PRE-SERVICE TEACHERS' PERCEPTION OF THE IMPACT OF SIMULATIONS AND ANALOGY ON STUDENTS ACHIEVEMENT IN FEDERAL UNIVERSIY OF TECHNOLOGY MINNA, NIGER STATE.

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2017/3/69345BE

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FEDERAL UNIVERSITY OF TECHNOLOGY MINNA,

NIGER STATE, NIGERIA.

AUGUST, 2021

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A PROJECT SUBMITTED TO THE DEPARTMENT OF SCIENCE EDUCATION, SCHOOL OF SCIENCE TECHNOLOGY EDUCATION

IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF TECHNOLOGY (B.TECH) IN CHEMISTRY EDUCATION

AUGUST, 2021

ABSTRACT

The aim of the study is to investigate the Pre-Service Teachers' Perception of the Impact of Simulations and Analogy on Students Achievement in Federal University of Technology Minna, Niger State. In order to obtain the pertinent information of the study four research questions and two null hypotheses was set to guide the study. A descriptive research design was adopted using questionnaire as the instrument consisting of 30 items for data collection. Total number of 90 pre-service students was used for collection of data from the total population of 473 Pre-Service Teachers'. Mean, Standard Deviation and ANOVA were used to analyze the data collected. The findings of the study revealed Science Education Students perceive Simulation to be a good method of teaching with the grand mean of 3.02. The findings of the study also disclosed that there is no difference male and female perception with mean gain score of 46.32 and 49.21 respectively. The p-value of 0.017 shows that there is significant difference on the Perception of Simulation. The findings of the study also revealed that Science Education Students perceive Analogy to be a good method of teaching with the grand mean of 2.79. The findings of the study show that there is no significance difference in the perception of male and female students' using Analogy with p-value of 0.397.The research thereby recommended that the curriculum planners should include the use of Simulation and Analogy as methods of teaching Science subjects, the school management should also implement the use of Simulation And Analogy in teaching science concepts. Teachers should to be enlightened on the importance of Simulations and Analogy in teaching science subjects and workshop/training should be organized to guide teachers on the use of use of Simulations and Analogy for teaching.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Science is a field that involves the study of science phenomena, and students are continuously required to identify the hidden concepts, define adequate quantities and explain underlying laws and theories using high-level reasoning skills (Konicek-Moran and Keeley, 2015). Thus, students are involved in the process of constructing qualitative models that help them understand the relationships and differences among the concepts of science phenomena. The main goal of science education is teaching for conceptual understanding (Konicek-Moran and Keeley, 2015). Conceptual understanding of science concept is a complex phenomenon. Based on the result of TIMSS' in the year 2015, it showed that there were only 32% in the overall of Indonesian students who had the correct answer for a question which demands conceptual understanding ability on science (Martin et al., 2015). It combines an understanding of single concepts such as sunlight, Chlorophylls, water, carbon dioxide or of a more complex concept such as chemical energy, which following certain rules and models, combines multiple individual concepts (e.g., photosynthesis), resulting in a new concept.

Learning a new concept is integration into an existing knowledge framework (conceptual growth) or fundamental reorganization of existing knowledge to fit the new concept into the framework (conceptual change). The increasing availability of science simulation in classrooms has prompted the investigation of their influence on processes of conceptual development and conceptual change. Science simulations can give real environments structured according to principles in the domain. Spatial, temporal, and causal phenomena can be represented that may be otherwise unobservable and not directly manipulable because they are too large (hurricanes), or too small (chemical reactions), too fast (earthquakes), or too slow (plant growth) (Quellmalz et al., 2012).

Some research on students' conceptual understanding and conceptual change in science education has been done previously (Hsu et al., 2008). A significant amount of previous research has demonstrated the effectiveness of computer simulations in student learning. A good number of these studies have focused on the acquisition of specific conceptual change. For example, Trundle & Bell (2010) found that simulations have been used to promote conceptual change in lunar concept. Additionally, Hursen and Asiksoy (2015) and Taskin and Kandermir (2010) in their studies found out that students who were taught using simulations were more successful than the students who were taught by the traditional approach in Physics. Besides, there is evidence that Simulations had shown a greater impact on students' achievement in other science subjects. Because simulations present simplified versions of the natural world, they can focus students' attention more directly on the targeted phenomena which include the capacity to recognize new information, construct explanation and make connections among scientific phenomena. For instance, scientific phenomena of photosynthesis and respiration. Students should be able to make the connection between photosynthesis and cellular respiration, which is an inverse relationship both are opposites of each other. The problem in conceptual understanding is students' difficulty to make the connection with complex science phenomenon in an everyday life situation. Complexity makes difficulty due to ideas and concepts existing at three different levels: macro and tangible, micro, and representational or symbolic. For instance using 'water' concept; this concept can be taught at the macro level where students can observe the characteristic of water. The teacher can also explain the concept at the micro level, for example, students are taught that water consists of molecules of hydrogen and oxygen. At the representational level, these molecules can be represented as a symbol H_2O.

Analogy as used in teaching would be comparing a topic that students are already familiar with, with a new topic that is being introduced so that students can get a better understanding of the topic and relate back to previous knowledge. In an attempt to address the problem of students' difficulties in understanding science and technology, Asishana 2010, suggested analogy as one of the instructional strategies that could be used for the teaching of abstract or difficult concepts in science and technology. This is because analogy instructional strategy which is based on Novak's theory of human constructivism sees production of new knowledge as a human construct. Thus analogy plays a critical role in a constructivist framework for learning science. In such framework, students develop by learning progressively more sophisticated mental models of science concepts. In physics, for instance the atom, current, voltage, resistance among others cannot be seen. Therefore, the use of analogy can pave way for the expansion of the target concept thereby helping to create understanding for the learner. Likewise, Deborah 2014, in her research studies revealed that Analogy instructional strategy has been found to be most effective in raising the self-efficacy of secondary students in chemistry. This instructional strategy transforms lesson to periods into interesting sessions of low threat, relaxed alertness and anxiety free periods. The advantage of teaching with Analogy model is that it capitalizes on students' relevant existing knowledge. Learning becomes relational rather than rote and therefore it is more meaningful. The process of joining new knowledge to existing knowledge is intrinsically motivating. Analogical thinking is also efficient, it helps to understand new phenomena and solve problems by drawing upon our past experiences.

1.2 Statement of the Problem

The phenomena of poor academic performance among Nigeria students especially the science students is a matter that become source of worry to successive government and major stakeholders in education sector in the country over years. Based on previousrecords of the Chief Examiner WAEC, there has been massive failure in science subjects especially in Chemistry.

Meanwhile over the years the problem of under achievement of science students has been a general problem. For example many researchers in Nigeria have conducted series of research to find out what could be responsible for the problem. Factors such as lack of adequate equipment, ineffectiveness and lack of good and effective teaching methods, lack of qualified teacher and the school have been identified as major causes of under achievement of science students in Chemistry. Despite these efforts, the poor performance of students still exists. To this end, this study sought to investigate how this factors mentioned above can be reduced to it minimal level.

1.3 Aim and Objectives of the Study

The main aim of this research study is to examine Pre-Service Teachers Perception of the Impact of Simulation and Analogy on Science Students Achievement.

The study seeks to achieve the following objectives:

i. To determine Pre-Service Teachers' Perception on the Impact of Simulation on students achievement.

ii. To find out Pre-Service Teachers' Perception on the Impact of Simulation based on gender.

iii. To examine the Pre-Service Teachers' Perception on the Impact of Analogy on students achievement.

iv. To find out Pre-Service Teachers' Perception on the Impact of Simulation based on gender.

1.4 Research Questions

Efforts will be made to answer the following questions which pinpoint the problem of the study.

i. What is the perception of Pre-Service Teachers' towards the use of Simulation on students' achievement?

ii. Is there any difference on the Pre-Service Teachers' Perception of the Impact of Simulation on students achievement based on gender?

iii. How do Pre-Service Teachers' perceive the Impact of Analogy on Students Achievement?

iv. Is there any difference on the Pre-Service Teachers' Perception of the Impact of Analogy on students achievement based on gender?

1.5 Research Hypotheses

The following null hypotheses which were tested at 0.05 level of significance provided focus for the study.

i. There is no significant difference on Pre-Service Teachers' Perception of the impact of Simulation on students' achievement based on gender.

ii. There is no significant difference on Pre-Service Teachers' Perception of the impact of Analogy on students' achievement based on gender.

1.6 Significance of the Study

The study will contribute towards the improvement of teaching and learning of science courses. And also, it will reduce the rate of failure in examinations. Students will benefit from the study if it is proved that Simulations and Teaching-With-Analogy as a model of science instructions leads to higher achievement in science. They will learn to spend quality time in studies even while enjoying science Simulations. By so doing, the students will also learn to generate their own analogies, thereby deepening their knowledge of science.

For science teachers, there will be a sure route to follow to take their students to what has remained a mirage in the past sustained interest and high achievement in science generally. The teachers' creativity will equally be challenged as they will be motivated to sketch and create simulations useable for instructions. These Simulations if vetted and passed could be produced for use in schools and homes. High level of job satisfaction will follow as one's efforts meet target objectives, high performance of students. Science teacher educators will have new grounds for fundamental studies in generating, sustaining interest and deepening knowledge in science lessons.

1.7 Scope and Limitation of the Study

The study is concerned with students' perception in the use of Play-Simulation method and teaching with Analogy among science students and is limited to science students in Federal University of Technology Minna.

1.8 Definition of Terms

Perception: is a process by which one become aware of changes through sense, sight, hearing e.t.c perception is the act or the power of the discernment of any modification.

Performance: use interchangeable with achievement means the level of acquisition of knowledge. Is the action or process of carrying out or accomplishing an action, task or function.

Simulation: A simulation is the imitation of the operation of a real-world process or system over time.

Conceptual understanding: Conceptual understanding is knowing more than isolated facts and methods.

Science learning: Learning sciences (LS) is an interdisciplinary field that works to further scientific, humanistic and critical theoretical understanding of learning as well as to engage in the design and implementation of learning innovations, and the improvement of instructional methodologies.

Analogy: A comparison between one thing and another, typically for the purpose of explanation or clarification.

Teaching: Teaching is the process of attending to people's needs, experiences and feelings and intervening so that they learn particular things and go beyond the given.

Science: is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe.

CHAPTER TWO

2.0 REVIEW OF RELATED LITERATURE

2. 1 Conceptual Frame Work for the Study

The way students perceive a teacher or a subject determines their success or failure in that subject. Some students today perceived science courses as no go area because of the negative impressions passed down to them by the past generation who had bad experience with unqualified science teachers which is still in circulation. On hearing all these negative expression since before school age or getting admission into school, the student psychologically develops fear for the subject and come to the lesson with these notion and if confronted with any science problem solving will quickly conceptualized him/herself, I cannot do any difficult task, it is not meant for people like me, accepting defeat before trying which is disassociate learning pattern, which are impossible to build upon. Therefore, the hierarchy needs of both teachers and students should be met to motivate both for better performance.

According to Maslow, teachers should do everything possible to help students satisfy their deficiency because an inner motivation for knowledge will not develop until these basic needs are met. He observed that teachers are not always able to intervene in student's life to the extent necessary to fulfill deficiency needs, but suggested that, teachers instead are in a position to provide a classroom conducive for learning that could fulfill deficiency needs, especially in physics. Primarily parents, as much as possible should help and encourage their children in meeting deficiency needs, which consequently could enhance effective teaching and learning of all subjects.

2.1.1 Concept of Simulation.

A search in literature reveals that the concepts of Simulation as used in science education have not retained the same meaning overtime. Development and changes that have affected their meanings include that of information and computer technology (ICT), education generally and science education in particular. These changes have modified the scopes, applications and adaptations of these concepts to suit various purposes.

Simulations are instructional scenarios where the learner is placed in a "world" defined by the teacher. They represent a reality within which students interact. The teacher controls the parameters of this "world" and uses it to achieve the desired instructional results. Students experience the reality of the scenario and gather meaning from it. A simulation is a form of experiential learning.

Simulations are characterized by their non-linear nature and by then controlled ambiguity within which students must make decisions. The inventiveness and commitment of the participants usually determines the success of a simulation. When students use a model of behavior to gain a better understanding of that behavior, they are doing a simulation. For example:

i. When students are assigned roles as buyers and sellers of some good and asked to strike deals to exchange the good, they are learning about market behavior by simulating a market.
ii. When students take on the roles of party delegates to a political convention and run the model convention, they are learning about the election process by simulating a political convention.
iii. When students create an electric circuit with an online program, they are learning about physics theory by simulating an actual physical set-up. Students often use Simulations to make predictions about the social, economic, or natural world.

Effective teaching methods stimulate learners' interest which therefore forms a base for achieving desired curriculum objectives in a school setting. Essentially, teacher-centered teaching methodologies are considered obsolete; a big burden with little impact on the learning development of the child; the conventional educational system emphasizes strongly on those teaching methods that will full and actively involved the child learner rather than considering him as passive, ignorant and mere recipient of knowledge. It is believe that involving learner in the teaching and learning via inquiry and simulation games teaching methods will make teaching and learning more interesting, make the classroom environment lively, arouse the interest of the learners and sustained their interest and attention throughout the teaching and learning period. Hence, exposure of the learner at early stage of education is regarded as a foundation, upon which the success or failure of future

Simulations can make abstract science phenomena more accessible and visible to students. For example, understanding science phenomena such as the circulatory system are difficult for some reasons. It is a complex interactive abstract scientific concepts, such as circulatory system, more accessible and visible to students. System that ranges in scale from the heart or blood vessels visible through the skin to blood cells circulating in capillaries much smaller than the human visual range.

They can provide detailed representations of unobservable science phenomena (Stieff, 2011; Ryoo & Linn, 2012). They can also animate dynamic changes in scientific processes that are difficult to infer from static illustrations found in the textbooks (Marbach-Ad, Rotbain, & Stavy, 2008; Ryoo & Linn, 2012). In particular, simulations or animations can help students visualize the phenomenon that might otherwise be difficult to depict (Chang, Quintana, & Krajcik, 2010). Thus, the benefit from simulations are making science abstract concept more accessible, visible, and can help students to understand science concepts. When students are unable to observe or experience abstract science phenomena directly, simulation can play a crucial role in helping them understand those phenomena. Simulations work to improve understanding the concept of science, not only students' understanding but also pre-service teachers' understanding.

Furthermore, creating simulation also enabled pre-service science teacher to develop more elements to contribute to their understanding of science concept (Nielsen & Hoban, 2015; Bell, Maeng, & Binns, 2013). Creating the multiple representations presented many opportunities to have their alternate conceptions and elements that underpinned the concepts challenged, discussed, negotiated, and revised. Importantly, the stop-motion construction process was halted several times enabling pre-service teachers to check, review, and revise information (Hoban & Nielsen, 2014). Thus the development process enables an ongoing interplay between existing knowledge. Further, in the process of developing simulations as a teaching resource, has potential to help them consider relationships between different representational and develop more sophisticated understandings.Moreover, simulations have potential to advance multiple science learning goals, including motivation to learn science, understanding of the nature of science, science process skills, scientific discussion and argumentation, and identification with science and science learning (Honey & Hilton, 2011). Simulations are highly structured and detailed models that reflect situations found in the real world, intended to create an effect on the mind of those so simulated. Simulations therefore are neither plays nor games. Simulations help the understanding of complex systems without necessarily facing the danger, cost or time that is required in dealing with the real process or system (GoldsimTechology Group, 2010).

Serving as a complement for traditional teaching methods, simulation software and serious games have been increasingly used as educational tools during the last decades (Costantino et al. 2012). The ongoing development of technology and programming languages has made simulation an advanced tool that reflects real situations with a high precision degree (Martin and McEvoy 2003). As noticed by Cai et al. (2016), SE and serious games are frequently overlapping concepts. On the one hand, a game is a competition between several players who aim at reaching a pre-established goal within a framework of rules and constraints. On the other hand, the term simulation usually refers to the computer-based representation of real-life situations. Although simulation is frequently employed to analyse complex systems, it can be also used to improve actors' knowledge and skills through experience. The simulation-based learning experience can be pedagogically designed as a competition-based problem where actors should accomplish a series of interactive exercises (Pasin and Giroux 2011). As indicated by Chapman and Martin (1995), the use of SE can enhance capabilities such as teamwork, problem-solving, decision making, or critical thinking. For instance, (Stanley and Latimer 2011) showed the effectiveness and suitability of simulation games in the nursing field, where students improved those skills in clinical practice scenarios. In some fields such as engineering, management, and science, SE has been used for training and learning purposes (Deshpande and Huang 2011). An extensive review on the use of serious games for management is provided in da Silva et al. (2019), including the analysis of previous studies on the subject. Likewise, an overview of the SE theoretical fundamentals can be found in Becker and Hermosura (2019). In the context of STEM education, Riley (2012) remarks on the role of network simulation tools both in research and practical applications. However, this author considers that SE tools have not been fully incorporated as a key methodological element in networking courses. The author analyses a personal experience on the use of the popular ns-3 network simulator. Avramenko (2012) explains a case study in which business simulation is used as a mean to reduce the gap between theory and practice, thus enhancing students' skills for employability. Alnoukari et al. (2013) consider the importance of SE in the training of computer scientists. They discuss how simulation-based courses can provide students with a training capacity that is not easy to reach by just using traditional laboratories. Tvrdon and Jurásková (2015) focus on the use of SE to teach courses on logistics and supply chain management. They describe their own experience in using the software Witness to facilitate the hands-on learning of advanced logistics concepts. Perera and Rupasinghe (2015) discuss the lack of in-house supply chain experts in many enterprises. Accordingly, the authors introduce a case study regarding the use of commercial simulation software to train professionals in supply chain dynamics. Frantzén and Ng (2015) introduceed a simulation software that models a conceptual factory. This software is specifically designed to support training courses for both students and workers. The goal is that they focus on learning how to analyse the modelled system. Haller et al. (2015) discuss the convenience of using port vehicle simulators to train ports personnel, as well as the difficulties to complete this training due to the elevated cost of high-quality port simulators. In Mavinkurve and Patil (2016), the authors describe a case study related to the use of an electronic circuit simulator in their engineering courses. According to their study, the simulator helped students to increase their evaluation scores. Bach et al. (2017) give examples of how simulation games can be effectively integrated into management-related courses. Tao and Wu (2017) provide an extensive review of commercial simulation games, while Vlachopoulos and Makri (2017) analyse the influence of simulation games on higher education. In particular, they study how these tools can help students to achieve their learning objectives. Lawson and Leemis (2017) presents a simulation-education package for the R statistical software. The authors propose to use the package in introductory simulation courses. Recognising the interdisciplinary importance of simulation, Ören et al. (2017) discuss the benefits of SE in STEM disciplines. These authors highlight the role of simulation as a tool for experiential learning and teaching via computer experiments that imitate real-life situations. Bruzzone and Massei (2017) analyse the challenges and opportunities that SE offers in military training and related areas. Leathrum Jr et al. (2018) propose increasing the cooperation between industrial and academic partners in order to develop simulation-based laboratories that enhance the training of students and prepare them better for their future professional activity. In their paper, they illustrate this concept with a simulation laboratory that allows students to test the performance of autonomous vehicles. McHaney (2018) introduces best practices regarding the use of SE in courses of cloud computing and big data. In the latter, for instance, students use simulation to generate large data sets on which they can test different data analytics techniques. Alsaadani and Bleil De Souza (2019) describe how universities are introducing SE to train architects in building performance. They consider some simulation-education examples from the literature and classify them into three different paradigms. All in all, the previous review reveals a growing interest in the possibilities of SE as tool not just for teaching courses to students of STEM degrees but also to train managers and engineers from different industries and business.

As described in Mazur (2016), the learning process can be simplified in three main blocks – behaviour, cognition, and affect–, and a number of interrelations among them. For instance, it is well-known that cognitive levels benefit from positive emotional engagement with the learning subject. Turner et al. (2018) highlight how online serious games are valuable to reach better critical thinking skills and to improve the content knowledge. Moreover, affect-related aspects such as motivation level and self-esteem are also increased. In addition, serious games allow putting the player in realistic situations, where they can learn through experience and improve their decision-making abilities. Serious games should be designed in a way that they provide the required mechanics to reinforce the interrelations between behaviour, cognition, and affect, thus enriching the learning experience. The game, sometimes through a storyline, requires the player to conduct a number of actions that are clearly pre-established to achieve a given objective. The partial outputs will depend on the player's performance, and their decisions will result in different consequential scenarios. In addition, as indicated by Lamb et al. (2018), serious games should foster the emotional attachment to the outputs. Thus, the design of efficient serious games is not a straightforward task, and it requires a deep understanding of the underlying dynamics, and how they relate to the learning mechanics. An efficient design of a serious game should guarantee that the level of demand by the player is compatible with his/her knowledge and skills, that is, challenging enough to provide the player a satisfactory feeling when achieving the goals, and affordable enough to prevent the player from discouraging and frustration. Thus, through progressing in the game as a result of the improved skills, tasks also become more complex. When this balance is reached, the level of engagement of the player is such that he/she is fully immersed in the learning process for a longer time period resulting in fewer distractions (Admiraal et al. 2011) and in a more effective content retention (Hainey et al. 2011). Thus, serious games are an interesting tool to support the learning process once the content has been already presented in a more formal manner, e.g., through lectures (Rondon et al. 2013). Nevertheless, the entertainment elements of the game might distract the attention of students if the serious game is not adequately designed (Bellotti et al. 2011) or correctly presented to the students. Some studies note how learning the game mechanics adds an extra load to the students that eventually lose the main focus of the game (Ameerbakhsh et al. 2019). In fact, although both students and educators are becoming more comfortable with technology, (Jarvis 1995) notices the concern of some students when including this type of tool in the academic curricula. The benefits associated with the use of serious games in the learning environment are not always easy to measure, although a good analysis of these benefits is provided in Boyle et al. (2016). In some cases, the invested time in becoming familiar with the game might not compensate for the learning outcomes. For that reason, the game should be designed in collaboration with instructors, and further improvements conducted if needed based on a comprehensive analysis of the learning achievements in a validation process (Serrano-Laguna et al. 2018).

Benefits of simulation-based education

The proliferation of personal and portable computers along with the progress in hardware and software experienced during the last decades has boosted the use of simulationbased activities in higher-education programmes (Qudrat-Ullah 2010). The benefits of Simulation based education have been documented by different authors, among them, Shapira-Lishchinsky (2015) and Braghirolli et al. (2016). Many documents describe experiences in which these benefits are illustrated. For instance, das Dores Cardoso et al. (2014) use Simulation based education in an automatic control course. They conclude that simulation allows students to gather hands-on experience and skills in different realistic scenarios. In the area of operations management and finance, Curland and Lyn Fawcett (2001) conclude that Simulation based education facilitates the acquisition of quantitativeanalysis skills among students without a strong mathematical background. Regarding e-learning, Balci et al. (2013) point out the additional challenges associated with teaching modelling and simulation to online students. They also provide some recommendations to overcome these challenges. Actually, Simulation based education is clearly an ideal resource in many online courses due to its capacity to support the development of virtual laboratories (Grasas et al. 2013; Ceberio et al. 2016). In the case of STEM programmes, simulation games make it possible for students to interact, in a safe environment, with models of real-life systems. Hence, students can develop their skills and acquire experience in the use of those systems that will encounter in their future professional careers. In most cases, only SE tools can provide students with these skills and experience. Hence, they constitute the perfect complement to theoretical lectures. In the area of revenue management, (Cleophas 2012) introduce a framework that facilitates the design of simulation games. As these authors state, simulation allows students to experience realistic variations in customers' demand and make the necessary corrective decisions without incurring costly mistakes. Examples illustrating the use of simulation-based games in education are abundant. For instance, Schäfer et al. (2013) propose the learning of logical concepts by using a collaborative-competitive simulation environment. Similarly, Rozhkova et al. (2016) describe an experience that involves the use of simulation-based games to learn algebra and geometry. These games cannot only be used for training purposes, but they can also include an evaluation component that provides feedback and scores to students.

Simulation in Education and Training

Simulation is extensively used for educational purposes. It is used for cases where it is prohibitively expensive or simply too dangerous to allow trainees to use the real equipment in the real world. In such situations they will spend time learning valuable lessons in a "safe" virtual environment yet living a lifelike experience (or at least it is the goal). Often the convenience is to permit mistakes during training for a safety-critical system.

Simulations in education are somewhat like training simulations. They focus on specific tasks. The term 'microworld' is used to refer to educational simulations which model some abstract concept rather than simulating a realistic object or environment, or in some cases model a real-world environment in a simplistic way so as to help a learner develop an understanding of the key concepts. Normally, a user can create some sort of construction within the microworld that will behave in a way consistent with the concepts being modeled. Seymour Papert was one of the first to advocate the value of microworlds, and the Logo programming environment developed by Papert is one of the most well-known microworlds.

Project Management Simulation is increasingly used to train students and professionals in the art and science of project management. Using simulation for project management training improves learning retention and enhances the learning process.

Social simulations may be used in social science classrooms to illustrate social and political processes in anthropology, economics, history, political science, or sociology courses, typically at the high school or university level. These may, for example, take the form of civics simulations, in which participants assume roles in a simulated society, or international relations simulations in which participants engage in negotiations, alliance formation, trade, diplomacy, and the use of force. Such simulations might be based on fictitious political systems, or be based on current or historical events. An example of the latter would be Barnard College's Reacting to the Past series of historical educational games. The National Science Foundation has also supported the creation of reacting games that address science and math education. In social media simulations, participants train communication with critics and other stakeholders in a private environment.

In recent years, there has been increasing use of social simulations for staff training in aid and development agencies. The Carana simulation, for example, was first developed by the United Nations Development Programme, and is now used in a very revised form by the World Bank for training staff to deal with fragile and conflict-affected countries.

Military uses for simulation often involve aircraft or armored fighting vehicles, but can also target small arms and other weapon systems training. Specifically, virtual firearms ranges have become the norm in most military training processes and there is a significant amount of data to suggest this is a useful tool for armed professionals.

History and Development of Simulations

Teachers have been using non-computer based simulations in their classrooms for many years in the form of science labs and demonstrations. Years before computers were introduced to schools, teachers tried to create activities that could show students how real life situations work, without actually being in the situation. This was necessary either because it was too expensive or dangerous to actually witness a situation (i.e. radioactive decay), because the situation was impossible to witness (i.e. microscopic/subatomic situations), the scale or time frame was too expansive (i.e. evolution). As a result, teachers recreated and modeled these situations using hands-on materials and props. These activities are not only helpful, but essential for science teachers if they are to build an environment of learning. "The process of teaching by simply telling students about a scientific theory is viewed as inadequate, for it fails to engage the students in reflecting upon and modifying their own view of the way they think the world works." (Richards et al, 1992)

Hands-on simulations are useful but have several drawbacks. Creating some of these activities is very labour intensive for teachers. Rode (1995) indicates that for her protein synthesis simulation "it should be noted that preparing the materials for this activity is rather tedious". Another drawback is the necessary participation of a large number of people. In the case mentioned above, "the simulation requires the participation of a minimum of 21 students" (Rode, 1995). While group work is beneficial at times, this limits the flexibility of the simulation and could cause difficulties if the simulation takes place over several days.

How to use Simulations in the Classroom

Due to these and other limitations, it has been useful to incorporate computers in designing and creating simulations in science education. Computer simulations allow students to create and explore situations that they would not normally be able to witness. They can repeat trials instantly and quickly change variables to understand the effects of change. "A computer enables repeated trials of an experiment with considerable ease in a limited time, provides immediate feedback, allows simultaneous observations of graphical representations and offers a flexible environment that enables students to proceed with their own plans" (Kara, 2007).

Students are exposed to situations that would have been difficult to construct with hands-on activities. "In addition there is added variety and perhaps novelty in [computer assisted instruction] along with the potential to use vivid and animated graphics, enabling 3 dimensional aspects and other features to be viewed more realistically" (Kara and Yesilyurt, 2007). Now more than ever we have the ability to create realistic looking graphics that engage students and correspond with non-educational activities they are already doing. With a little creativity, computer based educational simulations could replace some of the potentially dangerous gaming activities students partake in.

Computer simulations have shown to increase learning. Assessment results have shown that "…instructional software programs had significantly higher effect than CG (control group)" (Kara and Yesilyurt, 2007). These results show that computer simulations increase student learning and give teachers ways to reach a new generation of learners.

Pre-instructional

Simulations introduced before the bulk of the formal teaching takes place give students a chance to think about their current understanding of the scientific topic being introduced. Simulations based on scientific theory help to provide a set of interrelated experiences that challenge students' informal understanding of the science" (Richards et al., 1992). This can encourage genuine thought about a problem as students consider multiple potential solutions.

The use of simulation prior to any formal teaching can provide instructors with timely information about students' prior knowledge which can in turn help them to guide their formal instructional practices. According to Hargrave and Kenton, "Pre-instructional simulations can serve as a foundation for further learning, assist in the development of students' conceptions, reveal alternative conceptions in students' thinking processes, and encourage the development of questions related to content"(2000). These pre-instructional computer simulations afford students the chance to actively create their own knowledge structures, congruent with a constructivist model of learning (Papert, 2003) or a scientific discovery model of learning (de Jong & van Joolingen, 1998).

According to Hargrave and Kenton there are 4 characteristics of pre-instructional simulations that are important in science education

- hey are exploratory environments
- they contain variables that can be manipulated by the student
- they allow the student numerous attempts to complete the task
- they provide feedback that is consistent with the phenomenon it models

Creating games using computer simulations can be an effective way to get students interested in learning more about a topic. For example, if the goal is for students to learn about the effects of an electric field on a charged particle, students can be given the task of creating an electric field that will put a charged particle in a net. This challenges the students to understand the concept of electric fields, but also gives them the chance to be competitive with themselves or with other students. Alternatively teachers could give the student a score based on their manipulation of variables during the simulation. Students would then have to adjust their variables to achieve a higher score and thereby gain a deeper understanding of the concept and associated variables.

It should be clearly stated that students are not to be assigned simulations with no support. Podolefsky et al. (2010) concluded that scaffolding with appropriate affordances is essential to support student engagement in science simulations. This requires the teacher ensure the students are prepared with some level of understanding of the topic or basic vocabulary before embarking on the simulation exercise.

Post-instructional

Teachers can use simulations after formal instruction has been given in an attempt to keep the students from coming to incorrect conclusions or in order to use it to test the knowledge learned. Binns et al (2010) found that they could use Starry Night simulations to uncover misconceptions in understanding about moon phases and correct these with further discussion around and sing the simulation. There was a significant improvement in concept understanding by using the simulation after instruction in this manner.

Some feel that using simulations after instruction this may inhibit true scientific method as it causes students to enter the simulation activity with a narrower field of view with preconceived notions of what they are about to discover. Students need to use simulations in such a way that they can make their own discoveries and share them with their peers. "Post-instructional simulations often are used to test students' knowledge of content…" "...many post-instructional simulations do not require or encourage students to operate at advanced cognitive levels" (Hargrave and Kenton, 2000) Studies have also shown that students receiving domain information before the simulation do not profit from it (de Jong & van Joolingeng, 1998).

Post-instructional simulations can be useful for review or as a means to refer back to prior concepts needed to complete a larger picture of understanding. Teachers are encouraged to think about the learning outcomes, the prior knowledge their students have, potential misconceptions involved with the subject matter and the simulation they are using as factors in deciding the chronology of learning opportunities.

Supplemental Instruction

Computer simulations are a useful supplemental tool for student learning and understanding. Individuals who require more information on a topic or concept can be directed to a simulation to help further complete their knowledge building. Additionally, students with holes or gaps in their learning may find computer simulations a good way to incorporate foundational information into their understanding. Ng et al. (2009) found a significant correlation between online supplemental instruction and math final exam scores. In subject like math where foundational work is so important, gaps can be filled without the instructor needed to teach material which is pre-requisite for the course. Due to the individualized nature of the learning opportunity provided by computer simulations they are a very effective supplemental toolkit on a one to one basis.

2.1.2 Concept of Analogy

An analogy is a process of identifying similarities between two concepts. The familiar concept is called the base and the unfamiliar concept is called the target (Glynn & Takahashi, as cited by Krisette et al., 2018). By associating the features of the two concepts, students tend to acquire better understanding of the unfamiliar or target concept. Several researchers defined analogy differently. Mariah (as cited by Salih, 2010) defined analogy as a concrete and visualisable representation of the matches and mismatches between the base and target concepts. Gentner (as cited by Brown & Salter, 2010) defined analogy as a mapping of knowledge from the base to the target.

It is a constructivist-based teaching approach designed to provide a powerful means of bringing about this conceptual change in students which involves use of familiar situation (source or analog) to explain a similar unfamiliar phenomenon (target) (Maharaj-Sharma, 2012). Analogy must therefore be familiar if it is to be fruitful, it must be able to prove its competence in bringing about conceptual understanding of the needed concepts (Maharaj-Sharma, 2012).

An analogy is simply a characteristic or property that is seemingly shared between two things, processes or systems. Things, processes or systems that are analogous in one or more ways do not ordinarily belong together. This is why the familiar is the one used to explain the unfamiliar. For instance, "the wavy movement of water in a river is like the wave motion of light", is an analogous explanation.

In all cases of using analogies in science instructions, the aim has remained the same: To help learners understand (build knowledge of) new concepts presented in class by calling up knowledge (memory) of concepts they have already mastered or become familiar with. The new concepts to be mastered (have knowledge of) are referred to either as 'target or unfamiliar concepts' while the concepts they are already familiar with are referred to as 'base or analog concepts'. It does not really matter from what field of knowledge or experience the analog concepts are drawn from. Both concepts base and target are said to be analogous because they share some common features or characteristics. The process of using analogous concepts in a teaching/learning situation as a strategy is referred to as “teaching with analogy”.

In teaching with analogy, science teachers must be careful to help the students realize where the analogy breaks down. This is why Brown and Salter (2010) suggests that it is extremely important that due caution be exercised to be sure that students remember the content and not just the analogy, noting that analogy is only an aid to understanding a concept, content or process and not the concept, process or principle itself. Gender disparity in science is another issue of great concern and it affects both educational and research sectors. The cause of this problem has been a thing of worry to scientists. But unfortunately, no consensus has been reached about the effect of gender in science achievement. Babajide (2010) admitted that such conceptual sciences like physics and chemistry are given masculine outlook by educational practitioners. Ogunleye and Babajide (2011) reported that gender has no significant effect on students’ achievement and practical skills in physics. As a result of this inconsistency of opinion, there is a great need to carry out further studies in order to shade more light on the effect of gender in combination with the use of analogy in science achievement of students.

Basic knowledge in science, especially physics is a ‘sine qua non’ for all forms of modern development. To be able to appreciate, control and effectively tap from and utilize the resources from our natural environment, it is imperative to acquire this scientific knowledge – a basic tool of all forms of industrial and technological advancement of any nation (American physical society, 2014).

Aware of this obvious task, many nations, Nigeria inclusive, have recognized the importance of Science and Technology (S&T) especially physics in its developmental endeavors (Abubakar, 2012). This is because physics is the basic index in understanding the complexities of modern technologies (Aina, 2014). But students’ performance in the sciences in external examination has been consistently on the decline (WAEC, 2009 & 2010). Physics is even most badly affected. For instance, in WASC result of May/June 2010, the candidates' population of 469,019 in physics recorded a mean score of 20 and a standard deviation of 9.43 as against a mean score of 26 and a standard deviation of 9.0 in May/June 2009 WASSCE with a candidature of 465,498. This makes students demonstrate very negative attitude towards physics as the toughest of the three conceptual sciences, and they drop it at the earliest opportunity, leading to poor enrollment in physics and physics-related courses in our tertiary institutions (Opondo, 2014).

In Nigeria, between 2005 and 2010, on the average, less than 30% of the students who registered for WASSCE entered for physics. Out of these, only 40% passed at the credit level (WAEC, 2010). Some of the reasons for this poor enrollment and performance in physics have been blamed on the way science in general, and physics in particular is taught in secondary schools (Nwankwo, 2014), perceived poor teaching and learning environment and lack of appropriate and modern laboratory equipment, poor mathematical background and poor teaching method being adopted by many physics teachers (Nwagbo & Chikelu, 2011).

Analogies can be categorized based on relationship, presentation, and level of enrichment (Krisette et al., 2018; Orgill&Bodner, as cited by Spezzini, 2010).

Throughout the history of science, scientists and science teachers have used analogies to explain essential discoveries and concepts. Commendable textbook authors such as Hewitt (as cited by Krisette et al., 2018.) and Campbell and Reece (as cited by Krisette et al., 2018.) as well as local authors like Echija et al. (as cited by Krisette et al., 2018.) and Palima and Ines (as cited by Krisette et al., 2018.) also used analogies to expound science concepts. Many studies have related the role of analogies in improving students' learning in science. For example, Chui and Lin (as cited by Krisette et al., 2018.) investigated how multiple analogies affect student learning of the concept electrical circuit. The results show that using analogies not only advanced the profound understanding of intricate science concepts but it also helped students correct their misconceptions of these concepts. Salih (2010) discussed the potential of an analogical task in accelerating the thinking skills of Malaysian students. The analogical task given to the students enhanced the various thinking skills such as reasoning capabilities, and critical and creative thinking skills.

Yet, some studies have shown that analogies do not necessarily enhance learner performance (Radford as cited by Spezzini, 2010). Glynn (as cited by Krisette et al., 2018.) warned that an analogy is a double-edged sword. It can cause misunderstanding among students. Thus, researchers proposed several models for teaching science with analogies. Glynn's (as cited by Krisette et al., 2018.) Teaching with Analogies (TWA) model helps teachers use analogies systematically and effectively. Treagust, Harrison, and Venville (as cited by Krisette et al., 2018.) offered guidelines for thinking about the target, the analog, and the students during instruction. They call their model Focus, Action, and Reflection (FAR).

Reasoning Skills in Science

Reasoning has been the subject of a long line of research within psychology and education. Plotnik (as cited by krisette et al., 2018.) defined reasoning as a mental process that involves using and applying knowledge to solve problems, make decisions, and achieve goals. Other researchers have also provided their definitions of reasoning (Krisette et al., 2018; Johnson-Laird, Anderson as cited by She & Liao, 2010; Hogan &Fisherkeller, Holyoak& Morrison, Overton as cited by Zeineddin&Abd-El-Khalick, 2010). Scientific reasoning can be developed, improved and transferred through training and practice (Adey&Shayer, Bao et al., as cited by Krisette et al., 2018.). Fenci (2010), she and Liao (2010), and Abdullah and Abbas (as cited by Krisette et al., 2018.) found out that students who were exposed to the type of instruction they were investigating made significant gains in scientific reasoning skills. The present study investigated whether AEI will also make significant gains in terms of students' reasoning skills in science.

Scientific reasoning involves deductive and inductive processes (Plotnik, as cited by Krisette et al., 2018; Waters & English as cited by Zeineddin&Abd-El-Khalick, 2010). Deductive reasoning begins with making a general assumption that one knows to be true and then drawing specific conclusions based on the assumption. Inductive reasoning begins with making particular observations and then drawing a broader conclusion based on the observations. Piaget (as cited by Krisette et al., 2018.) characterized four stages of intellectual development – sensorimotor, preoperational, concrete operational, and formal operational. The latter two stages are relevant to scientific reasoning in that these are the stages during which advanced reasoning skills begin to develop. Lawson (as cited by Krisette et al., 2018.) renamed concrete operational stage as empirical-inductive thought, which comprises class inclusion, conservation, and serial ordering. He also renamed formal operational stage as hypothetical-deductive thought, which includes proportional reasoning, identification and control of variables, probabilistic reasoning, combinatorial reasoning, and correlational reasoning.

Analogical Argument

According to Bartha (2013), Analogical arguments vary greatly in subject matter, strength and logical structure. In order to appreciate this variety, it is helpful to increase our stock of examples. First, a geometric example:

Example 1: (Rectangles and boxes).

Suppose that you have established that of all rectangles with a fixed perimeter, the square has maximum area. By analogy, you conjecture that of all boxes with a fixed surface area, the cube has maximum volume.

Two examples from the history of science:

Example 1: (Morphine and meperidine).

The pharmacologist Schaumann (as cited by Bartha 2013), was testing synthetic compounds for their anti-spasmodic effect. These drugs had a chemical structure similar to morphine. He observed that one of the compounds—meperidine, also known as Demerol—had a physical effect on mice that was previously observed only with morphine: it induced an S-shaped tail curvature. By analogy, he conjectured that the drug might also share morphine's narcotic effects. Testing on rats, rabbits, dogs and eventually humans showed that meperidine, like morphine, was an effective pain-killer (Lembeck; Reynolds and Randall, as cited by Bartha, 2013.).

Example 2: (Priestley on electrostatic force).

Priestley (as cited by Bartha, 2013.), suggested that the absence of electrical influence inside a hollow charged spherical shell was evidence that charges attract and repel with an inverse square force. He supported his hypothesis by appealing to the analogous situation of zero gravitational force inside a hollow shell of uniform density.

Advantages of Analogy Method

1. It is cheap to operate as no special apparatus is needed It makes fewer demands on the teacher's time for planning and preparing and is therefore an attractive and easy method of teaching.
2. It is an efficient means of giving a vast amount of knowledge in a limited amount of time.
3. Large classes of students can be handled by the teacher.
4. It serves to channel the thinking of all students in a given direction.

Disadvantages of Analogy Method.

1. Students are passive listeners and do not participate in the development of the lesson.
2. The desired learning outcomes may not be accomplished.
3. The method is inadequate for teaching certain types of concepts e.g. attitudes and feelings which are not learned through pure telling.
4. Students' progress cannot be evaluated during the lesson since they are passive.
5. It cannot meet the different needs of the students as regards individual differences.
6. It rarely affords students the opportunity to practice communication skills.
7. It's largely denied of exploratory aspects of learning. Students may show a tendency to accept the teacher as the "final authority". Consequently they accept his biases and prejudices at face value.
8. It encourages rote learning or cramming.

2.2 Theoretical Frameworks

2.2.1. Vygotsky's Theory of Social Cognitive Development

Vygotsky‟s(1972) theory is based on the main theme that social interaction plays a fundamental role in the development of cognitions. An important concept in Vygotsky‟s theory is that, the potential for cognitive development is limited to a certain time span which he calls the „zone of proximal development‟. Vygotsky defines the „zone of proximal development as having four learning stages. These stages range between the lower limit of what the student knows and the upper limits of what the student has the potential of accomplishing. The stages can be further broken down as follow stage I – assistance provided by more capable hands (coaches, experts, teachers).Stage 2 - assistance by self, Stage 3 – internalization, automatization ,fossilization) and Stage 4 - de-automatization, recursiveness through prior stages.

Vygotsky‟s theory claims that instruction is most efficient when students engage in activities within a supportive learning environment and when they receive appropriate guidance that is mediated by tools (Vygotsky‟s, 1972). These instructional tools can be defined as cognitive strategies, a mentor, peers, computers and provide information for the learner. The role of the tool is to organize dynamic support to help (learners) complete a task near the upper end of their zone of proximal development (ZPD) and them to systematically withdraw this support as the (learner) moves to higher levels of confidence.

According of Otuka and Uzoechi (2009), the following principles should be kept in mind;

i. Full cognitive development in the learner requires social interaction.
ii. Cognitive development in the learner is limited to a certain range at any given age. However, Hausfather (1996) observed that traditionally, schools have not promoted environment in which the students play an active role in their own education. Vygotsky‟s theory however requires the teacher and students to play untraditional roles as they collaborate with each other instead of a teacher dictating learning of concepts for students to recite ,the teacher collaborate with his students in order to create a meaningful understanding of the concepts. In this way, learning becomes a reciprocal experience for the students and the teacher.The animation instructional strategy can be related to Vygotsky‟s theory of social cognitive development. The structure of our schools does not reflect the rapid changes our society is experiencing and Otuka and Uzoechi suggest that changing the learning contexts with computer technology is a powerful tool to improve teaching and learning (Otuka and Uzoechi 2009).

Computer technology is a cultural tool that students can use to mediate and internalize their learning. The animation instructional strategy involves both the teacher and students in the learning process and makes learning to be reciprocal according to the Vygotsky‟s theory. The theory also observed that instruction is most efficient when students engage in activities within a supportive learning environment and when they receive appropriate guidance that is mediated by tools like computers, mentor, printed materials or any instrument that organizes and provide information for the learner. The animation instructional strategy is made up of organized information and text showing motions of elections which is exciting to the students and may help them to understand and internalize the concept of chemical bonding .The teacher can assist the student more from the range of lower unit of what the students know to the upper limit of what the student has potential to accomplish.

2.2.2. Ausubel's Theory of Meaningful Verbal Learning

It is the opinion of majority of practitioners that science is often difficult to convey, not only to the general public but also to students. This difficulty is seen as emanating from the specialized nature of the discipline and its jargon. The difficulty level of a science course is made worse by the more common exposure of students to "text book science" rather than frontier science (Igor, 2005). Use of analogies, especially from relevant plays to which students have been exposed; serve as links between learners' previous knowledge and the target concepts of the teaching-learning situation. In this way analogies serve as advanced organizers found in David Ausubel's theory. Urevbu, (1991) writing extensively on Ausubel's theory of meaningful verbal learning, states that a concept, process and so on, being presented to students will only be meaningful if there is an equivalent representation of the concept or process in the mind of the learner. The new knowledge has to find an anchor in the existing cognitive structure of the learner to be meaningful. Using analogies drawn from familiar cultural backgrounds - a play to which the students have previously been exposed, to explain chemistry concepts for easy understanding, answers the descriptions of advanced organizers in David Ausubel's theory.

David Ausubel further divides advanced organizers into two – expository organizers, to be used when the new concepts are completely new and comparative organizers, to be used when the new concepts are somewhat familiar. It is the comparative organizers, which make use of similarities and differences between the new concepts and the existing cognitive structure that analogies in this study specifically represent. This is because at SS2 level, chemistry concepts, especially in the topic “metals and their compounds”, upon which this study is centered, are not completely strange but are extensions of earlier topics. Analogical links between knowledge therefore, can lead to “effective surprise” – the shock of recognition, beyond which there is no longer astonishment (Bruner, 1974). In this way analogies used as advanced organizers will help to bridge the gap in knowledge that makes some concepts difficult to understand simply because they do not easily fit in with existing body of knowledge.

2.2.3. Jerome Bruner’s Theory of Learning

Bruner is one of the founding fathers of constructivism. According to Gamaliel and Cherry (2004), Constructivism is an epistemology of learning based on the fact that reflection on experiences while constructing our own understanding of the world allows learners to formulate a more concrete meaning of subject matter. Constructivism deals with the cognitive processes in which the learner develops his or her knowledge. The major theme of the study is that learning is an active process in which learners construct new ideas or concepts based on their current or past knowledge.The learner selects and transforms information, constructs hypotheses and makes decisions based on the cognitive structure. Cognitive structure (i.e. schemata or mental model) provide meaning and organization to experiences and allows the individual to go beyond the information given. Opportunities are provided for learners to construct new knowledge and new meaning from authentic experiences. Could ANIS help students to construct new knowledge that could led to understanding of chemical bonding.

Gamaliel and Cherry (2004) reported that Bruner developed three stages of representation, namely enactive, iconic and symbolic. None of the stages are age specific to the learner compared to Piaget‟s research which has a specific age for each intellectual stage. In the Enactive stage, knowledge is largely in the form of motor responses. Students may be able to perform a physical task better than describing the exact same task that has just been accomplished. This shows that the learner is more in the enactive stage of representation. In the iconic stage, knowledge is largely more in visual images. When presented with new information, it is sometimes more helpful for people who are in the iconic stage of representation to have a diagram in order to visualize concepts being taught. When in the symbolic stage, knowledge is mostly in the form of arbitrary words, mathematical symbols and other systems. The symbol X which stands for multiplication sign in mathematics but can have different meanings in other disciplines such as language.

Otuka and Uzoechi (2009), based on Bruner‟s theory stated that the task of the instructor is to translate information to be learned into a format appropriate to the learner's current state of understanding. Curriculum should be organized in a spiral manner so that the student continually builds upon what they have already learned.

Otuka and Uzoechi (2009) states that Bruner‟s theory of instruction should address the following:-

- The ways in which a body of knowledge can be structured so that the learner can most readily grasp it.
- The most effective sequences in which to present material
- The nature and pacing of rewards and punishments.

According to Otuka and Uzoechi(2009), good methods for structuring knowledge should result in simplifying, generating new propositions, and increasing the manipulation of information. ANIS simplified the concept of chemical bonding so as make it easier for the learner to easily grasps it.

Bruner’s constructivist theory can be applied to instruction by applying the following principles.

- Instruction must be concerned with the experience and contents that make the student willing and able to learn (readiness).
- Instruction must be structured so that it can easily be grasped by the student (spiral organization).
- Instruction should be designed to facilitate extrapolation and or fit in the gaps (going beyond the information given).

Bruner‟s theory can be applied to chemical bonding using animation instruction strategy. The animated lesson should be prepared to suit the learners‟ current state of understanding and in a way that the learner can easily grasp the concept. The animation instructional strategy is simplified in order to generate new propositions which can enhance understanding of the concepts. Based on the Bruner’s theory mentioned before, the animation instructional strategy involving computer may make the students willing and ready to learn.Could ANIS make the concept of chemical bonding to be grasped easily because the movement of electrons can be seen through the visual display instead of using conventional method which makes the concepts to be abstract to the learner?

2.2.4. Information Processing Theory

Development psychologists who adopt the Information processing perspective account for mental development in terms of maturational changes in basic component of a child’s mind. The theory is based on the idea that human beings process information received. This equates the mind to a computer which analyses information from the environment. The mind’s machinery includes attention mechanism for bringing information in working memory for actively manipulating information and long term memory for passively holding information so that it can be used in future. According to the cognitivist, human mind is similar to a computer.

Human beings have many memory stores and information is transferred from one store to another. Cognitive processes include perception, recognition, imagining, remembering, thinking, judging, reasoning, problem-solving, conceptualizing, planning and applications. These cognitive processes can emerge from human language, thought, imagery and symbols. One wonders whether animation instructional strategy could help the students to perceive, recognize and conceptualize chemical bonding. The ANIS also involves imagery which deals with verbal and non-verbal presentation of the concept.

The Four Pillars of Information Processing Model: They are;

1. Thinking: This involves activities of perception of external stimuli, encoding the same and storing the data so perceived and encoded in one's mental recesses.
2. Analysis of Stimuli: This is the process by which encoded stimuli are altered to suit the brains cognition and interpretation processes to enable decision making. They are four distinct sub-processes namely encoding, strategization, generalization and automatization.
3. Situational Modification: It is when an individual uses his experience to handle a similar situation in future.
4. Obstacle Evaluation: At this stage, there is need for intellectual, problems-solving and cognitive acumen of the individual to be checked but the nature of the obstacle or problem also need to be evaluated.

Could ANIS help to alter encoded stimuli in order to suit cognition which can lead to decision making?. Could ANIS help to overcome obstacles and the experience gained through the use of Animation Instructional Strategy can it be used to handle future problems?. The structure of the information-processing system has three major components; namely: Sensory register, short-term memory and long term memory. The sensory system store, holds unto the sensory information long enough so that unconscious process may operate on these traces to determine whether the input should be brought into the working memory or be discarded. Short term memory is to be the centre of conscious thought, analogous to the central processing unit of a computer where information from long-term memory and the environment is combined to help solve problems. The short-term memory has a small capacity and cannot attend to much information at a time. Long term memory is the stored representation of all that a person knows. The item stored in long term memory lies dormant until they are called back into the working memory and put to use. (Retrieved from Wikipedia encyclopedia). The Animation Instructional strategy is based on how to make students to conceptualize chemical bonding involving transfer and sharing of electrons. The animation can be produced using Swishmax software. Could animation Instructional Strategy help the students understand the concept of chemical bonding, store and retrieve it when needed?

2.2.5 Aristotle's Theory

Aristotle sets the stage for all later theories of analogical reasoning. In his theoretical reflections on analogy and in his most judicious examples, we find a sober account that lays the foundation both for the commonsense guidelines noted above and for more sophisticated analyses.

Although Aristotle employs the term analogy (analogia) and discusses analogical predication, he never talks about analogical reasoning or analogical arguments per se. He does, however, identify two argument forms, the argument from example (paradeigma) and the argument from likeness (homoiotes), both closely related to what would we now recognize as an analogical argument.

The argument from example (paradeigma) is described in the Rhetoric and the Prior Analytics:

Enthymemes based upon example are those which proceed from one or more similar cases, arrive at a general proposition, and then argue deductively to a particular inference. (Rhetoric 1402b15, as cited by Bartha, 2013.).

Let A be evil, B making war against neighbors, C Athenians against Thebans, D Thebans against Phocians. If then we wish to prove that to fight with the Thebans is an evil, we must assume that to fight against neighbors is an evil. Conviction of this is obtained from similar cases, e.g., that the war against the Phocians was an evil to the Thebans. Since then to fight against neighbors is an evil, and to fight against the Thebans is to fight against neighbors, it is clear that to fight against the Thebans is an evil. (Pr. An. 69a1, as cited by Bartha, 2013).

Aristotle notes two differences between this argument form and induction (69a15ff.): it "does not draw its proof from all the particular cases" (i.e., it is not a "complete" induction), and it requires an additional (deductively valid) syllogism as the final step. The argument from example thus amounts to single-case induction followed by deductive inference. (Bartha, 2013).

Summarizing Aristotle's theory according to Bartha (2013) provides us with four important and influential criteria for the evaluation of analogical arguments:

• The strength of an analogy depends upon the number of similarities.

• Similarity reduces to identical properties and relations.

• Good analogies derive from underlying common causes or general laws.

• A good analogical argument need not pre-suppose acquaintance with the underlying universal (generalization).

These four principles form the core of a common-sense model for evaluating analogical arguments (which is not to say that they are correct; indeed, the first three will shortly be called into question). The first, as we have seen, appears regularly in textbook discussions of analogy. The second is largely taken for granted, with important exceptions in computational models of analogy. Versions of the third are found in most sophisticated theories. The final point, which distinguishes the argument from likeness and the argument from example, is endorsed in many discussions of analogy (e.g., Quine and Ullian, as cited by Bartha, 2013).

2.2.6 Analogical Cognitive Theory

One of the aims of diagnostic assessment of reasoning within science amongst others, is to monitor students' cognitive development, to make sure they possess the reasoning skills necessary for them to understand and master the science learning material in a meaningful way on the one hand, and to check if science education stimulates students' cognitive development as much as it can be expected, on the other hand (Csapo, 2012). This idea is echoed by Adey and Csapo (2012), Adey and Shayer (as cited by Csapo and Kambeyo, 2018.) and Csapo and Szabo (2012), who assert that the content-based methods of enhancing cognition by applying science material for stimulating development provide rich resources for identifying reasoning processes which can be relevant in learning science and which can be developed through science education.

Analogical cognition, which embraces all cognitive processes involved in discovering, constructing and using analogies, is broader than analogical reasoning (Hofstadter as cited by Bartha, 2013; Hofstadter and Sander 2013). Understanding these processes is an important objective of current cognitive science research, and an objective that generates many questions. How do humans identify analogies? Do non-human animals use analogies in ways similar to humans? How do analogies and metaphors influence concept formation?

This entry, however, concentrates specifically on analogical arguments. Specifically, it focuses on three central epistemological questions:

1. What criteria should we use to evaluate analogical arguments?

2. What philosophical justification can be provided for analogical inferences?

3. How do analogical arguments fit into a broader inferential context (i.e., how do we combine them with other forms of inference), especially theoretical confirmation?

To find such answers would constitute an important first step towards understanding the nature of analogical reasoning. To isolate these questions, however, is to make the non-trivial assumption that there can be a theory of analogical arguments—an assumption which, as we shall see, is attacked in different ways by both philosophers and cognitive scientists.

2.3 Relevant Empirical Studies

Reviewed Empirical studies on the use of simulations and Analogy method to communicate science can easily be categorized according to their impacts on skill acquisition, personality traits, motivation and achievement. Some of the studies also focused on the effects of these art forms on two or more of the factors listed above.

Ezeudo and Ezinwanne (2013) investigated the effect of simulation games on students' achievement in Senior Secondary School Chemistry in Enugu State, Nigeria. The design of the study was pre-test and post-test quasi-experimental. The sample consisted of 159 Senior Secondary Schools of (SSS 1) Students (80 males and 79 females). The achievement test in simulation (ATIS) was used to collect data on students' achievement. The result showed that simulation increased students' achievement in chemistry. There was no significant difference in achievement of male and female students in Chemistry concepts.

Bahrami*et al.,* (2012) carried out a study on a comparison of the effectiveness of game- based and traditional teaching on learning and retention of first grade math concepts in Iran. The population of the study consisted of all the female student of khorramabad province. Experimental group were taught using game-based teaching while the control group were taught using the traditional teaching. Data description was done using mean standard deviation and data comparison was done using independent T-test and Effect Size (ES). The results showed that the experimental group had higher score in learning and retention; this revealed that using educational games in teaching of first grade math can be remarkably helpful and efficient.

Hassan and Poopak (2012) in their study in Iran investigated the effect ofteacher-madeinstructionalcardgamesandcomputergamesforlearningchemistry concepts on high school students majoring in math and science. The sample consisted of three groups of 35 students. The results indicated that there was a significant difference between teacher – made card games and computer games.

Shubbar (2010) investigated rotation and diagrams of three dimensional structures using rotation of molecules for chemistry visualization problems. In the study, 96 boys aged 15-16 drawn at random from all science students at Bahrain High school were used. These students were classified as above average in terms of general education, ability and achievement. Shubbar‟s study revealed that the ability to visualize molecular structure was dependent on understanding the significance of the tools used to illustrate the structure, and the cues which were used to portray depth. He discussed foreshortening of lines, overlapping of lines and the representation of angles. The researcher required students to look at diagrams of a three-dimensional model and then select which of four other diagrams could represent the model. The students were able to refer to diagrams showing orientations of X and Y axes. The teaching method was used to assist the student in preparing for this test and employed animation with an explanation describing how to visualize the rotation of the molecular structure. The animation provided a shadow cue to assist in visualizing the rotation of the molecule

Hays (2011) in a study of spatial abilities and the effects of computer animations used one hundred and thirty one (131) students of higher school in suburban middle school. These students were considered to be above average in educational ability. Hays assumed two things:

(1) Spatial representations are the more appropriate form of memory representation for concepts involving time and motion.

(2) Animation communicates those ideas involving time and motion better than text, Hays concluded by noting that animation somehow managed to improved high spatial ability subjects and should allow subjects to make better use of their performance. The results indicated that lower ability subjects improved more through the use of animation than through the use of text only or static pictures. The improvement shown by participants indicated that the students with lower ability were almost equal with the students of higher ability after the use of animation. This result agreed with Hay's assumption that using three – dimensional objects moving in time and space could aid the lower spatial ability students; thereby making them to reach the same degree of understanding that students with higher spatial ability could attain.

The advancement in computer animation allows realistic scenes to be generated and provide interactive tools that students are able to use to create an environment that they are able to control. This ability provides the opportunity for a better understanding, greater retention, and improve spatial performance of instructional material. The use of animation is employed in many fields of study, reports and presentations of chemists, engineers, mathematicians, advertising agencies, commercial designers, and architects all use graphics to explain how things work. (Rieber (2010).

Emmanuel et al (2019) in their study titled; Effects of Problematic Analogy Strategy on Students' Achievement and Retention in Balancing Chemical Equation Concepts of

Secondary School Chemistry. They determined the effects of problematic analogy on achievement and retention of senior secondary students in balancing chemical equation in Bosso Local Government Area, Niger State. Quasi-experimental design of pretest, posttest, control group, non-randomize nonequivalent type was adopted for the study. Four null hypotheses were formulated and tested at 0.05 level of significance. Simple random sampling technique was used to select four secondary schools from Bosso Local Government Area and eighty-one (81) SSI students offering Chemistry as participants. Intact class was used. Chemical Equation Achievement Test (CEAT) in form of thirty multiple choice questions was used as instrument for data collection. Data collected were analyzed using mean, standard deviation, and Analysis of Covariance (ANCOVA). The findings of the study shows that there is a significant difference in the mean achievement scores of students taught using balancing of chemical equation using problematic analogy method and those taught using conventional (lecture) method in favor of those taught using problematic analogy method. There was also significant difference in the mean retention scores of students taught balancing of chemical equation using problematic analogy method and those taught using conventional method. Gender was not a significant factor in the students' achievement as well as retention in balancing of chemical equations. It was recommended among others that: science educators and curriculum planners should incorporate innovative strategies such as problematic analogy strategy into the teaching of chemistry concepts in secondary schools.

Ogunjobi (2021), on his research work; Effect of interactive-engagement, analogy-enhanced strategies and location on students’ academic performance and self-efficacy in chemistry. He focus the study to investigate the location effect of interactive-engagement and analogy-enhanced learning strategies on the academic performance and self-efficacy of students in chemistry. The population of the study consisted of all the Senior Secondary School Two (SSS II) students offering Chemistry in all the 187 public senior secondary schools in Ekiti State, Nigeria. 198 SSS II students offering chemistry from the intact classes of six selected secondary schools were the sample used for the study. The selection of the sample for the study was done through multistage sampling procedure. Quasi experimental design of the pretest, posttest control group design was adopted for the study. The students were divided into three groups (two experimental and one control); one of the experimental groups was exposed to interactive-engagement strategy and the second group was exposed to analogy-enhanced strategy while the control group was taught with conventional learning strategy. Two research instruments; Chemistry Students' Performance Test (CSPT) and Students' Self-Efficacy Rating Scale (SSERS) were used for collection of data. Analysis of Covariance (ANCOVA) was the inferential statistics used to analyze the data gathered. Findings of the study showed no significant location effect of interactive-engagement and analogy-enhanced strategies on the students' performance and self-efficacy in Chemistry (($F_{2,\ 191}= 0.207$; $p>0.05$ and $F_{2,\ 191}= 312.238$; $p<0.05$). Students' school location and treatment had no significant interaction effect on their performance and self-efficacy in Chemistry. It was recommended that Chemistry teachers should adopt interactive-engagement and analogy-enhanced learning strategies to improve students' performance and self-efficacy.

Deborah (2016), investigated the effects of interactive-engagement and analogy enhanced instructional strategies on self-efficacy of senior secondary school chemistry students. The moderating effect of gender and educational level of parents were also explored. The study adapted a pretest-posttest, control group quasi-experimental design, with3x2x2 factorial matrix. 492 participants were randomly drawn from six schools in two Local Government Area of Osun state. The instruments used for data collection are Teacher Instructional Guide; Self-efficacy Scale and Teachers' Assessment Sheet. Data were analyzed using Analysis of Covariance and Scheffe post-hoc test. Treatment had significant effect on students' self-efficacy ($F_{2,\ 479}$) =45.63; $p< .05$). The highest self-efficacy posttest mean score (x=54.71) was obtained by students taught using analogy-enhanced instructional strategy followed by the group taught using interactive-engagement instructional strategy (x= 53.81). The least self-efficacy posttest mean score was obtained by the Control group (x= 51.44). Gender and educational level of parents had no significant main effect on students' self-efficacy. There were no interaction effects of treatment, gender and educational level of parents on self-efficacy. The analogy enhanced instructional strategy was most effective in enhancing the self-efficacy of chemistry students. It was therefore recommended as a teaching strategy in chemistry classes for improving performance through enhanced self-efficacy.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

This chapter deals with the methodology adopted by the researcher in carrying out the research study. They include the design of the study, population of the study, sample and sampling techniques, research instruments, reliability of the instrument, validation of the research instrument, method of data collection and method of data analysis.

3.2 Research Design

The research design that was adopted for this study was a descriptive research design. A descriptive research is a type of research that describes a population, situation or phenomenon that is being studied. It is a research where a group of people are examined by collecting and analyzing data from their representatives through questionnaires. It is used to describe the distinctiveness of individuals or group.

3.3 Population of the study

The population for this study comprises of 473 undergraduate students in department of Science Education, Federal University of Technology Minna, Niger State.

Table 3.1: Distribution of Students in Department of Science Education, Federal University of Technology Minna, Niger State.

S/N	Level	Biology	Chemistry	Mathematics	Total
1	100 Level	39	7	6	52
2	200 Level	48	43	30	121
3	300 Level	46	59	48	153
4	400 Level	19	24	14	57
5	500 Level	35	20	35	90
	Total	**187**	**153**	**133**	**473**

Source: Examination Office Department of Science Education, Federal University of Technology Minna, Niger State 2019/2020 Academic Session.

3.4 Sample and Sampling Technique

A sample of 90 students from the total number 473 students in the department of Science Education was selected for this study. The 90 students are the 500level students in the Department. Purposive sampling technique was used for the selection because the 500level students have gone a Teaching Practice experience and might have little knowledge on the use of Simulations and Analogy in teaching, as such, they fit in the category of respondents that will be needed for the study as a result of their experience as students who have practiced teaching.

3.5 Research Instrument

A research instrument that was used to collect data for this study was questionnaire designed by the researcher. The questionnaire is titled "Pre-Service Teachers' Perception of the Impact of Simulation and Analogy on Students Achievement in Federal University of Technology Minna".

The questionnaire consists of 30 items and is divided into two sections. Section A consists of demographic information about the gender of the respondents while section B consists of statements to elicit the perceived intentions of students on Simulation and Analogy. A four point Likert scale questionnaire was used to elucidate information from the sample i.e. SA, A, D, SD.

3.6 Validity of the Instrument

The instrument was validated by an expert and also by the project supervisor both from the department of Science Education, Federal University of Technology Minna for face and content validity in terms of clarity, use of language, suitability, logical arrangement of the items were modified while some items were also added and some completely removed.

3.7 Reliability of the Instrument

A trial test of the questionnaire instruments was carried out by administering 40 of the instrument on the students of School of Midwifery Minna, Niger State but was not used for the main study. The reliability coefficient was determined using the Cronbach Alpha technique, which showed a reliability index of 0.87. Based on this result, the instrument was declared reliable.

3.7 Method of Data Collection

The researcher used self-administered questionnaire to collect the data from the respondents. The administration of the research instrument was done for about one week reason being that the research was not able to meet all the respondents at the same time since they were not all in the same option (Biology, Chemistry, Mathematics). After the administration of the research instrument, the researcher retrieved back the questionnaire. The complete copies of the questionnaire were collected for further analysis.

3.8 Method of Data Analysis

The data collected from the sampled students were analyzed using Mean, Standard Deviation and ANOVA, using the Statistical Package for Social Sciences (SPSS) Version 25.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Introduction

This chapter deals with presentation and analysis of data. The data's were analyzed using a bench mark of mean 2.5 for accepting or rejecting each of the questionnaire item and research questions.

4.2 Analysis of Research Questions

The data collected in order to answer the four research questions were analyzed and presented in tables 4.1 to table 4.4.

4.2.1 Research Question One

What is the perception of Pre-Service Teachers' towards the use of Simulation on students' achievement?

Table 4.1: Mean Score difference on perception of Pre-Service Teachers' towards the use of Simulation on students' achievement?

S/N	STATEMENTS	RATINGS SA	A	D	SD	MEAN($\bar{x}$)	S.D	REMARK
1	Simulation as a teaching method improves my teaching experience.	46	38	4	2	3.40	0.747	Accept
2	Simulation can be of advantage in teaching science concepts.	36	47	5	2	3.27	0.761	Accept
3	Simulation should be encouraged in teaching science.	35	45	5	5	3.22	0.790	Accept
4	Difficult concepts in science can easily be taught using Simulation method.	39	39	6	6	3.23	0.847	Accept
5	Simulation is a student centred method of teaching.	37	44	11	8	3.08	0.997	Accept
6	Simulation encourages active learning of science.	37	46	5	2	3.28	0.765	Accept
7	The use of Simulation enables student to express themselves freely.	44	39	1	6	3.40	0.667	Accept
8	Simulation provides good practice for problem-solving	37	43	7	3	3.22	0.845	Accept

9	Simulation helps students to maintain high degree of mental alertness to develop clear thinking.	38	46	3	3	3.32	0.700	Accept
10	Students who view science to be difficult find it more interesting using Simulation.	41	36	8	5	2.22	0.909	Reject
11	It takes a lot of time before a lesson is prepared and presented using Simulation.	27	30	18	15	2.73	1.100	Accept
12	Simulation does not allow for easy coverage of syllabus.	29	26	23	12	2.68	1.179	Accept
13	Few numbers of students participate in delivering a lesson using Simulation.	19	33	21	17	2.56	1.072	Accept
14	Most students get carried away in the play than the learning activities.	36	31	15	8	2.98	1.081	Accept
15	Simulation involves risk taking in learning some concepts.	22	33	20	15	2.63	1.086	Accept
	Grand Mean					**3.02**		Accept

Table 4.1 shows that fourteen items agree that Simulation is a good method of teaching which brings about positive achievements among science students and it also encourages the students in active learning while one item does not agree with how Pre-Service Teachers perceive the impact of Simulation on students' achievement.

The grand mean of table 4.1 shows a mean value of 3.02 which shows Science Education Students perceive Simulation to be a good method of teaching Science.

4.2.2 Research Question Two

Is there any difference on the Pre-Service Teachers' Perception of the Impact of Simulation on students achievement based on gender?

Table 4.2: Mean and Standard Deviation of Male and Female Pre-Service Teachers on Perception of Simulation.

S/N	Gender	Mean ($\bar{x}$)	SD	Mean Difference
1	47	46.32	5.39	0.45
2	43	49.21	5.84	

Table 4.2 above reveals the Mean and Standard Deviation of Male and Female Students on Perception of Simulation. The Perception of Simulation in the table above shows the mean and standard deviation values of 46.32, 5.39 and 49.21, 5.84 for male and female Pre-Service

Teachers' respectively. Similarly, the standard deviation values of 5.39 and 5.84 were not significantly different. This result indicates that the Male and Female Students nearly have the same perception in the use of Simulation for Teaching Science Courses.

4.2.3 Research Question Three

How do Pre-Service Teachers' perceive the Impact of Analogy on Students Achievement?

Table 4.3: Mean score difference on how Pre-Service Teachers Perceive the Impact of Analogy on Students Achievement.

S/N	STATEMENTS	RATINGS				MEAN($\bar{x}$)	S.D	REMARK
		SA	A	D	SD			
1	Analogy allows easy understanding of science concepts.	37	40	8	5	3.18	0.894	Accept
2	The method is cheap to operate as no special apparatus is needed.	24	46	9	11	2.84	0.891	Accept
3	Students perform better when taught using analogy.	26	39	15	10	2.84	1.027	Accept
4	Lessons conducted using analogy saves time.	24	39	17	10	2.78	1.047	Accept
5	Students do not undergo stress when receiving lectures using analogy.	26	39	18	17	2.81	1.069	Accept
6	Analogy helps to channel the thinking of students in a given direction.	26	50	8	6	3.04	0.847	Accept
7	Large class of students can be handled by the teacher using Analogy.	18	26	23	23	2.43	1.082	Reject
8	Lectures using Analogy are very boring.	31	40	14	5	2.98	1.016	Accept
9	Analogy encourages rote learning or cramming.	21	37	17	15	2.69	1.035	Accept
10	The desired learning outcomes may not be accomplished using analogy.	18	36	18	18	2.60	1.026	Accept
11	Students are passive listeners and do not participate in the development of the lesson.	23	33	21	13	2.64	1.105	Accept
12	Students' progress cannot be evaluated during the lessons since they are passive listeners.	23	33	18	16	2.68	1.105	Accept
13	Analogy does not meet the needs of students as regards individual differences.	27	37	15	11	2.84	1.038	Accept
14	Analogy rarely affords students the opportunity to practice communication skills.	28	36	18	8	2.82	1.087	Accept
15	The method is inadequate for teaching certain science concepts.	24	33	19	14	2.69	1.088	Accept
	Grand Mean					**2.79**		Accept

Table 4.3 shows that fourteen items agree that Simulation is a good method of teaching which brings about positive achievements among science students and it also encourages the students in active learning while one item is not in agreement about how Pre-Service Teachers perceive the Impact of Analogy on Students Achievement.

The grand mean of table 4.3 shows a mean score of 2.79 which indicates that Analogy is perceived to be a good teaching method for teaching science.

4.2.4 Research Question Four

Is there any difference on the Pre-Service Teachers' Perception of the Impact of Analogy on students achievement based on gender?

Table 4.4: Mean and Standard Deviation of Male and Female Pre-Service Teachers' Perception on the Impact of Analogy on Students Achievement.

S/N	Gender	Mean ($\bar{x}$)	SD	Mean Difference
1	47	41.36	6.63	
				1.12
2	43	42.65	7.75	

Table 4.4 above showed the Mean and Standard Deviation of Male and Female students on Analogy. The Perception of Analogy in the table above shows the mean and standard deviation values of 41.36, 6.63 and 42.65, 7.75 for male and female students of Science Education respectively. This indicates that Male and Female students nearly have the same perception on Analogy.

4.2.5 Research Hypotheses One

There is no significant difference on Pre-Service Teachers' Perception of the impact of Simulation on students' achievement based on gender.

Table 4.5: Summary of ANOVA analysis of difference between Male and Female Pre-Service Teachers' Perception on the Impact of Simulation.

Sources of Variation	Sum of Squares	df	Mean square	F	Sig
Between Groups	187.571	1	187.571	5.956	0.017
Within Groups	2771.329	88	31.492		
Total	2958.900	89			

*S: Significant p<0.05

Table 4.5 revealed the result of one way ANOVA comparison of the difference between Male and Female Pre-Service Teachers Perception on the impact of Simulation on students Achievement. The result revealed that there was a significant difference between Male and Female Pre-Service Teachers Perception on the impact of Simulation on students Achievement $F(1,88)=5.956$, sig=0.017, $p<0.05$) on this bases the hypothesis was rejected.

4.2.6 Research Hypotheses Two

Table 4.6: Summary of ANOVA analysis of difference between Male and Female Students Perception on Analogy.

Sources of Variation	Sum of squares	df	Mean square	F	Sig.
Between Groups	37.337	1	37.337	0.723	0.397
Within Groups	4544.619	88	51.643		
Total	4581.956	89			

N.S: Not Significant p>0.05

Table 4.5 revealed the result of one way ANOVA comparison of the difference between Male and Female Pre-Service Teachers Perception on the impact of Simulation on students Achievement. The result revealed that there was no significant difference between Male and Female Pre-Service Teachers Perception on the impact of Analogy on students Achievement $F(1,88)=0.723$, sig=0.397, $p>0.05$) on this bases, the null hypothesis was retained.

4.3 Discussion of Results

The purpose of this study is to investigate the Perception of Simulation and Analogy Enhanced among Science Education Students of Federal University of Technology Minna.

Based on research question one, the study reveals that Science Education Students Perceive Simulation a good method of teaching. This study therefore confirms the view of Chang, Quintana, & Krajcik, 2010 which states that simulations or animations can help students visualize the phenomenon that might otherwise be difficult to depict. Thus, the benefit from simulations are making science abstract concept more accessible, visible, and can help students to understand science concepts. Similarly, Honey & Hilton, 2011 stated that simulations have potential to advance multiple science learning goals, including motivation to learn science, understanding of the nature of science, science process skills, scientific discussion and argumentation, and identification with science and science learning.

The findings in line with research question two and research hypothesis one reveals that there is a significant difference between the mean perception of male and female students. This study confirms the view of Babajide (2010) who admitted that such conceptual sciences like physics and chemistry are given masculine outlook by educational practitioners. Similarly, The finding based on research question three reveals that Science Education Students also perceive the use of Analogy as a teaching method to be useful. The study is in confirmation with Krisette et al., 2018, who investigated how multiple analogies affect student learning of the concept electrical circuit. The results show that using analogies not only advanced the profound understanding of intricate science concepts but it also helped students correct their misconceptions of these concepts. Salih 2010, discussed the potential of an analogical task in accelerating the thinking skills of Malaysian students. The analogical task given to the students enhanced the various thinking skills such as reasoning capabilities, critical and creative thinking skills.

The findings in line with research question four and research hypothesis two reveals that there is no difference in mean perception of male and female students on the use of Analogy as a teaching method. This study is in confirmation with Ogunleye and Babajide (2011) who reported that gender has no significant effect on students' achievement and practical skills in physics.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the findings of the study on Pre-Service Teachers' Perception of the Impact of Simulation and Analogy on Students Achievement in Federal University of Technology Minna, Niger State. These results gave insight on the effect of Simulation and Analogy in teaching of Science.

From the findings of the study it could be concluded that

1. There is a significant influence of Simulation on students' achievement in learning sciences.
2. There is a significant influence of Simulation on student's achievement in learning sciences.
3. There is no difference in the performance of male and female students when taught science concepts using simulation and analogy.

5.2 Recommendations

Based on the findings of the study the following are the recommendations are made:

1. The curriculum planners should incorporate innovative strategies on the use of Simulations and problematic Analogy strategies into teaching science.
2. The school management should also implement the use of Simulation and Analogy in teaching Science courses/Subjects.
3. Science teachers should to be enlightened on the importance of Simulation and Analogy in teaching science subjects.
4. Workshops/training should be organized to guide science teachers on the use of Simulation and Analogy in teaching.

5.3 Contribution to the Knowledge

1. The study serves as an insight towards the importance of the adopting Simulation and Analogy method in teaching science.
2. The study also adds up to the already exiting literatures in the implementation of Simulation and Analogy in teaching science.

5.4 Suggestion Further study

The following research topics are suggested for further study

1. An Evaluative Study on the Factors Affecting the Implementation of Simulation in teaching of Science.
2. Assessment of Teachers and Students activities in the Implementation of Simulation in teaching science.
3. An Evaluative study on the factors affecting the Implementation of Analogy in teaching science.
4. Assessment of students' performance on the use of Analogy in Learning Science concepts.

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APPENDIX I

QUESTIONNAIRE ON "PRE-SERVICE TEACHERS' PERCEPTION OF THE IMPACT OF SIMULATION AND ANALOGY ON STUDENTS ACHIEVEMENT IN FEDERAL UNIVERSITY OF TECHNOLOGY MINNA".

SECTION A

INSTRUCTION AND PERSONAL DATA

Instructions:

i Please answer sincerely the question below.

ii Your answers would be treated confidentially.

iii Please kindly tick () the response categories you thick is most appropriate for item.

The categories are

Strongly Agree = SA

Agree = A

Disagree = D

Strongly Disagree = SD

iv Thanks for your anticipated cooperation.

Personal Data

1. Gender: Male [ ] Female [ ]

SECTIONB

Please tick ( ) to indicate your level of agreement on the validity and reliability of assessment instrument. The response categories are Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD).

Research Question I: What is the perception of Pre-Service Teachers' towards the use of Simulation on students' achievement?

S/N	ITEMS	SA	A	D	SD
1	Simulation as a teaching method improves my teaching experience.				
2.	Simulation can be of advantage in teaching science concepts.				
3.	Simulation should be encouraged in teaching science.				
4.	Difficult/dangerous concepts in science can easily be taught using Simulation method				
5.	Simulation is a student centered method of teaching.				
6.	Simulation encourages active learning of science.				
7.	The use Simulation enables student to express themselves freely.				
8.	Simulation provides good practice for problem-solving				
9.	Simulation helps students to maintain high degree of mental alertness to develop clear thinking.				
10.	Students who view science to be difficult find it more interesting using Simulation.				
11.	It takes a lot of time before a lesson is prepared and presented using Simulation.				
12.	Simulation does not allow for easy coverage of syllabus.				
13.	Few numbers of students participate in delivering a lesson using Simulation.				
14.	Most students get carried away in the play than the learning activities.				
15.	Simulation involves risk taking in learning some concepts				

Research Question 2: How do Pre-Service Teachers' perceive the Impact of Analogy on Students Achievement?

S/N	ITEMS	SA	A	D	SD
1.	Analogy allows easy understanding of science concepts.				
2.	The method is cheap to operate as no special apparatus is needed.				
3.	Students perform better when taught using analogy.				
4.	Lessons conducted using analogy saves time.				
5.	Students do not undergo stress when receiving lectures using analogy.				
6.	Analogy helps to channel the thinking of students in a given direction.				
7.	Large classes of students can be handled by the teacher using analogy.				
8.	Lectures using analogy are very boring.				
9.	Analogy encourages rote learning or cramming.				
10.	The desired learning outcomes may not be accomplished using analogy.				
11.	Students are passive listeners and do not participate in the development of the lesson.				
12.	Students' progress cannot be evaluated during the lessons since they are passive listeners.				
13.	Analogy does not meet the needs of students as regards individual differences.				
14.	Analogy rarely affords students the opportunity to practice communication skills.				
15.	The method is inadequate for teaching certain science concepts.				

APPENDIX II

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT SCIENCE EDUCATION

Vice Chancellor: PROF. ABDULLAHI BALA, Ph.D Fssn
Head of Department: DR. RABIU M. BELLO PhD, MSTAN

Federal University of Technology
P.M.B. 65,
Minna, Niger State.
Nigeria.

Date: 31/05/2021

Name: JEREMIA ADAMS EDERYE

Matriculation No: 2017/3/69345BE

TO WHOM IT MAY CONCERN

The student/ Candidate whose particulars appear on the form is carrying out his/her final year project work.

Please, kindly assist him/her in whatever way possible towards completing this research work.

Thank you in anticipation of your full cooperation.

Head of Department
Science Education
Fed. University of Technology
Minna
DATE

Dr. Rabiu M. Bello
HOD, Science Education.

Contacts: +234-803-592-7009
+234-802-635-6884
E-mail: drrabiu@futminna.edu.ngssssss

APPENDIX III

RESEARCH INSTRUMENT VALIDATION FORM

Sir/Ma,

The candidate JEREMIAH ADAMS ECEKYE with Admission Number 2017/3/69345BE is a student of the department. You are requested to make amends or inputs that will improve the quality of the instrument. Your professional expertise is expected to assist the researcher towards the award of degree.

Thank you.

29 APR 2021

Dr. Rabiu M. Bello

HOD (Signature, Date & Official stamp)

Title of the Research instrument: PERCEPTION OF PLAY-SIMULATION AND ANALOGY AMONG SCIENCE EDUCATION STUDENTS IN FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

SECTION A

1. Appropriateness of the Research Instrument title: It is quite appropriate and Satisfactory enough.
2. Suggest amendment if not appropriate: Nil
3. Completeness of Bio-data Information: It's ok.
4. Suggest inputs if incomplete —
5. Suitability of items generated The items generated are suitable enough for the research work.
6. Structure of the questionnaire/ test items generated The test items generated are well structured.
7. Structure of the instrument in line with the objectives of the study. Satisfactory
8. Items coverage and distribution across constructs and domains measured
9. Appropriateness of the instrument in relation to the type of data to be collected The extent of coverage is satisfactory enough.
10. What is the general overview and outlook of the instrument? Generally Satisfactory
11. Rate the Instrument between 1-10

8

SECTION B

Name of the validator: Dr. Babagana, M.

Designation/Rank: LI

Name of institution: F.U.T.

Department/ School: Science Education

Telephone No/GSM No: 08066553470

E-Mail Address: mohd.bgana@futminna.edu.ng

10/05/2021

Signature, Date and stamp (if available)

APPENDIX IV

THE EXAMINATION OFFICE SCIENCE EDUCATION DEPARTMENT

TOTAL NUMBER OF STUDENT IN THE DEPARTMENT

LEVEL	BIO	CHM	MAT	TOTAL
100 LEVEL	39	7	6	52
200 LEVEL	48	43	30	121
300 LEVEL	46	59	48	153
400 LEVEL	19	24	14	57
500 LEVEL	35	20	35	90

Ahmad Ibn Shuaeeb

[signature] 02/06/2021.

Assistant Examination Officer.

APPENDIX V

```
MEANS TABLES=POPSTOTAL BY GENDER
  /CELLS=MEAN COUNT STDDEV
  /STATISTICS ANOVA.
```

Means

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
POPSTOTAL * GENDER	90	100.0%	0	0.0%	90	100.0%

Report

POPSTOTAL

GENDER	Mean	N	Std. Deviation
Male	46.32	47	5.394
Female	49.21	43	5.841
Total	47.70	90	5.766

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
POPSTOTAL * GENDER	Between Groups	(Combined)	187.571	1	187.571	5.956	.017
	Within Groups		2771.329	88	31.492		
	Total		2958.900	89			

Measures of Association

	Eta	Eta Squared
POPSTOTAL * GENDER	.252	.063

Page 1

```
GET DATA /TYPE=XLSX
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  /SHEET=name 'Sheet1'
  /CELLRANGE=full
  /READNAMES=on
  /ASSUMEDSTRWIDTH=32767.
EXECUTE.
DATASET NAME DataSet1 WINDOW=FRONT.
FREQUENCIES VARIABLES=POPS1 POPS2 POPS3 POPS4 POPS5 POPS6 POPS7 POPS8 POPS9 PO
PS10 POPS11 POPS12
    POPS13 POPS14 POPS15
  /STATISTICS=STDDEV MEAN
  /ORDER=ANALYSIS.
```

Frequencies

[DataSet1]

Statistics

	N		Mean	Std. Deviation
	Valid	Missing		
POPS1	90	0	3.40	.747
POPS2	90	0	3.27	.761
POPS3	90	0	3.22	.790
POPS4	90	0	3.23	.849
POPS5	90	0	3.08	.997
POPS6	90	0	3.28	.765
POPS7	90	0	3.40	.667
POPS8	90	0	3.22	.845
POPS9	90	0	3.32	.700
POPS10	90	0	3.22	.909
POPS11	90	0	2.73	1.100
POPS12	90	0	2.68	1.179
POPS13	90	0	2.56	1.072
POPS14	90	0	2.98	1.081
POPS15	90	0	2.63	1.086

Frequency Table

POPS1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	4	4.4	4.4	4.4
	SD	2	2.2	2.2	6.7
	A	38	42.2	42.2	48.9
	SA	46	51.1	51.1	100.0
	Total	90	100.0	100.0	

POPS2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	5	5.6	5.6	5.6
	SD	2	2.2	2.2	7.8
	A	47	52.2	52.2	60.0
	SA	36	40.0	40.0	100.0
	Total	90	100.0	100.0	

POPS3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	5	5.6	5.6	5.6
	SD	5	5.6	5.6	11.1
	A	45	50.0	50.0	61.1
	SA	35	38.9	38.9	100.0
	Total	90	100.0	100.0	

POPS4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	6	6.7	6.7	6.7
	SD	6	6.7	6.7	13.3
	A	39	43.3	43.3	56.7
	SA	39	43.3	43.3	100.0
	Total	90	100.0	100.0	

Page

POPS5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	11	12.2	12.2	12.2
	SD	8	8.9	8.9	21.1
	A	34	37.8	37.8	58.9
	SA	37	41.1	41.1	100.0
	Total	90	100.0	100.0	

POPS6

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	5	5.6	5.6	5.6
	SD	2	2.2	2.2	7.8
	A	46	51.1	51.1	58.9
	SA	37	41.1	41.1	100.0
	Total	90	100.0	100.0	

POPS7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	1	1.1	1.1	1.1
	SD	6	6.7	6.7	7.8
	A	39	43.3	43.3	51.1
	SA	44	48.9	48.9	100.0
	Total	90	100.0	100.0	

POPS8

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	7	7.8	7.8	7.8
	SD	3	3.3	3.3	11.1
	A	43	47.8	47.8	58.9
	SA	37	41.1	41.1	100.0
	Total	90	100.0	100.0	

POPS9

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	3	3.3	3.3	3.3
	SD	3	3.3	3.3	6.7
	A	46	51.1	51.1	57.8
	SA	38	42.2	42.2	100.0
	Total	90	100.0	100.0	

POPS10

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	8	8.9	8.9	8.9
	SD	5	5.6	5.6	14.4
	A	36	40.0	40.0	54.4
	SA	41	45.6	45.6	100.0
	Total	90	100.0	100.0	

POPS11

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	18	20.0	20.0	20.0
	SD	15	16.7	16.7	36.7
	A	30	33.3	33.3	70.0
	SA	27	30.0	30.0	100.0
	Total	90	100.0	100.0	

POPS12

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	23	25.6	25.6	25.6
	SD	12	13.3	13.3	38.9
	A	26	28.9	28.9	67.8
	SA	29	32.2	32.2	100.0

POPS13

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	21	23.3	23.3	23.3
	SD	17	18.9	18.9	42.2
	A	33	36.7	36.7	78.9
	SA	19	21.1	21.1	100.0
	Total	90	100.0	100.0	

POPS14

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	15	16.7	16.7	16.7
	SD	8	8.9	8.9	25.6
	A	31	34.4	34.4	60.0
	SA	36	40.0	40.0	100.0
	Total	90	100.0	100.0	

POPS15

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	20	22.2	22.2	22.2
	SD	15	16.7	16.7	38.9
	A	33	36.7	36.7	75.6
	SA	22	24.4	24.4	100.0
	Total	90	100.0	100.0	

```
FREQUENCIES VARIABLES=POA1 POA2 POA3 POA4 POA5 POA6 POA7 POA8 POA9 POA10 POA11
 POA12 POA13 POA14
    POA15
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  /ORDER=ANALYSIS.
```

Frequencies

Statistics

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	Valid	Missing		
POA1	90	0	3.18	.894
POA2	90	0	2.94	.891
POA3	90	0	2.84	1.027
POA4	90	0	2.78	1.047
POA5	90	0	2.81	1.069
POA6	90	0	3.04	.847
POA7	90	0	2.43	1.082
POA8	90	0	2.98	1.016
POA9	90	0	2.69	1.035
POA10	90	0	2.60	1.026
POA11	90	0	2.64	1.105
POA12	90	0	2.68	1.069
POA13	90	0	2.84	1.038
POA14	90	0	2.82	1.087
POA15	90	0	2.69	1.088

Frequency Table

POA1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	8	8.9	8.9	8.9
	SD	5	5.6	5.6	14.4
	A	40	44.4	44.4	58.9
	SA	37	41.1	41.1	100.0
	Total	90	100.0	100.0	

POA2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	9	10.0	10.0	10.0
	SD	11	12.2	12.2	22.2
	A	46	51.1	51.1	73.3
	SA	24	26.7	26.7	100.0
	Total	90	100.0	100.0	

POA3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	15	16.7	16.7	16.7
	SD	10	11.1	11.1	27.8
	A	39	43.3	43.3	71.1
	SA	26	28.9	28.9	100.0
	Total	90	100.0	100.0	

POA4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	17	18.9	18.9	18.9
	SD	10	11.1	11.1	30.0
	A	39	43.3	43.3	73.3
	SA	24	26.7	26.7	100.0
	Total	90	100.0	100.0	

POA5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	18	20.0	20.0	20.0
	SD	7	7.8	7.8	27.8
	A	39	43.3	43.3	71.1
	SA	26	28.9	28.9	100.0
	Total	90	100.0	100.0	

POA6

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	8	8.9	8.9	8.9
	SD	6	6.7	6.7	15.6
	A	50	55.6	55.6	71.1
	SA	26	28.9	28.9	100.0
	Total	90	100.0	100.0	

POA7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	23	25.6	25.6	25.6
	SD	23	25.6	25.6	51.1
	A	26	28.9	28.9	80.0
	SA	18	20.0	20.0	100.0
	Total	90	100.0	100.0	

POA8

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	14	15.6	15.6	15.6
	SD	5	5.6	5.6	21.1
	A	40	44.4	44.4	65.6
	SA	31	34.4	34.4	100.0
	Total	90	100.0	100.0	

POA9

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	17	18.9	18.9	18.9
	SD	15	16.7	16.7	35.6
	A	37	41.1	41.1	76.7
	SA	21	23.3	23.3	100.0
	Total	90	100.0	100.0	

POA10

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	18	20.0	20.0	20.0
	SD	18	20.0	20.0	40.0
	A	36	40.0	40.0	80.0
	SA	18	20.0	20.0	100.0
	Total	90	100.0	100.0	

POA11

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	21	23.3	23.3	23.3
	SD	13	14.4	14.4	37.8
	A	33	36.7	36.7	74.4
	SA	23	25.6	25.6	100.0
	Total	90	100.0	100.0	

POA12

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	18	20.0	20.0	20.0
	SD	16	17.8	17.8	37.8
	A	33	36.7	36.7	74.4
	SA	23	25.6	25.6	100.0
	Total	90	100.0	100.0	

POA13

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	15	16.7	16.7	16.7
	SD	11	12.2	12.2	28.9
	A	37	41.1	41.1	70.0
	SA	27	30.0	30.0	100.0
	Total	90	100.0	100.0	

POA14

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	18	20.0	20.0	20.0
	SD	8	8.9	8.9	28.9
	A	36	40.0	40.0	68.9
	SA	28	31.1	31.1	100.0
	Total	90	100.0	100.0	

POA15

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	19	21.1	21.1	21.1
	SD	14	15.6	15.6	36.7
	A	33	36.7	36.7	73.3
	SA	24	26.7	26.7	100.0
	Total	90	100.0	100.0	