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# Pre-Service Mathematics Teachers Conceptions of the Constructivist Teaching and Learning Approach in the Colleges of Education Classrooms

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***Author's contribution***

*The sole author designed, analysed, interpreted and prepared the manuscript.*

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## ABSTRACT

The study sought to examine the perceived conceptions and effectiveness of the constructivist approach to teaching and learning among pre-service mathematics teachers on the development of problem-solving skills in the colleges of education. A survey design with a quantitative data was gathered for the study. Stratified sampling method was used to select 240 pre-service mathematics teachers in Ashanti and Western North regions of Ghana. The data collection had a response rate of 94.6% representing 227 pre-service mathematics teachers. The study employed both close-ended and open-ended questionnaire. The close ended questionnaire data collected were analysed using frequencies and percentages while the open-ended data were analysed using themes. The findings revealed that 88% of the pre-service mathematics teachers have good number of conceptions which constitute teaching acts that promote constructivism in a

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mathematics classroom. The findings also indicated that 80% of the pre-service mathematics teachers hold the view that constructivist approach of learning is effective on the development of students' problem-solving skills in mathematics. The data again indicated that the pre-service mathematics teachers have adequate knowledge about the mathematics curriculum they are going to work with in the future, and the constructivist approach of teaching and learning was effective in promoting the development of pre-service mathematics teachers' problem-solving skills. The study recommended that stakeholders of Teacher Education should put in place a scheme that will address the need to place emphasis of public examination on non-routine and real-life investigative problems in colleges of education to convince mathematics teachers on teaching through constructivism.

*Keywords: Constructivist teaching approach; constructivist learning approach; constructivism; developing problem-solving skills; classroom practices.*

## 1. INTRODUCTION

Education is seen as the development of a sound mind in a sound body. It is a continuous and purposeful social process by which the innate powers of man are developed, his knowledge and skills are enhanced and his behavior is changed, and he is made a cultured and civilized citizen (Lamichhane, 2018). It functions as a catalyst for analytical thinking, drives scientific advancement, and contributes to the promotion of sustainable development (Sayed & Ahmed, 2015). The current primary school curriculum in Ghana emphasizes the significance of transmitting both local knowledge and scientific breakthroughs to upcoming generations, promoting innovation and creativity (Dagnew, 2017, Misra, 2020, Gordon, 2009). In order to achieve educational goals, teachers are strongly encouraged to adopt a variety of suitable teaching methods, including the active participation approach, as recommended by the Ministry of Education in 2018.

In the opinion of Atteh., (2023) the effectiveness of learning concepts as well as skills depends on the methods and techniques employed by teachers during classroom instruction. Hence, the methodologies and tactics employed by educators in their instruction directly impact the attainment of mathematical concepts and skills. The rise of active learning, also known as experiential learning, learning via action, student-centered learning, peer collaboration, and cooperative learning, has highlighted the importance of constructivism. The dominant education paradigm globally strongly supports the use of Constructivist Teaching and Learning Approaches. Nevertheless, teachers frequently implement these ideas in a manner that diverges from the intellectual ideals of this paradigm, as stated by Jitka et al., (2018) In numerous developing nations, such as Ghana, the instructional techniques utilized in mathematics lessons are often considered to be inefficient in promoting students' comprehension of concepts that are relevant and practical in their everyday lives (Atteh, 2023). In order to achieve the objectives of mathematics education, educators must possess sufficient knowledge, skills, and teaching techniques. This includes a thorough understanding of constructivist teaching and learning approaches and practices, which are essential in the 21st century.

Constructivist teaching and learning approaches strive to provide learners with essential skills and a lasting reservoir of knowledge by engaging them in active and participatory curricular and co-curricular activities (Mbise & Lekule, 2023). The constructivist teaching and learning technique, recognized in the field of education for its efficacy in addressing practical obstacles, empowers students to explore their emotions, thoughts, and strategies when solving problems. This strategy promotes a captivating educational and learning experience by utilizing interactive technique (Brame, 2016). This pedagogical approach promotes the utilization and implementation of mathematical concepts in practical situations, real-world challenges, and within the realm of mathematics itself. Constructivism in mathematics education enables individuals to develop their scientific reasoning and thinking skills by engaging with various mathematical problems. It moreover offers a platform for learners to develop their own concepts about mathematics and to assume responsibility for their own learning.

Jean Piaget in his studies suggested that through processes of accommodation and assimilation, individuals construct new knowledge from their experiences. And when individuals assimilate,

they incorporate the new experience into an already existing framework without changing that framework. In confirmation, Brooks cited in Aka., (2009) outlined four guiding principles of constructivism. These are:

- ✓ Learning is a search for meaning. Therefore, learning must start with the issues around which students are actively trying to construct meaning.
- ✓ Meaning requires understanding wholes as well as parts. And parts must be understood in the context of wholes. Therefore, the learning process focuses on primary concepts, not isolated facts.
- ✓ In order to teach well, we must understand the mental models that students use to perceive the world and the assumptions they make to support those models.
- ✓ The purpose of learning is for an individual to construct his or her own meaning, not just memorize the "right" answers and regurgitate someone else's meaning.

Nabie., (2001) argued further that to enable learners apply what they learn to real life situations, teachers must teach mathematics within the learners experiential domain. This should be the practice that pertains in the classrooms.

## 1.1 Problem Statement

The mathematics syllabus in Ghana, recommends that students should be able to use mathematics in their daily lives by recognizing and applying appropriate methods through the use of constructivism (Ministry of Education Ghana, 2018). As a result, teachers who teach at the basic schools must be well equipped in mathematics teaching and learning processes so that they can impart the knowledge they have received to the younger generations to assist them go through the senior high school and the tertiary with ease.

However, studies have shown that students are not able to solve non-routine mathematical problems (TIMSS, 2003, TIMSS, 2007, Or and Bal, 2023, Foster, 2023) and that applying problem solving approach in dealing with mathematics is unpopular among students. The question that I believe will be ringing in the minds of most people is that, what is simply wrong with the study of Mathematics? Is it a student factor, teacher factor or administrative factor? Many believe that, more emphasis on teaching are based on the theoretical aspects while equal attention is not focused on the practical aspects of teaching (Mereku, 2004, Atteh et al., 2014, Andam et al., 2015). In the view of Al-Agili, Mamat, Abdullah and Maad., (2012) several factors influence students' achievement in Mathematics. These factors are student personal attitudes towards Mathematics, classroom climate, Mathematics anxiety, teachers' attribution as lack of experienced Mathematics teachers and shortage of qualified Mathematics teachers, teaching practices and teaching methods, students' beliefs and attitudes toward Mathematics.

It seems to a greater number of people including the researcher that, the pre-service teachers having a good knowledge about teaching practices and teaching methods towards a subject will certainly ignite a great interest in the study of the subject as well as providing the necessary motivation needed for the learners in studying the subject. Acquiring such skills has a good potential of changing the classroom narratives to a positive one with the pre-service teacher at the center of learning in the future. With the introduction of the new curriculum in colleges of education in 2018, mathematics teacher education in Ghana was expected to take a turn towards using constructivist teaching and learning approach with the idea that teachers teach the way they are taught. Hence this study was designed to investigate the conceptions and perceived effectiveness of the constructivist approach of teaching and learning among pre-service mathematics teachers in college of education math classroom.

## 1.2 Research Question

The study was intended to provide answers to the following questions:

1. What are pre-service teachers' conceptions of the constructivist approach of teaching and learning in the mathematics curriculum at the colleges of education?
2. How effective is constructivist approach of teaching and learning on the development of pre-service teachers' problem-solving ability in mathematics at the colleges of education?

## 1.3 Literature

Constructivism is a philosophy that elucidates the process of learning, irrespective of whether

learners utilize their experiences to comprehend a lecture or adhere to instructions to build a model. Constructivism places great emphasis on the significance of instructional meaning, students' prior knowledge, and the active involvement of learners in the learning process. Constructivism views each learner as an individual with distinct requirements and personal histories. According to the constructivist viewpoint, individuals generate information by engaging with the world and drawing from their personal experiences (Atteh, 2023). From a socially constructivist perspective, it is crucial to consider the learner's historical and cultural background during the learning process. This context plays a significant role in shaping the information and reality that the learner generates, uncovers, and attains throughout their learning journey (Makena, 2022).

Unlike the traditional approach to learning, which involves teachers taking an active role in the teaching/learning process and learners passively receiving knowledge, constructivists argue that learning should prioritize the learner. Hence, regardless of the level of engagement of a learner in a learning endeavor, the child must be situated in a learning setting that aligns with the child's age-related developmental and individual learning limitations in order to acquire knowledge. A study conducted by Simon., (1995) discovered that our understanding of the environment is constructed based on our impressions and observations, which in turn are influenced by our prior knowledge. According to Atteh et al., (2017), teachers should abandone the belief that learners are passive recipients of knowledge and instead adopt a teaching method that encourages active learning and comprehension. Teachers must actively engage learners in their instruction to enable pupils to cultivate their own knowledge (Atteh et al., 2014).

The constructivist perspective on learning and teaching in the classroom encompasses various instructional methods. In general, they hold the belief that learning is most effectively achieved through a practical and experiential method. Through the process of learning, individuals acquire knowledge and develop the ability to draw conclusions, make observations, and form assumptions independently, rather than being provided with predetermined information. Teachers will promote the utilization of constructive approaches, such as conducting experiments and engaging in real-world problem solving, among pupils. Moreover, there is a general consensus that the knowledge students acquire is heavily shaped by the way they are instructed (Kennedy, 1997). Instructors are expected to adopt the role of facilitators rather than traditional teachers (Bauersfeld, 1995). A facilitator assists the learner in attaining their own comprehension of the subject, while a teacher delivers a didactic lecture on the topic. In the former scenario, the student assumes an active role, while in the latter scenario, the learner assumes a role that is passive in the learning process. Mathematics requires learners to be totally engaged in order to learn.

## 2. METHODS

### 2.1 Research Design

The study adopted the descriptive survey design to obtain data from participants in order to examine conceptions and practices of constructivist approach of teaching and learning among pre-service teachers and tutors. Survey study design are quantitative research procedures in which researchers conduct a survey to a sample or to the entire population of individuals to identify the population’s views, beliefs, behaviors or characteristics (Creswell, 2012). It is believed that surveys use a standard set of questions to get a broad overview of a group’s opinion’s, attitudes, self-reported behaviours, and demographic and background information (Onley & Barnes, 2008). The study specifically used Cross-sectional survey to collect information on conceptions of constructivist approach of teaching and learning among pre-service teachers in the college of education mathematics classrooms. In a cross-sectional study, time is assumed to have random effect that produces only variance, not bias. Creswell., (2012) argues that cross-sectional survey design has the advantage of measuring current attitudes or practices. It also offers information in a limited time span, such as the time needed to conduct the survey and collect the information. Cross-sectional survey was preferred as a method of data collection over others in this particular study due to the fact that many questions were asked and it was possible to reach the entire college of education mathematics tutors and student within a short period of time (Fowler, 2002). Moreover, respondents’ anonymity was easily protected as data was collected without having to identify respondents. In addition, a semi-structured interview was employed to gather perspectives on the conceptions and perceived effectiveness of the constructivist learning approach

among pre-service mathematics teachers. The semi-structured interview was used for the study due to its flexibility and adaptability (Mears, 2009). The semi-structured interview specifically targets the two research questions to gather further qualitative data for the study.

## 2.2 Sample

The population consisted of all Colleges of Education in the Western North and Ashanti.

regions of Ghana. Purposive sampling technique was employed to select eight colleges of education for the study in such a way the school represented a category of colleges such as mixed colleges and single sex colleges. Level 300 students were used because they had more educational experience in Mathematics than those at the level 100 and 200 in the colleges. In addition, the level 400 students would have been part of the study but they were outside the school undertaking their internship programme. A guideline provided by Krejcie and Morgan., (1970) was duly followed in determining the sample size. In order to select the sample size in each school, each school was divided to its stratum by the use of the stratified sampling method. This stratum is the various courses offered in Maths/science area which create different classes at the level 300. The sample size was determined in each school to form the overall sample size for the study by using the proportionate stratified sampling technique.

In selecting the sample unit in each school, the systematic sampling technique was used. This was done by determining the sample frame which is the register of students in each class which records all the names of the students in class. The width of the interval was determined by dividing the population in each stratum (class) by the sample size for each stratum. Then the simple random sampling technique was used in selecting a student from the first interval, followed by selecting the same order of students from each subsequent interval till the sample size for each stratum is obtained. This was done in each school.

## 2.3 Instrument

The main instruments used for data collection were questionnaire (both close ended and open ended). The questionnaire was used to collect data from the pre-service mathematics teachers to find out the conceptions and the perceived effectiveness of constructivism in the mathematics classroom. A questionnaire's benefits include consistent submission of questions to respondents, assurance of respondents' anonymity and less time to administer (Fraenkel & Wallen, 2000; Muijs, 2004). The questionnaire focused on three (3) main parts. Part (A) of the questionnaire contain items that solicited for information on the demographic information of the respondents (i.e. gender, grade levels of students, the awareness of constructivist approach of teaching and learning in the mathematics curriculum, and proportion of students who learn mathematics through constructivism). The second part (B) consisted of four (4) items that solicited for information on pre-service teachers' perceptions of conceptions of constructivism in teaching and learning of mathematics. The third part (C) consisted of five (5) items that solicited for information on pre-service teachers' perceptions of effectiveness of teaching mathematics through constructivism. In both part B and C of the questionnaire used a 5-point Likert scale starting from Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), Strongly Disagree (SD). The open-ended questionnaire (interview) consisted of structured questions to afford the researcher the opportunity to find out more on the conceptions and perceived effectiveness of constructivist approach of teaching and learning among preservice mathematics teachers.

**Table 1. Sample size determination of students in each college**

| School | Number of Students | Sample Size in each School |
|---|---|---|
| School "A" | 120 | 32 |
| School "B" | 113 | 30 |
| School "C" | 118 | 31 |
| School "D" | 110 | 30 |
| School "E" | 115 | 30 |
| School "F" | 108 | 28 |
| School "G" | 112 | 29 |
| School "H" | 121 | 30 |
| **Total** | **917** | **240** |

*Source: Field data, 2021*

## 2.4 Reliability and Validity

In this study face validity of the instruments was assessed by three senior mathematics lecturers who are experts in curriculum research and instruction. Their suggestions were used to improve the validity of the instrument. Later, the improved questionnaire was pilot-tested to establish not only its reliability but also to identify defective items, and ensured that the instrument was clearly understood by respondents. The feedback of the respondents helped to improve the quality of the survey in terms of content coverage, content validity and reliability. The questionnaire had a reliability coefficient of 0.703, which is highly reliable since the reliability coefficient is above 0.5.

## 2.5 Data Collection Procedure

With consent from the Principals, the Heads of the mathematics department of the participating colleges were informed about the study. The researcher personally distributed the questionnaire to the participants in the participating schools. The process began by the explanation of the questionnaire items to the respondents. This measure was put in place so that accurate information could be retrieved from the respondents. They were also assured of the confidentiality of the information they provided. It took one month and two weeks to administer the questionnaires. The questionnaire was administered personally to help improve the collection and response rate of the questionnaire. The questionnaire was collected as soon as it was completed by the respondents. In all, 227 pre-service mathematics teachers responded to the questionnaires. This indicates 94.6% return rate of the 240 questionnaires administered.

In addition, an open-ended questionnaire (interview) which consisted of structured questions were administered to afford the researcher the opportunity to find out more on the conceptions and perceived effectiveness of constructivist approach of teaching and learning among preservice mathematics teachers. These questionnaires were distributed to six selected students who agreed to participate in that activity after completing the close ended questionnaire. This occupied a major part of the fieldwork and was mainly to gather qualitative data in the participants own words so that insights could be developed on the study.

## 2.6 Data Analysis Procedure

To answer the research questions that were formulated to guide the study, the type of statistical analysis employed was descriptive in nature. Specifically, the biographical data and the research questions were quantitatively analyzed by the use of simple frequency tables and percentages. After administering the open-ended questionnaire (interview), notes were made and analyzed immediately thereafter. The transcription was done by the researcher and constructed into categories and analyzed which was explained and inferences were drawn.

## 3. RESULTS AND DISCUSSION

This section presents the results obtained in a Table and thereafter discusses the results to address the research questions raised for the study. The respondents for this study were 227 college of education level 300 pre-service mathematics teachers from the Western North region and the Ashanti region of Ghana of which 59 of them representing 26% are females and 168 representing 74% are males.

Table 2 presents the results on the respondents' awareness of constructivist approach of learning in the mathematics curriculum. It was evident that all (100%, n=227) of the respondents were fully in awareness of constructivist approach of teaching and learning in the mathematics curriculum.

Table 3 presents the results on the proportion of respondents who experience mathematics teaching through constructivism for the study. From the table, none of the respondents do not experience mathematics teaching through constructivism. However, 81.5% (n= 185) of the respondents experience mathematics teaching occasionally through constructivism and 18.5% (n=42) also experience mathematics teaching through constructivism all the time.

## 3.1 Research Question One

What are pre-service teachers' conceptions of the constructivist approach of teaching and learning in the mathematics curriculum in college of education?

Table 4 indicate pre-service mathematics teachers' ratings on their conceptions of the constructivist approach of teaching and learning in the mathematics curriculum. Majority of the respondents (92.5%, n = 210) generally agreed

with the first item which indicates that accepting a challenging mathematical problem and striving hard to resolve it lead to constructivist approach of learning. For the second item, 206 (90.7%) out of 227 respondents generally agreed that, providing students with open ended problems to solve can lead to open investigations and multiple solutions which is deemed as constructivist approach of learning.

In furtherance, with the third item, 209 (92.1%) of the respondents generally agreed that, solving mathematical problems which involves real life situations most often lead to constructivist approach of learning in the mathematics classroom. Lastly, for the fourth item, 200 (88.1%) of the respondents generally agreed that, accepting to solve a difficult mathematical task which has no apparent and immediate method of solving is often considered as constructivist approach of learning. In summary, most of the respondents had good level of knowledge about the conceptions of the constructivist approach of teaching and learning in the mathematics curriculum as it is evident in the results presented Table 4.

**Table 2. Pre-service teachers awareness of constructivism in the mathematics curriculum**

| Awareness of constructivist approach of learning | N | % |
|---|---|---|
| Fully aware | 227 | 100 |
| Not aware | 0 | 0 |
| **Total** | **227** | **100** |

*Source: Field data, 2021*

**Table 3. The proportion of respondents who learn mathematics through constructivism**

| Proportion of pre-service teachers who experience mathematics teaching through constructivism | N | % |
|---|---|---|
| Not at all | 0 | 0 |
| Occasionally | 185 | 81.5 |
| All the time | 42 | 18.5 |
| **Total** | **227** | **100.0** |

*Source: Field data, 2021*

**Table 4. Pre-service maths teachers' conceptions of the constructivism in the curriculum**

| Item | SA N(%) | A N(%) | N N(%) | D N(%) | SD N(%) | Total |
|---|---|---|---|---|---|---|
| Usually, accepting a challenging mathematical problem and striving hard to resolve it lead to constructivist approach of learning. | 82(36.1) | 128(56.4) | 17(7.5) | 0(0) | 0(0) | 227 |
| Providing students with open ended problems to solve which lead to open investigations and multiple solutions is deemed as constructivist approach of learning | 122(53.7) | 84(37.0) | 12(5.3) | 9(4.0) | 0(0) | 227 |
| Solving mathematical problems which involves real life situations most often lead to constructivist approach of learning | 78(34.4) | 131(57.7) | 18(7.9) | 0(0) | 0(0) | 227 |
| Accepting to solve a difficult mathematical task which has no apparent and immediate method of solving is often considered as constructivist approach of learning | 43(18.9) | 157(69.2) | 27(11.9) | 0(0) | 0(0) | 227 |

*Source: Field data, 2021*

### 3.2 Results of Open-ended Questionnaire on Research Question One

The interview results are presented under these themes:

- ✓ Preservice mathematics teachers conceptions about constructivist approach of teaching and learning.
- ✓ Teachers role in a constructivist classroom.

The abbreviation P followed by a number in the presentation is the identity of the preservice mathematics teacher interviewee (e.g. P2 means second preservice mathematics teacher interviewee) and R represents question asked by the researcher.

R: In your own opinion what do you think constructivist approach of teaching and learning is all about?

P1 and P3 in response to the question said:

> *P1: Constructivist approach has to do with ensuring that new knowledge is constructed by learners base on their previous existing knowledge.*
>
> *P3: It is a process of learning that occurs as learners are actively involved in a process of making meaning and knowledge construction as opposed to passively receiving information from the teacher.*

The responses indicate that *P1* and *P3* conceived constructivist approach of teaching and learning as the process of learning through the use of mathematical task for which the learners are directly involved in the learning process.

In responding to the same question, P5 and P6 stated:

> *P5: In this approach of learning, learners become the builders and creators of meaning and knowledge on their own through their prior knowledge.*
>
> *P6: With this approach of teaching and learning the learner is at the centre of the learning (knowledge construction) process since learning depends on what the leaner already knows, and meaningful learning occurs when one relies on old ideas to assist him/her to arrive at a new conclusion about new ideas which may conflict with our old ideas.*

It could be deduced from the responses of *P5* and *P6* that pre-service mathematics teachers conceived constructivist teaching and learning approach as a process where learners rely on old ideas to achieve new understanding.

> R: What is the teachers' role in constructivist classroom?

In responding to the question, *P1* stated that:

> *P1: In fact, our teachers most often provide timely interventions and guidance to learners in our knowledge construction process. Sometimes the teachers make sure that we the students are working in groups to foster effective discussions for better knowledge construction. The needed assistance is given to all students either in groups or individuals.*
>
> *P2* and *P3* in responding to the same question, said:
>
> *P2: At times our teachers provide we learners with open ended problems/questions to open the door for meaningful discussions and deliberations. The discussion allows for corrections of misconceptions among learners to pave way for new knowledge construction.*
>
> *P3: Okey our teacher's watch, listen, and pose questions to we the students in order to learn about us and about how we learn so that teachers may be more helpful to us the students.*

Similarly, *P5* and *P6* response to the same question was:

> *P5: Our teachers usually ensure that the classroom environment is conducive and not intimidating for learning.*
>
> *P6: Our teachers at all times motivate learners to succeed in their quest to find solution to a given problem.*

The excerpts of the interview responses of *P1, P2, P3, P5* and *P6* indicate that preservice mathematics teachers are aware that in a constructivist classroom the teachers pose worthwhile questions for discussions/ investigations, and make sure the classroom

environment is conducive for learning. Teachers assist learners to construct their own knowledge. Based on the responses of the pre-service mathematics teachers, one can conclude that both the learners and the teachers have a role to play in a constructivist teaching and learning environment to achieve curriculum objectives.

### 3.3 Research Question Two

How effective is constructivist approach of learning on the development of pre-service teachers' problem-solving ability in mathematics?

Table 5 indicates pre-service mathematics teachers' ratings on their perceptions on effectiveness of constructivist approach of teaching and learning on the development of students' problem solving ability in mathematics. Majority of the respondents (91.2%, n = 207) generally agreed with the first item which indicates that constructivist approach of teaching and learning provide avenue for better understanding of mathematics and its applications in daily life. For the second item, 184 (81.1%) out of 227 respondents generally agreed that constructivist approach of teaching and learning makes the learning of mathematics more interesting and enjoyable. With the third item, 220 (96.9%) of the respondents generally agreed that constructivist approach of teaching and learning enhances both teacher to students and student to student interaction in the mathematics classroom.

In furtherance, with the fourth item, 206 (90.7%) of the respondents generally agreed that, the constructivist approach of teaching and learning assist students to develop more methods of solving mathematical problems. Lastly, for the fifth item, 182 (80.2%) of the respondents generally agreed that constructivist approach of teaching and learning enables students to develop positive attitude towards mathematics. In summary, most of the respondents had positive perceptions about the effectiveness of constructivist approach of teaching and learning on the development of students' problem-solving ability in mathematics as it is evident in the results presented above.

### 3.4 Results of Open-ended Questionnaire on Research Question Two

The interview results are presented under these themes:

- ✓ The classroom environment under the constructivist approach of teaching and learning.
- ✓ Effectiveness of constructivist approach of teaching and learning.

The abbreviation P followed by a number in the presentation is the identity of the pre-service mathematics teacher interviewee (e.g. P2 means second preservice mathematics teacher interviewee) and R represents question asked by the researcher.

R: How is the classroom environment under the constructivist approach of teaching and learning?

**Table 5. How effective is constructivist approach of teaching and learning?**

| Item | SA N(%) | A N(%) | N N(%) | D N(%) | SD N(%) | Total |
|---|---|---|---|---|---|---|
| Provide avenue for better understanding of mathematics and its applications in daily life. | 94(41.4) | 113(49.8) | 20(8.8) | 0(0) | 0(0) | 227 |
| It makes the learning of mathematics more interesting and enjoyable. | 106(46.7) | 78(34.4) | 27(11.9) | 16(7.0) | 0(0) | 227 |
| Enhance both teacher to students and student to student interaction. | 146(64.3) | 74(32.6) | 7(3.1) | 0(0) | 0(0) | 227 |
| Students develop more methods of solving mathematical problems. | 87(38.3) | 119(52.4) | 21(9.3) | 0(0) | 0(0) | 227 |
| It enables students to develop positive attitude towards mathematics. | 68(30.0) | 114(50.2) | 32(14.1) | 13(5.7) | 0(0) | 227 |

*Source: Field data, 2021*

*P1* and *P2* in response to the question said:

> *P1: This approach gives opportunity for us learners to openly express our thoughts in the course of learning without intimidation. Communication in the classroom is very open and not restricted. We are allowed to ask all questions that bother us in our learning in the classroom.*
>
> *P2: In this classroom the learners are directly involved in all matters that occur in the classroom that affect their being there as learners and as people.*

In responding to the same question, *P4 and P5* stated:

> *P4: We are always encouraged to do social discussions among ourselves and students are sometimes in small groups or larger groups depending on the class size for a fruitful classroom discussion. This allows learners to clear their misconceptions in their individual groups. Individuals as well as groups are encouraged to come up with varied solutions or solution processes.*
>
> *P5: This approach provides the opportunity for learners for asking their own questions, this allows students acquire more consciousness of and control over their thinking.*

It could be deduced from the responses of *P1* and *P2* that pre-service mathematics teachers conceived constructivist teaching and learning environment to provide students with enough opportunity to ask the needed questions for clarifications in the learning process. From the response of *P4* and *P5*, Constructivist teaching and learning also provide a room for collaboration and small group interactions among learners to improve their comprehension skills and correct misconceptions as well.

R: How effective is constructivist approach of teaching and learning?

In responding to the question, *P1*, *P2* and *P3* states:

> *P1: This teaching and learning approach allows our teacher to provide students with experiences that allow them to predict, manipulate objects, pose questions, research, investigate, imagine, and invent. It gives room for students to explore all manner of options to arrive at a solution to a given problem.*
>
> *P2: In our groups and as individuals, our teachers serve as a guide to our learning to arrive at a solution whenever we get confuse in our solution process.*
>
> *P3: It always positions students at the centre of learning which turn to promote active instructions which produce active learning among students. We the students either in groups or as individuals determine the pace of lesson delivery to benefit our understanding.*

*P4* and *P6* in responding to the same question, said:

> *P4: This approach to teaching and learning ensures collaboration which in turns enhances learners strategic know how, and process skills through this collaborative learning. This give way for students to learn through peer interaction, and at that level students can ask all the needed questions that affect their understanding.*
>
> *P6: Since this approach permits students to go through several processes in looking for a solution to a problem, therefore, the learner's problem-solving abilities/skills are improved.*

The excerpts of the interview responses of *P1, P2,* and *P3* indicate that constructivist approach of teaching and learning is effective since it allows teachers to provide students with experiences that encourage predictions, research, investigation and inventions. From the response of *P4* and *P6*, Constructivist teaching and learning is effective since it provides room for collaborations among learners to improve learner's comprehension skills, problem solving skills, and process skills.

**Discussion of results with respect to research question one:** The pre-service teachers are the future of our classroom teaching and learning. Conceptions of the teachers implicitly inform their classroom decisions. What teachers teach in class, how they teach it using specific teaching resource materials, and why they teach it using a specific strategy, is largely influenced by how they conceive it in the curriculum. In Shulman's., (1986) view, the school curriculum covers a wide range of

teaching materials available in relation to the subject matter to be handled, and the set of characteristics that guide the use of specific curriculum materials in particular circumstances. In this study it was found that pre-service mathematics teachers have diverse conceptions of constructivism as contained in the curriculum of mathematics base on their responses to both the questionnaires and interview questions. Different conceptions of constructivism were identified. Some pre-service mathematics teachers in this study conceive constructivist approach of teaching and learning as accepting a challenging mathematical problem and striving hard to resolve it. Pre-service mathematics teachers in this category believe that constructivist approach of learning occurs when students accept a challenge and willing to resolve it. Accepting such challenge will lead the student to adopt varied strategies within mathematics to look for solution to such problem and this lead to new knowledge construction in the learner. This conception of constructivism is in consistent with Dollah., (2006) previous finding. Most of the pre-service teachers in this study conceive that providing students with open ended problems to solve which lead to open investigations and multiple solutions is deemed as constructivist approach of learning.

In another perspective, constructivism is conceived by pre-service mathematics teachers in this study as solving mathematical problems which involves real life situations most often lead to constructivist approach of learning. Earlier study conducted by Saleh., (2009) supports this conception of constructivism. Additionally, most of the pre-service teachers in this study conceive constructivist approach of teaching and learning as a process of solving difficult mathematical task for which there is no apparent and immediate method of finding the solution. This finding is consistent with NCTM., (2000) and Hiebert., (2003) conception of constructivist approach of teaching and learning. Teachers with this conception in mind believe that when there is a direct algorithm that can be applied to arrive at the solution then there is no application of constructivist approach of learning.

The study found that preservice mathematics teachers hold the conception that teachers assist learners to construct their own knowledge in a constructivist teaching and learning classroom. This conception of constructivism is in consistent with Brooks and Brooks., (1999) and Gray., (1997) previous finding in their studies. The constructivist classroom, according to Brooks and Brooks., (1999) is no longer a place where the teacher pours information into learners who are waiting to be filled like empty vessels, but rather a place where the learners are actively engaged in the knowledge construction process. The teachers serve as a guide to the learners by providing clues and support at where students may get stalked in the learning process. Additionally, the study revealed that in a constructivist classroom environment teachers pose worthwhile questions for discussions/investigations, and make sure the classroom environment is conducive for learning. This view was supported by Van de Walle., (2000) in his study which indicated that constructivism as a strategical instructional method fully engage students in important mathematics learning situations to facilitate problem solving, which includes posing questions to initiate discussions and providing a conducive learning atmosphere.

The preservice mathematics teachers hold the view that in constructivist classroom learners are directly involved in the learning processes. This suggests that learners are at the center of learning, therefore, they do control the progress of the learning process. A study conducted by Rosa and Orey ., (2011) supports this conception of constructivism which suggested that in a constructivist learning environment, it is critical to adapt to the learner's unique cultural context in order to improve student learning and active involvement in the teaching-learning process. In a different perspective, it was found that preservice mathematics teachers hold the perception that in a constructivist classroom students rely on old ideas to achieve new understanding. Eggen and Kauchak., (2003) study also suggests similar findings which conclude that students create their own understanding by interpreting information using prior knowledge. This indicate that richness of learners background in terms of mathematics can affect your learning in the constructivist classroom.

The fact that pre-service teachers, who are future implementers of the mathematics curriculum, have positive conceptions about constructivist approach of teaching and learning is satisfactory because teachers' classroom practices are informed by their conceptions.

**Discussion of results with respect to research question two:** Most pre-service mathematics teachers in this study hold the

perception that the constructivist approach of teaching and learning enhance both teacher to students and student to student interaction. The constructivist approach of teaching enabled the students to participate actively in the lessons and also encouraged cooperative learning among the students. This finding is consistent with Andam et al., (2015) and Atteh., (2022). Their studies suggested that in a constructivist's classroom, each student in the class is not only responsible for learning what is being taught alone, but also help other classmates who are still having problems and thus create a good learning atmosphere. It was also found in this study that pre-service mathematics teachers have good perception towards constructivist approach of teaching and learning with the reason that it can assist students develop more methods of solving mathematical problems.

In another perspective, constructivist approach of teaching and learning is perceived by pre-service teachers in this study as an avenue for better understanding of mathematics and its applications in daily lives, and makes the learning of mathematics more interesting and enjoyable thereby enhancing interaction among peers and teachers in developing students competence in problem solving skills. Additionally, it was found in this study that pre-service mathematics teachers have perception that constructivist approach of teaching and learning assist students to acquire different methods of solving mathematical problems thereby enabling students to develop positive attitude towards mathematics. Similar findings were identified by Bryant, (2009), Ontario Ministry of Education., (2007) and Atteh., (2022) in their studies.

The preservice mathematics teachers hold the view that constructivist teaching and learning approach is effective since it provide students with enough opportunity to ask the needed questions for clarifications in learning. Asking the needed questions help clear their misconceptions and misinformation in learning so that students can learn better. The study findings suggests that constructivist approach of teaching and learning is effective in a sense that it provide room for collaboration and small group interactions among learners to improve their comprehension skills and correct misconceptions among learners. This finding is in line with study by Ma., (1996) suggesting the relevance of group learning. The study by Ma., (1996) concluded that group learning allows students to think in higher-order terms and results in both low and high gains from one another. In groups, students are engaged in meaningful discussions to arrive at a solution to a given problem, these discussions promote deeper understanding among learners who have limited knowledge about the concept under discussion.

The study found that constructivist approach of teaching and learning is effective since it allows teachers to provide students with experiences that encourage predictions, research, investigation and inventions. It encourages learners to come up with different solutions and solution processes since solution and its process are to be justified by individual students and groups. Additionally, the study found that constructivist approach of teaching and learning is effective since the collaborations among learners turn to improve learner's problem-solving skills, and process skills. Andam et al., (2015) and Atteh., (2022) suggested similar findings in their study which concluded that the collaboration and small group interactions which are encouraged in the constructivist classroom help improve students problem solving skills and process skills which manifested through the improvement in their performance. Students in their various groups learn from each other through imitation, and this help to improve their problem-solving abilities and procedural skills. Hence, adopting constructivist approach of teaching implies that there are certain advantages students will benefit, that is, developing students' problems solving abilities.

### 3.5 Major Findings

- ✓ The pre-service mathematics teachers are aware of teaching acts that constitute constructivist approach of teaching and learning. This suggests that the pre-service mathematics teachers have adequate knowledge about constructivist approach in the mathematics curriculum they are going to work with in the future.
- ✓ The pre-service mathematics teachers hold conceptions that in a constructivist classroom teachers are serving as facilitators in assisting learners to construct their own knowledge, teachers provide worthwhile questions for discussions/investigations, and make sure the classroom environment is conducive for learning, learners are directly involved in the learning processes suggesting that learners are at the center of learning, and

students rely on old ideas to achieve understanding of new concepts.

- ✓ Constructivist approach promotes an active and interactive learning environment for the students as they worked together for the development of pre-service mathematics teachers' problem-solving skills in mathematics.

## 4. CONCLUSION

This study investigated the conceptions and effectiveness of constructivist approach of teaching and learning among pre-service mathematics teachers in the colleges of education in Ghana. The study revealed that pre-service mathematics teachers are aware of teaching acts that constitute constructivist approach of teaching and learning. These teaching acts include: accepting challenging mathematical problems and striving hard to resolve them, encountering open ended mathematical problems which lead to open investigations and multiple solutions, striving to solve mathematical problems which involves real life situations, accepting to solve a complex mathematical task which has no apparent and immediate solution method. Therefore, practicing constructivist approach of teaching and learning in mathematics classroom in the future is eminent. The results of the study demonstrated that, the constructivist approach of teaching and learning enable student to create their own understanding rather than being delivered to them in an organized form. The constructivist approach of teaching and learning allows cooperative learning, where students become more comfortable communicating among themselves and discusses the problems at hand. This contribute to the development of pre-service mathematics teachers' problem-solving skills in mathematics in the essence that; It provides an avenue for better understanding of mathematics and its applications in daily life, it makes the learning of mathematics more interesting and enjoyable, it enhances both teacher to students and student to student interaction, it enables students develop more methods of solving mathematical problems, it enables students to develop positive attitude towards mathematics.

## 5. RECOMMENDATION

The findings of this study indicate that some mathematics tutors place emphasis on teaching mathematics through constructivism in their instructional practices occasionally. Considering the benefit of constructivist approach of teaching and learning to pre-service mathematics teachers, it is recommended that:

- ✓ The Stakeholders of Teacher Education should put in place a scheme that will address the need to place emphasis of public examination on non-routine and real-life investigative problems in colleges of education. This will convince the mathematics teachers on teaching mathematics through constructivism.
- ✓ The Stakeholders of Teacher Education in collaboration with the Ministry of Education should organize regular teacher collectives where mathematics teachers will meet to share ideas, solve problems, discuss about ways of teaching mathematics through constructivism to help their classroom practice.

## 6. SUGGESTIONS FOR FURTHER STUDIES

The researcher suggests that future research study should investigate:

- ✓ The relationship between teachers' beliefs about teaching mathematics through constructivism and their classroom practices, and
- ✓ Factors affecting the teaching and learning of mathematics through constructivism in the colleges of education in Ghana.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

## CONSENT

As per international standards or university standards, Participants' written consent has been collected and preserved by the author(s).

## COMPETING INTERESTS

Author has declared that no competing interests exist.

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