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Exploring Epistemological Beliefs and Their Relationship with Academic Achievement in Mathematics Among Senior High School Students in Sene East District, Ghanas

Alhassan Taah Malik[1], Isaac Brilliant Essuman[2*], Mohammed Ali[3], Samuel Aseidu-Addo[3], Michael Larbi[4]

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ABSTRACT

The purpose of the study was to investigate the epistemological beliefs of students about mathematics teaching and learning and their relationship with academic achievement. In this study, a quantitative research approach through the correlational method was used. Three hundred and fifteen (315) students were randomly sampled from the Kajaji senior high school in the Sene East district of the Bono East region of Ghana. The discipline-focused epistemological beliefs questionnaire (DFEBQ) was adapted after ensuring its validity and reliability. It was found that senior high school students held more absolutist epistemological beliefs about Mathematics teaching and learning than fallibilist epistemological beliefs. It was also found that the students' academic performance was above average with a good percentage of 63.5% obtaining the tertiary education qualifying grades (A1-C6).based on the findings of the study, it was therefore recommended that stakeholders and policy makers on education in Ghana should train educators on recognizing and addressing absolutist beliefs in students through teaching strategies that will promote relativist or evaluative thinking. It therefore implied that mathematics instructors in high schools should include elements that challenge absolute views such as debate, proofs, interdisciplinary projects which can promote epistemological development among students.

INTRODUCTION

Epistemology is a discipline of philosophy that explores the origin, nature, boundaries, and justification of human knowledge (Hofer, 2002). In recent decades, there has been a developing understanding in the disciplines of psychology and education that ordinary people build interrelated sets of ideas about these topics, which may be referred to as a naive theory of epistemology or a personal epistemology. Personal epistemology is the study of how an individual creates such conceptions of knowledge and knowing and uses them to construct an understanding of the world (Hofer, 2002).

Empirical research has provided modest support for self-report assessments of personal epistemology, and factor analyses have confirmed the validity of four epistemological belief factors that are interpreted similarly to those in Schommer's original model (Schommer-Aikins, Mau, Brookhart, & Hutter, 2000). Two elements concern learning (learning ability and speed of learning) while the other two-address knowledge (structure and stability of knowledge) (structure and stability of knowledge). Concerning learning, there are significant individual variances in adults' opinions about their ability to learn. Some individuals regard this skill as generally fixed while others think it to be adjustable via effort. Individual variances are also evident concerning ideas about the pace with which learning takes place. Some people believe that learning is a quick and all-or-nothing process, whilst others believe it is more gradual and cumulative. When it comes to knowledge, adults have different perspectives on the structure of knowledge. Some individuals believe knowledge to be arranged as discrete pieces of information whereas others see knowledge as theoretical, complicated, and comprised of interrelated concepts. Differences are also seen in beliefs about the stability of knowledge. Some individuals regard knowledge as mostly unchangeable, whereas others perceive it as continually evolving and subject to revision. This four-factor structure has been reached with college students (Bendixen, Dunkle, & Schraw, 1994; Morell, M., García, R., & Díaz-Méndez, R. 2021) and high, school students (Schommer, 1993). Much of the research on people's epistemological beliefs are located inside certain subject-matter fields, like mathematics. For that area, according to the philosophical beliefs and practice, there are two separate views on nature and the acquisition of knowledge (epistemological beliefs about mathematics), namely an absolutist (Platonist) and a fallibilist perspective (Ernest, 2014). Paul Ernest (1991) describes the two as opposing perspectives as the absolutist view of mathematical knowledge" which "consists of certain and unchallengeable truths" and the "fallibilist view", which "is of the view that mathematical truth is fallible and corrigible, and can never be regarded as beyond revision and correction". He contends that the rejection of the absolutist position "leads to the acceptance of the opposing fallibilist view". According to Ernest (1985), philosophical epistemological ideas are of use for the teaching of mathematics in that it determines what mathematics is taught, its nature, and how it is taught and learned. The absolutist theories of mathematics include logicism, formalism, and Platonism.

[1] William M. Raines High School, 3663 Raines Ave. Jacksonville, FL 32209, United States
[2] University of Education, Winneba. CoDEL Tamale branch, United States
[3] University of Education, Winneba, Ghana
[4] Stanton College Preparatory, 1149 13th st W Jacksonville, FL 32209, US
[*] Corresponding author's e-mail: essumanisaac21@gmail.com

These typically believe that mathematical knowledge is absolute, unchangeable, and its existence independent of the knower. This group claims that mathematical knowledge is certain, objective, and true. The job of mankind is to find its truth.

The absolutist viewpoint presupposes that mathematical knowledge is reliable, unchanging, and objective. They think that mathematical objects are actual things that exist independently of human thought. Mathematical truths must be found rather than created to obtain mathematical knowledge. On the other hand, supporters of the fallibilist viewpoint see mathematics as the product of social processes. It is believed that mathematical knowledge is subject to error and correction. Fallibilists place more emphasis on doing mathematics - within the social conventions in a particular context- and its human side rather than emphasizing the acquisition of a fixed set of mathematical concepts and processes. Ernest (2014) contends that neither the absolutist nor the fallibilist perspective is correct or wrong, but that both positions have their legitimacy. Ernest goes beyond the contrast between simplistic and complex epistemological ideas. Although there is a wide variety in the ways that different epistemological beliefs are expressed in the mathematics education literature, the majority of theoretical frameworks on teachers' and students' mathematics-related epistemological beliefs somehow relate to Ernest's (2014) fundamental distinction between the absolutist and fallibilist perspectives. Examples include using the terms "static" (Felbrich, Kaiser, & Schmotz, 2012) and "realist" (Bolden & Newton, 2008) to describe epistemological beliefs that are similar to Ernest's absolutist perspective, while terms like "dynamic" and "relativist" (Bolden & Newton, 2008) reflect a more fallibilist perspective.

Students' mathematical epistemological belief about critical thinking is a significant segment of their learning experience, which influences their mathematics learning activities and mathematics achievement (Abedalaziz & Akmar, 2012). Nasser and Birenbaum (2006) said that there was an aberrant impact of epistemological beliefs on mathematics achievement and gender directly influenced their beliefs. Liu (2010) examined the unique view of two students in Mathematics (for example, imagining mathematics as a procedure, including individual imagination) executed better on the identical calculus problems contrasted with a static instrumentalist view of two students in mathematics as a lot of followed rules. So also, students' mathematical epistemological beliefs scores predicted their mathematical performance (Schommer-Aikins, Unruh, & Morphew, 2015).

Students' learning belief was associated with their academic progress. Moreover, mathematical performance is indirectly affected by general epistemological beliefs as well as directly affected by domain-specific epistemological beliefs (Arslantaş, 2015, Rastegar, Jahromi, Haghighi, & Akbari, 2010; Schommer-Aikins & Duell, 2013). Köller (2001) provided evidence that constructive conception, certain knowledge, simple knowledge, and implication of mathematics are noteworthy indicators of high school students' mathematics achievement. Viholainen, Asikainen, and Hirvonen (2014) reported that students' beliefs about Mathematics as a static system and the formalism-related orientation. Moreover, the mathematics curriculum prescribed for senior high school classes has a wide range of concepts that must be learned and mastered by Ghanaian students. It contains specialized knowledge that needs a certain frame of mind (i.e. Analytical and logical thinking). Its structure, operations, and processes provide students with a framework and tools for reasoning and expressing ideas clearly. Thus, the present study was designed to measure senior high school students' epistemological beliefs about mathematics teaching and learning and explore their associations with students' academic performance. There are no known studies examining the relationship between senior high school students' epistemological belief towards the teaching and learning of mathematics and their performance in mathematics especially in our country and specifically in the Sene East District. Therefore, there is a need to find out the relationship between senior high school students' epistemological beliefs and their performance in mathematics in the Sene East in the Bono East Region of Ghana.

Research Questions/ hypothesis

These research questions were designed to help achieve the stated objectives;

1.What are students' epistemological beliefs about mathematics in the Kajaji senior high school?

2.What is the overall performance in mathematics of students in the Kajaji senior high school?

LITERATURE REVIEW

The Epistemological Beliefs

Designing effective learning materials for both "conventional" learning contexts, such as classrooms, and distance or mixed online learning requires consideration of individual characteristics. The main goal of studying individual differences is to identify the key differences between learners. By doing this, it is argued, educators can capture these differences and use them in the design of learning materials that will improve students' academic performance and help to make sure they are appropriately motivated, content, and knowledgeable about the learning process. According to this theory, students will perform better and learn more effectively if their preferred learning styles are reflected in the manner they are taught (Koc, 2005). Therefore, it's crucial to identify that learning type and consider individual variances so that teachers may make the appropriate plans.

Knowledge acquisition is one of the fundamental goals of education, as was previously demonstrated. When it comes to figuring out what influences learning and the creation of information, researchers and educators pay close attention. The cognitive elements, such as learners' ways of thinking and information processing, are the main

focus of individual learning variations. How students acquire knowledge is influenced by psychological aspects of personality. Emotions, passions, and ideas are a few instances of psychological elements (Bråten & Olaussen, 2005). It has been extensively researched to see how it affects learners' attitudes about obtaining information and knowing. One psychological element is that it is tied to knowledge and knowing. Their epistemological beliefs refer to what students think about how they learn and what they think about knowledge itself. These are essential when examining individual differences since it is obvious that various people will have different ideas, and it is crucial to comprehend these beliefs if we, as educators, are to help them more effectively in the classroom.

The Importance of Epistemological Beliefs in Education

Four decades ago, many researchers linked epistemological beliefs and learning (Dweck & Leggett, 1988; Hammer, 1994; Hofer and Pintrich, 1997; Schraw *et al.*, 1995). The study of people's epistemological beliefs is shared by psychologists and educators (Schraw & Sinatra, 2004) who have investigated the theories and models that are linked to epistemological beliefs and cognitive processes, thinking strategies, and how this relationship is integrated with education (Hofer, 2004a; Hofer & Pintrich, 1997). A significant amount of research has been carried out about personal epistemology in the field of educational psychology because individuals' beliefs about knowledge are important to the learning process in different ways (Richardson, 2013; Schraw, 2001). Personal epistemology is related to notions of learning and knowledge that influence the way that individual's approach and estimate information and the challenges they face in both the classroom and in their daily lives. These notions of learning and knowledge may be referred to as cognitions, attitudes, beliefs, ways of thinking, or reasoning skills (Pintrich, 2002).

Many attempts have been made by educators in the past few years to link learners' epistemological beliefs with their efficiency at learning. The outputs of the studies have provided evidence for the influence of epistemological beliefs on related aspects of learning (Hofer, 1994; Ryan, 1984a; 1984b; Schommer, 1993b; Schommer, Crouse and Rhodes, 1992; Schutz *et al.*, 1993; Buehl & Alexander, 2005; Richardson, 2013). Some of these aspects associated with epistemological beliefs are academic performance (Ryan, 1984b, Schommer-Aikinsa & Easter, 2006; Mohamed & El-Habbal, 2013; Muis *et al.*, 2011), moral reasoning (Bendixen *et al.*, 1998), study strategies and motivational beliefs (Paulsen & Feldman, 1999; Schommer, Crouse, and Rhodes, 1992; Buehl & Alexander, 2005; Lin *et al.*, 2013), and also reasoning about complicated issues (Kardash & Scholes, 1996; Schommer-Aikens & Hutter, 2002). The way that students see their education has a significant impact on both their learning and their performance.

Students learning, test performance, and test preparation methods are all impacted by the extent of their epistemological beliefs. Schommer *et al.* (1992) carried out a study on undergraduates to measure the relationship between undergraduate epistemological beliefs, comprehension of statistical information as well as study strategies, and learning. This study discovered a significant association indicating that undergraduates who had simplistic ideas about knowledge understood statistical material less well. They also discovered a high correlation between test performance and undergraduates' epistemological beliefs in basic knowledge, with the indirect effects being communicated through test-preparation techniques.

With respect to defining relationships between epistemological beliefs and student motivation and self-regulated learning, Bråten *et al.*, (2009) claim that students' epistemological beliefs may be essential for their academic motivation. For instance, students who believe in knowledge and effort integration are more positively motivated for academic tasks (Buehl*et al.*, 2002). While assessing the epistemological beliefs and university students' self-regulated learning, Phan (2008) found that their epistemological beliefs influence their approach to learning. Students with higher levels of belief in the ability to learn, structure of knowledge, and stability of knowledge are more likely to use goals, self-regulatory strategies and be self-sufficient.

Epistemological beliefs have been tested also with the addition of two important elements in students' learning, academic success, and conceptual knowledge. Conn *et al.* (2010) used epistemological beliefs' data to improve academic success. This information was obtained and examined to ascertain students' assessments of their knowledge as well as their levels of independence and self-control. They discovered that students' views of knowledge and knowing, self-regulation, and self-sufficiency were positively correlated with their epistemological beliefs. Regarding student comprehension, Sahin (2010) measured undergraduates' beliefs and conceptual knowledge using a problem-based learning environment. The results showed a strong relationship between the undergraduates' conceptual understanding and their epistemological beliefs. Therefore, the better the undergraduates' conceptual understanding ratings were at the conclusion of the semester, the more expert-like opinions they had. In addition, Sahin (2010) concluded that the same instructional methods may have little or no impact on undergraduates' attitudes or beliefs even though certain instructional techniques could improve undergraduate understanding of conceptual knowledge.

Another study applied topic-specific epistemic beliefs and several measures of the textual understanding of undergraduates to predict the strength of different dimensions of epistemological beliefs on their understanding of texts (Bråten *et al.*, 2008). The outcomes showed a strong correlation between undergraduates' epistemology and comprehension of multiple texts, meaning that simplistic beliefs were a predictor of

comprehension measures (Bråten *et al*, 2008). They also claimed that epistemological beliefs may be seen as an aspect of domain expertise; this relationship probably clarifies why learners try to apply fewer heuristics than experts when tackling multiple texts (Bråten *et al*, 2008).

Paulsen and Feldman (1999) conducted a study to look at the correlation between the epistemological beliefs' dimensions of Schommer's (1990) study, focusing on the undergraduates' epistemological beliefs and their motivation. As with Schommer (1992), the findings showed that the undergraduates' beliefs in simple knowledge were related to their motivation. This implies that pupils are more motivated to learn when they have sophisticated beliefs about simple knowledge.

It is obvious that epistemological beliefs have a significant relationship with learning. The connection between students' beliefs and their learning is described by Bromme *et al.* (2010). A series of studies to examine the influence of learning on undergraduates' epistemological beliefs confirm that their beliefs acted as a lens through which learners captured the task and thereby the knowledge which they assumed they had to acquire while working on these tasks (Bromme *et al.*, 2010). Furthermore, while students may interpret the assignment via their epistemological framework, their decision to do so would depend on a variety of other circumstances. This study discovered that students had the ability to choose and use their epistemological lens, and they could decide whether to act simply in some circumstances or to be more advanced in activities owing to outside influences like motivation for the activity.

The ideas and beliefs that learners have about what they learn (knowledge) and how they learn (knowing) are related to their motivation, academic performance and success, self-regulated learning, thorough understanding, learning methodologies, test-preparation tactics, and other elements of their learning. The correlations between epistemological beliefs and all of these learning-related factors have sparked curiosity about how beliefs may be formed, altered, and changed during a person's learning and development process. Gender, age, education, and background are examples of personal traits that can have a significant impact on an individual's epistemological belief system.

Students' epistemological beliefs about mathematics

Different categorization approaches for students 'epistemological beliefs have been created within the realm of mathematics. The first categorization by Ernest (1989) identifies three viewpoints of students on the essence of mathematics: an instrumentalist, a Platonist, and a problem-solving approach. Those with an instrumentalist view understand mathematics as an accumulation of unconnected facts, abilities, and rules. Students adhering to a Platonist approach regard mathematics as a static corpus of highly-structured and connected information that should be discovered. Finally, pupils with a problem-solving view of mathematics emphasize the process-nature (rather than product-nature) of mathematics and perceive it as a dynamic and relative human invention. Whereas the first two viewpoints relate to an absolutist perspective on mathematics, the last one takes a fallibilist perspective on mathematics.

Additionally, Muis' (2004) study of research that examined students' perspectives on mathematics revealed, first and foremost, that students at all educational levels primarily hold unsupportable beliefs (i.e., beliefs that have a detrimental impact on learning outcomes) (i.e., negatively influencing learning outcomes). Another key conclusion was that the majority of the research supported the notion that student views are domain-specific rather than generic. Additionally, it was discovered that students' attitudes about mathematics, in general, were less helpful than their beliefs about other study disciplines. However, according to Muis, the available study was burdened with various theoretical concerns (e.g., the multiple viewpoints on the dimensional structure of these beliefs) as well as methodological challenges (e.g., how to acquire appropriate insight into students' opinions).

Since Muis' (2004) review, research has given further evidence for her conclusions about the non-availing and unique nature of students' mathematics-related epistemological beliefs (e.g., Buehl *et al.*, 2002).

Four categories are used by Blömeke *et al.* (2008) to characterize students' epistemic beliefs about the nature of mathematics. A scheme-related perspective, which sees mathematics as a body of rules and formulae, is analogous to Ernest's instrumentalist perspective. A formalist perspective, which emphasizes the precise, formal, and logical nature of mathematics, is analogous to Ernest's Platonist perspective. A process-related perspective, which sees mathematics as a science characterized by problem-solving, is analogous to Ernest's problem-solving perspective. The last two categories view mathematics as a fallibilist process, in contrast to the first two categories, which maintain an absolutist viewpoint.

Felbrich *et al.* (2012) used a third categorization that builds on the work of Blömeke *et al.* (2008) but combines the first two and last two categories into two overarching categories, namely mathematics as a static science (which corresponds to Ernest's (2014) absolutist perspective) and mathematics as a dynamic process (an equivalent of Ernest's fallibilist perspective).

The instrumentalist view, the platonist view, and the constructivist view are three alternative perspectives that mathematics teachers and students have on the subject's nature and how it is taught and learned, according to Ernest (1989). Students' perceptions of the nature of mathematics, according to Thompson (1992), are not fully formed mathematical ideologies. They could be thought of as the beginnings of philosophy.

MATERIALS AND METHODS

The study employed a quantitative research approach. The quantitative approach provides explanations and predictions of events happening regularly as a base for

human activities and the social world (Hussey & Hussey, 1997). This approach was adopted because of it array of strength. Specifically, a descriptive survey design was employed for data collection in the study. The design refers to the procedure of gathering data about the characteristics, performance, and attitudes of a large number of participants, called population (Pinsonneault & Kramer, 1993). The targeted population for the study was students of the Senior High Schools in the Sene East District of the Bono East Region with a total population of two thousand and seventy-five (2,075) students of which 922 were girls and 1,153 were boys. There are two senior high schools in the district, that is the Kajaji SHS and Bassa SHS all being public senior high schools. However, Kajaji Senior High School is made up of 781 males and 694 females with an overall population of 1,475 students. Form three (3) students were selected purposively for the study since they have been taught almost all the topics as stipulated in the syllabus and their performance can be compared to that of the previous year's West African Senior School Certificate Examination (WASSCE) performance. Students were sampled using Yamane's (1967) sampling method. Yamane (1967) provides a simplified formula to calculate sample sizes.

The formula shown below was used to calculate the sample sizes at a 95% confidence level and $\alpha = 0.05$ are assumed.

$n = N / [1 + N^* e^2]$

Where n is the sample size, N is the population size, and e is the level of precision (Yamane, 1967). The students in Kajaji SHS established the sample frame for the research. For the sample size to be objectively represented, the sample size is calculated at a 95% confidence level (at a 0.05 significance level) and 1,475 as the total student population.

$n = 1,475 / [1 + 1,475 (0.05) 2]$

$n = 1,475 / [1 + 1,475 *0.0025]$

$n = 1,475 / 4.6875$

$n = 314.666 \approx 315$

The sample size ($n = 314.666 \approx 315$) of the students was determined by employing the proportional method of sample size.

The study employed both primary and secondary data. The primary data was collected through the administration of questionnaires. The questionnaire included two sections of information arranged as follows: 1) the demographic information; and 2) Hofer's Discipline-Focused Epistemological Belief Questionnaire (DFEBQ). The questionnaires used a five-point Likert-type scale where the participants' responses were: five for strongly agree, four for agree, three for neutral, two for disagree, and one for strongly disagree. The participants were asked to take all the time needed to answer all the questions. The secondary data on the other hand were the terminal reports of participants which was collected from the mathematics department of Kajaji Senior High School.

The data were analysed and presented using, descriptive statistics to answer the first research question which sought to find out what the students' epistemological beliefs about mathematics was, and inferential statistics (one-way repeated measures ANOVA) was used to answer the second research question which sought to find out what the students' overall performance was. (1)

RESULTS AND DISCUSSION

Research question 1: What are students' epistemological beliefs about mathematics teaching and learning at the Kajaji senior high school?

The first research question sought to find out what epistemological beliefs the students of Kajaji Senior High School have towards the subject of mathematics. To answer this question, an 18-item specific-domain epistemological beliefs questionnaire was adopted and administered which consists of four dimensions certainty/simplicity of knowledge; justification of knowledge; source of knowledge; and attainment of truth, and is structured on a 5-point Likert scale.

To investigate this, the researchers analyzed the specific domain epistemological belief questionnaire with the aim of finding out whether they hold the fallibilist/ constructivist beliefs or the absolutist/traditionalist beliefs about mathematics teaching and learning. The descriptive statistics of the students' ratings of the statements are presented in Table 4.2.

Table 1: Descriptive Statistics of Students Epistemological Beliefs About Mathematics

	N	Minimum	Maximum	Mean	Std. Deviation
Truth in the field of mathematics in Unchanging	315	1	5	3.60	1.337
In the field of mathematics, most work has only one right answer	315	1	5	3.66	1.403
All teachers in the field of mathematics would probably come up with the same answers to questions in the field	315	1	5	3.48	1.390
Most of what is true in the field of mathematics is already known	315	1	5	3.44	1.328
In the field of mathematics, it is good to question the ideas presented. R	315	1	5	1.97	1.232

Principles in the field of mathematics are unchanging	315	1	5	3.65	1.464
Answers to questions in the field of mathematics change as teachers gather more information. R	315	1	5	2.39	1.246
All teachers in the field of mathematics understand the field in the same way	315	1	5	2.20	1.317
Sometimes you just have to accept answers from the teachers in the field of mathematics, even if you don't understand them.	315	1	5	2.51	1.509
If you read something in a textbook for this subject, you can be sure it is true	315	1	5	3.47	1.417
If my personal experience conflicts with ideas in a mathematics textbook, the book is probably right.	315	1	5	3.72	1.323
I am most confident that i know something when i know what the teachers think	315	1	5	3.55	1.340
Correct answers in the field of mathematics are more a matter of opinion than fact	315	1	5	3.27	1.378
There is no way to determine whether someone has the right answer in the field of mathematics	315	1	5	2.31	1.193
I am more likely to accept the ideas of someone with first-hand experience that the ideas of researcherss in the field of mathematics	315	1	5	3.02	1.379
First-hand experience is the best way of knowing something in the field of mathematics	315	1	5	3.43	1.390
If teachers try hard enough, they can find the answers to almost anything	315	1	5	3.66	1.322
Teachers in the field of mathematics can ultimately get to the truth	315	1	5	3.77	1.194
Valid N (listwise)	315				

Source: Field data, 2022

From table 2, it can be seen that 11 out of 18 (i.e., 61%) of the statements from the specific domain epistemological beliefs were rated with mean scores above 3.41 indicating most of the students held an absolutist belief of the statements.

The overall mean ratings of each respondent's epistemological beliefs about mathematics teaching and learning were computed and recoded into three categories as follows: (i) mean scores between the range of 1.00-2.60 for respondents that held a fallibilist/constructivist beliefs; (ii) mean scores between the range of 2.61-3.40 for respondents that neither held an absolutist belief nor a fallibilist belief; and (iii) mean scores between the range of 3.41-5.00 for respondents that held an absolutist/traditionalist beliefs. Manu, J., Bonsu, R. O., and Atta, G. P. (2015) contented that, one important characteristics of Hofer's instrument which should be borne in mind is that higher scores represent agreement with less sophistication (absolutist).

Table 2 shows the proportion of students falling within each of the three categories. From Table 4.3, one hundred and two (192) out of the three hundred and fifteen (315) participants representing 61% hold absolutist/traditionalist epistemological beliefs about the nature of mathematics teaching and learning, while only 28% representing eighty-eight (88) participants hold fallibilist/constructivist beliefs, and 11% representing 35 respondents do not hold either of the two categories of beliefs. This result implies that the "transmission" and "command" methods of teaching and learning, as

Table 2: Proportion of Students Falling within each of the two Epistemological Beliefs Categories

Epistemological Beliefs	**Students holding belief**	
	Number	**Percentage**
Absolutist Belief	192	61%
Neither Absolutist nor Fallibilist Belief	35	11%
Fallibilist	88	28%
Total	315	100

described by Fredua Kwarteng and Ahia (2015), continue to dominate mathematics instruction and learning in Ghanaian classrooms. They claim that rather than asking questions for clarification, students learn mathematics in Ghanaian classrooms by just listening to their teachers and reproducing what they see on the chalkboard. As a result, students study mathematics by recalling facts, theorems, or formulae rather than looking into the significance and understanding of mathematical concepts. The logical or philosophical questions that underlie certain mathematical concepts, facts, or formulas are challenging for students to pose.

Overall performance of students in the Kajaji Senior High School

Research Question 2: What is the overall performance in mathematics of students at the Kajaji senior high school? To answer Research Question 2, the researchers employed the use of a one-way repeated measures ANOVA to analyze the results of three (3) separate exams scores of the respondents, (i.e., End of second term exams scores, first mock examination scores, and Second mock examination scores) with the aim of finding out the overall performance of the respondents. The descriptive statistics of the student's overall performance is illustrated in table 1 below.

From Table 1, The mean score for the end of second semester examination was 62.80 with a minimum score of 34, a maximum score of 93, and a standard deviation of 17.598; the mean score for the first mock examination was 61.96 with a minimum score of 30, a maximum score of 94, and a standard deviation of 18.384; and the mean score for the second mock examination was 67.20 with a minimum score of 40, a maximum score of 93, and a standard deviation of 15.530. The mean scores of 62.80, 61.96, and 67.20 are above the expected minimum pass mark of 50%. This indicates that the performance of the students was above average.

Table 3: Descriptive Statistics of Students Overall Performance

	N	Minimum	Maximum	Mean	Std. Deviation
*Scores of end of second semester examination	315	34	93	62.62	17.761
*Scores of first mock examination	315	30	94	61.78	18.567
*scores of second mock examination	315	40	93	67.06	15.643
Valid N (listwise)	315				

To ascertain whether the means of the three (3) different scores of the participants were significantly different from each other, a one-way repeated measures ANOVA was used. But before the one-way repeated measures ANOVA was conducted, the assumptions underlying the one-way repeated measures ANOVA were checked. The results of the assumptions are as follows:

The dependent variables, in this case, were the scores obtained by the respondents which were continuous variables and so they met the assumption that the dependent variables should be measured on a continuous scale.

The p-value for the end of the second term examination was 0.274 which is greater than the of 0.05 indicating that the distribution is significantly not different from the normal distribution. Also, the p-value for the first mock examination was 0.266 which was also greater than the of 0.05 indicating that the results were significantly not different from the normal distribution. Again, the p-value for the second mock examination was 0.553 which is greater than the of 0.05 indicating that the results were significantly not different from the normal distribution. These indicate that the distribution met the normality assumption underlying the one-way repeated measures ANOVA. The test was based on the hypothesis that, the distribution is significantly not different from the normal distribution. Test for homogeneity of variance: To test for equality of variances, Mauchly's test for Sphericity was conducted and the results were displayed for the result.

The analysis was conducted on the hypothesis that the three (3) different scores have equal variances. The p-value of 0.024 which is less than the of 0.05 indicates that there is a significant difference in the variances between the three groups. Therefore, an appropriate correction was made by the use of Huynh-Feldt by using its Epsilon value which indicates the degree to which sphericity is present. An Epsilon value of 0.983 was obtained which means perfect sphericity. This indicates that the variances are significantly equal.

After the assumptions were tested, a one-way repeated measures ANOVA for the three (3) different scores was performed to test the null hypothesis that "there is no significant difference between the mean scores of the three (3) different scores of the participants". That is, to determine whether or not the difference observed are statistically significant at a 95% confidence interval and an alpha value of 0.05. The results of the one-way repeated measures ANOVA are presented in Table 4.6.

From table 4. A one-way within-subjects ANOVA was conducted to explore if there is a significant difference between the mean scores of students in the three different examinations (end of second semester, first mock, and second mock). The results indicate that there was a significant difference in the mean scores [F (1.966, 617.390) =8.595, p=.000].

CONCLUSION

The results indicated that the students of Kajaji senior high school in this study generally hold an absolutist epistemological belief about the teaching and learning of mathematics since 61% of them hold are absolutists. The present study also found out that, the student's

Table 4: A one-way repeated measures ANOVA of the three Examination Scores

Tests of Within-Subjects Effects						
Measure: MEASURE_1						
Source		**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Exams	Sphericity Assumed	5058.440	2	2529.220	8.535	.000
	Greenhouse-Geisser	5058.440	1.954	2588.604	8.535	.000
	Huynh-Feldt	5058.440	1.966	2572.686	8.535	.000
Error (Exams)	Sphericity Assumed	186100.893	628	296.339		
	Greenhouse-Geisser	186100.893	613.593	303.297		
	Huynh-Feldt	186100.893	617.390	301.432		

Table 5: Pairwise Comparisons of the Three Examination Scores

Tests of Within-Subjects Effects						
Measure: MEASURE_1						
					95% Confidence Interval for Difference	
Performance (I)	**Performance (J)**	**Difference (I-J)**	**Std. Error**	**Sig.**	**Lower Bound**	**Upper Bound**
1	2	.836	1.455	1.000	-2.665	4.337
	3	-4.402*	1.259	.002	-7.433	-1.372
2	1	-.836	1.455	1.000	-4.337	2.665
	3	-5.238*	1.352	.000	-8.492	-1.984
3	1	4.402*	1.259	.002	1.372	7.433
	2	5.238*	1.352	.000	1.984	8.492

Based on estimated marginal means

**. The mean difference is significant at the .05 level.*

b. Adjustment for multiple comparisons: Bonferroni.

From table 3, a post hoc comparisons using the Bonferroni adjustment revealed that students were able to get a greater mean score of (67.06) in the second mock examination than they scored in the end of the second-semester examination, (62.80, p=.002) and first mock examination (61.96, p=.000). However, the difference in mean score between the end of the second-semester examination and first mock examination was not statistically significant, p=.999.

performance in mathematics was above average with a good percentage of 63.5% of the students obtaining the tertiary education qualifying grades (A1-C6).

Recommendations

Based on the findings of the study, the researchers therefore concludes that;

1.Stakeholders and policy makers on education in Ghana should train educators on recognizing and addressing absolutist beliefs in students through teaching strategies that will promote relativist or evaluative thinking (understanding that knowledge is contextual or evidence-based).

2.Researchers should explore the relationship between students' beliefs and students' performance. Future should look at the reason why absolute beliefs correlate with above average performance. Research should investigate if these beliefs enhance focus, discipline, or adherence to established methods

Implication of the study

While structured methods are effective, educators should gradually integrate activities which will promote critical thinking adaptability, and openness to uncertainty to prepare students for complex, real-world problems. Mathematics instructors in the senior high schools should include elements that challenge absolute views such as debate, proofs, interdisciplinary projects which can promote epistemological development.

Data availability

Data generated or analysed during this study are available from the authors upon request.

Conflict of Interest

The authors declare no conflict of interest.

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