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IMPROVING PRE-SERVICE TEACHERS PERFORMANCE IN SELECTED CHEMISTRY TOPICS USING HYBRID LEARNING APPROACH

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DECLARATION

STUDENT'S DECLARATION

I, ISSAHAKU SHAHADU, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE:…….

DATE:…….

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of thesis as laid down by the University of Education, Winneba.

SUPERVISOR'S NAME: DR. EMMANUEL K. OPPONG

SIGNATURE:…….

DATE:……..…….

DEDICATION

I dedicate this study to my lovely two daughters, Amina Shahadu and Samiatu Shahadu, My son, Zainul-Aabideen Shahadu and to My Special wife, Rafiatu Issah.

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ABSTRACT

The action research design (single group pre-test post-test) was adopted for this study using non-equivalent pre-test and post-test. One group of pre-service teachers (Primary education specialism) took part in the study. Quantitative and qualitative were involved. The qualitative data consisted of responses of the questionnaire from the pre-service teachers with regards to the perceptions on the use of hybrid learning and quantitative data consisted of the pre-test and post-test scores. The group received the pre-test first in the face-to-face session before the use of the hybrid learning as a treatment (hybrid learning). The sample consisted of 89 pre-service teachers (56 males and 33 females) which were purposively selected from the population of Gambaga College of Education pre-service teachers. Data were analysed using descriptive statistics such as percentages which were used to determine the perceptions of pre-service teachers in the chemical concepts. Analysis from the data depicted that there was a significant differences in the mean scores between the performances of teacher trainees in selected chemistry topics when taught using the traditional method and when taught using the hybrid learning approach. However, there was no significant difference between the mean academic performance of male and female pre-service teachers in some selected chemistry topics when they were taught with the lecture method (that the t-calculated value of 2.0656 is greater than the t-critical value of 1.6706 at $p<.05$ alpha level). Findings also indicated pre-service teachers' positive perceptions towards the use of hybrid learning.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter describe the background to the study, statement of the problem, the purpose, objectives, significance of the study and research questions. It also includes null hypothesis, limitations, delimitation, operational definition of terms and organisation of the study.

1.1 Background to the Study

Chemistry is a fundamental subject, and students' lack of comprehension in chemistry has a significant negative impact on practically every area of the economy and every aspect of life (Singh & Moono, 2015). For a long time, it has been a source of considerable concern that students' performance in this subject has consistently fallen short of our expectations, and what has caused this? Even more concerning is the lack of understanding of the matter. It is important to develop innovative tactics that will lead to improved achievement and comprehension of the subject (Singh & Moono, 2015). As a relevant and experimental science subject, chemistry necessitates a proactive teaching style involving effective student participation in hands-on-minds-on experiences to generate information, develop scientific skills, attitudes, and social values (Udofia, 2016; Udoh & Udo, 2020). The learning of chemistry without a thorough comprehension of the fundamental ideas from the start may have a severe impact on students' academic performance (Udoh & Udo, 2020). Chemistry education aims to teach students how to observe and handle physical objects so that their distinguishing characteristics resulting from interactions with other types of matter or

attributes under various conditions may be recognized and used to solve man's problems (Odo, 2013; Udoh & Udo, 2020).

One learning technique that is generally utilized in evolved nations today is hybrid learning. In the view of Rob Hubbert's assessment, hybrid learning is a blend of customary face-to-eye learning by coordinating innovation in the structure of web based learning (Vonti & Rahmah, 2019). Hybrid learning is an instructional method that combines online and face-to-face learning (Halverson & Graham, 2019; Shen, 2016). This method employs web innovation to help schooling become famous among the instructors to improve the nature of teaching method by carrying out the combination web learning and face-to-face learning (Ariffuddin et al., 2021; Dai et al, 2021). A hybrid learning guidance addresses how teachers teach by combining both internet learning and face-to-face learning. It allows teachers to use the media for learning, displaying teaching and learning materials and given assignment to students (Garrison & Kanuka, 2004; Hoic-Bozic et al, 2009).

In educational science research, hybrid learning is also a recent trend. Hybrid learning can be divided into two categories: a mixture of (1) traditional teaching method (or teaching means) and (2) online teaching method (Picciano et al, 2014). Hybrid learning is a formal educational program in which students learn at least in part through online information and instruction, with some control over time, location, method, and pace, and have at least some traditional classroom learning supervised away from home (Dai et al., 2021). As a result, hybrid learning is a teaching approach that is united and uses the same information throughout the learning program.

1.2 Problem Statement

The problem of arriving at appropriate method of teaching chemistry has generated a lot of concerns to chemistry educators over the years. Chemistry is an important subject that explains how the chemical phenomena occur around us. However, students face problems in understanding the subject despite its association with daily life experiences (Taber, 2020; Teo, 2014).

Scholarly accomplishment of understudies in science subjects by and large and in Chemistry specifically had seen a miserable pattern in the previous many years (Nja, Cornelius-ukpepi, Edoho, & Neji, 2020). Report from 2015 to 2020 have reliably uncovered poor accomplishment in Chemistry in Gambaga College of Education auxiliary school endorsement assessment coordinated by University for Development Studies Examination Council. Experimental works audited showed that in proper showing strategies, absence of educational materials/assets as explanations behind helpless scholastic execution of understudies in chemistry (Nja et al., 2020).

However, some studies also concentrated on the effectiveness of hybrid learning in some chemistry concepts. For instance, studies have been conducted on the effects of hybrid learning towards students' performance in electrochemistry topic among secondary school students in Malaysia (Ariffuddin et al., 2021). The findings of this study revealed that, hybrid learning and traditional learning had improved students' performance in Electrochemistry topic. Similar of this research is the effect of the implementation hybrid learning in an organic chemistry course (Lo & Tang, 2018). The result indicated that hybrid learning intervention can promote students' advanced knowledge of synthetic tools. In many studies, problem-based learning was employed as a learning strategy in hybrid learning that included a variety of methodologies and

approaches (Ratnaningtyas et al, 2020). For example, (Hibbard, 2019) used a noteworthy story to teach chemistry, while Weaver and Sturtevant (2015) used a newsworthy tale to teach chemistry. In the context of a Student-Centered Active Learning Environment, problem-based learning is used.

It became clear through the Researchers' interactions with the pre-service teachers during his class lessons delivery that student's comprehension of some chemical concepts were problematic. These concepts seemed abstract to them. Students in the concreate operational and formal operational stages always want to feel and handle materials before they could comprehend simple concepts (McLeod, 2015). The Researcher also encountered similar problems during her study of biology as a young student. However, research revealed that tutors in colleges of education in Ghana still use the traditional method of teaching in teaching pre-service teachers (Wood, 2006).

The traditional lecture method is considered to have some expressions which are very problematic for pre-service teachers to comprehend and its always in abstract way of understanding some chemical concepts (Hinampas et al, 2018). Nevertheless, some pre-service teachers also have some perceptions which are untrue about the use of hybrid learning in teaching and learning processes that is why the researcher decided to embark on this study to erase some of the misconceptions that the pre-service teachers have on the use of hybrid learning in teaching and learning processes.

Yılmaz, (2017) stated that the best way to solve the lack of interaction problem faced in technology-based learning is to balance traditional learning and online learning. Throne (2003) emphasized that the blending of these two learning approaches occurs by combining CD ROM, e-mail, conference, online animation, audio message,

multimedia technology and real classroom environment and he states that it should be presented to the student with traditional classroom management and face to face learning.

From this point of view, Hybrid learning can be a good solution by offering different learning environments to the teacher trainees or pre-service teachers who have individual differences as well as approaches to learning. This study want to look at pre-service teachers' achievement in some selected topics in chemistry as a results of using hybrid learning.

1.3 Research Objectives

This study was carried out to investigate the effect of hybrid learning on academic performance of some selected topics in chemistry in Gambaga College of Education. Specifically, the study tends:

1. To determine the academic performance of pre-service teachers in some selected chemistry topics when taught using hybrid learning and when they are taught with lecture method.
2. To examine the academic performance of male and female pre-service teachers in some selected chemistry topics when taught using hybrid learning and when taught with lecture method.
3. To investigate the perceptions of pre-service teachers towards using hybrid-learning to learn chemistry topics.

1.4 Research Questions

1. What are the academic performance of pre-service teachers in some selected chemistry topics when taught using hybrid learning and when they are taught with lecture method?

2. What are the academic performance of male and female pre-service teachers in some selected chemistry topics when taught using hybrid learning and when taught with lecture method?
3. What are the perceptions of pre-service teachers towards hybrid-learning in the learning of chemistry topics?

1.5 Null Hypotheses

HO_1: There is no significant difference in academic performance of pre-service teachers in some selected chemistry topics when taught using hybrid learning and when they are taught with lecture method.

HO_2: There is no significant difference between the mean academic performance of male and female pre-service teachers in some selected chemistry topics when taught using hybrid learning and when taught with lecture method.

1.6 Purpose of the Study

The purpose of this study is to use the hybrid learning approach to improve pre-service teacher's performance in selected chemistry topics in Gambaga College of education in the North East Region of Ghana.

1.7 Significance of the Study

The findings of this research will be of benefit to both tutors and pre-service teachers in colleges of education in Ghana. The use of online platform for assignment delivery will offer students the opportunity to study without stress and at their own pace while at home and even submit assignments without the stress of going to school. Moreover, it saves the students the burden of carrying text books form their houses to the school. Chemistry tutors will also deliver their lessons, give pre-service teachers assignment and administer test and examinations online through the online platform. Furthermore, the use of internet guarantees safety storage of information and easy retrieval at all times to both pre-service teachers and tutors. The findings will be very useful to all stakeholders in education when they are formulating their educational policies.

1.8 Limitations of the Study

The study was limited to pre-service science teachers in Gambaga College of education and this may have some challenges on the scope of the findings in terms of generalisation. Thus the outcome of the study was not the outcome of the entire pre-service teachers in Gambaga College and all Colleges of education in Ghana. The research will also be limited to some selected topics in chemistry and not the entire topics in chemistry.

1.9 Delimitations of the Study

This study was delimited to the effect of hybrid learning on the performance of pre-service teachers in some selected topics in chemistry. The study was also delimited to only those who offer chemistry as an elective course (primary education pre-service teachers) in Gambaga College of Education.

1.10 Definition of Terms

Hybrid learning: Hybrid learning is one such approach which inculcates online and offline learning or hybrid learning approach is an approach which combines online and face-to-face teaching (Attard, 2020).

Pre-service teachers: Pre-service teachers are those who are in a **teacher-**education program to pursue **teaching** credentials in public schools or private sectors domestically or internationally.

Face-to-face learning (F2F): A course that meets in the classroom with the instructor and the student, physically face-to-face (Elbaum, McIntyre & Smith, 2002).

CHAPTER TWO

REVIEW OF THE RELATED LITERATURE

2.0 Overview

This chapter would review literature on the following areas, the history of hybrid learning, the concept of hybrid learning, hybrid learning methodology and its added value, the effects of hybrid learning, research conceptual framework, history of hybrid learning, evolution and development of the hybrid learning, the theory underpinning the study, knowledge gap or deficit Identified, benefits and challenges of the hybrid learning and the perceptions of pre-service teachers/students on the use of hybrid learning.

2.1 The Concept of Hybrid Learning

The term hybrid learning is frequently used among both researchers and practitioners (Stefan, 2019). However, what do we mean by hybrid learning? What, how and why are we blending? Even though the term hybrid learning is frequently used, there is ambiguity about what it actually meant (Hrastinski, 2019; Oliver & Trigwell, 2005). In a critical review, Oliver and Trigwell concluded that the term hybrid learning simply requires two or more different kinds of things that can then be mixed. Hybrid learning as defined by Dziuban et al. (2004), is an instructional method that includes the efficiency and socialization opportunities of the traditional face-to-face classroom with the digitally enhanced learning possibilities of the online mode of delivery. Characteristics of this approach include (a) student centered teaching where each student has to be actively involved in the content (b) increased opportunities for interaction between student-faculty, student-student, content-student, and student-additional learning material (c) opportunities to collect formative and summative

assessment to improve course offerings (Watson, n.d.). A hybrid course comprises in-person sessions that are accompanied by online resources and tasks essentially a combination of both face-to-face and online learning. A central element of a hybrid course is that online resources are not used to substitute for in-person class time; rather, they are intended to enhance and build upon the concept discussed in the classroom. Blended and hybrid learning are used interchangeably, however, there is a difference as online components of hybrid courses intend to substitute in-person class time. Online interactions in hybrid medium of instruction can be completed either synchronously using real time meeting sessions or asynchronously where students interact at different times (Siegelman, 2019).

Hybrid learning is a mixture of classroom and online learning that includes some of the conveniences of online courses without the complete loss of face-to-face contact (Roval & Hope, 2004). Literature according to Hrastinski (2019) stated that, the two definitions of hybrid learning which are frequently been used have been cited 2149 and 3116 times, respectively in Google Scholar in Oct 25, 2018. The two definitions are been suggested by Graham (2006), and Garrison & Kanuka (2004).

According to Graham (2006) hybrid learning is defined as a system of combining face-to-face instruction with computer-mediated instruction (p. 5). Garrison and Kanuka (2004) also define hybrid learning as the thoughtful integration of classroom face-to-face learning experiences with online learning experiences (p. 96). Hrastinski (2019) concluded that there is an overall agreement according to these two definitions, the key ingredients of hybrid learning are face-to-face and online instruction or learning.

Hybrid learning is a new type of education prepared for a certain group by combining the positive aspects of different learning approaches (Kazu & Demirkol, 2014). Hybrid learning will provide a big convenience for the course to achieve its target by combining the face-to-face interaction in traditional learning and time, place and material richness provided by Web-based learning. Yılmaz (2017) stated hybrid learning is a combination of the traditional face-to-face learning and online learning in a way that will solve the lack of interaction problem faced between the teachers and students. Hybrid learning is the combination of two learning approaches such as combining CD ROM, e-mail, conference, online animation, audio message, multimedia technology and real classroom environment and he states that it should be presented to the student with traditional classroom management and face to face learning (Throne, 2003; Yılmaz, 2017). From this point of view, hybrid learning can be a good solution by offering different learning environments to the students who have individual differences as well as approaches to learning.

According to Bersin (2004), hybrid learning is a learning approach formed with the combination of the different learning environments and activity types for a certain group with the addition of electronic sources to the face-to-face learning. This approach has the facilities to meet the necessities of our time. The fact that it is applicable and renewable, and it has the technological innovations that are brought by our modern age stands as a proof approach which is worthy of research.

Hybrid learning is a combination of more than one method of delivery. By combining different modes of delivery educator can optimize the learning outcome. According to Pallavi and Ambedkar (2020) hybrid learning involves;

- ✔ Face-to-face education involves traditional classroom learning.

- ✔ E-Learning is learning utilizing electronic technologies to access educational curriculum outside of a traditional classroom.
- ✔ Self-Paced Courses are available to watch or listen to on your own time and at your own pace, with no deadlines or expiration dates.

Pallavi and Ambedkar (2020) summarised the characteristics of the hybrid learning model using the diagram below.

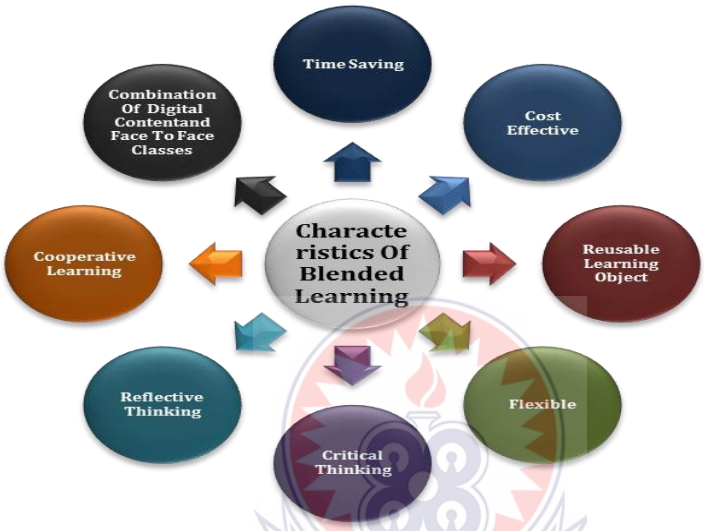

Fig 1: Characrtistics of hybrid learning according to (Pallavi & Ambedkar, 2020)

According to Friesen and Norm (2012), hybrid learning is a formal education program in which a student learns at least in part through delivery of content and instruction via digital and online media with some element of student control over time, place, path, or pace.

The hybrid learning model consists of two dimensions: in-class as the face-to-face instruction and out-of-class as the virtual education dimensions. In the face-to-face instruction, teaching is carried out in the classroom environment and reinforced and

deepened in the virtual learning dimension by digital learning tools (Ross and Gage 2006).

The concept of Hybrid Learning or Blended Learning refers to the combination of an online learning environment by gaining the flexibility of distance or outside of classroom learning, and a face-to-face (F2F) classroom instruction (Hentea, Shea, & Pennington, 2003). Hybrid learning also affords learners the opportunity to meet with course instructors and their peers face-to-face to discuss, debate, question, and acquire instruction. Courses that are taught completely online obviously do not provide for these physically experiences. Hybrid learning combines the benefits of both distance and face-to-face learning. Teachers play the role of facilitators by assisting the students whenever necessary, and the role of instructors by providing complementary lessons in line with the online courses of the students.

Halverson, Graham, Spring, and Drysdale (2012), defined hybrid learning as "a diverse and expanding area of design and inquiry that combines face-to-face and online modalities" (p. 381). In addition, Qi and Tian (2011) stated hybrid learning has four properties introduced, particularly, (1) mix of collective learning and individual learning, (2) mix of synchronous learning and asynchronous learning, (3) a mix of self-paced and group-paced learning, and (4) mix of formal learning and non-formal learning in terms of lifelong learning incorporation and/or setting of learning. In these four properties, hybrid learning as a mix of collective learning and individual learning, as explained by Nguyen (2011), brought by the collective intelligence of multi-agent systems in a collaborative setting that work parallel with the learner along with the method, strategies, and channels employed for the processing and communicating of the instructions. Hybrid learning incorporates a unique

management of time in delivering instructional approaches, particularly through (a) synchronous learning similar to an online classroom that can be taught on a one-to-one or one-to-many basis or (b) asynchronous learning that provides an ideal platform for distance learning approaches (Wang, Fong, & Zhang, 2009). Bruton and Ormand (2011), stated "asynchronous online discussion was reportedly useful for 'encouraging in-depth, more thoughtful discussion; communicating with temporally diverse students; holding ongoing discussions where archiving is required; and allowing all students to respond to a topic'" (as cited on Johnson, 2005, p. 46).

In terms of learning pace, hybrid learning allows a convenient approach of self-paced learning that uses rich media resources provided through the internet, and/or provides a collaborative group learning using synchronized or F2F settings (Stanford-Smith, Chiozza, & Edin, 2002). While the conventional educational programs require the presence of learners at one place of learning, hybrid learning, through the incorporation of information and communication, has modified the structure of education with the application of intelligent teaching systems and utilization of intelligent agents (e.g. collaborative teaching agents, web interface agents, etc.) capable of recognizing the difficulties and variances of the learners and the process of learning to these identified factors (Tecuci, 1998; Anastasiades & Retalis, 2002).

Anastasiades and Retalis (2002) pointed out that in hybrid learning: (a) there are changing roles between the student and the teacher; (b) the teacher evolves into coordinators of knowledge sources capable of handling and processing the pace of learning; (c) the student's attendance and examination requirements are replaced by active participation in the learning processes, development of individualized learning area, and multiple or two-way basis of evaluation; and (d) the time frame of training

process changes into a lifelong learning endeavor. Hybrid learning terminates the conventional start-to-end notion of acquiring education, and in return, it introduces the concept of lifelong learning endeavor that can be acquired throughout the person's individual life span, but courses should by through the learning system. However, a new phase of distance learning has become the leader of the concept of lifelong learning, called Massive Open Online Courses (MOOC) is this phase learning becomes available for all and not required to be attend at an institute or any education system.

2.1.1 History of the hybrid learning

Technology has changed the face of higher education. Initially, traditional face-to-face learning was the only form of instruction where both instructor and students met physically in a brick-and-mortar school (Jones, 2019; Nortvig et al., 2018; Schaber et al., 2010). During the 1990s online learning also started gaining popularity, as students were able to complete their course work asynchronously without coming to campus and being physically present in class room (Nortvig et al., 2018; Jones, 2019). It is also important to note that academic administrators felt that online learning could replace in-person learning, as it was an economically viable option for students. As a result, there was an increased push to increase online course offerings in mid-1990s (Schaber et al., 2010). Despite increased efforts to launch additional courses, online education was not as effective as predicted, as learning was primarily a passive activity (Schaber et al., 2010; Jones, 2019). Over the years, a third method of teaching commonly known as Blended learning has gained wide acceptance among instructors and researchers. By combining strengths of different technologies, web-based tools, and learning theories, this approach promises the best of both worlds (online and

traditional face-to-face system). Research suggest that combination of on-campus and online work is ideal and can prove to be very effective when compared to sole use of one form or the other (Haijian et al., 2011; Jones, 2019). Hybrid learning has the potential to create additional opportunities as it allows them to be included in in-person instruction on a regular basis (Alijani et al., 2014; Jones, 2019) while giving them much needed flexibility to progress at their own pace.

2.1.2 Evolution and development of hybrid learning

Prior evidence suggests that students who complete course work using hybrid modality (combination of in-person and online instruction) excel when compared to peers who may have access to only one form of instruction. Hybrid learning offers a creative option to faculty and academic leaders so they can make information available to students even outside of the four walls of the classroom. This helps in optimizing and maximizing productivity of individual students during in-person sessions (Powell et al., 2015). The history of blended learning dates back to the 1840s when Sir Issac Pitman launched the first distance education course. Shorthand texts were sent to students via postcards and they were required to complete the work and send it back for grading and feedback. It is important to note that feedback and evaluation were extremely important even though mobile devices and computers were not involved (Pappas, 2015). During the 1960s and 1970s, employers were able to deliver training to several employees using computers. This was a ground-breaking revolution because for the first-time employees completed their training without traveling or attending face-to-face live sessions (Pappas, 2015) (see Figure 2).

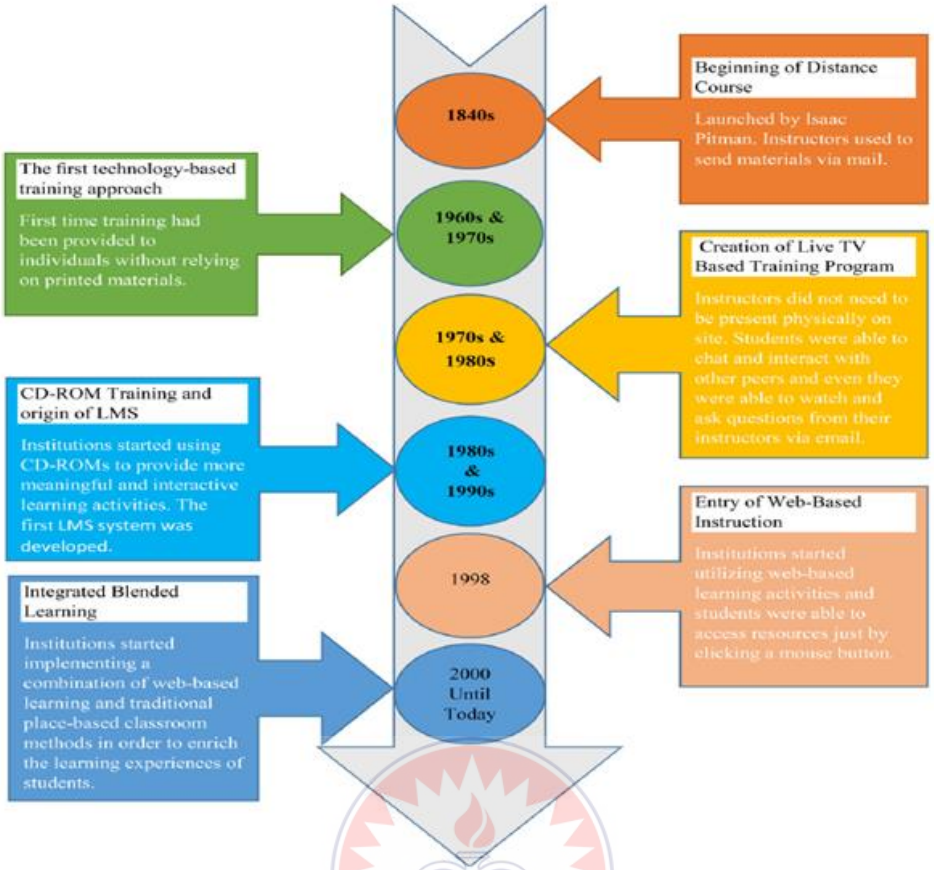

Figure 2. Timeline of hybrid learning (Singh, Steele & Singh., 2021).

2.2 Hybrid learning Methodology and its Added Value

Research found four main ideologies of hybrid learning as follows; hybrid learning enriches the benefit of the learner's diverse needs and preferences, any technology should be applied in a pedagogically appropriate way and used for creating and maintaining socially situated and highly interactive learning (Lin, 2009; Vaughan, 2007). It combines original developing pedagogies and learning theories such as constructivism or activity theory. Together with the new challenging roles of students and teachers in the process of acquiring knowledge and its understanding. Principle of the hybrid learning methodology should ensure the quality and effectiveness of education. The main reasons why hybrid learning should be employed in teaching is as follows: it contributes to pedagogy because it supports more interactive strategies,

not only face-to-face teaching (Graham, 2008; Osguthorpe & Graham, 2003); it thus encourages collaborative learning; students or educators can work together on some projects from anywhere and at any time (Bruffee, 1993); it deepens intercultural awareness since it puts together researchers, educators, and students from anywhere in the world.

Research finding showed that the application of hybrid learning benefited the lecturers and also the students in some aspects; one of them is the students' improvement in science achievement. However, the suggestions about the implementation of hybrid learning was about the orientation to both the students and the lecturers (Vonti & Rahmah, 2019). A study about the hybrid learning conducted by Al-Qahtani and Higgins, (2013) and Ariffuddin et al (2021), showed that students who were exposed to hybrid learning group showed the highest achievement compared to e-learning and traditional learning method. In this study, the researchers have investigated the effects three different of instructional approach in order to improve students' achievement in academic. The findings revealed that there was no significant different when comparing the e-learning and traditional learning. However, the blended learning results showed the positive effects on students' achievement. Furthermore, hybrid learning has the ability to increase students' science achievement as well as their attitude (Alsalhi, Eltahir, & Al-qatawneh, 2019). The study involved 112 ninth-grade students from the United Arab Emirates. The study's findings revealed that there was a substantial difference between the experimental and traditional learning groups in terms of academic achievement in science subjects and student attitudes. Hinampas et al (2018) conducted a study on the impacts of blended learning on students' academic accomplishment and practical skills in science laboratories among university students,

and found that blended learning had a favorable impact on students' practical abilities in science laboratories. The findings according to Khader (2016), found that students in hybrid learning groups performed better on exams than students in traditional learning groups.

Research on hybrid of chemistry learning activities in secondary school through development of the flipped classroom model showed that students' scientific literacy on the topic of the reaction rate given by the problem-based learning-flipped classroom model was higher than the Problem-Based Learning-Traditional Classroom model (Paristiowati & Fitriani, 2019). Moreover, a study conducted by (Kazu & Demirkol, 2014) also indicated that the students who have studied in blended learning environment are academically more successful than the students who have studied in traditional learning environment.

A study according to Isiaka et al (2013) to discover the effectiveness of hybrid learning and E-learning instructional modes on undergraduates' performance in universities in Kwara State, Nigeria found that the hybrid learning mode of instruction was effective for learning educational technological concepts when the undergraduates were taught using hybrid learning mode of instruction than their counterparts taught using e-learning and traditional teaching method.

However, there were several research that opposed the effectiveness of hybrid learning in order to improve students' achievement. A research conducted by Chang, Shu, Liang, Tseng, and Hsu (2014), revealed that blended learning had no significant different for the electrical machinery performance among the students in blended learning group and traditional learning method group. The findings were in line with a

study conducted by (Elmer et al., 2016) which revealed that blended learning did not compromise students' performance in physiological education among the university students.

Based on the description above, and the elements that must be in hybrid learning, e-learning and traditional teaching method. We can understand that many learning theories underlie this hybrid Learning. Namely the theory of learning Constructivism (individual learning), from Piaget. Knowledge is human thought. Humans construct their knowledge through interaction with objects, phenomena, experiences and their environment. Knowledge cannot be transferred from someone to another without understanding the context (Suparno, 1997). Dahar (1989) asserts that knowledge is built in the child's mind, not acquired passively by someone. Suparno (1997) says that, knowledge is basically adaptation into a reality, as an organism adapts to its environment. Adaptation according to Piaget is a balance between assimilation and accommodation.

Assimilation is the absorption of new information into the mind, while accommodation is rearranging the structure of the mind because of new information, so that information has a place (Ruseffendi, 1991). E-learning strongly supports the process of assimilation and accommodation simultaneously during learning. The assimilation occurs when students absorb new information when doing e-learning, anytime and anywhere through the website, and accommodation goes naturally when students learn according to the optimum conditions of students. Cognitive theories from Bruner, Gagne and Blooms that sharpen individually student's cognitive abilities, when learning independently through the website, as well as during classical

learning, and social constructivist (collaborative learning) from Vygotsky. This can be seen during classical learning, group work, discussion, expressing opinions in class.

Hybrid learning offers learners flexible learning opportunities. Besides face-to-face education, it enables students to learn anytime and anywhere without space and time limitation (Stein & Graham 2014). Hybrid learning increases student-teacher and student-student interaction, and provides a more dynamic and interactive learning environment, which leads to a higher level of participation (Donnelly, 2009). Moreover, it provides learners with additional learning opportunities and helps them to achieve deeper and more meaningful learning levels and to solve complex problems (Patrick & Sturgis, 2015). In addition, learners in the hybrid learning model can demonstrate their ability to reflect themselves socially and academically in the virtual learning environment as well as in face-to-face education. In today's world, as lifelong learning becomes very important, the acquisition of digital learning skills becomes imperative to be lifelong learners. In addition, the blended learning model help learners improve their skills to use various information technologies that enable them to make progress towards becoming technologically literate (Cleveland-Innes & Wilton 2018).

Studies have reported that the post-test scores of the experimental group students who went through the blended learning process were higher than scores of those who went through the face-to-face learning process only (Alsalhi et al., 2019; Balaman & Tüysüz 2011; Ceylan & Elitok Kesici 2017; Obiedat et al. 2014; Pesen and Oral 2016; Sarıtepeci & Çakır 2015). In addition to this, some studies have reported that the blended learning model positively influenced students' motivation and class participation (Bosch et al. 2019; Sarıtepeci & Yıldız, 2014), and improved learning

(Wai & Seng, 2015), self-efficacy (Abello, 2018), self-regulated and self-directed learning skills (Uz & Uzun 2018) and long-term learning (Bağcı & Yalın 2018). In this study, a significant difference was found in favor of the experimental group in the retention test. In the light of this finding, it can be stated that pre-service teachers achieved long-term learning by developing their self-regulated and self-directed learning skills with the blended learning model, and by repeating and reinforcing what they had learned in face-to-face education via virtual classroom activities outside the school. Another important result of this study is that the blended learning model fostered pre-service teachers' twenty-first century skills (information and technology literacy, critical thinking and problem solving, entrepreneurship and innovation, social responsibility and leadership, and career awareness). In line with these findings, it can be stated that the teacher candidates in the experimental group who experienced the blended learning model developed their twenty-first century skills. In the literature, studies have reported that blended learning has the potential to contribute to various skills including twenty-first century skills. Research has reported that the blended learning model positively contributed to students' problem-solving skills (Suprabha & Subramonian 2019), science process skills (Harahap et al. 2019), professional development skills (Yeh et al. 2011), transfer of learning and knowledge transformation skills (Demirer & Sahin 2013; Jou et al. 2016),

2.3 Research Conceptual Framework

Conceptualization is the process of forming ideas, designs, and plans. A framework deals with concepts assembled by virtue of their relevance and the research problems, which provides a certain frame of reference for clinical practice, research, and education. Theoretical and conceptual frameworks broadly present an understanding

of the phenomenon of interest and reflect the assumptions and philosophic views of the models (Devi, Khandelwal & Das, 2017)

Understudies' learning experience and execution can be further developed when instructive innovation and ICT are coordinated with customary types obviously conveyance, like face to face talks and instructional exercises (Stacey & Gerbic, 2007). Nonetheless, if the innovation isn't utilized viably to help learning, and not connected at all to the students', there is a danger that understudies will become embittered and lessens possible advantages to the students (Love & Fry, 2006). Innovation is never intended to be an ideal answer for any instructive issues. It in any case, is planned to be an empowering influence to better educating and learning encounters. Hence, the degree to which new innovation is utilized in courses should be painstakingly considered to guarantee that it addresses the issues of the students (Deed & Edwards, 2011). A few examinations like (Mayes, 2002); Love and Fry, (2006); Dzakiria et al., (2006); Dzakiria et al., (2012) , and Greenwald et al, (1996). Further, blending the learning resources can provide a range of functions for learners and teachers to give some real benefits to traditional learning environments, such as reducing the time-lag between production and utilization of materials and the free sharing of information (Floridi, 1995).

When properly designed and implemented, the use of HL empowers students by giving them the freedom and responsibility to control their learning environment (Becker & Dwyer, 1994). In order for HBL to improve learning outcomes, it must be shown to be doing more than merely developing flexibility in the delivery of course materials. What is really needed is an environment which will provide students with an environment that enhances learning and enables students to control their learning

space and develop a variety of learning styles (Follows, 1999). The combination of multimedia in teaching and collaborating among the students are some of the effective techniques to help the students' in order to master the lesson as well as improving their performance in academic (Asparin & Tan, 2018). The participation of students in the online learning discussion could make the instructional become more effective and enhance the active learning among them. The objective of this study is to elicit students' perspectives on HBL in relation to performance.

2.4 The theory Underpining the Study

This study used the principle of cognitivism which is considered a reaction to the "rigid" emphasis by behaviorists on predictive stimulus and response (Harasim, 2012, p. 58). Cognitive theorists promoted the concept that the mind has an important role in learning and sought to focus on what happens in between the occurrence of environmental stimulus and student response. They saw the cognitive processes of the mind, such as motivation and imagination, as critical elements of learning that bridge environmental stimuli and student responses. For example, Noam Chomsky (1959) wrote a critical review of Skinner's behaviorist work in which he raised the importance of creative mental processes that are not observable in the physical world. Although written mainly from the perspective of a linguist, Chomsky's view gained popularity in other fields, including psychology. Interdisciplinary in nature, cognitive science draws from psychology, biology, neuroscience, computer science, and philosophy to explain the workings of the brain as well as levels of cognitive development that form the foundation of learning and knowledge acquisition. As a result, cognitivism has evolved into one of the dominant learning theories. The future of cognitivism is particularly interesting as more advanced online software evolves

into adaptive and personalized learning applications that seek to integrate artificial intelligence and learning analytics into instruction.

Piaget (1977) asserts that learning occurs by an active construction of meaning, rather than by passive recipients. He explains that when we, as learners, encounter an experience or a situation that conflicts with our current way of thinking, a state of disequilibrium or imbalance is created. We must then alter our thinking to restore equilibrium or balance. To do this, we make sense of the new information by associating it with what we already know, that is, by attempting to assimilate it into our existing knowledge. When we are unable to do this, we accommodate the new information to our old way of thinking by restructuring our present knowledge to a higher level of thinking.

The cognitive school views (1) learning as an active process "involving the acquisition or reorganization of the cognitive structures through which humans process and store information" and (2) the learner as an active participant in the process of knowledge acquisition and integration (Good & Brophy 1990, 187; Merriam & Caffarella 1999, 254; Simon 2001, 210). This theory describes knowledge acquisition as a mental activity involving internal coding and structuring by the learner (Derry, 1996; Spiro et al. 1992) and suggests that learning happens best under conditions that are aligned with human cognitive architecture (Sobel, 2001). Cognitive psychologists place more emphasis on what learners know and how they come to acquire it than what they do. For this reason, the cognitive approach focuses on making knowledge meaningful and helping learners organize and relate new information to prior knowledge in memory. Instruction should be based on a student's existing mental structures or schema to be effective (Ertmer & Newby 1993).

According to Piaget, the process of intellectual and cognitive development resembles a biological act, which requires adaptation to environmental demands (Gillani, 2003). Having done many experiments to explore the ways children think, Piaget argued that children do not passively receive environmental stimulation. Rather, they actively seek it, naturally exploring and acting on their world to understand it (Bransford, Brown & Cocking 2000, 80; Fox, 2001). Piaget's studies and ideas focused on the mechanism of learning within the context of natural sciences instead of the type of logic that learners use (Booth 1994; Fosnot 1996). He posited that the biological maturation that human beings go through causes distinct stages in cognitive development. Each of these stages is sequential, dependent on one another to develop, characterized by acquisition of discernable skills, and reflects qualitative differences in cognitive abilities (Fosnot 1996; Gillani, 2003; Jarvis, Holford & Griffin 2003; Piaget 1970). According to Piaget, the mechanism of change in cognition is equilibration, which is a dynamic interplay of progressive equilibria, adaptation and organization, and growth and change in the master developmental process (Fosnot 1996, 13–14; Ho 2004). Once encountered with a new learning situation, the individual draws on his or her prior knowledge to make the new experience understandable (Gillani, 2003).

Experiencing a new event, situation, or learning environment at times engenders contradictions to one's present understandings, which in turn makes them insufficient and leads to perturbation and a state of disequilibration in the mental schemata (Fosnot, 1996; Gillani, 2003; Ho 2004; Palincsar, 1998). To handle this situation and to form a comfortable state of equilibrium in the cognitive structure, the individual needs to modify or reorganize his or her schemata via adaptation. This internal

process of restructuring the schemata is done through assimilation and accommodation (Gillani, 2003). While assimilation is a process of integrating new information with existing knowledge, accommodation is a process of modification or transformation in existing cognitive structures in response to a new situation. Once confronted with an imbalance, learners may resort to three kinds of accommodations. They may (1) disregard the contradictions and adhere to their original scheme; (2) vacillate by maintaining both theories simultaneously and trying to cope with the contradiction via viewing each theory as separate or specific cases; or (3) form a new, modified notion to explain and resolve the prior contradiction. In each type of response to contradiction, the learner's internal and self-regulatory behavior leads to the compensations (Fosnot 1996, 16).

In hybrid learning contexts, cognitive and metacognitive strategy use and the closely correlated ability of self-regulation (Pintrich & DeGroot, 1990; Sun & Rueda, 2012) are particularly important. Meyer (2014) wrote, "Learning self-regulation is especially important in online learning [where being successful] … depends upon the student's discipline, self-direction, and ability to remain motivated" (p. 24). Hypermedia use, a feature common in hybrid instruction, "greatly increases task demands and requires the learner to stretch limited processing resources across two major constraints: to-be-learned information and the hypermedia environment" (Schraw, 2010, p. 258). Fortunately, online tasks also provide new ways to measure cognitive and metacognitive strategy use and self-regulation: Winne and Baker (2013) proposed using educational data mining techniques to produce real-time data about these factors and the learning process "as it unfolds" (p. 1).

Hybrid learning is regarded by some researchers as the combination of strong and advantageous aspects of web-based learning and that of the face-to-face (Horton, 2002; Osguthorpe & Graham, 2003). According to Kanuka and Rourke (2014), hybrid learning is a method used to remove time, place and obstacles whiles given chance to high and excellent interactions between tutors and learners. Hybrid learning and its related technologies is regarded as the core basic information communication technologies to rest of such technologies (Harahap, 2019; Hinampas et al., 2018). However, information communication technology have become a means of communication that brings smooth interactions between its users (Hussain et al, 2018). Due to hybrid learning, alphanumerical technologies are considered by force technologies according to its features (Dziuban et al., 2018). Components such as streaming video, web-based tuition synchronous and asynchronous communication with local face-to-face interactions are the main components of the hybrid learning (Abidoye, 2015; Harahap, 2019).

This research seeks to apply the combination of both online and face-t-face instructions. Research according to Wijaya (2012) states that, online mode of learning is a procedure embarked by researchers through network. This makes learning materials available to learners by means of ICT and its related technologies. Munir (2009) defines website-based learning (e-learning) as information technology, which is applied in the field of education, in the form of virtual world. The term website-based learning (e-learning) is more appropriate is an attempt to make a transformation of the learning process that exists in schools or colleges into digital forms through internet technology. The usage of hybrid learning in learning and teaching has become a popular approach in higher education, Kintu et al, (2017) stated that the

introduction of hybrid learning initiatives is part of these innovations but its uptake, especially in the developing world faces challenges for it to be an effective innovation in teaching and learning. As mentioned before, hybrid learning benefits for students and lecturers. Poon (2013) said hybrid learning facilitates improved learning outcomes, access flexibility, a sense of community, the effective use of resources, and student satisfaction. Research shows that, the designing of hybrid learning model can enhance the academic performance of learners and helps them to cultivate a good attitudes towards its application to learning (Boyle, 2003; Dziuban, 2004; Francis & Susan, 2013; Lim & Morris, 2009; Maguire, 2005; O'Toole & Absalom, 2003; Simpson, & Anderson, 2009; Wigg, 2003). Furthermore, hybrid learning also improves the scientific knowledge of learners that can significantly contribute positively in their academic outcomes instead of the orthodox way of learning (Bayrak, & Bayram, 2009; Harahap eta al & Manurung, 2019; Krishnan, 2015)

According to the learning theory by (Bandura, 1977), that environment shapes behavior, and behavior shapes the environment; this is in line with the current student environment who are accustomed to using information and communication technology devices that have been connected to the internet so that learning materials to be developed are web-based. Teacher needs to implement instructional strategies that engage students in activities that build both cognitive and conactive skills (Michael & Simonson, 2015). Cone of experience (Davis, 2015) in Dale illustrates that the learning experience gained can go through the process of action or experience for yourself what is learned. Learning is divided into two types, namely active learning and passive learning. In passive learning, reading contributes to mastering material and memory by ten percent (10%), listening to twenty percent (20%), and

seeing contribute thirty percent (30%). However, active learning, where when someone says, teaches, demonstrates, or discusses, it can give seventy percent (70%) understanding and memory of the material mastered, and if active in doing/applying knowledge, it contributes ninety percent (90%) to understanding and our memory of something. Assessment of basic competencies is carried out based on indicators of achievement of competencies that contain one or more domains (Cognitive, Affective, and Psychomotoric) related to the cognitive realm, namely the ability to think, which includes intellectual abilities, ranging from the ability to remember until to solve problems (Jusuf, Ibrahim & Suparman, 2019)

2.5 Knowledge Gap or Deficit Identified

Many studies showed the effectiveness of hybrid learning compared with the traditional way in Diyarbakir Anatolian High School using quisal-experimental design specifically control and experimental groups (Kazu & Demirkol, 2014). There are studies that showed a statistically significant difference in student's achievement due to the method of the blended learning (Al-Rimawi, 2014). Studies by Pallavi & Ambedkar (2020) focused on only the perception of 75 PG students towards hybrid learning using survey method and the results showed the suitability and effectiveness of the method for better learning in higher education. Graham (2017) also found that 42.1% of all hybrid learning research studies focused on the cognitive and behavioral domains while only 25.4% of studies focused on areas such as student perceptions, experiences, and anticipations. The researcher comes with a blended learning to improve students' performance in electrochemistry topic (Aziz et al., 2021). Thus, there is a gap in the field in terms of student perceptions of hybrid learning courses. Students felt confused for the topic of electrolysis process due to the difficulty in

assimilating their knowledge across physic and chemistry (Taber, 1998). Several research revealed that students are facing misconception in differentiate the electrical flows in electrolytes and metal conductor (Sanger & Greenbowe, 1997; Allsop & George, 1982; Karsli & Çalik, 2012). On the other hand, there were several research contrary about the effectiveness of blended learning in order to improve students' achievement. Research conducted by Chang, Shu, Liang, Tseng, and Hsu (2014), revealed that blended learning had no significant different for the electrical machinery performance among the students in blended learning group and traditional learning method group. The findings were in line with a study conducted by Elmer, Carter, Armga, and Carter (2016) which revealed that blended learning did not compromise students' performance in physiological education among the university students.

Research showed that students who value face-to-face instruction, in-person class discussions, and organic bonding between faculty and students may not enjoy online learning (Roval & Jordan, 2004). It will be hard for them to shun face-to-face learning activities and sit in front of computers to complete the work.

However, this study differs from the previous studies, it is focusing on the pre-service teachers' performances in the use of hybrid learning in Gambaga college of Education.

2.6 Benefits and challenges of the Hybrid Learning

2.6.1 Benefits

The combination of the two learning environments has created hybrid learning environments that have brought several benefits not only to the facilitators but also to the participants (Harahap et al., 2019). The "hybrid" approach is appealing because it

offers the convenience of an online course with the stability of personal interaction from a traditional course (Clement & Jones, 2007). Osgathorpe & Graham (2013) and (Tabor, 2007) discussed six reasons why hybrid learning environments are beneficial and are changing traditional learning (training): 1. Improved pedagogy allows for increased peer-peer interaction as well as allowing learners to take a more active role in their learning experience. 2. Hybrid learning environments provide increased access and flexibility. Training is often at the "mercy" of the facilitator, and even if the participant is not ready for learning, the training continues.

Hybrid learning allows for increased flexibility with the work-life balance. Studies have found it to be important for mature participants with outside commitments such as family obligations. 3. Increased social interaction is also a benefit of hybrid learning environments. While not tying participants to a facilitator and a classroom, it still allows for personal interaction between the two (Osgathorpe & Graham, 2013). F2F instruction is still a large part of learning (training) and always will be. Peer-to-peer learning and community building which takes place in person is vitally important in the learning process (Bersin, 2003). 4. Cost effectiveness is another important benefit, especially for the organizations responsible for training and development (Osguthorpe & Graham, 2003).

Hybrid learning environments provide an opportunity for reaching a large, globally dispersed audience in a short period of time with consistent, semi-personal content delivery (Osguthorpe & Graham, 2003). Bersin (2004) is known for documenting corporate cases that have effectively used hybrid learning to provide a large return on investment (ROI) (Bersin, 2004). Unlike traditional education, corporate training exists primarily to improve business performance (Bersin, 2004). 5. Hybrid learning

environments provide for ease of revision. 6. Hybrid learning assists in personal agency (beliefs in self-regulation; the exercise of personal responsibility, choice, and control in learning) (Osguthorpe & Graham, 2003). Like F2F courses, online and blended courses are not ideal for everyone. To succeed in a learning environment, learners must have appropriate learning styles and necessary competencies (El-Mansour & Mupinga, 2007). The styles can be different based on generational differences of the learners.

Research according to Pallavi and Ambedkar (2020) states that, from a pedagogical perspective, hybrid learning aims to incorporate the best aspects of face-to-face classroom learning experiences with the best of mobile and online learning experiences. It is an opportunity for students to practice technology skills in navigating online course materials and creating their own digital content for assessment (Ambedkar, 2020). An increase in learning outcome measures and lowering of attrition rates compared to fully online courses. The ability to reserve face-to-face time for interactive activities, such as higher-level discussions, small group work, debates, demonstrations, or lab activities.

Garrison and Vaughan (2008) considered hybrid learning to be essential for student learning as no single method or learning environment would be sufficient for all students in any particular subject. The use of hybrid learning has been shown to have multiple benefits in several contexts. For example, hybrid learning has been studied in economics (Zhang & Seiler, 2014), vocational schools (Tsai, Shen & Tsai, 2011), and science (Oikawa et al, 2013). Benefits of hybrid learning over that of traditional courses have included the ability to allow students to study at their own pace (Caulfield, 2011; Linder, 2017; Yılmaz, 2017), improved student outcomes (Means et

al., 2010; Tsai et al., 2011), increased student engagement (Baepler, Walker, & Driessen, 2014; Smith, Groves, Bowd & Barber, 2012) and increased student satisfaction (Martínez-Caro & Campuzano-Bolarín, 2011). Many positive effects of hybrid learning might be caused by the flipped nature of the environment. In many traditional classrooms, students are passive for longer periods but this passiveness is not observed as often in hybrid learning environments (Baepler et al., 2014). Yılmaz and Malone Smart Learning Environments (2020) 7:18 Page 2 of 21, noted that since students enrolled in hybrid learning classrooms were able to listen to a significant portion of the course content online, more time was gained for the creation of a face-to-face (F2F) learning environment in which active participation increased. However, the findings of improved student outcomes have been challenged by other studies such as Oikawa et al. (2013).

Oikawa et al. (2013) determined that while students had positive attitudes towards hybrid learning in chemistry their academic achievement was not significantly affected. Thus, it seems that the specific designs that were used and the needs of the students may have to be carefully considered to enhance student learning as much as possible. Yılmaz (2017) determined that undergraduate students enrolled in hybrid learning courses because they thought the HL course design would provide for (1) better information sharing, (2) more practical and functional interactions, (3) easier course preparation and evaluation, (4) increased student engagement in research, (5) increased study time, (6) better preparation for the lecture, (7) greater cooperative learning, and (8) innovative instruction. Thus, since students have specific reasons for enrolling in hybrid learning courses it is very important to study their perceptions of these courses after taking them.

Rao (2019) in his research stated that hybrid instruction and methods are high levels of student achievement and more effective than purely face-to-face or purely online classes

- Students can work on their own with new concepts free from teachers, using a combination of digital instruction and one-on-one face time Teachers can now streamline their instruction to help all students reach their full potential, as they were in a traditional classroom (Rao, 2019). He indicated that hybrid learning can also come with the bellow benefits as;
- It provides a simultaneous independent and collaborative learning experience for college/university students
- Information and communication technologies have been used to develop students' learning attitudes
- It creates and improves communication between lecturers and students to better evaluate their understanding of course material with the use of computer-based qualitative and quantitative assessment modules
- It reduces educational expenses and training costs, by putting classrooms in the online space and it essentially replaces pricey textbooks with electronic devices
- It provides opportunity for data collection and customization of instruction and assessment as two major benefits of this approach
- It helps schools choose to reallocate resources to boost student achievement outcomes
- It facilitates students, who have special talents or interests outside of the available curricula, use educational technology to advance their skills or exceed grade restrictions

- It allows for personalized education, replacing the model where a teacher stands in front of the classroom and everyone is expected to stay at the same pace
- It lets students work at their own pace, making sure they fully understand new concepts before moving on
- It is the virtual learning environment that helps connect professors with students without physically being present, thus making this a 'virtual café'.

Graff (2003) concluded that hybrid learning had a significant impact on how students approached learning, and that quantity of interaction was not a significant predictor of the quality of the learning experience. In addition to increased student learning, hybrid courses also show great potential over the other course modalities in several aspects. First, hybrid mode has the potential benefits of making courses more accessible and learning more convenient for students, providing faculty with greater flexibility in how they structure their time, and increasing classroom space for institutions to serve more students without building more classrooms (Clark & Mayer, 2007). Furthermore, a hybrid course has the potential of accommodating some of the various learning needs of the students because of its advantage of multiple instructional deliveries (Bonk & Graham, 2006). Research by Lin (2009) on student views of hybrid learning examined hybrid learning in two elementary teacher education courses using both quantitative and qualitative methods showed that a majority of students held positive views, but some had negative experiences and faced challenges.

This form of instruction involves both in-person meetings on campus and flexible schedule online learning. Hybrid and blended instruction allow students to experience both face-to-face and online learning, as well as scheduled and self-paced classwork

(Singh, 2017). This form of instruction can be the new norm as it allows instructors to reinvent and revise the content especially in disciplines where instructors struggled to provide engaging learning experience for students in an online medium of instruction (Rodriguez, 2020). Hybrid learning inclusion courses in academic programs could lead to improvement in students' time management skills, critical thinking skills, and comprehension skills (Crawford Barker, & Seyam 2014)

The online component of learning also added the advantage of more flexible scheduling than a traditional course to meet diverse learning needs (Lin, 2009). For instance, the students in the study were satisfied that the flexible scheduling helped balance their study and work and helped them to learn at their own pace when they could take a simulated test online or participate in online discussions instead of having to make a trip to campus. These findings illuminate several important implications.

2.6.2 Challenges of hybrid learning

For the effective implementation of hybrid learning, the resources to initiate its process of implementation must be available. Research in the implementing hybrid learning at the Developing University discovered the following challenges hindering its implementation;

- The University lacks comprehensive institutional and organisational mechanisms for facilitating the development and growth of hybrid learning.
- Lack of a policy that promotes hybrid learning within teaching and learning;
- Lack of quality management processes to enhance hybrid learning.
- Limited initiatives for the professional development of staff to integrate hybrid learning within existing curricula.

- No structures in place for technical and system support.
- Lack of support from leadership for change management; and
- Considerable funding is needed to implement a successful hybrid learning programme (Tshabalala, M., Ndeya-Ndereya, C., & van der Merwe, T.,2014).

Alebaikan and Troudi (2010) addressed three main challenges of applying hybrid learning in Saudi higher education to be adaptation of this element in the traditional university culture, finding the right design of hybrid learning and the time issue is also considered a crucial challenge facing hybrid learning faculty. In general, the challenges of hybrid learning can be grouped into three major catego-ries: the culture and blended learning environments; finding the right design; and demand on time (Graham, Allen & Ure 2003). Research according to Sait et al. (2003) stated that some instructors are against new technological methods as a replacement for face-to-face instructions that revealed a type of instructor resistance that should be taken into consideration. Unlike a traditional approach, hybrid learning requires a high level of student discipline and responsiveness (Alebaikan & Troudi 2010). A study that was conducted on freshman students argued that some students did not take online instruction seriously as it was not used by other instructors and students at the college (Al-Jarf, 2005).

Classroom training can be expensive if learners must travel to the classroom location. Also, learners are required to attend sessions at a set time and this usually requires large blocks of time on the part of the learner. If the session is lecture-based, discussion and interaction are reduced. Classrooms can place the learner in a passive role and their attention may be lost (Woodall, 2010).

According to Rao (2019) stated in his research that hybrid learning has the following challenges as;

- the use of lecture recording technologies can result in students falling behind on the materials
- It is observed that providing effective feedback is more time-consuming and more expensive
- Access to network infrastructure is another serious issue.
- Ineffective use of learning technology tools can waste resources.
- Learners must have basic technology knowledge or a willingness to learn.
- High technology set up and maintenance costs.
- Lack of motivation.
- Wastage of offered resources.
- Hybrid learning may have disadvantages in technical aspects, if it is not properly planned and executed, as it depends on the technical resources or equipment.
- IT literacy can serve as a significant barrier for students attempting to get access to the course materials, making the availability of high-quality technical support paramount.
- It can be a challenge for group work because of difficulties with management in an online setting.

Cavanaugh, Sessums, and Drexler (2014), presented several matters considered as detractors to student achievement in a blended learning environment. Their study found no remarkable difference in academic success between the traditional and the technology-aided modes of instruction. Researchers noted that the use of Web 2. 0

tools in a blended learning environment were associated positively with better learning outcomes and final grades (Goyal & Tambe, 2015). The study found that students showed positive outcomes with the LMS which improved their understanding of the course from sharing study material s rational therefore to argue that Web 2. 0 tools contribute to student learning and is a useful educational tool. Despite the strong case that blended learning will reduce the student's workload, Lowes and Lin (2015) found that increased workload for students who now must go beyond classroom learning to online learning is very challenging. Beck (2010) also found that students fall behind on their assignments as the online and face-to-face work will increase. He also found that since a significant amount of the content is online, students may not be able to interact with the material especially if they are not able to access the material or understand the material presented to them.

The newness of engaging in blended instruction is as confusing to the student who now must learn new technologies such as using discussion forums and chat rooms (Lowes, 2014). Results of Hill, Chidambaram, and Summers (2013) study, showed that blended learning instruction allowed for more exceptional student performance but these findings were contrary to comparable studies in this review. Similarly, Kwak, Menezes, and Sherwood (2013) study presented the idea that blended learning does not affect student academic performance. Using various studies which compared face-to-face with blended learning to support their claim, the authors stated that student performance and success is not affected based on the delivery mode used in the teaching and learning process. They posit that students perform equally in both learning environments. Gedik et al., (2013) evaluated some challenges teachers meet when teaching in a blended learning environment. Some of these challenges centered

on the need for related training, the limited time associated with the digitizing and uploading content and the lack of technical support to use the platform efficiently. However, more importantly, they reemphasized the point that teachers need technical support to employ technology effectually. Successfully designing blended learning environments will require an analysis of the teachers' technological background and students' learning capacity.

Gedik et al., also discovered that instructors found that blended learning placed a burden on them cognitively and physically as they should redesign modules, prepare materials for uploading, provide feedback and grade online assessments. Also, their research confirmed that high levels of effort are required for blended learning to efficiently implementing it. Similar evidence was produced by Tshabalala, Ndeya-Ndereya, and Merwe's (2014) from their study at a South African University. This study highlighted faculty challenges to include time constraints, lack of experience, an inadequate support structure, and an increasing workload as barriers to successfully preparing and using blended learning strategies to promote student performance.

The instructional design of the course, the collaborative activities and the organization of learning material will impact learner satisfaction in the online environment (Lim, Morris & Kupritz 2014). An argument that underpins this research is that of Richardson et al., (2015) who saw the teacher's new roles in blended learning to include preparing instructional and learning materials, managing the students' learning processes, organizing course activities, providing course content and preserving the learning environments. However, despite growing interest in blended learning, if teachers are not adequately trained to perform these tasks, they will be challenged while navigation the blended learning environment, and inadvertently fail

to establish a social presence to eliminate the feelings of isolation (Richardson et al., 2015).

Hofman (2014) confirmed that when the user gets into difficulty with technology, this may lead to the abandonment of the learning and eventually, failing to use the technology. As research suggests, facilitating online learning requires the teacher to have an active voice. Elia, Secundo, Assaf, and Fayyoumi (2014) found similar challenges associated with the student's ICT competence and their attitudes toward the use of ICT for teaching and learning. Therefore, all of these aspects may contribute to teachers' failure to integrate technology into their instruction even though the appropriate technologies are readily available (Kurt, 2014). The most prominent challenge, then, will be finding ways in which the teacher can successfully use technology ensuring the student's commitment, considering the individual's learning styles. The implications for these findings will need to be addressed by the opportunities the institution puts in place for professional development and technical support.

2.7 Traditional Method of Teaching

This method of teaching is also referred to as the conventional or expository method of teaching. It is also referred to as the lecture method of teaching (Nartey, 2016). It is mostly described as teacher-centred, teacher dominated, or teacher activity method. The role of the student is less active and more passive in the teaching and learning interaction. Teachers occasionally may demonstrate a process for students to observe, engage students in brief discussion and questioning, and often use illustration from diagrams, and charts. The teacher mostly does the talking. Wood (2007) observed that science elective teachers in the secondary schools introduce lessons followed by

explanations and demonstrations. Meanwhile according to Maryellen (2013), students often prefer to participate in a lesson rather than to be passive learners in a lecture or teacher dominated lesson. During activities, students work alone, and collaboration is discouraged. Teachers must recognize that students can learn from each other and that the deepest learning happens when students have the opportunity to practice and obtain feedback (Maryellen, 2013). Wood (2007) noticed that most schools had inadequate charts and diagrams hence sometimes illustrations were missing from teaching. He observed that few questions are allowed from students of which teachers answered. After each explanation, the teacher dictated copious notes for students to write. He reported that during his research, he inspected the notebooks of the students and found out that all of them had the same notes, indicating that they had their notes solely from their biology teachers. He reported that teaching was direct from teacher to learner.

According to Tamakloe, Amedahe, and Atta University of Education Winneba http://ir.uew.edu.gh 23 (2005), for students to benefit fully from such a method which is teacher centered, the teacher must prepare adequately, reading from many sources to get quality information. This will help the teacher get mastery over the method. Larbi (2005), conducted a study in the eastern region of Ghana comparing the indigenous method approach to the traditional method of teaching. He found out that students taught with indigenous method of teaching science achieved significantly higher marks than those taught with the traditional method. Likewise, Wood (2007), reported that students who were exposed to the constructivists approach achieved significantly higher marks than their counterparts exposed to the traditional method. Research shows that those exposed to concept mapping achieved significantly higher

scores than those exposed to the traditional method (Bunting, Coll, & Campbell, 2006; Asan, 2007; Akpinar & Ergin, 2008).

2.7.1 Effect of traditional method on students achievement

Knight, and Wood, (2005), carried out an experiment to determine whether students learn best through the use of the traditional method or interactive teaching style in biology lesson. In two successive semesters, they presented the same course syllabus using the two different teaching styles. They used performance on pretests and posttests, and on homework problems to estimate and compare student learning gains between the two semesters. Their results indicated significantly higher learning gains and better conceptual understanding in the more interactive course than the traditional method. Charlton (2006), on the other hand thinks the traditional method is probably the best teaching method in many circumstances and for many students; especially for communicating conceptual knowledge, and where there is a significant knowledge gap University of Education Winneba http://ir.uew.edu.gh 24 between teacher and students. It is effective because they exploit the spontaneous human aptitude for spoken (rather than written) communications.

Merits of Traditional Method Tamakloe, Amedahe, & Atta (2005) enumerated the following as merits of the traditional method. The traditional method provides great opportunity for students to learn to take down notes. The teachers have greater control over what is being taught in class. The traditional method enables a great amount of course content to be covered in the face of a heavy loaded syllabus or programme of instruction. The traditional method makes for economy since a large number of students can be taught at a time in one classroom. It is a straight forward way to

impart knowledge into students. It is more helpful for teaching specific facts, concept or laws.

Ormrod, (2015), outlines the following as pros of traditional method of teaching. When education is teacher-centered, the classroom remains orderly. Students are quiet, and the teacher retains full control of the classroom and its activities. Because students learn on their own, they learn to be independent and make their own decisions. Because the teacher directs all classroom activities, they don't have to worry that students will miss an important topic. University of Education Winneba http://ir.uew.edu.gh 25.

Jusuf, Ibrahim and Suparman (2019) stated that, for face-to-face class, the learning process is done in class, lecturers teach theory, and in computer laboratories to make programs, after finishing studying the material in one session, students working on test questions using the Mentimeter application before and after a test, because the Mentimeter application is interesting, real-time and monitored easily by students and lecturers.

Chang et al (2014) stated that, face-to-face teaching, on one hand, allows a kind of immediate, real-time engagement that can be difficult to capture online. Back-and-forth discussions, group work, presentations, and in-depth conceptual scrutiny can often be more robust in this setting, where visual cues (such as confused faces) and immediate interaction can offer meaningful learning opportunities. Deeper collegial relationships can be fostered among students and the instructor, leading to a community atmosphere that can be more difficult to forge online.

2.7.2 Demerits of traditional method of teaching

Tamakloe, Amedahe, and Atta (2005), pointed out the following disadvantages of the traditional method. Generally, the traditional method is not suitable for students who are low on the academic ladder. They find it difficult to listen and take notes at the same time. It does not take into consideration individual differences. The traditional method in most cases encourages rote learning. It does not give the students enough chance to develop their oral skills. Teacher activity overshadows that of students making them play comparatively passive role in the teaching and learning process. On the spot feedback is usually very scanty and unreliable. There is little scope for student activity; hence the traditional method goes against the principle of learning by doing. In the traditional method, the teacher to a large extent spoon feeds the students and does not allow them to develop their powers of reasoning. Ormrod, (2015), outlines the following as cons of traditional method of teaching. When students work alone, they don't learn to collaborate with other students, and communication skills may suffer. Teacher-centered or traditional instruction can get boring for students. Their minds may wander, and they may miss important facts. Teacher-centered or traditional instruction doesn't allow students to express themselves, ask questions and direct their own learning. That the traditional learning is ineffective in terms of learners' participation and interaction, it is filled into a limited time period and that the distance learning limits the interaction between the learners have caused the emergence of this new learning environment (Kazu & Demirkol, 2014).

2.9.3 The perceptions of pre-service teachers/students on the use of hybrid learning

Studies on perceptions of students in higher education toward hybrid learning have revealed varying results according to (Krishnan, 2016). For instance, while Gecer and Dag (2012) found that freshmen in a mathematics department responded positively to the hybrid mode, Ashby, Sadera and McNary (2011) revealed that college students taking a hybrid mode algebra course performed the worst compared to those in the face- to-face and the online learning modes. Students in the Gecer and Dag (2012) study were experiencing hybrid mode for the first time and found that blended learning mode supports active participation, the course materials are interesting and useful, and that the hybrid mode increased their learning responsibilities.

Hybrid courses otherwise known as blended courses maximize the advantages of both the traditional classroom and technology use in the virtual classroom (Vernadakis et al., 2012). Instruction takes place mostly in a traditional classroom setting but is strengthened by online activities that replace some of the class face-to-face time (Scida & Saury, 2013). According to Vernadakis et al (2012), researchers found that the hybrid or blended learning environment enables students to be more involved in their learning process, thus improving their learning. In addition, hybrid courses provide flexibility in terms of time and location, make courses more accessible and interactive, increase students' interest and self-exploration, and accommodate students' varied learning needs.

Scida and Saury (2013) pointed out that the success of any hybrid course depends on two factors. The first, online activities and the use of computer should be realistic in the topics that allow concrete and positive use of technology. Second, students must take more responsibility over their learning by reading the materials provided prior to

the lessons. In particular, the online activities should provide students with opportunities to communicate effectively with their instructor, promote active learning, and allow application of knowledge and effective student interaction (Dell, Low & Wilker, 2010). Additionally, instructors should understand the learning process well and be skilled in designing online instruction. They must also be able to facilitate higher order thinking skills through problem-based activities (Dell et al., 2010). The study conducted by Ugur et al. (2011) on university students' perceptions of hybrid learning showed that the students gave highly positive opinions. The students found that blended learning is an easy and effective way to understand the lessons, provides them with opportunities to participate in forum discussions and enable them to remember most of the lesson contents without memorization.

Accoridng to Vernadakis et al. (2012), although literature shows that hybrid learning has positive influence on learning, the disadvantage of the hybrid learning mode did not go unnoticed. In comparing the traditional and the online mode, different opinions have been observed. In their own study, Vernadakis et al. (2012) found the students to be more satisfied with the hybrid learning environment. Research conducted by Chang et al (2014) stated that students who learned through hybrid e-learning had more positive perceptions of cognition and skill because blended e-learning can make up for the drawbacks of traditional learning. The explanation for it is that hybrid e-learning provides both a traditional learning and an e-learning environment at the same time, which enables students to review the material repeatedly and discuss with peers online.

Much like the studies about academic performance, results of studies on student perception have also been inconsistent. Frimming et al. (2013) examined students' reports of their course perceptions –the teacher's organization, passion for the subject, care for the students, etc. – and their personal experiences gained from the course format. While statistical analysis showed no significant difference in student self-reported perception, there was a significant difference in student self-reported experiences.

Despite the improvement of student scores in a hybrid class over the traditional face-to-face format, students in Wichadee's (2014) study reported a lack of access to the necessary technology, or faults in the technology as the largest component of their negative experience. In addition, they claimed that group projects and assignments were much more difficult to schedule and complete when students were not consistently meeting on campus (Wichadee, 2014). Coordination for group projects may well have been complicated by faulty technology. Most of the students complaints of technological malfunction were centered on school-provided equipment (Wichadee, 2014). The availability of technology is an important component to understand before moving to a hybrid class system.

Yoko et al (2008) acknowledged that most of the students preferred the online learning to the traditional classes and they felt that the combination of online learning and face-to-face learning was advantageous for learners. Further, hybrid learning allows for a range of teaching and learning practices to be combined for a customized learning experience even for diverse learning needs and different formats.

Simon et.al (2008) developed a multimedia online learning resource for medical students specifically designed to support problem-based learning sessions and to enhance student-engagement and to promote clinical reasoning. The online courses so delivered resulted in much greater access to and use of educational materials than in previous years. Further, the study concluded that the hybrid learning facilitated delivery of the common contents, so developed, at geographically distant sites and helped to engage students in interactive project-based learning seminars.

Tolks et.al (2014) reached similar conclusions in the study in which they developed a blended learning course following the Inverted Classroom Model as a part of the faculty development curriculum. The course proved to be successful and was accepted during the implementation by the participants.

Hwang and Arbaugh (2006) examined student feedback seeking behavior of the students enrolled in seven blended undergraduate HR and management courses. They assessed that the students who seek positive behavior tended to participate more actively in discussion forums and seek feedback both inside and outside of class meetings, whereas students having negative feedback-seeking behavior tended to seek instructions outside of classroom and participate in more discussion forums but with less intensity.

Raturi et al (2011) found that the learners in their sample were keen and enthusiastic about the use of technology. The study revealed that the group was found to be technology. The study also found a high level of digital awareness among female learners and their good access to tools; technology and experience make them capable of studying in blended-learning or e-learning mode.

Peterson and Bond (2004) also found that students may perceive that they learned more through FTF, even though their course performance was no different than the online students. However, more researchers agree that the factor that affects students' choice of online vs. FTF instruction is related to the different learning styles.

CHAPTER THREE

METHODOLGY

3.0 Overview

This chapter covered the research design, population, sample and sampling procedure, instrument, data collection procedure, description of treatment/ interventions and data analysis.

3.1 Design of the Study

The research design was action research design, since the study was to solve a particular classroom problem. The researcher sees it to be in line with the main purpose of action research, that is solving a specific classroom or school problem or improve a practice. The goal here is to improve practice immediately within a classroom. Action research is a systematic approach to investigation that enables people to find effective solutions to problems they confront in their everyday lives (Dustman et al., 2014).

Unlike traditional experimental/scientific research that looks for generalizable explanations that might be applied to all contexts, action research focuses on specific situations and localized solutions. Action research provides the means by which people in schools, business and community organizations; teachers; and health and human services may increase the effectiveness of the work in which they are engaged. It assists them in working through the sometimes puzzling complexity of the issues they confront to make their work more meaningful and fulfilling. It offers a good combination of practical and theoretical enquiry; it is a means of generating and proving scientific theory (Baskerville, 1999, Mumford, 2001). Action research undergoes three main steps as follows;

3.1.1 Pre-Intervention

At this stage, the researcher is trying to define or diagnose the perceived problem before the actual intervention to be use, the research instruments that will be employed in this action research is test.

3.1.2 Intervention

This where the researcher tested the treatment (hybrid learning). The intervention kept in place by the researcher to help improve the academic performance of pre-service teachers in some selected chemistry concepts was the hybrid learning where the taught lessons using both the traditional lecture method coupled with the online method.

3.1.3 Post-Intervention

This is where the researcher conducted the non-equivalence post-test of some selected topics in chemistry. The outcome of the results was then compared with the outcome of the results of the pre-test to see whether the intervention was effectively applied. These results showed there was an improvement in the performance of the pre-service teachers after been taught using the hybrid learning approach.

3.1.4 Characteristics of action research

Hult and Lennung (1980) and McKernan (1991) suggest that action research makes for practical problem-solving as well as expanding scientific knowledge, enhances the competencies of participants, it is collaborative, it is undertaken directly in situ. Moreover, action research uses feedback from data in an ongoing cyclical process, it seeks to understand particular complex social situations, it also seeks to understand the processes of change within social systems, is undertaken within an agreed

framework of ethics. In addition, action research seeks to improve the quality of human actions, focuses on those problems that are of immediate concern to practitioners, action research is participatory, it also frequently uses case study, it tends to avoid the paradigm of research that isolates and controls variables and it is a formative, such that the definition of the problem, the aims and methodology may alter during the process of action research.

However, aside these benefits, this action research was time consuming, laborious, required a lot of justification or explanation for whatever the researcher did also the researcher did not have sufficient resources to cover a large respondent.

One group of pre-service teachers (Primary education specialism) took part in the study. Both quantitative and qualitative were involved. The qualitative data consisted of responses of the questionnaire from the pre-service teachers with regards to the perceptions on the use of hybrid learning and quantitative data consisted of the pre-test and post-test scores. The research embraced the hybrid learning for this study which involved the combination of both face-to-face instruction and the online interaction (Eduviews, 2009; Krishnan, 2015).

The group received the pre-test first in the face-to-face session before the use of the hybrid learning as a treatment (hybrid learning). After the treatment, a post-test was conducted to determine whether the intervention (hybrid learning) had enhanced the performance of the pre-service teacher's performance in some chemical concepts or not. The group covered the same chemical concepts in chemistry such as Writing of chemical formulae, Naming of chemical compounds, Chemical bonding, balancing of

chemical equations and Mole concept in both the hybrid learning environment and that of the face-to-face learning environment.

3.2 Research Setting and Duration

The research site is situated in Gambaga, the municipal capital of the east Mamprusi municipality in the North East Region of Ghana. The participants were admitted to this institution from different parts of the country because all citizens of the country who happened to have met the qualification to pursue the Degree programme in Primary Education were given the chance. The researcher started this study in early July, 2021.

Figure 3: Map of Gambaga showing the College of Education

3.3 Population

The target population for this study was Gambaga College of education pre-service teachers. The study participants consisted of 89 pre-service teachers of which 56 of them are males and 33 of them are females which were all level 300 primary education pre-service teachers. All participants offered integrated science I for upper primary as a core course.

3.4 Sample and sampling procedure

3.4.1 Sample and sampling technique

The sample consisted of 89 pre-service teachers (56 males and 33 females) which were purposively selected from the population of Gambaga College of Education pre-service teachers. The suitable nature of this sampling technique was the main reason why the researcher used it in sampling the pre-service teachers. Purposive sampling technique is a non-probability sampling technique which depends on the good judgement and experience of the researcher. Research subjects are judged to be typical or representative of the population of interest are selected. The Researcher administered the pre-intervention chemistry test, post-intervention chemistry test and questionnaire to all the selected pre-service teachers.

Gambaga College of education is a college within the north east region of Ghana who is affiliated to the University for Development Studies. This college train pre-service teachers with the following specialism; Bachelor in primary education and Bachelor in Junior High School (mathematics and ICT, social and religious and moral education, social/music and dance). The primary education pre-service teachers were offering general chemistry as a core course and thus they were selected for this study.

3.5 Research Instruments

3.5.1 Questionnaire

Questionnaire is defined as a series of questions asked by individuals to obtain statistically useful information about a given topic. When questionnaire are properly constructed and responsibly administered, they become a vital instrument by which statement can be made about specific of people of entire population said in (wikipedia.org.). Yousaf et al., (2012) a questionnaire is a data collection instrument

consistent of a series of questions and other prompts for the purpose of gathering information from respondents. Before a research constructs questionnaire for a group of people the researcher need to consider the following; how he will use the results of the questionnaire before he starts. The research objectives and frame of reference should be defined beforehand, including the questionnaire context of time. How (random or not) and from where (your sampling frame) he selects the respondents will determine whether you will be able to generalize his findings to the larger population.

Questionnaires and test were the main instruments used. The test forms the quantitative data whiles the questionnaire constituted the qualitative data. The questionnaires were made up of the pre-service teacher's perceptions which were organised in a form of 5-point Likert-scale style consisting of 15 items, ranging from strongly agree to strongly disagree towards the use of hybrid learning. The scale was valued as follows: Strongly Agree (SA) = 4, Agree (A) = 3, Neutral (N) =2, Disagree (D) = 1 and Strongly Disagree (SD) = 0.

3.5.2 Test

Test, to Delta, (2007) is a set of questions, exercises or practical activities to measure someone's skill, ability or knowledge. It is used to determine the weakness or strength of pupils in a lesson. Test is an instrument used to measure the level of ability of someone or somebody or a specific level of measurement. It may be administered orally or written depending on the purpose of which it was been set. The test items were designed to find pre-service teachers knowledge of understanding about the selected chemistry concepts. It also helped the researcher to identify pre-service teacher's problems and plan appropriate intervention for them. The test was made of 20 objectives test which were mainly questions on selected chemistry topics. Each

multiple choice question had four options with one correct answer. The pre-test questions served to ascertain equivalence of ability of the pre-service teachers on the selected chemical concepts and the post-test to determine the effect of the treatment on the chosen chemical concepts.

3.6 Validity of Research Instruments

The content validity of the instruments was determined by subjecting them to expert judgment (Dorcas, 2016; Rye & Rubba, 2002). The two research instruments used for this study were subjected to inspection by experts including the supervisor of this work and my head of science department in Gambaga College and other two general chemistry tutors from Gambaga College of education for their judgments on the content and the level of language.

3.7 Reliability of Research Instrument

Reliability according to Joppe (2000) is the degree to which the outcome of results are dependable over time, and can accurately represent the considered population. The reliability of the instruments were determined by employing the internal consistency estimate of reliability (Isaac, 2011). A pilot testing on the test instrument was done on the third year pre-service teachers of Gambaga College of education and the Cronbach alpha Coefficient were found to 0.82 and 0.83 respectively. According to Patton (2007), for test instruments to determine the cognitive capacity accurately, the Cronbach Alpha Coefficient of the instrument should be 0.80

3.8 Instructional Procedure

The study aim was on giving treatment in a form of hybrid learning to the pre-service students. The researcher was the author of this study. The normal class time was used

to carry out this study. Writing of chemical formulae, Naming of chemical compounds, Balancing of chemical equations and Mole concept were some of the chemical concepts identified as areas the pre-service teachers had difficulties as far as the basic chemistry is concerned.

Steps in instructional procedure and implementation of the Hybrid learning

Step 1: The researcher taught these concepts by first using the traditional lecture of face-to-face method without using the hybrid learning. After this, the pre-test was conducted and scores of pre-service teachers' recorded (pre-intervention stage).

Activities under step 1

Tutor: Tutor introduced the lesson by revealing to the students the learning indicators and also reviewing their knowledge of the chemistry concepts above. Tutor took them through chemical formulae by letting them identified the number of atoms present in compounds. For example, how many number of C-atoms are there in CO_2?

Students: Students demonstrated their understanding by identifying the atoms. CO_2 contains 1-atom of C and 2-atoms of oxygen.

Tutor: Tutor introduced students to naming of chemical compounds by touching on oxidation numbers of atoms in neutral and charged compounds with examples.

Students: Students demonstrated their understanding of this concept by solving problems under naming of chemical compounds.

Tutor: Tutor introduced students to balancing of chemical equations first touching on products and reactants in a chemical equation, mole ratios and how to identify the mole ratio of atom, compound, ions and electron in a chemical equation.

Students: Students demonstrated their understanding in these concepts by solving examples under these concepts.

Tutor: Tutor demonstrated how to identify atomic masses of elements in Periodic Table. S/he explained that particles of element cannot be counted but can be represented in grams. Each element measured in grams = 1 mole = Av No = 6.023 $x10^{23}$.

Students: Students demonstrated their understanding on the concepts of mole by solving problems based on the concepts and also asking questions.

Tutor: Tutor defined the term mole and linked it to dozen of eggs. Tutor demonstrated to students how to calculate the molar mass and amount of a substance.

Students: Students performed simple calculations regarding number of moles and molar mass of substances.

Tutor: Tutor evaluated the lesson based on the chemistry concepts taught.

Students: Students observed, listened and answer teacher's questions. The results are then recorded as the pre-test results.

Step 2: The group was then given the treatment in a hybrid learning form. The main researcher uploaded four materials (topics) into e-learning under the concept's chemical formulae, balancing chemical equations and mole concept. The whole process is represented in the figure 4 below.

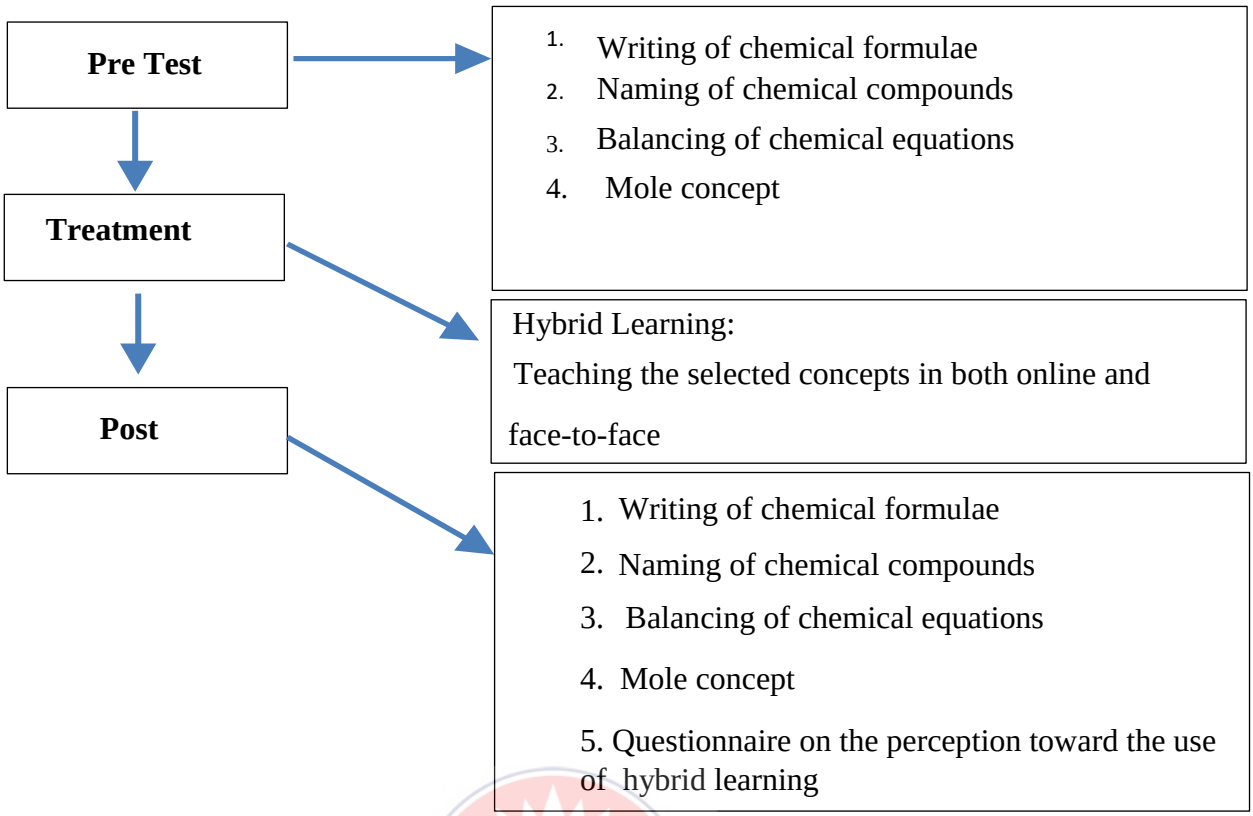

Fig 4: The procedure of the research (Vonti & Rahmah, 2019)

Step 3: The researcher administered the post-test at the end of the semester**.** Questions were based on the selected chemistry concepts above. The researcher also gave out the questionnaire about the perceptions of pre-service teachers towards the use of the hybrid learning.

3.9 Data Collection Procedure

The Pre-test items were administered to the pre-service teachers after taking them through the selected chemical concepts without using the hybrid learning, this is to identify their level of comprehension on the selected concepts before the treatment began. The group were taught through the face-to-face or traditional lecture method for 8 weeks about the chemistry concepts before the pre-test was conducted. The researcher then applied the intervention (hybrid learning) in teaching the pre-service

teachers and after which a post-test was conducted. The post-test items were different form of the pre-test items. Both the pre and post-test items consisted of 20 multiple choice questions and each question consisted of four options. These questions were basically based on the concepts selected for this study. After which, a questionnaire was administered to the students to ascertain their perception towards the use of hybrid learning after the treatment.

3.10 Data Analysis Procedure

The data were analysed based on the stated research questions. Data were analysed using descriptive statistics such as percentages which were used to determine the perceptions of pre-service teachers in the chemical concepts (Hinampas at al., 2018; Isaac, 2011). Paired t-test was used to determine whether there was a significance difference in performance between the pre-service teacher's pre-test and post-test scores at 0.05 confidence level. Research questions 3 were analysed using Statistical Package for Social Sciences (SPSS) version 25.0.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter presents the results of the study and discussions of findings based on the literature presented above.

4.1 Results Presentation and Analysis

The results of the study were presented in the light of the research questions as follows:

Research Question 1: What are the academic performance of pre-service teachers in some selected chemistry topics when taught using hybrid learning and when they are taught with the traditional lecture method?

H_1: There is no significant difference in academic performance of pre-service teachers in some selected chemistry topics when taught using hybrid learning and when they are taught with lecture method.

To find whether performance about pre-service teachers in some chemical concepts in chemistry before the treatment and after the treatment, the mean scores were computed using an independent t-test at the pre-test and post-test levels.

Table 1: T-test results for the pre-test and post-test levels

Method	N	$\bar{x}$	SD	T	Df	Sig
TLM	89	16.8876	0.8317	5.1324	88	0.5955
HL	89	17.4831	0.7849			

Table 1 above indicate that, there was a significant differences in the mean scores between the performance of teacher trainees in selected chemical concepts when taught using the traditional method and when taught using the hybrid learning approach. The mean score and standard deviation of the performance in the traditional face-to-face or at the pre-test level is ($\bar{X}$ = 16.8876, SD = 0.8317) and the mean score and standard deviation of the performance in the hybrid learning approach or at the post-test level is ($\bar{X}$ = 17.4831, SD = 0.7849). The mean score interval between the two mean scores at the two levels or two methods is 0.5955. These findings accepted the null hypothesis in research question 1. This is an indication that there was improvement in terms of chemical concepts performance of pre-service teachers after the intervention or treatment. These findings supported the following findings;

1. Findings in (Ariffuddin et al., 2021; Isaac, 2011) stated that there was statistically significant difference on the mean scores of the chemistry concept performance pre-test between the blended learning group (M=8.5161, SD = 3.03173) and the traditional learning method group.
2. Findings according to (Al-Qahtani & Higgins, 2013) stated that students who were exposed to hybrid learning got high achievements than those with the old face-to-face method of teaching.
3. Research results suggested that there was a statistically significant difference in academic achievements in science between the experimental group who were exposed to hybrid learning and those who were not exposed to hybrid learning among nine-grade students in united Arab Emirates (Alsalhi & Al-Qatawneh, 2019; Ariffuddin et al., 2021).

4. Similar research stated that use of blended learning has depicted a positive effects on the teaching and learning of chemical concepts in asynchronous teaching and learning of chemistry (Christensson & Jesper, 2014; Ds et al., 2020).
5. Research carried out by Hinampas et al (2018) revealed that there is a significant impact in students motor skills in the science laboratory as a results of the use of blended learning approach in the laboratory.
6. Ceylan and Kesici (2017) in their research investigating the impact of blended learning on academic achievement of middle school students' suggested there was a significant effect of students' academic achievement for the experimental group than that of the control group.
7. Research according to Oweis (2018) states that there was a positive effect as a result of using blended learning to teach the experimental group than the control group. The findings show a statistically significant difference in academic performance in the experimental group (mean = 1.938 than in the control group (mean = 1.835).
8. According to Isti'anah, (2017), the academic performance of students after employing blended learning in an English grammar class has improved. Blended learning had a positive effect on the Grammar test scores.
9. Study the effects of blended learning on ninth-grade students' achievement in science. 112 students' experimental group (n = 61) and a control group (n = 51). Blended learning had a positive effect on the science test scores of intermediate school students (Alsalhi et al, 2019).

10. Truitt (2016) explore the experiences of learning in Station Rotation model. Finding proposed five positive themes; technology, learning, variety of activities, getting help, and fun and two negative themes; technology and challenging work.
11. Harfoushi et al (2015), evaluate the effectiveness of hybrid learning on the academic achievement of students. Blended learning had a positive impact on academic achievement of the students.
12. Hybrid learning model, one of the contemporary learning approaches that blends face-to-face education and distance education and contributes to twenty-first century skills such as learning to learn, self-directed learning, deepening learning, reflective and critical thinking, problem solving, information and technology literacy, will have a positive influence on students' academic achievement, their twenty-first century skills and their lifelong learning (Atef and Medhat 2015; Huang et al. 2008).
13. Research according to Şentürk (2021) noted that the implementation of this model is more likely to provide significant contributions to students' learning with the qualities required by the age and lifelong learning skills by offering hybrid learning opportunities to teachers and students through distance education software, especially in universities.

The above findings in research question 1 contradicts the following findings below;

1. Smith (2013), investigated the impact of hybrid and face-to-face learning in K-12 school in Auckland, New Zealand. The findings depicted no significant difference observed. On the other hand, pupils who were exposed to the hybrid learning were evaluated more higher than those in the traditional class.

2. A third line of research found no significant differences in hybrid courses compared with other formats (e.g., Coates, Humphreys, Kane, & Vachris, 2004; Fortune et al., 2006; Olapiriyakul & Scher, 2006).
3. In Vignare's (2002) research, course completion rates of 95% were almost exactly the same for both fully online and hybrid courses offered at the Rochester Institute of Technology.
4. Analysis of online discourse in hybrid courses supported that more knowledge construction occurred online, but it was no different in the amount of triggering events or the resolution phase (Swan, 2005).
5. Wu and Hiltz (2004) found that online discussions in hybrid courses were meaningful, but no evidence was shown to support the hypothesis that hybrid was significantly better than full
6. Lin (2009) Although the study found that students thought hybrid courses provided more chances for student interaction in different settings, it also found that not every student was equally benefiting from hybrid learning.

Research question 2: What are the academic performance of male and female pre-service teachers in some selected chemistry topics when taught using hybrid learning and when taught with lecture method?

HO_2: There is no significant difference between academic performance of male and female pre-service teachers in some selected chemistry topics when taught using hybrid learning and when taught with lecture method.

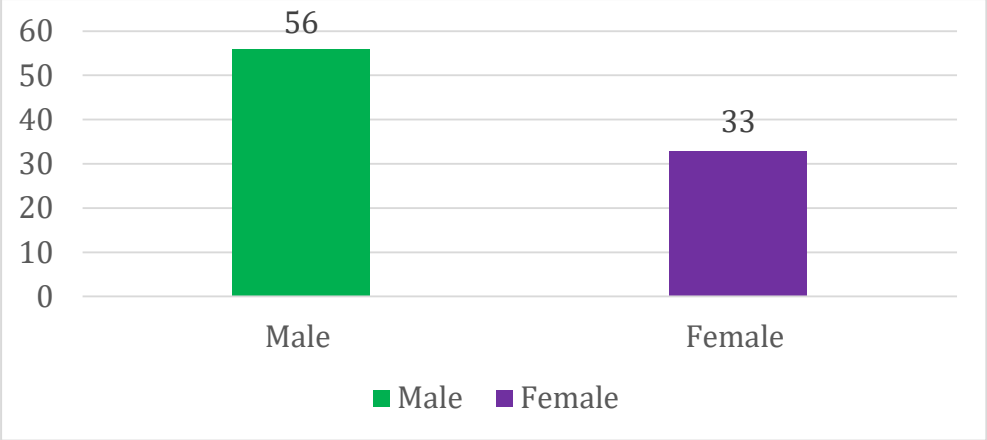

Fig 5: Primary Education Teacher Trainees' Distribution According to Gender

Table 2: t-test results for the Pre-test between Gender

Gender	N	$\bar{x}$	SD	Mean D	Df	t-calc	t-critical
Male	56	17.5357	0.8304	0.4145	60	2.0656	1.6706
Female	33	17.1212	0.9603				

***=significant at p<.05**

Analysis from **Table 2** depicts that the t-calculated value of 2.0656 is greater than the t-critical value of 1.6706 at p<.05 alpha level. Thus there is no significant difference between the mean academic performance of male and female pre-service teachers in some selected chemistry topics when they are taught with the lecture method since the null hypothesis has to be rejected.

Table 3: t-test results for the post-test between genders

Gender	N	$\bar{x}$	SD	Mean D	Df	t-calc	t-critical
Male	56	17.4464	0.6854	0.5980	60	3.6019	1.6704
Female	33	16.8484	0.7953				

***=significant at p<.05**

The t-test analysis from **Table 3** indicated that the t-calculated value of 3.6019 is greater than the t-critical value of 1.6704 at p<.05 alpha level. Thus we reject the null we reject the null hypothesis. Therefore, there is no significant difference between the mean academic performance of male and female pre-service teachers in some selected chemistry topics when they are taught with blended learning.

Research question 3: What are the perceptions of pre-service teachers towards hybrid-learning in the learning of chemistry concepts?

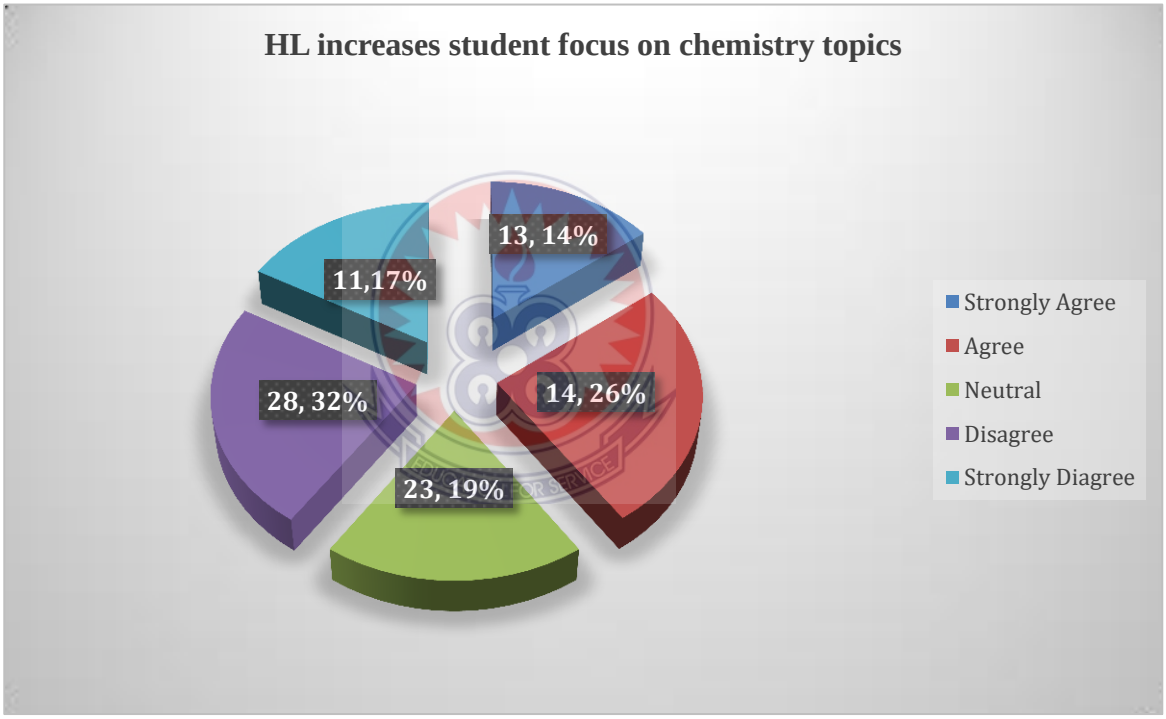

Figure 6: Perception on HL Increases students focus on Chemistry Topics

The pie chart above depicts that majority of pre-service teachers (**28, 31%**) disagreed, (**23, 26%)** remain neutral, (**11, 12%**) strongly agreed, (**13, 15%)** strongly disagreed, and (**14, 16%)** agreed to the statement that HL increases students focus on chemistry topics. These findings opposed the findings in Sarkar (2021) which was of the view

that 74.3% of students attention and engagement in class were enhanced by hybrid learning.

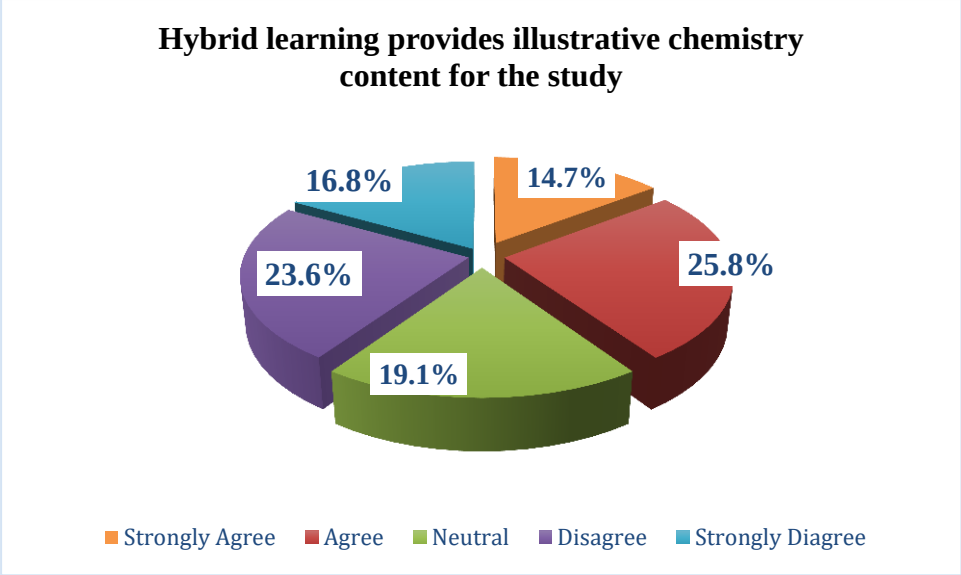

Figure 7: Pie chart indicating the percentages of pre-service teachers on perception on Hybrid learning provides illustrative chemistry content for the study

From the **figure 7** above, the highest percentage (40.4%) of pre-service disagreed and strongly disagreed to the statement that hybrid learning provides illustrative chemistry content for the study, 19.1 % the teachers remain neutral to the statement and 40.5% of the students agreed and strongly agreed to the statement. According to these findings, the highest percentage of the pre-service teachers disagreed and strongly disagreed that hybrid learning provides illustrative chemistry content for the study. A contradictory finding as a result of using hybrid learning was found according to Isiaka et al (2013) to discover the effectiveness of hybrid learning and E-learning instructional modes on undergraduates' performance in universities in Kwara State, Nigeria found that the hybrid learning mode of instruction was effective for learning.

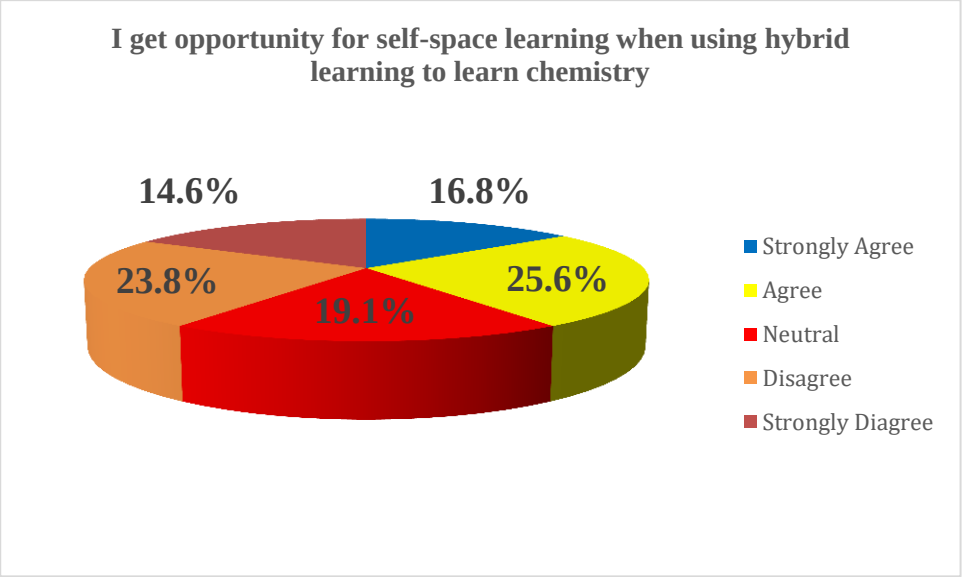

Figure 8: Pre-service teachers perception on I get opportunity for self-space learning when using hybrid learning to learn chemistry topics

Figure 8 above depicted that whiles 16.8% of teachers strongly agreed, 25.6% of the pre-service teachers agreed and 19.1% of them remain neutral to the statement that they get opportunities for self-space learning when using hybrid learning to learn chemistry topics. However, 23.8% of the pre-service teachers disagreed to the statement whiles 14.6% strongly disagreed to the statement. This finding suggested the percentage (42.4%) of pre-service teachers endorsed that HL helped them to learn chemistry topics and granted them the opportunity of self-space learning whiles 43.4% did not endorsed this statement. This finding supported the finding of Ughade et al., (2020) in the study of blended learning - a study on student's perception about suitability of the framework for higher education, which stated that fourty (40) students representing 54.8% agreed to a similar statement.

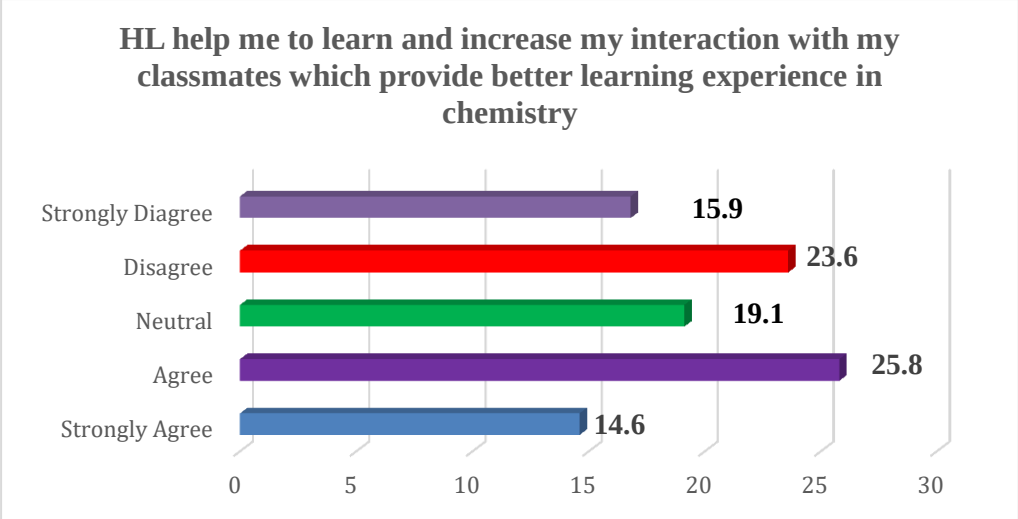

Figure 9: Perceptions of Pre-service teachers on how HL help them to learn and increase my interaction with my classmates which provide better learning experience in Chemistry

The above graph shows that 14.6% and 28.8% of the pre-service teachers strongly agreed and agreed with the view that HL help them to learn and increase their interaction with their classmates which provide better learning experience in chemistry, 19.1% remain neutral to the statement whiles 21.6% and 15.9% of them disagreed and strongly disagreed to the statement. Since the highest percentage (43.1%) of the pre-service teachers agreed and strongly agreed that hybrid learning help them learn and increase their interaction with their mates, it goes to mean that hybrid learning positive on their studies. This finding is in line with the findings that hybrid learning help increase students focus on topics and also grant them self-paced learning and better understanding of some chemical concepts as well as improve their collaboration with their colleagues in their studies (Ambedkar, 2020).

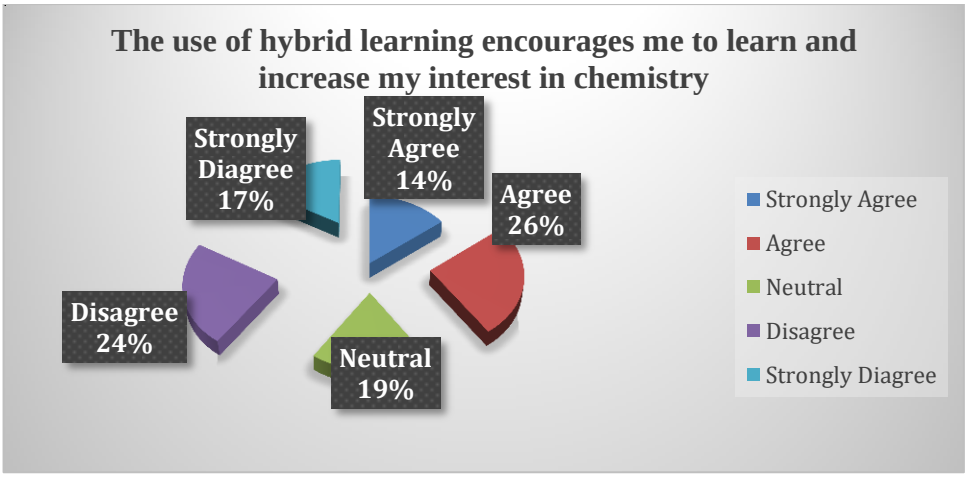

Figure 10: The use of hybrid learning encourages me to learn and increase my interest in Chemistry

Pre-service teacher's opinions from the above **figure 10** shows that 40% of them agreed and strongly agreed that the use of hybrid learning encourages them to learn and increase their interest in chemistry, 19 % of the teachers were neutral whiles 41% of the pre-service teachers strongly disagreed and disagreed that the use of hybrid learning encourages them to learn and increase their interest in chemistry.

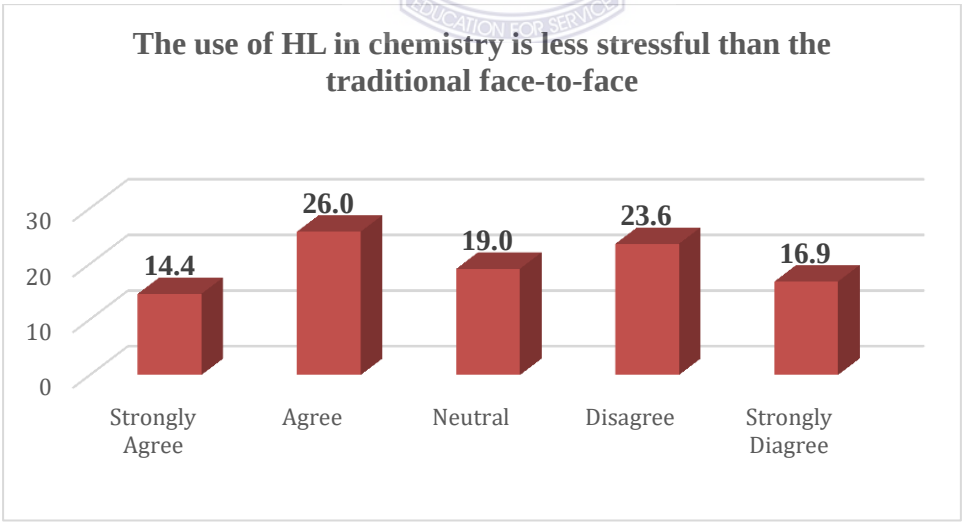

Figure 11: The use of HL in Chemistry is less stressful than the traditional face-to-face

Majority of the pre-service teachers (40.4%) agreed and strongly agreed that the use of HL in chemistry is less stressful than the traditional face-to-face. About 19.0% remain neutral to the statement and 40.5% of the teachers agreed and strongly agreed to the statement.

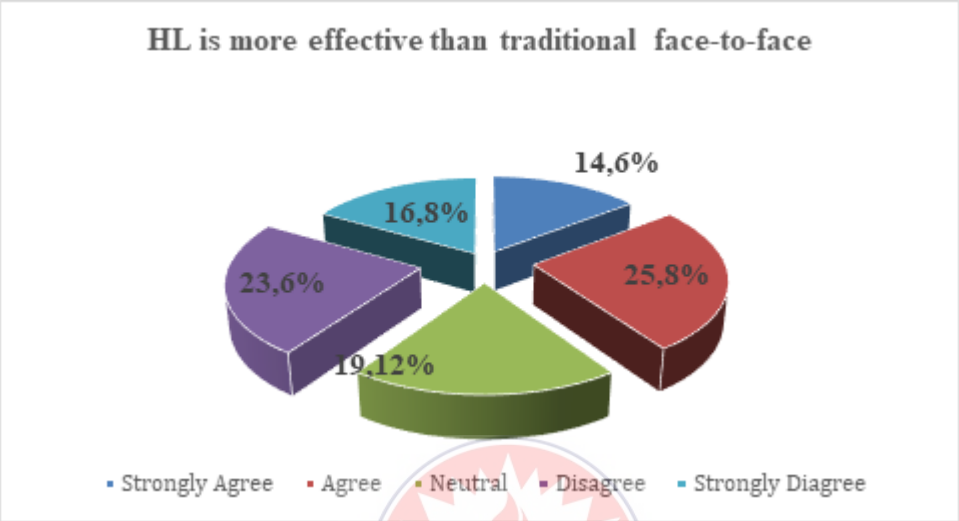

Figure 12: HL is more effective than traditional face-to-face

The **figure 12** above indicates that, 16.8% of pre-service teachers strongly agreed that HL is more effective than traditional face-to-face, 23.6% agreed to the statement, whiles only 19.1% of them remain neutral to the statement, 40.4% disagreed and strongly disagreed to the statement.

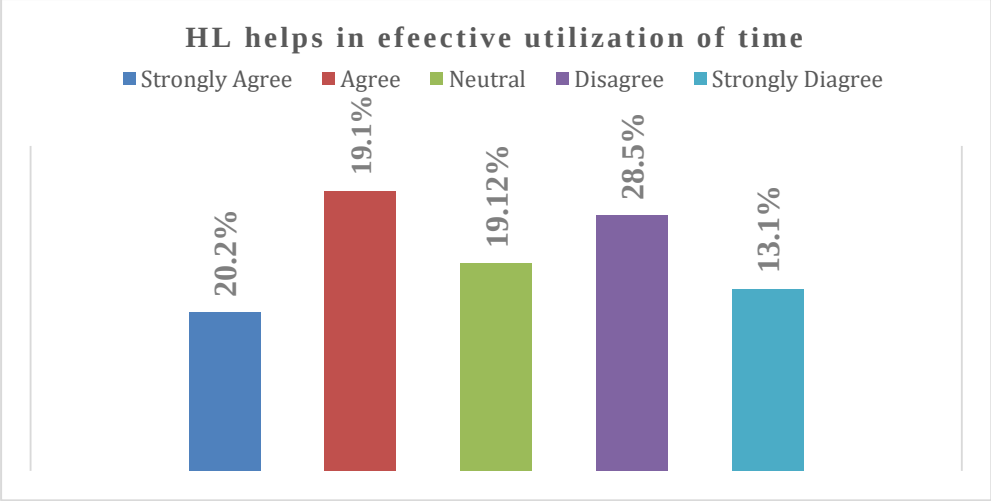

Figure 13: HL helps in Effective Utilization of Time

From **figure 13** above, majority of the pre-service teachers (28.5%) disagreed that HL helps in effective utilization of their time. Only 13.1 % of the teachers strongly agreed to this statement. Whiles 19.1 of the teachers maintained a neutral position of the statement, 19.1% of the teachers agreed to the statement and 20.2% of them strongly disagreed that HL helps in effective utilization of their time.

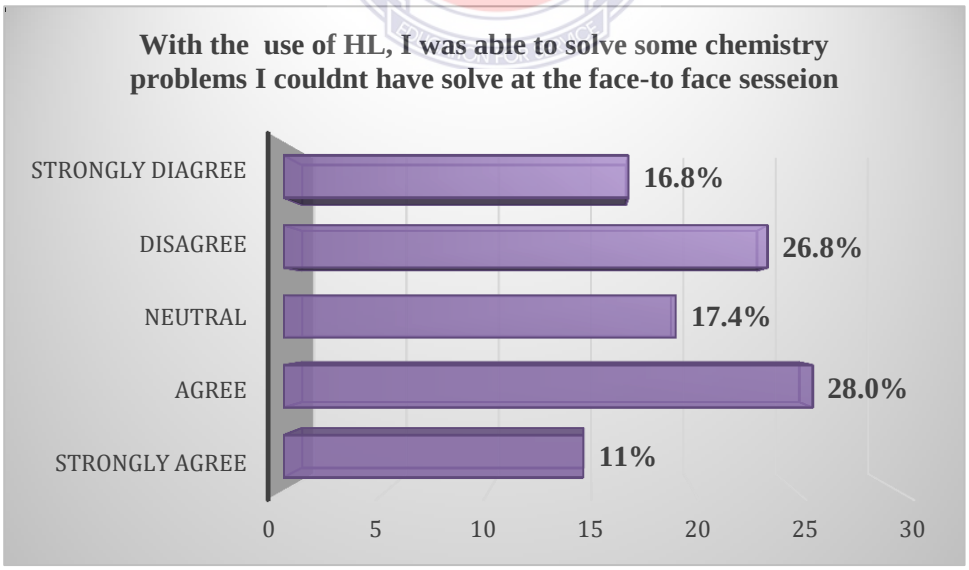

Figure 14: With the use of HL, I was able to solve some chemistry problems I could not have solve at the face-to face session

In the **figure 14** above, the bar graph depicts that majority of pre-service teachers (**43.6%**) disagreed and strongly disagreed, **(17.4%)** remain neutral, **(11%)** strongly agreed and (**28%)** agreed to the statement that with the use of HL, they were able to solve some chemistry problems they could not have solve at the face-to face session. Since majority are in disagreement with the statement above, the findings disagree to the findings that hybrid learning has the ability to increase students' science achievement as well as their attitude (Alsalhi et al., 2019; Vonti & Rahmah, 2019).

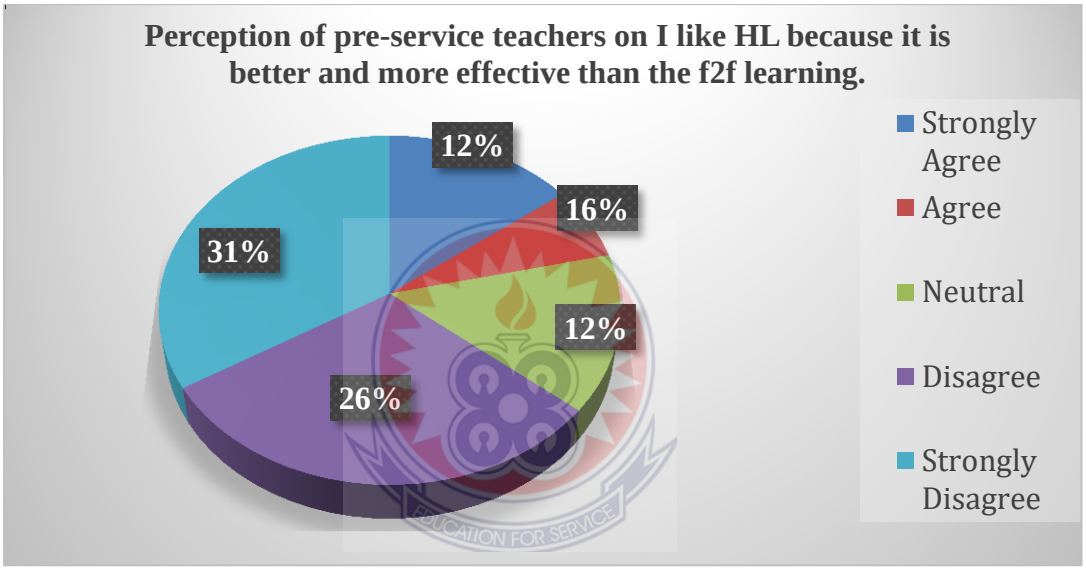

Figure 15: Perception of pre-service teachers on I like HL because it is better and more effective than the f2f learning

From the **figure 15** above, thirty (30) teachers constituting 31% strongly disagreed to the statement HL, is better and more effective than the f2f learning, twenty-seven (27) teachers representing 26% disagreed to the statement. Whiles thirteen teachers 12% strongly agreed, only six (6) teachers representing 16% agreed to the statement and thirteen 12% teachers remain neutral to the statement.

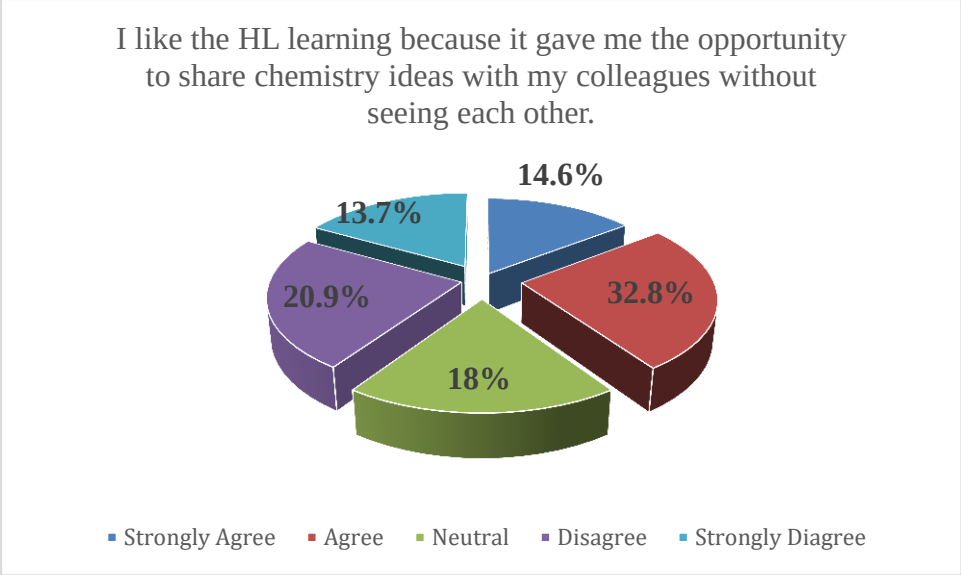

Figure 16: Perception of pre-service teaches on I like the HL learning because it gave me the opportunity to share chemistry ideas with my colleagues without seeing each other

From the **figure 16** above, the highest percentage (47.4%) of pre-service strongly agreed and agreed to the statement that on they like HL learning because it gave them the opportunity to share chemistry ideas with their colleagues without seeing each other, 18% of the teachers remain neutral to the statement and 34.6% of the students disagreed and strongly disagreed to the statement. This finding suggested that number of pre-service teachers who agreed and strongly agreed to the statement the HL gave them the opportunity to share chemistry ideas with their colleagues without seeing them face-to-face. This finding supported the research finding of Dzakiria et al., (2012) which stated that HL gives students a space to better interact and share ideas to their contentment.

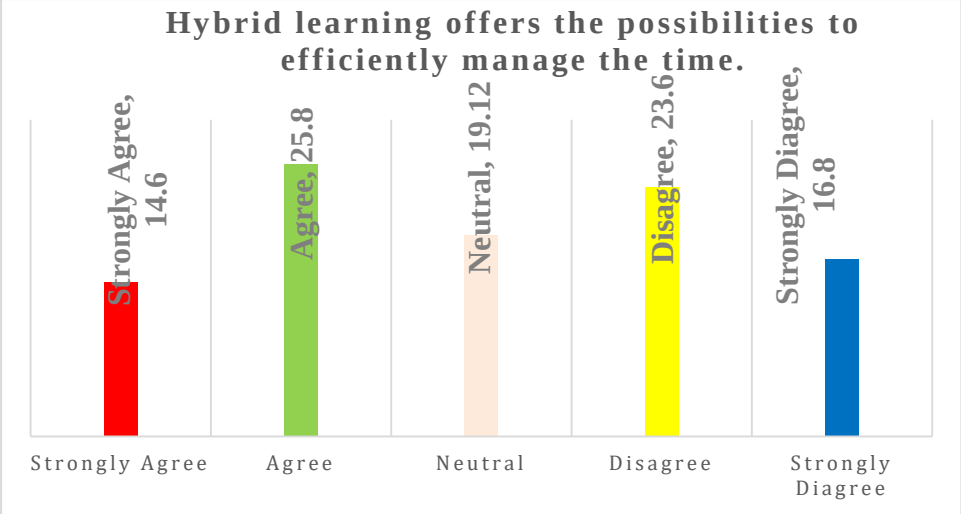

Figure 17: Hybrid learning offers the possibilities to efficiently manage the time

From the above **figure 17**, few of the pre-service teachers (14.6%) strongly agreed to the statement that blended learning offer them possibilities to efficiently manage their time. Twenty five percent (25.8%) of the pre-service teachers agreed to the statement and 19.12% of the teachers were neutral to the statement whiles 40.4% of the teachers strongly disagreed and disagreed to the perception that hybrid learning offer them possibilities to efficiently manage their time.

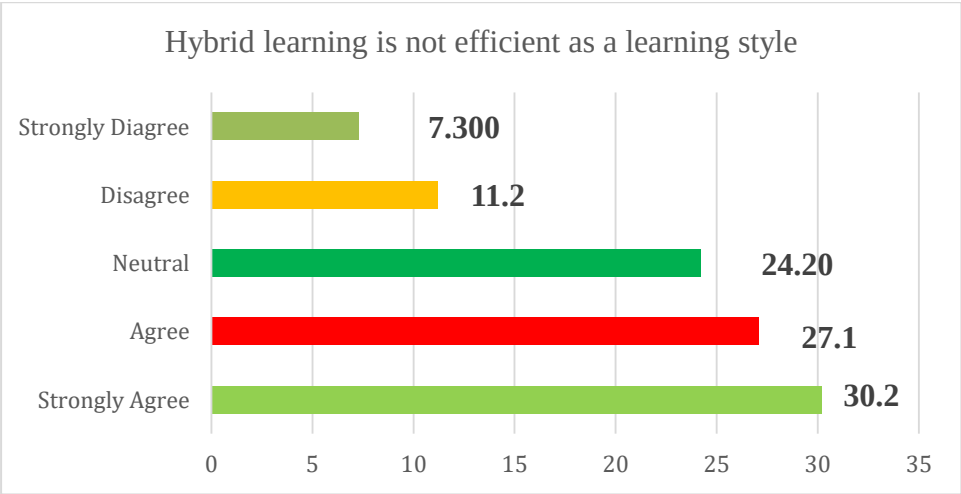

Figure 18: Hybrid learning is not efficient as a learning style

The **figure 18** above depicted that 57.3% of the pre-service teachers strongly agreed and agreed that Hybrid learning is not efficient as a learning style whiles 24.2% of the pre-service teachers remain neutral to the statement. Whiles 11.2% of the pre-service teachers disagrees to the statement hybrid learning is not efficient as a learning style, 7.3% of them strongly disagreed to the statement. The researcher's findings above shows that majority (57.3%) of the pre-service teachers strongly agreed and agreed that hybrid learning is not an efficient learning style which contradicts with the finding in the research conducted by Sarkar (2021) which stated that 75.2% of students strongly agreed and agreed that HL was an effective motivating learning process.

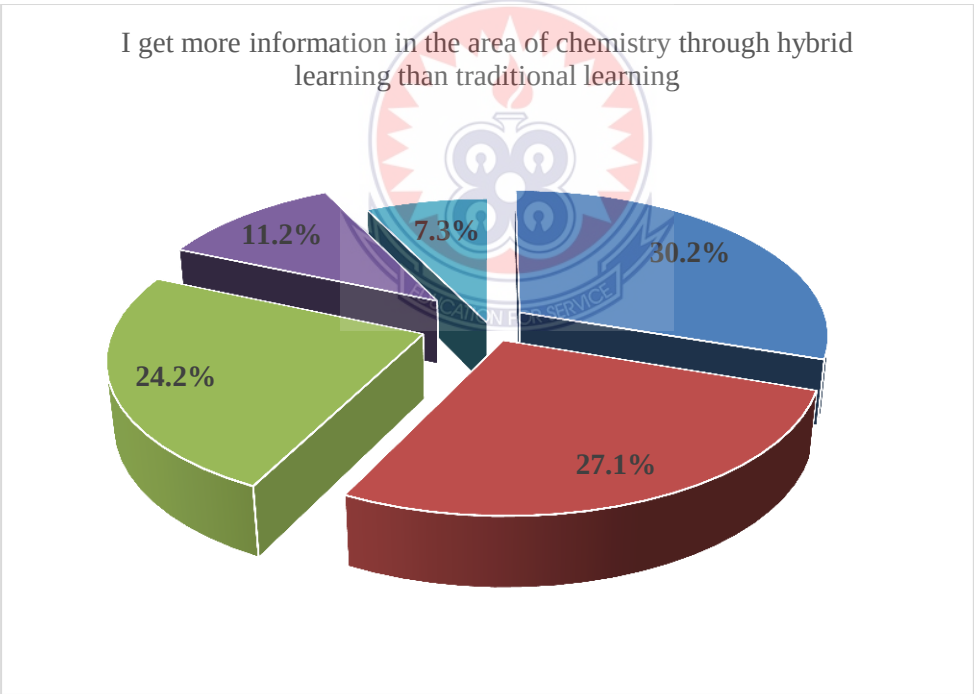

Figure 19: I get more information in the area of chemistry through hybrid learning than traditional learning

Figure 19 shows that 30.0% of the pre-service teachers which represent the highest percentage strongly agreed to that they get information in the area of chemistry through hybrid learning than the traditional learning whiles 27.1% agreed to the statement. Whiles 24.2% of the teachers remain neutral to the statement, 18.5% of the teachers disagreed and strongly disagreed to this statement.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

This chapter presents the summary of the study, conclusion and the recommendations/ suggestions for further research.

5.1 Summary

The study was to investigate whether the use of hybrid learning approach can improve pre-service teacher's performance in selected chemistry topics in Gambaga College of education within the North Eastern Region of Ghana. The study employed action research design (single group pre-test post-test) using non-equivalent pre-test and post-test within one group of pre-service teachers (Primary education specialism) in Gambaga College of education. The study participants consisted of 89 pre-service teachers of which 56 of them were males and 33 of them are females which were all level 300 primary education pre-service tearchers.

The research investigation used questionnaires and test as the main research instruments. The tests were made of 20 objectives which were mainly questions on selected chemistry topics and the questionnaires were made up of the perceptions of pre-service teachers as a result of the use of the hybrid learning.

The Pre-test items was administered to the pre-service teachers after taking them through the selected chemistry concepts without using the hybrid learning, this was to identify their level of comprehension on the selected concepts before the treatment began. The group was taught through the face-to-face or traditional lecture method for 8 weeks about the chemistry concepts before the pre-test was conducted.

Data were analysed using Paired t-test and percentages. Analysis of the data depicted there was significant difference between the academic performance of pre-service teacher's pre-test and post-test scores in some selected chemistry topics when they were taught with the lecture method since the null hypothesis has to be rejected. There was also no significant difference between the mean academic performance of male and female pre-service teachers in some selected chemistry topics when they are taught with hybrid learning.

5.2 Conclusion

Technology improvement had made Teaching and learning in education more understanding, very useful and easy. The hybrid learning is one of the improved technological strategies that can be used to improve the performance of teacher trainees in Gambaga College of Education. The research findings revealed that there was statistical significance improvement in pre-service teacher's performance when they were taught using the hybrid learning approach than when they were taught using the traditional face-to-face method, though teacher trainees had mixed feelings on the perceptions of the usage of this strategy. However, there was no significant differences between the mean academic performance of male and female pre-service teachers in some selected chemistry topics when they were taught with the lecture method and when they were taught using the hybrid learning approach. With regard to the perceptions of pre-service teachers towards the use of hybrid learning, teachers had mixed feelings (both positive and negative perceptions) towards its use. Findings indicated also the enthusiasm of pre-service teachers about the integration of hybrid learning in Education. Therefore, with the help of technology, hybrid Learning can be

used as an alternative strategy in teaching and learning in order to improve pre-service teachers' academic performance in Education.

5.3 Recommendations/Suggestions for further Research

5.3.1 Recommendation

The following recommendations are made based on the findings of the study:

1. Since the findings of this study indicated there was positive feedback in terms of pre-service teacher's performance in some selected chemical concepts after using the hybrid learning approach, the researcher recommends the use of hybrid learning for other chemistry tutors in our Gambaga College of Education as well as other colleges in Ghana.
2. The researcher recommended Gambaga College of Education authority to provide the science departments with recommended resources to practice this hybrid learning strategy.
3. Gambaga college science tutors should adopt this model (HL) and use it on regular basis so that pre-service will develop full interest in the use of the model.

5.3.2 Suggestions for further Research

1. Since there was no significant difference between the mean academic performance of male and female pre-service teachers in some selected chemistry topics when they were taught with the lecture method, the researcher suggest further research should be carried out this area.
2. The finding of the study of the perceptions of pre-service teachers on the use of hybrid learning in the learning of chemistry topics suggested that they had mixed

feelings in its usage. The researcher therefore suggested further research should be done on the perception of pre-service teachers on the use of hybrid learning.

3. The researcher also suggested further research to be done on the resource availability to use this teaching and learning strategy (hybrid learning).
4. The research was carried out in Gambaga College of education in which the findings cannot be considered as the general findings in Colleges of education in Ghana. The researcher therefore suggested this study be conducted in other colleges of education in Ghana.

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APPENDICES

APPENDIX A

Questionnaire on perceptions of the use of hybrid learning (HL)

This questionnaire aims to investigate teacher trainees' views on blended learning and its two sessions face-to-face learning and online learning. Using the 5 point Likert-Scale below, kindly tick the appropriate number on the right which corresponds to your view about the statement on the left. Please be objective as much as possible. Strongly Agree (SA) = 4, Agree (A) = 3, Neutral (N) =2, Disagree (DA) = 1 and Strongly Disagree (SD) = 0

Sr. No,	Questions	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	BL increases focus on chemistry topics.	4	3	2	1	0
2	BL provides illustrative chemistry content for the study	4	3	2	1	0
3	I get opportunity for self-pace learning when using BL to learn chemistry.	4	3	2	1	0
4	BL help me to learn and increase my interaction with my classmates which provide better learning experience in chemistry.	4	3	2	1	0
5	The use of BL encourages me to learn and increase my interest in chemistry.	4	3	2	1	0
6	The use of BL in chemistry is less stressful than the traditional face-to-face.	4	3	2	1	0
7	BL is more effective than traditional face-to-face.	4	3	2	1	0
8	BL helps in effective utilization of time.	4	3	2	1	0

9	With the help of the BL, I was able to solve some chemistry problems I couldn't solve at the f2f session.	4	3	2	1	0
10	I like BL learning because it is better and more effective than f2f learning	4	3	2	1	0
11	I like the BL learning because it gave me the opportunity to share ideas with my colleagues without seeing each other.	4	3	2	1	0
12	Blended learning offers the possibilities to efficiently manage the time.	4	3	2	1	0
13	Blended learning is not efficient as a learning style.	4	3	2	1	0
14	I get more information in the area of chemistry through blended learning than through traditional courses.	4	3	2	1	0
15	Blended learning helps me feel self-confidence.	4	3	2	1	0

Thank you

APPENDIX B

Pre-test

1. What is the chemical formulae of carbon dioxide?

   a. CO

   b. CO_2

   c. CO_3

   d. Co_2

2. Find the molar mass of ethanol (CH_3CH_2OH)

   (C = 12, H = 1, O = 16)

   a. 40 g/mol

   b. 44 g/mol

   c. 45 g/mol

   d. 46 g/mol

3. How many moles of carbon dioxide is present in 11g of carbon dioxide (CO_2)?

   (C = 12, O = 16)

   a. 0.23 mol

   b. 0.24 mol

   c. 0.25 mol

   d. 0.26 mol

4. Calcium burns in chlorine to form calcium chloride, a solid. Write a balanced equation for the reaction.

   a. $Ca_{(s)} + Cl_{2(g)} \rightarrow CaCl_{2\ (s)}$

   b. $Ca_{(s)} + Cl_{(g)} \rightarrow CaCl_{2\ (s)}$

   c. $2Ca_{(s)} + Cl_{2(g)} \rightarrow CaCl_{2\ (s)}$

   d. $Ca_{2\ (s)} + Cl_{2(g)} \rightarrow CaCl_{2\ (s)}$

5. What is the concentration in moles if 2.6 g NaCl is dissolved in 250 cm^3 solution?

   (Na = 23, Cl = 35.5)

   a. 0.0104 $moldm^{-3}$

   b. 0.1760 $moldm^{-3}$

   c. 0.1860 $moldm^{-3}$

   d. 0.1960 $moldm^{-3}$

6. Calculate the of 500 cm^3 of 0.15M or mol/dm^3 NaOH solution

   (Na = 23, O = 16, H = 1)

   a. 1.0 g

   b. 2.0 g

   c. 3.0 g

   d. 4.0 g

7. $Zn + \mathbf{X}HCl \rightarrow ZnCl_2 + H_2$

   What the value of X in the equation above?

   a. 1

   b. 2

   c. 3

   d. 4

8. A reaction in which one element replaces a similar element in a compound is called ….

   a. Decomposition reaction

   b. Double decomposition reaction

   c. Displacement reaction

   d. Double replacement reaction

9. $2Mg + O_2 \rightarrow 2MgO$

   The chemical reaction above is an example of a ……..

   a. Decomposition reaction

   b. Synthesis reaction

   c. Displacement reaction

   d. Double replacement reaction

10. How many molecules are there in 6g of H_2S gas?

    (H = 1, S =32, L = $\mathbf{6.02 \times 10^{23}}$)

    a. 1.060×10^{23} molecules

    b. 10.60×10^{23} molecules

    c. 106.0×10^{23} molecules

    d. 1060×10^{23} molecules

11. The chemical formulae of tetraoxosulphate (VI) acid is represented as ……..

    a. H_2SO_4

    b. H_3SO_3

    c. HSO_4

    d. H_2SO_3

12. In every 1 dm^3 of a solution, there is ……..

    a. 10 cm^3

    b. 100 cm^3

    c. 1000 cm^3

    d. 10000 cm^3

13. The relationship between amount of substance, number of particles and Avogadro's constant is ……

    a. $\mathbf{n = N \times L}$

b. **L = n×N**

c. **N = n+ L**

d. **N = n×L**

14. Which of the following reactions is a decomposition reaction?

a. $2Mg + O_2 \rightarrow 2MgO$

b. $2Fe + O_2 \rightarrow 2FeO$

c. $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

d. $CaCO_3 \xrightarrow{\triangle} CaO + CO_2$

15. A solution whose concentration is accurately known is called……..

a. Concentrated solution

b. Super saturated solution

c. Dilute solution

d. Standard solution

16. A balanced equation when Magnesium burns in oxygen to form magnesium oxide is …..

a. $2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$

b. $2Mg_{(s)} + 2O_{2(g)} \rightarrow 2MgO_{(s)}$

c. $Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$

d. $2Mg_{(s)} + 2O_{(g)} \rightarrow 2MgO_{(s)}$

17. If 10g of sugar is dissolved in $100dm^3$ of solution, then calculate the **concentration** of the solution.

a. $0.1\ g/dm^3$

b. $0.01\ g/dm^3$

c. $0.001\ g/dm^3$

d. $0.0001\ g/dm^3$

18. The number of moles of solute dissolved in one litre (or one cubic decimetre) of solution is called…….

    a. Parts per million

    b. Mole fraction

    c. Molarity

    d. Molality

19. One mole of any atom contains a fixed number of particles i.e. …….

    a. 6.02×10^{20} atoms

    b. 6.02×10^{21} atoms

    c. 6.02×10^{22} atoms

    d. 6.02×10^{23} atoms

20. What is the mass of 0.25 mol of $CaCO_3$?

    (Ca = 40, C= 12, O = 16)

    a. 24 g

    b. 25 g

    c. 26 g

    d. 27 g

APPENDIX C

Post-test

1. Which of the following compound is diatomic?

   a. CO

   b. CO_2

   c. CO_3

   d. CO_2

2. Calculate the mass of 0.15M NaOH as follows

   (Na = 23, H = 1, O = 16)

   a. 1 g

   b. 2 g

   c. 3 g

   d. 4 g

3. Calculate the mass concentration of 14.6g of hydrochloric acid in 1 dm^3 solution

   (Cl = 35.5, = 1)

   a. 13.6 g/dm^3

   b. 14.6 g/dm^3

   c. 15.6 g/dm^3

   d. 16.6 g/dm^3

4. Calcium burns in chlorine to form calcium chloride, a solid. Write a balanced equation for the reaction.

   a. $Ca_{(s)} + Cl_{2(g)} \rightarrow CaCl_{2\ (s)}$

   b. $Ca_{(s)} + Cl_{(g)} \rightarrow CaCl_{2\ (s)}$

   c. $2Ca_{(s)} + Cl_{2(g)} \rightarrow CaCl_{2\ (s)}$

   d. $Ca_{2\ (s)} + Cl_{2(g)} \rightarrow CaCl_{2\ (s)}$

5. Calculate the concentration in moldm^3 of a solution containing 58.5 g of NaCl in 250 cm^3 of solution. (Na = 23, Cl = 35.5)

   a. 4 moldm^{-3}

   b. 5 moldm^{-3}

   c. 6 moldm^{-3}

   d. 7 moldm^{-3}

6. What is the symbol of mole?

   a. n

   b. mol

   c. M

   d. C

7. If the atomic number of an element is 19 and its mass number is 39, find the number of neutrons of the element.
   a. 17
   b. 18
   c. 19
   d. 20

8. How many molecules are there in 6g of H_2S gas?

   (H = 1, S =32, L = **6.02 ×10^{23}**)

   a. 1.060 ×10^{23} molecules

   b. 10.60 ×10^{23} molecules

   c. 106.0×10^{23} molecules

   d. 1060×10^{23} molecules

9. What is the IUPAC name chemical formulae of tetraoxosulphate (VI) acid is represented as ……..

   a. H_2SO_4

   b. H_3SO_3

   c. HSO_4

   d. H_2SO_3

10. In every 1 dm^3 of a solution, there is ……..

    a. 10 cm^3

    b. 100 cm^3

    c. 1000 cm^3

    d. 10000 cm^3

11. The alloy brass id made up of …….

    a. Copper & Tin

    b. Copper and Zinc

    c. Nickel and chromium

    d. Copper and Iron

12. The method of separating mixture by passing it in solution or suspension or as a vapor through a medium in which the components move at different rates is called…….

    a. Chromatography

    b. Distillation

    c. Fractional distillation

    d. Sieving

13. All the following elements are metalloids except……..

    a. Boron (B)

    b. Silicon (Si)

    c. Germanium

    d. Iron

14. A balanced equation when Magnesium burns in oxygen to form magnesium oxide is …..

    a. $2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$

    b. $2Mg_{(s)} + 2O_{2(g)} \rightarrow 2MgO_{(s)}$

    c. $Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$

    d. $2Mg_{(s)} + 2O_{(g)} \rightarrow 2MgO_{(s)}$

15. Calculate the molarity of a solution made by diluting 0.050 L of 0.10 M HCl solutions to a volume of 1.0 L.

    a. 5.0×10^{-1} M HCl

    b. 5.0×10^{-2} M HCl

    c. 5.0×10^{-3} M HCl

    d. 5.0×10^{-4} M HCl

16. All the following conditions accelerate rusting except…….

    a. Heat

    b. Dilute acids/dilute base and

    c. Sodium chloride (sea water)

    d. Oil

17. Which of the following expresses the actual ratio of the atoms present in a compound. …?

    a. Atomic number

    b. Chemical formulae

    c. Molecular mass

    d. Valency

18. The balanced equation for the equation $Al_{(s)} + O_{2(g)} \rightarrow Al_2O_{3(s)}$ is……..

    a. $2Al_{(s)} + 3/2O_{2(g)} \rightarrow Al_2O_{3(s)}$
    b. $2Al_{(s)} + 3O_{2(g)} \rightarrow Al_2O_{3(s)}$
    c. $3Al_{(s)} + O_{2(g)} \rightarrow Al_2O_{3(s)}$
    d. $Al_{(s)} + 2O_{2(g)} \rightarrow Al_2O_{3(s)}$

19. What is the concentration in moles of sodium hydroxide (NaOH) per decimeter cube of solution 60g of sodium hydroxide in one litre of solution? (Na = 23, O = 16, H = 1)

    a. 1.5 mol/L

    b. 1.4 mol/L

    c. 1.3 mol/L

    d. 1.2 mol/L

20. The mass of one mole of a substance is called…….

    a. Amount mass

    b. Mass density

    c. Molar mass

    d. Volume mass

APPENDIX D

t-Test: Paired Two Sample for Means

	HL	*TLM*
Mean	17.48315	16.88764045
Variance	0.61619	0.691777324
Observations	89	89
Pearson Correlation	0.084092	
Hypothesized Mean Difference	0	
df	88	
t Stat	5.132432	
P(T<=t) one-tail	8.46E-07	
t Critical one-tail	1.662354	
P(T<=t) two-tail	1.69E-06	
t Critical two-tail	1.98729	

APPENDIX E

t-Test: Two-Sample Assuming Unequal Variances

	MALE	*FEMALE*
Mean	17.53571	17.12121
Variance	0.68961	0.922348
Observations	56	33
Hypothesized Mean Difference	0	
df	60	
t Stat	2.065694	
P(T<=t) one-tail	0.021592	
t Critical one-tail	1.670649	
P(T<=t) two-tail	0.043184	
t Critical two-tail	2.000298	