റിഡോക്സ് റിയാക്ഷൻ

57. ഫോസ്ഫോറിക് ആസിഡിന്റെ (H.PO,)അയോണീകരണ സമാക്യം എഴുതുക

A. $H_3PO_4 \longrightarrow 3^{H+} + PO_4^{2-}$ B.$H_3PO_4 \longrightarrow H^+ + PO_4^{2-}$

C. $H_3PO_4 \longrightarrow 2^{H+} + PO_4^{2-}$ D. $H_3PO_4 \longrightarrow 4^{H+} + PO_4^{2-}$

58. സോഡിയം ഹൈഡ്രോക്സൈഡും നേർപ്പിച്ച ഹൈഡ്രോക്ലോറിക് ആസിഡും തമ്മിലുള്ള നിർവിരീകരണ പ്രവർത്തനത്തിന്റെ രാസസമവാക്യം ഏതെന്നു കണ്ടെത്തുക.

A. $NaOH + HCl \longrightarrow NaCl + H_2O$ B. $NaOH + HCl \longrightarrow NaCl + H_2Cl$

C.$NaOH + HCl \longrightarrow NaH + HOCl$ D.$NaOH + HCl \longrightarrow NaH_2 + ClO$

59. സൂര്യനിലും നക്ഷത്രങ്ങളിലും മുഖ്യഘടകം ഏതാണ്?

A. ഹൈഡ്രജൻ B. ഓകസജിൻ

C. കാർബൺ D. നൈട്രജൻ

60. വസ്തുക്കൾ കത്തുമ്പോൾ കറുത്തപുക ഉണ്ടാകാനുള്ള കാരണം എന്താണ്

A. കാർബൺ

B. ഓക്സിജൻ

C. ഹൈഡ്രജൻ

D. ക്ലോറിൻ

Appendix XVI

FAROOK TRAINING COLLEGE, KOZHIKODE

Research Centre in Education, University of Calicut

ACHIEVEMENT TEST IN CHEMISTRY FOR IX STANDARD PUPILS OF KERALA (English Version)

Prof. (Dr.) T. Mohamed Saleem
Principal & Professor
Farook Training College

Sukanya Rani P
Research Scholar

Instructions:

It is a test to assess the knowledge level of 9th standard students in the subject Chemistry. There are 60 questions in this test. Four options are given to each question. Read each question and mark the most appropriate answer of these four options with a tick mark (✓). You will get one mark for each correct answer.

1. is formed by the combination of two or more atoms.

   A. Compound B. Atom C. Element D. Molecule

2. What is called a negatively charged Particle of an Atom?

   A. Proton B. Neutron C. Electron D. Nucleus

3. Who introduced the solar system model of the Atom?

   A. Ernest Rutherford B. James Chadwick

   C. J.J. Thomson D. William Crookes

4. The total number of protons in an atom indicates its ....

   A. Atomic Number B. Mass Number

   C. Atomic Mass D. Molecular Mass

5. What is the maximum number of electrons that can be contained in the outermost shell of any Atom?

   A. 6 B.8 C. 10 D. 14

6. What is the Covalent bond by two pairs of electrons?

   A. Binary Bonding B. Tertiary Bonding

   C. Chemical Bonding D. Ionic Bonding

7. What would be the Chemical Formula of Magnesium Chloride?

   A. MgCl2 B.MgCL C.Mg2Cl2 D. MnCl2

8. Substances that change the chemical reaction quickly without undergoing self- permanent chemical change are ....

   A. Catalysts B. Chemical Bonds C. Covalent Bonds D. Ionic Bonds

9. What is the law that has been brought regarding to the *Saptaswaras* in music?

   A. Periodic Law B. Octetrule

   C. Modern Periodic Law D. Triangles

10. Metals are known as ………… because they release the electron and become a positive ion?

    A. Electro Positive B. Transition Element

    B. C.Electro Negative D. Noble Gases

11. Releases when acid react with carbonates.

    A. Carbon Dioxide B. Chlorine C. Oxygen D. Hydrogen

12. Write the chemical name of salt.

    A. NaC1 B. NaOH C. NaCo3 D. Na2CO3

13. Which element is known as burning gas?

    A. Hydrogen B. Oxygen C. Carbon D. Chlorine

14. What is name of the element found in nature in the elemental state and in compound form?

    A. Carbon B. Oxygen C. Chlorine D. Nitrogen

15. Coke, coal, charcoal etc. are variants of …………

    A. Carbon B.Nitrogen C.Oxygen D.Hydrogen

16. is used as fuel in nuclear plants.

    A. Uranium 235 B. Iodine131

    C. Cobalt 60 D. Hydrogen

17. Who is known as the father of electricity?

    A. Michael Faraday B. Sir Humphry Devy

    C. Heinrich Geibler D. Julius Plucker

18. The electrons in each shell have a fixed energy. What's the name of those shells?

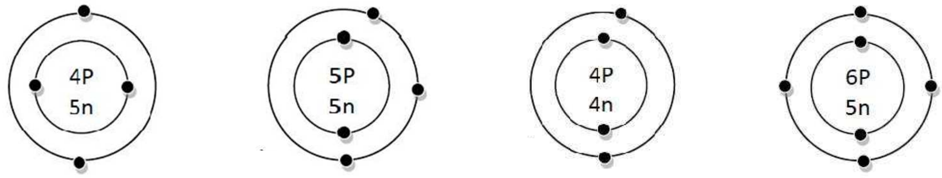
    A. Energy Levels B. Atomic Number

    C. Mass Number D. Nucleus

19. Maximum number of electrons contained in the K-shell?

    A. 2 B. 6 C. 8 D. 10

20. Find out which is the Bohr model of the beryllium element



A. B. C. D.

21. Carbonic isotope,......................used to determine the chronology of fossils and historical objects.

A. Deuterium B. Carbon-14 C. Tritium D. Proteome

22. The arrangement of 8 electrons in the outermost shell is known as ……

A. Ionic Compounds C. Covalent Bonding

B. Octet electron alignment D. Ionic Bonding

23. The covalent bond shared by three pairs of electrons is known as..............

A. Binary Bonding B. Tri-bonding

C. Polygamy D. Chemical Bonding

24. What is a catalyst that speeds up a chemical reaction?

A. Positive Catalyst B. Negative Catalyst

C. Reactants D. Catalyst

25. What is the name of the elements belonging to groups 3 to 12 in the periodic table?

A. Transition Elements B. Noble Elements

C. Lanthanides D. Actinides

26. What is the chemical name of Caustic Soda?

A. NAOH B. $NaCO_3$ C. $NaHCO_3$ D. Na_2CO_3

27. ……………… is the hardest form of carbon.

A. Diamond B. Graphite C. Carbon D. CO_2

28. Which of the following is NOT a characteristic of diamond?

A. Hardness is very high. B. Transparent

C. Low thermal conductivity D. Does not conduct electricity.

29. The compounds containing only carbon and hydrogen are known as………………

A. Hydro Carbon B. Methane C. Ethane D. Propane

30. The process of converting liquid substances into their constituents by passing electricity is ……………..

    A. Electrolysis B. Electroplating C. Chemical bonding D. Bonding

31. What is the maximum number of electrons occupied in the L shell?

    A. 2 B.6 C. 8 D. 10

32. What is the name given to different atoms of an element with same atomic number and different mass number?

    A. Isobars B. Isotones C. Isotopes D. Chemical bonding

33. The compounds formed by ionic bonding are known as……………

    A. Ionic compounds B. Ionic bonding

    C. Chemical bonding D. Bonding

34. Compounds formed by bonding are …………..

    A. Ionic compounds B. Covalent compounds

    C. Covalent bonding D. Chemical bonding

35. ……………. is an electron accepting activity.

    A. Oxidation B. Deoxidation C. Bonding D. Chemical bonding

36. According to the modern periodic law, the chemical and physical characteristics of the elements are a product of their periodicity.

    A. Atomic number B. Atomicmass C. Octet rule D. Mass number

37. By which name Lanthanoids are known?

    A. Rare earths B. Transition elements C. Noble gases D. triangles

38. …………… are elements that exhibit the characteristics of metals and nonmetals.

    A. Sub-metals B. Transition elements C. Noble gases D. Triangles

39. If base is it is called mono basic acid

    A. 1 B.2 C. 3 D. 4

40. Which is the most abundant gas in the atmosphere?

    A. Nitrogen B. Oxygen C. Hydrogen D. Carbon

41. is a triatomic molecule composed of three oxygen atoms

    A. Ozone B. Neon C. Helium D.Oxygen

42. …………refers to the ability of atoms of the same element to combine with each other.

    A. Catination B.Redoxreaction C. Decomposition D. Electroplating

43. Atoms of any element are made up mainly of particles called Electron, and Neutron.

    A. Proton B. Hydrogen C. Nucleus D. Nitrogen

44. Protium, deuterium and tritium are isotopes of …………….

    A. Hydrogen B. Nitrogen C. Oxygen D. Carbon

45. The teacher suggests preparing a fire extinguisher to be used in case of fire in the house. What components will you use for this?

    A. Sodium Carbonate and soda water B.Sodium Carbonate and water

    C. Baking Soda and Vinegar D. Baking soda and diluted hydrochloric acid

46. Atoms are stabilized in outer shell gaining electron by chemical bonding.

    A. 2 B. 6 C. 8 D. 10

47. nature is the basis for the different characteristics of water.

    A. Polar B.Ionic character C. Bonding D.Octate configuration

48. Who is the scientist who classified elements as metals and non-metals?

    A. Antoine Lavoisier B. Johann Wolfgang Dobereiner

    B. John Newlands D. Dmitri Mendeleev

49. …………of elements increases when the number of shells increases as you move from top to bottom in a group in the periodic table.

    A. size B. Atomic number C. Atomic mass D. Mass number

50. Which of the following is not a remedy for air pollution?

    A. Planting of trees

    B. Reduce excessive use of vehicles

    C. Use natural fuels like charcoal or firewood

    D. Control the number of industries.

51. Damu told Amma that *Pulissery* should not be cooked in an aluminum pot. What would be the reason for Damu to say this?

    A. The taste of *Pulissery* will decrease when cooked in aluminum pot

    B. A toxin is produced by reacting with acid and metal

    C. Because copper pot is better than aluminum pot.

    D. Because it costs more fuel.

52. In which of the following ways do you dispose the residues of vegetable and meat after cooking in your home?

    E. Residues will be bagged and deposited in public places.

    F. Residues shall be deposited in waste storage boxes established by Panchayats

G. Residues are processed into natural fertilizers and used for home vegetable and plant cultivation.

H. Residues will be deposited in the empty space in the house plot.

53. …………….. gas is formed when acids react with reactive metals.

A. Hydrogen B. Oxygen C. Nitrogen D. Carbon

54. What are the constituents of PVC?

A. Carbon, Hydrogen and Oxygen B.Carbon, nitrogen and oxygen

C. Carbon, Oxygen and Boron D. Carbon, Nitrogen and Boron

55. Which compound is used in refrigerator, AC, etc.?

A. Chloro Fluoro Carbon B. Carbon Dioxide

C. Nitrousoxide D. Carbon tetrachloride

56. The process of rise in temperature because of an increase in the amount of CO_2 in the atmosphere is called as …………………..

A. Greenhouse effect B. Catination C. Oxidation D. Redoxreaction

57. Write the ionization equation for phosphoric acid (H_3PO_4).

A. $H_3PO_4 \rightarrow 3^{H+}+PO_4^{2-}$ B. $H_3PO_4 \rightarrow H^+ +PO_4^{2-}$

C. $H_3PO_4 \rightarrow 2^{H+}+PO_4^{2-}$ D. $H_3PO_4 \rightarrow 4^{H+}+PO_4^{2-}$

58. Find the chemical equation for the neutralization reaction between sodium hydroxide and diluted hydrochloric acid.

B. $NaOH+HCl \rightarrow NaCl+H_2O$ B. $NaOH+ HCl \rightarrow NaCl + H_2Cl$

C. $NaOH+ HCl \rightarrow NaH +HOCl$ D. $NaOH+HCl \rightarrow NaH_2+ClO$

59. Which is the main element in sun and stars?

A. Hydrogen B. Oxygen C. Carbon D. Nitrogen

60. What is the cause of black smoke when things burn?

A. Carbon B. Oxygen C. Hydrogen D. Chlorine

Appendix XVII

FARUOK TRAINING COLLEGE, KOZHIKODE

Research Centre in Education, University of Calicut

ACHIEVEMENT TEST IN CHEMISTRY

RESPONSE SHEET

Name of student: Class:

Division: Name of school:

Type of School: Aided/Govt. Gender:

Qn.No.					Qn.No.					Qn.No.				
1	A	B	C	D	21	A	B	C	D	41	A	B	C	D
2	A	B	C	D	22	A	B	C	D	42	A	B	C	D
3	A	B	C	D	23	A	B	C	D	43	A	B	C	D
4	A	B	C	D	24	A	B	C	D	44	A	B	C	D
5	A	B	C	D	25	A	B	C	D	45	A	B	C	D
6	A	B	C	D	26	A	B	C	D	46	A	B	C	D
7	A	B	C	D	27	A	B	C	D	47	A	B	C	D
8	A	B	C	D	28	A	B	C	D	48	A	B	C	D
9	A	B	C	D	29	A	B	C	D	49	A	B	C	D
10	A	B	C	D	30	A	B	C	D	50	A	B	C	D
11	A	B	C	D	31	A	B	C	D	51	A	B	C	D
12	A	B	C	D	32	A	B	C	D	52	A	B	C	D
13	A	B	C	D	33	A	B	C	D	53	A	B	C	D
14	A	B	C	D	34	A	B	C	D	54	A	B	C	D
15	A	B	C	D	35	A	B	C	D	55	A	B	C	D
16	A	B	C	D	36	A	B	C	D	56	A	B	C	D
17	A	B	C	D	37	A	B	C	D	57	A	B	C	D
18	A	B	C	D	38	A	B	C	D	58	A	B	C	D
19	A	B	C	D	39	A	B	C	D	59	A	B	C	D
20	A	B	C	D	40	A	B	C	D	60	A	B	C	D

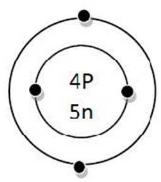
Appendix XVIII

FAROOK TRAINING COLLEGE, KOZHIKODE

Research Centre in Education, University of Calicut

ACHIEVEMENT TEST IN CHEMISTRY

ANSWER KEY

Qn.No.	Answer	Marks
1	A Compound	1
2	C Electron	1
3	A Ernest Rutherford	1
4	A Atomic Number	1
5	B 8	1
6	A Binary Bonding	1
7	A $MgCl_2$	1
8	A Catalysts	1
9	B Octetrule	1
10	A Electro Positive	1
11	A Carbon Dioxide	1
12	A NaCl	1
13	A Hydrogen	1
14	A Carbon	1
15	A Carbon	1
16	A Uranium 235	1
17	A Michael Faraday	1
18	A Energy Levels	1
19	A 2	1
20	 A	1
21	B Carbon-14	1
22	C Octet electron alignment	1

Qn.No.	Answer	Marks
23	B Tri-bonding	1
24	A Positive Catalyst	1
25	A Transition Elements	1
26	A NAOH	1
27	A Diamond	1
28	C Low thermal conductivity	1
29	A Hydro Carbon	1
30	A Electrolysis	1
31	C 8	1
32	C Isotopes	1
33	A Ionic compounds	1
34	B Covalent compounds	1
35	B Deoxidation	1
36	A Atomic number	1
37	A Rare earths	1
38	A Sub-metals	1
39	A 1	1
40	A Nitrogen	1
41	A Ozone	1
42	A Catination	1
43	A Proton	1
44	A Hydrogen	1
45	C Baking Soda and Vinegar	1
46	C 8	1
47	A Polar	1
48	A Antoine Lavoisier	1
49	A size	1
50	C Use natural fuels like charcoal or firewood	1
51	B A toxin is produced by reacting with acid and metal	1
52	C Residues are processed into natural fertilizers and used for home vegetable and plant cultivation.	1

Appendix

Qn.No.	Answer	Marks
53	A Hydrogen	1
54	A Carbon, Hydrogen and Oxygen	1
55	A Chloro Fluoro Carbon	1
56	A Greenhouse effect	1
57	A $H_3PO_4 \rightarrow 3^{H+} + PO_4^{2-}$	1
58	A $NaOH + HCl \rightarrow NaCl + H_2O$	1
59	A Hydrogen	1
60	A Carbon	1