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The Recommended Instructional Approach in Ghanaian Basic Schools; A Review of Constructivist Approach of Teaching and Learning in the Mathematics Classroom

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Author's contribution

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ABSTRACT

Teaching and learning mathematics in Ghanaian basic schools has been a concern for many years. This is because of the low learner achievement in national assessments by the West African Examination Council, where learners' performance in mathematics at the end of primary education has been consistently low. In other assessments, such as the Trends in International Mathematics and Science Survey (TIMSS) report, the average performance of Ghanaian learners has been below the international average score. In an attempt to address the issues and improve the quality of teaching and learning mathematics, there have been curriculum reforms that revised the content-objective-based curriculum to a learner-standard-based curriculum and aimed at shifting teaching from traditional teacher-centered to more learner-centered (constructivist) teaching approaches. Adopting constructivist techniques as a teaching strategy and fostering a positive learning environment produce an active learning environment that enhances learning for both students and

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teachers and encourages students to think critically. In this paper, we review the constructivist approach to teaching and learning, analyze its successes and challenges, and discuss the implications for students and teachers of teaching and learning mathematics through constructivism in schools.

Keywords: Teaching and learning math; constructivist teaching approach; constructivist learning approach; constructivism.

1. INTRODUCTION

Mathematics forms part of the core subjects in Ghana's basic education curriculum for the reason that it equips ordinary citizens with the skills to do simple arithmetic in their day-to-day activities. Therefore, teaching and learning in the mathematics classroom are intended to empower learners with the basic skills to navigate the world around them [44]. Besides, the subject of mathematics is linked to several disciplines, including the sciences, social sciences, technology, healthcare, and engineering [35], hence the need to study the subject in Ghana. Fundamentally, the goal of mathematics instruction and learning is to foster the learner's ability to solve a wide variety of both simple and complex mathematical problems in their daily lives [46]. Primarily, researchers in mathematics education are concerned with the tools, methods, and approaches that facilitate practice or the study of practice. That is the reason the curriculum recommends that students acquire procedural knowledge. Teaching involves the process whereby the teachers prepare the learners for learning by using different methods, techniques, and aids, creating suitable circumstances for learning for them, and assisting them in learning [39].

To a large extent, the successful learning of mathematical concepts and skills is a function of the approaches and strategies that teachers use in their classroom delivery. Therefore, the approaches and strategies that teachers use in their teaching determine the successful learning of mathematical concepts and skills. However, for the past three decades, practically everywhere on the globe has been concerned about improving the teaching and learning of mathematics. These demands have prompted restructuring as well as the adoption of new curricula for schools and instructional strategies. These new school curricula and teaching strategies are being developed to find ways to enable students to study mathematics through practical and investigative approaches [53]. This new curriculum calls for the introduction of a constructivist approach as the backbone of teaching in the mathematics classroom. The growth of active learning, often referred to as learning by doing, learning by experience, learning via action, student-centered learning, peer collaboration, and cooperative learning, has brought attention to the significance of constructivism. With constructivism, every problem in mathematics trains an individual in the scientific method of reasoning and thinking. It also provides a platform for students to construct their ideas about mathematics and take responsibility for their learning. It further provides students with opportunity to participate in meaningful mathematical discourse, which includes assessing various representations and arguments for solutions, allowing students to develop their problem-solving abilities [10].

Despite the emphasis on using constructivist approaches in teaching mathematics in the curriculum, the teaching and learning of mathematics in basic schools continues to be a concern. This paper begins by presenting an overview of the study, considering the recommended teaching strategy in the new mathematics curriculum for Ghanaian primary schools. Then we give the context of the conceptions of constructivism as a teaching and learning strategy. In the rest of the paper, we discuss and aim to address the following questions: Why choose the constructivist approach to teaching and learning in a math classroom? What is a teacher's role in a constructivist classroom? What are students' roles in a constructivist classroom? What are the challenges of teaching math through a constructivist approach? Finally, we discuss the implications of these for improving the teaching and learning of mathematics in Ghanaian basic schools.

2. THE CONCEPTIONS OF CONSTRUCTIVISM

In the early 1980s, a wave of changes throughout mathematics education started in reaction to public demand for innovative ways of

teaching and learning math. It was during this period that many scholars and educators in our schools promoted the use of constructivism as the focusing philosophy for teaching and learning mathematics. It is a theory that explains how learning occurs, whether or not students use their prior knowledge to comprehend a lecture or adhere to directions to build a model. Essentially, constructivism emphasizes the importance of the meaning of instruction, the prior knowledge of students, and constructive engagement between the learner and the material to be learned. Constructivism regards every learner as a unique person with unique needs and histories. In the constructivist perspective, information is created by the person through his or her experiences with the world. From a socially constructivist point of view, it is important to take into account the learner's history and culture throughout the learning process, as this context also helps form the information and reality that the learner produces, discovers, and achieves in the learning process [56].

In contrast to the conventional way of learning, where teachers play an active role in the teaching and learning environment and learners passively receive information, constructivists claim that learning should be focused on the learner. Therefore, regardless of how involved an individual is in a learning endeavor, the child must work in a learning environment that adheres to their age-appropriate developmental and personal learning restrictions to learn better. Research by Simon [60] found that from our impressions and observations, which are themselves influenced by our previous knowledge, we build our understanding of our environment. Atteh et al. [7] noted that teachers must give up the notion that learners are empty vessels to be filled with the authority's knowledge and follow a proper teaching approach that promotes active learning and understanding. It is critical that teachers actively involve learners in their teaching to allow the students to develop their knowledge [8]. A constructivist view of learning and teaching in the classroom can point to several different teaching practices. Generally, they believe learning is best accomplished through a hands-on approach. By learning, learners learn and are left to make their inferences, observations, and assumptions, not to be told what will happen [11]. This means teachers will encourage students to use constructive methods (experiments, problem-solving in the real world). Additionally, it is strongly believed that what students know is greatly influenced by how they are taught [61]; instructors have to conform to the role of facilitators rather than teachers [13]. A facilitator assists the student in achieving his or her comprehension of the subject, while a teacher presents a lecture on the subject. In the former scenario, the learner plays an active role in the learning process, whereas in the latter scenario, the learner plays a passive role. Essentially, by its essence, the subject of mathematics demands that the learners be fully engaged to learn. A study by Van de Walle [55] described the constructivist approach to teaching and learning as a strategic instructional process used to fully engage students in important mathematics learning situations to promote problem-solving. It also goes beyond the domain of mathematics to include everyday life activities in general, i.e., engaging in an endeavor for which there is no immediate solution [45,33].

3. REASONS FOR CHOOSING CONSTRUCTIVISM

The arguments in favor of using constructivist teaching methods highlight the importance of fostering learners' cognitive activity and self-awareness in the learning environment—a commitment that is consistent with the definition of learning that both behavioral and cognitive viewpoints have agreed upon. According to Cobb [19], the cognitive view that students consciously build their awareness by making connections from personal experience to the world's new information is perfectly true. Constructivist teaching is important because the influence of individuals over their behavior is essential to their intrinsic motivation [22].

Numerous studies have proven the effectiveness of constructivist-based pedagogies. In Mader's [40] informal experiment for over four (4) semesters in university classes with more than 100 students, she let students rate themselves and then gave them extensive guidance and input. At the end of each term, one survey was conducted. Many students mentioned that they learned more during the process and felt like they learned what they wanted to learn because they did not have to worry about teachers grading them. Furthermore, they were both more frank with themselves and with their teachers. Nelson-Johnson [48] used constructivist teaching methods as therapy for 30-seventh-grade participants in an after-school math program. It included fifteen students in both the study group and the control group. It was noticed that in an

organized state standardized test, there was a significant improvement for the experimental group of students. Both had higher attendance at the school and more positive attitudes toward math compared to the control group that was taught in traditional ways. Gatlin [25] compared two high school biology classrooms and found that students who were taught traditionally or conventionally had significantly higher scores than those taught in a constructivist way in the researcher-crafted tests. In the delayed post-test, however, the scores of students in the constructivist community increased while those of the conventional group decreased. Students taught using constructivist methods had greater retention. In a study by Bimbola and Daniel [15], they experimented with hundred and twenty (120) junior high school students who had slightly different outcomes, using researcher-crafted tests based on the class content. The different test results showed that the scores of students taught with constructivist methods were significantly higher in both post-test and delayed post-test assessments than those of students taught through lectures. In a similar study, Atteh [9] conducted action research on college students with a constructivist teaching and learning approach as an intervention strategy. The study reported that students exhibited improved performance after the intervention, suggesting that constructivist teaching and learning approaches are effective and should be adopted in math classrooms. It was also reported that students exhibited good retention of concepts months after the intervention was administered. Gyan et al.'s [28] action research study in 2021 included a sample of 35 second-year students from Ghana's Akontombra Senior High School, with the goal of determining how the constructivist approach affected students' ability to solve trigonometric word problems. Comparatively, the study's findings revealed that using constructivist teaching and learning approaches significantly improved students' ability to solve word problems including trigonometry. This meant students learned better from constructivist methods and absorbed more than their counterparts taught by lecturing methods [9,16,28].

Makanong [41] conducted a study involving 9th-grade algebra classrooms using a mixed method. The quantitative statistical results found that there was no significant difference in student achievement in both constructivist and traditional treatment classes. Nonetheless, qualitative data suggested that the students were more engaged in classrooms in the constructivist method community and worked harder on this subject. To enhance students' conceptual understanding of the ideas involved in solving linear equations, Andam et al. [4] did a similar study with a sample of 40 high school students in Ghana. Based on a descriptive analysis of test results, it appears that a constructivist approach to teaching linear equations aids students in understanding the principles involved in solving linear equations with one variable. The results show an improvement in student academic performance. In a quantitative analysis of the 9th-grade high school algebra classes, Granas [26] had similar results. She found that teacher-centered and constructivist approaches had no significantly different effects on the achievement of the student, which was measured at a traditional end-of-course exam. But there was substantial evidence that students in constructivist classrooms performed better on open-ended assignments than students in teacher-centered classrooms. It is believed that constructivist approaches to teaching and learning tend to create an exciting environment for students to learn mathematics and enhance their self-esteem, thereby allowing them to construct their knowledge, which assists them in having control over mathematical concepts and thinking mathematically [62]. The constructivist classroom permits students to employ any approach they can imagine, rely on any piece of acquired knowledge, and justify their ideas in whatever manner they deem convincing [4,16,28].

4. TEACHERS' ROLE IN A CONSTRUCTIVIST CLASSROOM

A learning atmosphere that promotes creativity needs to be one where students feel comfortable enough to express their formative thoughts [43]. Yelon [57] outlines ten instructional principles that teachers can adopt in their classroom instruction, which are as follows:

- *Meaningfulness*: The instructor has to inspire students by helping them relate the subject to be studied to their past and present experiences.
- *Prerequisites*: The instructor is expected to evaluate the level of knowledge and skills of the students and also change the mode of instruction.
- *Open Communication*: Make sure the students figure out what they need to know so they can concentrate on what they can learn.

- *Organized Essential Ideas*: Help students focus on the important ideas, organize them, and be able to learn and remember those ideas.
- *Learning Aids*: Help students use apps for quick and easy learning.
- *Novelty*: Vary the progress of the lesson to keep the students attentive.
- *Modeling*: Show the students how to remember, think, behave, and solve problems.
- *Active Practice*: Provide practical problem-solving, remembering, analyzing, and practicing problems so that students apply and make their learning better.
- *Pleasant Conditions and Consequences*: Make learning fun so that students combine familiarity with what they learn.
- *Consistency*: Provide clear goals, assessments, practice, content, and explanations. This will help the students learn what they need and use what they have learned outside of the educational environment.

In addition, Crawford and Cobb [21] concluded that math teachers must create successful groups, assign appropriate tasks, be attentive during group activities, identify problems quickly, and provide guidance or knowledge necessary to keep all groups moving forward. Therefore, the group discussions must be focused on mathematical critical thinking problems. By doing so, students do not give straight answers to the teacher's questions but rather discuss the issue thoroughly with peers to arrive at the right answers to the questions.

The teacher's role in the constructivist classroom is to help students develop their knowledge and monitor the student's presence in the classroom during the learning process. In the view of Atteh [9], a constructivist instructor values learner reflection and cognitive conflict and encourages peer interaction. "Constructivist teachers allow student responses to drive lessons, shift instructional strategies, and alter content," according to Kompf [38]. The premise of the teacher's limited role is to encourage students to engage in collective learning. In the constructivist approach to teaching and learning, the teacher performs both the roles of controller and facilitator in transferring information to the students. The teacher facilitates the learning process, which encourages students to be responsible and independent [27]. A teacher acts as a facilitator by combining opportunities for collaborative work, problem-solving, and meaningful tasks and should provide rich environments, experiences, and learning activities, indicating that the instructor focuses not on teacher performance but on student learning [47].

5. STUDENT'S ROLE IN A CONSTRUCTIVIST CLASSROOM

The constructivist teaching and learning philosophy views participation in educational practices as valuable work. This enhances students' communication skills, creates opportunities for them, and helps them comprehend new information and techniques. It compels them to examine their thought patterns and recognize the need to reconsider their thinking [54]. Aydisheh and Gharibi [12] claimed that constructivist classes usually have an environment like training workshops where students learn from each other and teach each other. They embrace cooperation in learning as a concept. Research by Zhan [59] suggested that collaborative learning activities will include the involvement and interaction of students, work together towards a shared academic goal, and increase the level of satisfaction and feelings of connection and community. In the constructivist classroom, these practices can be seen clearly, and students are encouraged to take responsibility for their learning activities to fit well into society. The role of the teacher in this collaborative approach is to create a structure for the learning of students and to facilitate a time of experimentation in which students have direct interactions with materials and resources and learn how to learn. The role of the instructor is that of a facilitator who wants to create the moment when the student says, "I understand the concept."

Constructivism implies that learners create awareness from their own experiences and their experiences with the world [24]. In contrast to the objectivist approach, the constructivist approach implies that learning is the creation of the learner's truth (knowledge) in his mind about an object, event, or idea, or at least the process of interpreting reality [23]. This opposes the conceptualization of the learner as actively adapting to the world and learning through the active internalization of other-given information. Instead, the learner is regarded as an intrinsically capable, self-regulating person with a will and purpose. The prior knowledge and interactions of

the students are the starting points for new learning. Such previous knowledge systems are seen as both sources and facilitators of new ideas and experiences and can be transformed during learning [36,20,30,32]. Constructivists emphasize that real understanding can only come about when students are fully involved in their learning. According to Clements and Battista [18], such full involvement leads to a deeper and richer understanding and application of knowledge, thereby promoting the application of what has been learned.

Since constructivism emphasizes how the learner produces knowledge, defining what information is according to the constructivist approach is critical. In view of Hendry [31], the essence of knowledge for teachers and students and its consequences are elaborated below:

- *Knowledge exists only in the minds of people.* Knowledge occurs in the classroom only in the minds of students and teachers. It does not show up on the boards, in books, when teachers or students talk, or in the things that teachers and students think about.
- *People's meanings or interpretations of objects are dependent on their knowledge.* Students and teachers interpret curriculum or instructional materials based on their prior knowledge and beliefs.
- *Knowledge is constructed from within through its interaction with the outside world.* The construction process of students working in interrelationship with the outside environment of the classroom often operates in their interrelationship with the curriculum and other students inside the classroom.
- *Knowledge can never be certain*. Any knowledge, including the knowledge of students and teachers, can never be certain because knowledge is available for re-examination and revision.
- *Common knowledge is the result of a shared intellect and body, both of which are part of the same universe.* Teachers and students from diverse contexts share specific knowledge; ultimately, they can develop the same perceptual awareness through a particular program.
- *Knowledge is constructed through perception and action*. Students build new awareness by perceiving and acting on issues in the classroom and through perception-action by interacting with and/or with the teacher.
- *The construction of knowledge requires time and energy*. Knowledge building is time-consuming and challenging. It requires a great deal of energy, but it does offer pleasure and satisfaction. Since the teacher is aware of this, he strives to spend each moment in a manner that promotes learning for students [49,50].

The perceived need to change educational practice from an associational or behaviorist approach to one that emphasizes the higher-level knowledge building needed to handle rapid information expansion is at the root of the growing interest in constructivist approaches to learning and teaching [1].

6. CHALLENGES OF TEACHING MATH THROUGH CONSTRUCTIVISM

Research suggests that some teachers lack the requisite knowledge, skills, and expertise for teaching mathematics through constructivism [5]. Lack of mathematical knowledge for instruction decreases teachers' confidence in utilizing constructivism when imparting mathematics. To the detriment of teaching students to construct meaningful knowledge using a constructivist approach to teaching and learning, such instructors rely on traditional methods that require students to memorize rules. In a review of the literature on teaching mathematics through constructivist approaches, McIntosh et al. [42] discovered that many textbooks lack an adequate number of nonroutine problems for teachers to choose from. Due to their reliance on textbooks as their primary source of information, this has an impact on the constructivist approach to the teaching of mathematics. In a similar study, Anderson, Sullivan, and White [6] identified textbooks and assessment regimes used in the school and the schedule for mathematics lessons as impediments to the teaching of mathematics through a constructivist approach to teaching and learning.

Many teachers who have been teaching for many years tend to continue their traditional teaching methods rather than move to a new paradigm and reinvent their teaching practices [2,17]. Teachers are more concerned with behavior control than with student learning in classrooms [17]. Constructivist-based approaches seem to create confusion, which could cause teachers to

lose control over the entire learning environment. It takes time, for example, to let students speak for themselves and share classroom management, both of which can lead to unforeseen results due to the immaturity of students [3,17]. According to Zanzali [58], many teachers place more importance on classroom management than on pedagogical or instructional issues. These categories of teachers believed that the best way to learn mathematics was to do routine problems repeatedly while students sat down quietly and listened to what they said [58].

Many teachers do not see any reason to change because their present approach works well, and this ensures that students get good grades in exams and perform well on various tasks in or outside classrooms. In the view of Anderson [5], pressure from parents over exam outcomes causes teachers to focus more on preparing students for tests than on constructivist teaching methods to foster conceptual understanding. Zanzali [58] noted the influence of exams on what and how mathematics should be taught to learners as a barrier to instructors using constructivist methods of instruction in a research study to record restrictions that teachers experience in carrying out the goals of the curriculum.

The belief of teachers in teaching has been a significant element in education over the years [14,37]. As Hsiao and Yang [34] pointed out that, beliefs in teaching were key factors influencing the decision-making of teachers in their teaching behavior. Perhaps these are threats to their convictions. In practicing constructivist teaching, teachers who believe that objective reality is independent of human experiences will consider such a form of instruction a challenge [51,52]. More precisely, Haney and McArthur [29] used the Constructivist Learning Environment Survey to examine teacher beliefs in five facets of a constructivist classroom: personal relevance, critical voice, shared control, uncertainty, and student negotiation, and found personal relevance, scientific uncertainty, and student negotiation to be the core beliefs of constructivist teachers. Shared control, however, was a peripheral belief among some teachers who believed that it was difficult to incorporate it into teaching. Therefore, it is believed that the constructivist teaching beliefs of teachers strongly influence their intention to incorporate constructivism in their classrooms [14].

7. SUMMARY OF THE REVIEW

Constructivism is the philosophy of knowledge and learning. It does not provide teaching strategies, but teaching concepts. While constructivist learning theory doesn't tell us how to teach mathematics, a teacher with a constructivist background can promote knowledge building by applying different constructivist teaching methods consistent with this theory of learning. In research by Katic et al. [63], they pointed out that teachers use a variety of resources to solve a problem in mathematics and create theories about the learning process; they then ask questions about the problems at hand to explain their solutions. This approach is promoted in social theories such as constructivism since it usually helps keep learners on track. This suggests that the classroom environment must offer a natural setting where students can present different solutions to their class or group and learn mathematics through social interactions, meaning negotiation and arriving at a shared understanding [8,63,64]. Therefore, learning through such means helps students clarify their ideas and acquire different perspectives on the concept or idea they are learning, i.e., several strategies for solving mathematical problems [65,66].

Brooks and Brooks [17] suggested that teachers need to value and support student autonomy and initiative, listen to student feedback and teach appropriately, empower students to ask questions, create opportunities for student interaction and communication, and foster students' exploration of knowledge ambiguity. Fosnot and Perry [67] proclaimed that in constructivist classrooms, the following needs to be observed:

- Teachers need to allow students to critically question and think and provide opportunities to verify their ideas.
- Teachers need to build spaces for students to discover, debate, and express themselves.
- Teachers should provide students with opportunities to reflect on and relate to personal experiences in classrooms to facilitate their learning.
- During the learning process, students are at the center of learning. They are responsible for themselves and the community of learners. There is a need to promote

activities involving the students in dialog and negotiation.

The constructivist classroom respects the autonomy of students and gives ownership of learning to students, which means students are at the core of learning and teachers act as the learning facilitator for students [68]. One of the educational goals is to promote long-term working memory for students, and it is not deniable that this process needs to be constructive [69].

8. CONCLUSION AND RECOMMENDATION

Reviewing numerous theoretical and empirical studies aimed at guiding for improving skills, it was found that the constructivist approach is more suitable to improve students' performance. In addition, historical interactions, a concrete sense of social learning, and visual representations will form the basis for knowledge building. In general, the teaching and learning of mathematics require a combination of methods and practical strategies, and therefore, it is necessary to make students follow the correct principle that will produce the expected results. Most importantly, acquiring problem-solving techniques should not only involve the memorization of facts but also be focused on methods for gaining a deeper understanding of ideas and concepts in mathematics. Consequently, using the constructivist approach to teaching and learning, which in essence is difficult to practice, will help the students acquire the needed concepts in mathematics.

Constructivist approaches, as presented in the studies above, have shown a positive impact on student learning. But the issue of the accountability of traditional school assessment needs to be addressed. It is suggested that constructivist pedagogies should be evaluated in constructivist ways so that they can accurately explain their advantages and benefits [70].

COMPETING INTERESTS

Author has declared that no competing interests exist.

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