Contemporary Mathematics and Science Education
2023, 4(1), ep23002
ISSN 2634-4076 (Online)
https://www.conmaths.com/

Research Article

OPEN ACCESS

Constructive instructional teaching and learning approaches and their mathematical classroom teaching practices: A junior high school perspective

Emmanuel Oppong-Gyebi [1]*, Ebenezer Bonyah [1], Lauren Jeneva Clark [2]

[1] Department of Mathematics Education, Akenten Appiah Menka University of Skills Training and Entrepreneurial Development, Kumasi, GHANA
[2] Department of Mathematics, The University of Tennessee, Knoxville, USA
***Corresponding Author:** eopponggyebi@gmail.com

Citation: Oppong-Gyebi, E., Bonyah, E., & Clark, L. J. (2023). Constructive instructional teaching and learning approaches and their mathematical classroom teaching practices: A junior high school perspective. *Contemporary Mathematics and Science Education*, 4(1), ep23002. https://doi.org/10.30935/conmaths/12541

ABSTRACT

Mathematics classrooms are becoming increasingly diverse as a result of modernity, with different people, cultures, and perspectives on how to grasp and apply practical mathematics problems. These pose challenges to teachers on the need to outline the best constructive instructional teaching approaches amid inspired mathematical classroom teaching practices. As a result, conducting this study to gain insight into the perceived intentions surrounding the use of cultural diversity, teaching with technological devices, experiencing mathematics, problem-based learning, and contextual teaching, and learning approaches in the teaching of junior high school students is extremely important. A quantitative study was conducted with 78 mathematics teachers purposively sampled from three conveniently sampled districts in Ghana's Ashanti Region. The data were checked for accuracy and factored into four components. The data was then analyzed using the IBM SPSS-26 software, which included one sample Wilcoxon signed ranked test, an independent sample Kruskal-Wallis test, and Spearman's bivariate rank correlations. In addition to its originality and kind in Ghana, important results about the factored components were obtained, showing how well teachers have embraced constructive approaches in the teaching and learning of mathematics at the junior high level, except for diversity in teaching with technology. It was also revealed that diversity in contextual problem-based learning recorded the lowest correlation coefficients with all the associated factor components, especially with technological experiencing mathematics teaching, and diversity and technological teaching. Because the selected districts are highly cosmopolitan and the world has become extremely diversified at the heart of this technological generation, mathematics teachers in junior high schools are more cautious when integrating cultural diversity with any other constructive instructional approach, especially with technology, for fear of losing students' interest in the subject.

Keywords: constructive instructional practices, cultural diversity, contextual experiencing, technological teaching, problem-based learning

Received: 25 Aug. 2022 ◆ Accepted: 09 Oct. 2022

INTRODUCTION

Mathematical application has a significant role in many facets of human existence because it focuses on strengthening communication skills through symbols and intellect to solve problems that arise in everyday life (Syamsuddin & Istiyono, 2018). Its rich contexts are solidly embedded in real-life situations which dictate the current generation of industrial developments and need appropriate teaching and learning strategies to find knowledge in solving mathematical problems (Afni & Hartono, 2020).

Diversity in our modern classroom is in ascendancy as a result of the global movement of people in search of jobs, freedom, and quality education (Katwibun, 2013). However, a teacher-centered teaching and learning model requires a somewhat organized learning environment to take place for this paradigm. These strategies are embedded in instructional models in teaching that has been a major topic in the field of mathematics education due to their influence on the educational process (Reigeluth, 1983).

This poses a challenge to educators to create a good learning environment while providing quality multiple instructional strategies that accommodate diversified teaching with technology in an active and interactive learning manner when students solve real-life problems (Hurtado et al., 2003). Mathematics teachers are being challenged to come up with formidable instructional methods that will create a learning environment in which students will solve some problem-based project activities in either small or large groups centered on contextual learning rather than traditional knowledge-based curricula as they are being trained to extend their craft in preparing more diversified students for work and life beyond school (Paris & Winograd, 2003).

Instructional teaching and learning approaches such as culturally diverse teaching, teaching with technology, contextual mathematics teaching and learning, problem-based teaching and learning, and experiential mathematics teaching, have a major role in any teacher's propensity to develop a zeal for teaching mathematics (ChoiKoh, 2009). Teachers would be more enthusiastic about their teaching and driven to work more, resulting in improved mathematics instructional delivery performance or a significant impact on their mathematical classroom teaching practices, resulting in increased student participation in learning (Albeshree et al., 2022; Rocca, 2010). There is a need to examine the teachers' opinions on their performance about these constructivist instructional teaching approaches that eventually lead to effective teaching and learning success.

Statement of the Problem

Lachman (1997) defines learning as the process of generating a reasonably stable modification in stimulus-response relations as a result of functioning environmental contact through the senses. Learning is a broad phrase encompassing a wide range of activities that our students might engage in (De Houwer et al., 2013).

According to Kamphorst (2018) and Orak and Al-khresheh (2021), to gain knowledge, students must have the ability to develop a robust theory that correlates to a type of activity with a real-life situation and formulate the new and individually different knowledge for themselves. Hence, a variety of instructional methods should be employed to emphasize learning activities and educate students on how to think critically and develop strong reasoning skills (Kara, 2018).

Behaviorist approach to mathematics education

Behaviorism, probably among the most acclaimed learning theories in education as advocated by Ian Pavlov (1897), John B. Watson (1924), Edward L. Thorndike (1927), and B. F. Skinner (1953), claimed that learning resulted via the establishment of links between stimuli and responses through the use of rewards (Berns & Erickson, 2001; Kaplan, 2018; Stoilescu, 2016). Positive reinforcers, according to Skinner, strengthen behavior, whereas reactive strategies are more likely when such a stimulus is eliminated (Mukhalalati & Taylor, 2019).

The evolution of mathematics education, as well as teaching and pre-service teacher preparation, has benefited greatly from behaviorism. Behaviorists believe that by employing standard instructional strategies and principles that are followed by previously defined pedagogical procedures, students may learn something specific that they otherwise would not be able to acquire on their own (Stoilescu, 2016). It was not surprising that Doolittle and Camp (1999) highlighted how behaviorism was used as the basic teaching and learning model for career and technical education in the early twentieth century, and still see its relevance in performance objectives, criterion-referenced measures, task lists as a source of curriculum, and specific, predetermined skills demonstrated to industry standards. However, Eisenberg (1975) depicted the narrowness of behavioral objectives, outcomes-based education, mastery learning, programmed learning, and an over-emphasis on skills drill, as well as how it is skewed to mastery testing instead of incorporating test understanding and application of knowledge, potentially creating mathematics to be seen as a predetermined set of rules.

According to Eisenberg (1975), Gagne (1977), and Stoilescu (2016), many behaviorists see teaching mathematics as a linear means of providing students with commentaries on already existing theory, conceptual knowledge, and experiences that are expected to commence from concrete to abstract, and as a result, students are also required to react in a similar mannered rule. As a result, one educational outcome for mathematics instructors on was the assumption that mathematics can be taught by intentionally impacting the proper knowledge and rhetoric at the proper moment (Stoilescu, 2016).

Meanwhile, Aliakbari et al. (2015) argued that behaviorism cannot work without reinforcement and that these impulses haven't been demonstrated to be as effective as they claim. As their forms change, the focus of learning should shift from reinforcement to systematic enhancement of knowledge (Johnston, 2016). When students receive feedback on their replies, it undoubtedly reduces the number of incorrect responses in a short exam; yet it merely requires repetition without requiring new information alignment (Masethe et al., 2017).

Cognitivist approach to mathematics education

To break away from the concept of behaviorism, Jean Piaget (1896-1980) contributed to the establishment of cognitive psychology in the 1950s. Jean Piaget studied the sensorimotor, preoperational, concrete operational, and formal operational stages of the sequential process to demonstrate how children think by observing their interactions with stimuli in the environment (Aliakbari et al., 2015; Alicia & Dusing, 2020). Cognitive abilities have focused on fact processing, thought pattern description, and action control in recent years, and it is clearly described as the technique of gathering, organizing, and establishing information (Govindaraju, 2021).

It is based on the student's cognitive and internal environment structures rather than situations or the external environment (Mukhalalati & Taylor, 2019). Furthermore, according to Akhigbe (2019), teachers' explanations and demonstrations of new ideas assist in giving environmental input to students. Students also build cognitive strategies through reflecting on their own experiences, as well as a variety of other internally structured skills that manage their processing, storing, and retrieving learning behaviors through practice (Mohammed & Elkhider, 2016).

Meanwhile, early cognitivism admitted that the knowledge terms, operations, and symbols do not utter the meaning of the mathematical build-ups and can be learned using behaviorism learning theory. However, as cognitivist research evolved, they were convinced that the language employed in mathematical discussion to use these symbols and operations requires a cognitive process to articulate pre-existing concepts and thoughts (Schoenfeld, 1987). This prompted the inclusion of mathematical knowledge and enhanced problem-based learning skills as a major priority on the agenda of early generations of cognitive science (Stoilescu, 2016).

Before constructivism emerged as the third key learning theory for its instructional teaching methodologies, behaviorism and cognitivism were critical to understanding human learning (Orak & Al-khresheh, 2021). Bergen and Parsell (2019) suggest, however, that these three theories are important enough to be considered independently because they overlap in many ways and provide diverse explanations for the learning process. The regions of learning attention shifted dramatically from passive to active interaction learning as the emphasis shifted from behaviorism-cognitivism to constructivism (Johnson & Johnson, 2019).

Constructivist approach to mathematics education

The constructivist theory recognizes students' active participation in knowledge reconstruction through individual and social experiences, while also considering the variability of reality when transmitting it, according to Krishnamoorthy et al. (2021). This suggests that aspects like the learning environment, social interaction, prior experience, and knowledge influence knowledge reconstruction, making it an effective learning theory for contextual mathematical learning. Some research suggests, however, that knowledge formation is a dynamic rather than a static process, and that students' practice and connections also modify knowledge, making it more applicable to a wider range of real-life settings (Masethe et al., 2017).

Constructivism, in particular, plays a significant role in many fields of education, social science, and science. Although it began as a learning theory, it has tried to evolve into a pedagogical theory that now includes a technique for blending personal, social, and scientific knowledge to come up with teaching methods that were consistent with the principle of not teaching the answers but instead influencing the student's understanding (Radford, 2008). This took a new turn with the integration of the concept of mathematics as a social activity and the classroom as a venue for meaning interpretation (Radford, 2008).

According to Masethe et al. (2017), there are various types of constructivism, including social, radical cultural, trivial, and critical constructivism. In social-constructivism learning theory, where students are psychologically equipped to learn with the aid of teachers or peers to grasp the given problem, Rashid et al. (2015) proposed that scaffolding plays a critical role in supporting collaborative learning in the social-constructivism learning theory, where students are psychologically equipped to learn with the help of teachers or peers to comprehend the given challenge. According to van Es and Sherin (2021), teachers are not merely passive spectators observing; rather, they influence interactions to obtain access to extra information that would permit for more collecting and analyzing data on student thinking. Teachers, as organizers and sources of information, guarantee that students construct knowledge through the zone of proximal development with the help of their companions in society or class (Ekanayake et al., 2020; Smagorinsky, 2018). Sajedeh et al. (2019) stressed that mental construction has marginalized social constructivism and rather identifies individual collaboration in connection with cultural, social, and environmental activities during the learning process.

However, Cobb (1994), based on the analogy of forefathers, socio-constructivism's Jean Piaget (1896-1980) and Lev Vygotsky (1896-1934), emphasized the importance of focusing on the investigation of students' mental structure development and the emergence of meanings as a result of students' interactions in the classroom, as the two main constructivist study areas. The detailed analyses of classroom interaction and the sophisticated methodologies designed to scrutinize the negotiation of meanings underpinning the students' conceptual growth have helped the community of mathematics educators to become aware of the variety of meanings that students mobilize in tackling mathematical problems (Radford, 2008). Stoilescu (2016) was of the view that constructivist educators have contributed significantly to mathematics education by criticizing the teaching-centered approach, the lack of interest in mathematical content, overly standardized lessons without mathematical application, and the absence of social activity in the mathematics classroom. This supports Vygotsky's "The impact of social and cultural factors on learning," which emphasizes the importance for educators of acknowledging society as a part of learning that works best when it conforms to students' social needs and concerns (Sajedeh et al., 2019).

Constructivism has surely aided us in further grasping the nuances of students' learning processes; made mathematics teaching more collaborative and emphasized teamwork learning practices as part of their vow to make mathematics more acceptable to students (Radford, 2008). Stoilescu (2016) is also convinced that the constructivists have helped fix their ideology in the redesigning of fundamental themes that emerge in mathematics education inquiry to promote interactive learning in challenging situations and problem-solving in social contexts. Comparatively, constructivists, for example, openly utilized errors to increase students' understanding of mathematical principles, whilst behaviorists used error analysis as the best tool for assessing the origins of mistakes and misconceptions (Kay & Kibble, 2016; Krishnamoorthy et al., 2021). Similarly, problem-solving methodologies were completely revamped, as early techniques simply provided a synopsis of concepts for the essential processes in problem-solving (Stoilescu, 2016).

However, as mathematicians recognized, these explanations were highly overly simplistic, as they did not provide sufficient assistance for students to develop expertise in addressing large types of situations. More individualized, interpretive, and psychological aspects were engaged in expressing and implementing learning expertise and skills in problem-solving, as constructivist mathematics educators acknowledged.

Constructivist instructional methods in mathematics education

According to Xie et al. (2018), the role of a teacher in an instructional model is to develop lessons with predefined objectives in mind and presentation skills and knowledge in a predefined sequence, while students' functions are to passively attain teacher-specified knowledge and skills. Teachers in the student-centered constructivist instructional paradigm incorporate students in planning when creating learning environments, accept their ideas, and provide them autonomy and choice to interact with others to actively participate in investigations and problem-solving activities (Arends, 2013). Based on their analysis of relevant literature, Cooney and Wiegel (2003) developed three philosophies for teaching pre-service mathematics: handling mathematics as a multicultural subject; creating opportunities for educators to know and exemplify mathematics instruction and allowing mathematics educators to experience it as a procedure. Joyce and Weil (1986) in their book "Model of teaching" identified the broadest level of instructional practices in four models, namely information processing, behavior, social interaction, and personal. Despite the similarities between these models and Bandura's social cognitive theory of 1986, this research focuses on constructivist social interaction (diversity) and information processing (technology).

Social interaction instructional model: The demand for an integrated, constructivist approach that does not fail our students is fueled by diversity in our schools and classrooms, as well as the challenge of high expectations for all students in the integrated real-world development progress in constructivist classroom practices (CP) (Harris & Alexander, 1998). According to Katwibun (2013), educators have been bringing to the attention of mathematics teachers how to be more aware and able to recognize diversity in their respective classrooms as a way to address diversity. Social interaction as an example of an instruction model has historically played a key impact on a wide range of students' mathematics achievement, mathematics course enrolment, graduation rate, and future career decisions (Katwibun, 2013). This tends to mean that teachers' process of integrating tradition, alternative viewpoints, and diverse character traits, and then focus specifically on social practices (e.g., classroom, home, and neighborhood), which include students of various races, ethnicities, socioeconomic status, class, and language, promote effective teaching and learning. According to Schoenfeld (2006), multiculturalism has both advantages and disadvantages. On the other hand, this approach obscures the long-term focus on disparities between subsets of the population, such as racial achievement gaps.

Curriculum developers, according to Wiest (2001), have attempted to include elements with cultural aspects or notions about what it means to teach mathematics in a multicultural manner in the present educational program. According to Flavin and Hwang (2022), success in intercultural mathematics is substantially associated with students' admission into tertiary and the choice of their potential employment. In a series of assessments of educational scenarios involving cultural concerns, the premise that all countries and cultures develop mathematical concepts was especially essential in discrediting the claim that mathematics from the west is but one of the countless (Bishop, 1988). ChoiKoh (2009) acknowledged fairness in students of diverse cultures and also restored teachers' viewpoints towards post-standardization by incorporating innovative curricula premised on students' attributes; applying direct and anchored instruction; linking through communication and information technology using group activity; developing programs that enhanced by language teaching; and generating curriculum for their neighboring country's students.

Information processing instructional model: Mathematics education has seen a rapid transformation with the emergence of computing technologies in the mid-twentieth century. Despite significant investments in schools and instructors, Lavicza (2010) believes that the realities of education and the complexities of a technology-enabled world obstruct the integration process envisioned in the 1980s. Borba et al. (2016) identified five major development patterns utilizing case studies and provided these remarks in their study on how recent discoveries in digital technology in the mathematics education sector have progressed. They begin by expressing their reservations about mobile technology, which they claim undermines the conventional flow of mathematical information from instructor to student. Fabian et al. (2016) conducted a comprehensive assessment of sixty studies on mobile devices in mathematics and found that while student views regarding mobile use were mainly favorable, the impact on students' attitudes toward mathematics was mixed, which somehow supports (Borba et al., 2016; Hwang & Wu, 2014) claims on mobile technology.

In addition, a systematic and orderly analysis of different research about the use of massive open online courses (MOOCs) revealed that students' academic achievement can be altered by MOOCs, which has the benefit of easing the learning process by providing resources and allowing information exchange (Al-Rahmi et al., 2019). This may destabilize conventional educational systems while simultaneously delivering free online education (Borba et al., 2016). When it comes to digital libraries and constructing learning objects, many students increasingly check these resources before consulting an instructor or a textbook. Furthermore, collaborative learning using digital technology raises concerns concerning the design and usage of learning management systems and personal learning environments (Borba et al., 2016; Fox et al., 2002).

Their final development pattern on computing technology, that is blended learning in mathematics might give an overview of the issues and possibilities for implementing hybrid learning in schools as a consequence of its ability to increase students' ability to think critically (Sukma & Priatna, 2021). Borba et al. (2016) also stressed that teachers employ a flipped classroom model to turn the classroom into a space for augmentation and interpretation instead of direct instruction, citing fears about the need to examine the many blended learning teacher training approaches. However, Lavicza (2010) argues that due to the widespread use of mathematical software (computer algebra systems) in students' research and teaching improves our knowledge of technological integration at all university levels. Drew (2015) offers a critical analysis of three worked examples of how technology can be used to expand traditional definitions of the classroom environment.

Morale (2019) worked to establish fairness in computing education by utilizing six aspects: political and social awareness, ethnomathematics, dialect culture, life stories, community engagement, and user experience to inspire and respond to the needs of disadvantaged students in instructional technology.

Contextual teaching and learning mathematics: Contextual learning is based on a constructive theory that strives to connect students to real-world problems through integrated teaching and learning of mathematics. As noted by Krishnamoorthy et al. (2021), learning that is influenced by the things surrounding us in our daily lives has gotten a lot of attention recently. Afni and Hartono (2020) see contextual learning as based on the teacher presenting real-life problems amid mathematics learning as students focus and are guided in the process of linking real-life context with mathematical concepts. Johnson (2012) mentioned how much fun it is when students' learning is tied to their environment and experience, and not only by learning and taking notes but by learning through a real-life experience process. He went on to say that when students mix classroom learning with real-life challenges, contextual learning becomes more meaningful and real.

Problem-based learning: Problem-based learning techniques have an ancient legacy of promoting expert-based education (Hmelo-Silver, 2004). Allen et al. (2011) explain that problem-based learning involves students working in collaborative groups to handle complicated, real-life issues while also being supervised by teachers. Hmelo-Silver (2004) and Wood (2003) also explain it as an instructional technique in which students' study by solving issues and also focus on complicated topics with no one correct solution by working in groups to determine what they need to learn to address an issue. Through the problem-solving experience, learners can understand both knowledge and reasoning skills (Hmelo-Silver, 2004). Allen et al. (2011) investigate the basis for the strategy's success in cultivating a deep comprehension of content and assess the possibilities for improving thinking skills like research, collaboration and teamwork, writing, and vocal communication.

Research Objectives/Research Questions

The purpose of this research is to look into the constructive instructional teaching and learning approaches and their CP in Ghana. This will aid in examining and comprehending the perspectives of mathematics teachers on the use of cultural diversity teaching, teaching using technology, contextual teaching and learning, problem-based learning, and experiential teaching and learning.

The study tries to answer the following research questions:

1. What constructive instructional teaching approaches does the teacher believe to be used in the teaching of junior high mathematics?
2. How do the teachers view constructive instructional teaching approaches to junior high schools (JHS) mathematics teaching?

Inquiring into these concerns is critical for developing a teacher master plan for selecting and implementing constructive instructional teaching approaches in a mathematical classroom using good CP. These questions will bring to light teachers' perceived approaches to instructional delivery, as well as the possibility of relating them to the mathematical curriculum.

METHODS

Research Design

This research used a quantitative approach. A quantitative research approach focuses on gathering measurable and analyzable data by examining hypotheses or research questions with statistical tools to support or disprove underlying assumptions (Williams, 2007). By quantifying and analyzing factors, the researcher obtains results using a quantitative research approach. It comprises the use and analysis of numerical data using specialized statistical processes to answer the study objectives.

Population

The mathematics curriculum in JHS is divided into three years; years I, II, and III. Its layout, on the other hand, does not follow a set of topics and is not consistent year to year. On average, a school with a class for each year level will have a mathematics teacher, making them not as many as expected, unlike that of the senior high schools. This prompted the researcher to choose mathematics teachers from three districts in Ghana's Ashanti Region: Kwabre East, Old Tafo-Pankrono, and Afigya-Kwabre South.

Sample and Sampling Techniques

A purposive sampling technique was used to select one hundred mathematics teachers from private and public JHS in the three conveniently sampled districts in Ghana's Ashanti Region to participate in this study. Purposive sampling, according to Bernard (2006), occurs when a researcher determines what information should be highlighted and then sets out to find people who can willingly provide the information to the best of their abilities or competence. 7 of the 100 potential active respondents were eliminated from the final analysis because their data was incompletely filled, and the rest did not submit them, resulting in a 78% response rate. As a result, the final sample size in the survey is 78 (74 males and four females).

The age distribution of the 78 respondents from **Table 1** is 38.5%, 35.9%, 14.1% and 11.5% for 26-35, 36-45, 46-55, and ≤25 years, respectively. Over 69.2% of the sample have a degree, while 25.6% have a Diploma/HND, and as little as 5.1% master's degree as their highest educational level. All the 78 respondents are professionals with 84.6% of the teaching in public schools while only 15.4% are in private JHS. The respondents have teaching experience ranging from 1-5 years, followed by 11-15 years, 6-10 years, over 20 years, and 16-20 years representing 34.6%, 30.8%, 15.4%, 14.1%, and 5.1%, respectively.

Table 1. Demographic statistics

Measure	Category	Number	Percentage (%)
Gender	Male	74	94.9
	Female	4	5.1
Age (years)	<25	9	11.5
	26-35	30	38.5
	36-45	28	35.9
	46-55	11	14.1
Highest educational level	Dip/HND	20	25.6
	Degree	54	69.2
	Master's degree	4	5.1
Status	Professional	78	100.0
Teaching experience (years)	1-5	27	34.6
	6-10	12	15.4
	11-15	24	30.8
	16-20	4	5.1
	Over 20	11	14.1
School type	Public	66	84.6
	Private	12	15.4

Data Collection Instrument

The research questionnaire contained 46 items in three sections. The researcher developed these items based on the literature review. The first section collected the demographic profile (like gender, age, highest education, status in teaching, teaching experience, and school type) of the teachers. Section two was made up of twenty-five items equally selected from five constructive instructional teaching and learning approaches, namely cultural diversity, teaching with technology, contextual teaching and learning mathematics, problem-based learning, and experiencing mathematics. A five-point Likert ranging from strongly disagree (1) to strongly agree (5) was used as possible answers to measure each item under this section. The final section contained fifteen items selected from all possible mathematics classroom teaching practices. This was also scaled with a five-point Likert scale ranging from never (1) to always (5). The printed questionnaires were personally administered by the researcher to get only the JHS mathematics teachers to respond to them.

Data Collection Procedure

To enable the smooth conduct of the study, the researcher obtained a letter of introduction from the School of Graduate Studies and forwarded it to the three district directors of education as well as the heads of JHS. Before obtaining approval from mathematics teachers, the researcher informed them about the purpose of this study and its relevance to enhancing their instructional delivery approaches. They were assured of the survey's anonymity before the questionnaires were administered. The respondents voluntarily committed themselves to this exercise, and hence it took us about twelve days between May and June 2022 to collect all the responses. After booking an appointment with the respondents, the researcher then comes for the questionnaire at a later date as deemed fit by the respondents.

Validity and Reliability

The researchers used IBM SPSS (version 26) software as a suitable statistical tool to ensure the validity and reliability of the data acquired from the study sample. Before conducting the analytical tests, the

Table 2. Reliability coefficients for the composite variables

Constructs	n	Number of items	Cronbach's alpha
CDB	78	12	.948
TEM	78	5	.893
DCP	78	5	.766
DTT	78	3	.733
DA	78	6	.861
CP	78	7	.831
Overall	78	38	.957

reliability test for all the 38 items of the study was a test that proved to have a very strong Cronbach's alpha of 0.957.

The exploratory factor analysis, which operates on inter-related factors, yielded a KMO statistic of 0.851, which is much higher than the 0.5 required factor value, as specified by Hair et al. (2014). Bartlett's sphericity test was significant with a Chi-square score of 1,508.263 and 300 levels of freedom. A significant p-value of less than 0.001 indicates that there is enough connection to justify the component analysis. The five components explained 67.746% of the overall variation described by the cumulative squared loadings of the rotation sum. The rotating varimax technique was utilized to minimize the number of complicated parameters while enhancing the average yield.

All the composite variables obtained from the factor analysis showed excellent reliability levels, indicating strong internal consistency among the study variables, suggesting that the study variables were internally consistent as recommended by Tucker (1955). (**Table 2**).

Data Analysis Approach

The items under the constructive instructional teaching methods were passed through a principal component factor analysis test and came out with four mashed-up components tagged contextual problem-based teaching (CPB), technological experiencing mathematics teaching (TEM), diversity in contextual problem-based teaching (DCP), and diversity and technological teaching (DTT) (**Table 2**). Again, two components were also derived from the CP, which were also tagged as didactic and assessment (DA) and CP. Two items, F14 and F15, could not join any of the two components, although the factor absolute value was below 0.3 and eventually deleted.

The researcher further performs a non-parametric normality test by Kolmogorov-Smirnov and Shapiro-Wilk normality test for the six variables–CPB, TEM, DCP, DTT, DA, and CP (**Table 3**). A one-sample

Table 3. Normality test of the variables

Variables	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
CPB	.124	78	.004	.940	78	.001
TEM	.198	78	.000	.886	78	.000
DCP	.107	78	.026	.973	78	.099
DTT	.164	78	.000	.927	78	.000
DA	.157	78	.000	.873	78	.000
CP	.096	78	.070	.962	78	.020

Note. [a]Lilliefors significance correction

Wilcoxon signed ranked test was used followed by an independent-samples Kruskal-Wallis test to examine interrelationships among respondents' demographic characteristics (age, highest educational level, and teaching experience). Finally, the test for significance associated between the pairs of the six variables was conducted using a spearman's rank correlation analysis.

RESULTS

78 responses were validated and qualified for data analysis. At a $p<0.05$), all the variables that were related to constructive instructional teaching and learning and its classroom teaching practices were not normally distributed when tested using both the Kolmogorov and Shapiro tests (**Table 3**). This paves the way to perform the remaining test using a non-parametric test (one-sample Wilcoxon and Kruskal-Wallis test) on the variables.

Contextual Problem-Based Teaching

Table 4 shows a one-sample Wilcoxon signed rank test performed to examine the CPB and learning approaches used by mathematics teachers in the JHS. The test results showed that teachers perceive contextual teaching and learning approaches in the teaching of mathematics to be less stressful ($T=1,162.0$, $Z=2.788$, $p=0.005<0.05$), help students connect knowledge to real-life problems ($T=1,090.50$, $Z=2.170$, $p=0.030<0.05$), and also make students apply mathematics in their daily decision making ($T=1,123.5$, $Z=2.017$, $p=0.044<0.05$) but disagree that it makes learning very easy as its p-value is greater than 0.05.

They also agreed that problem-based learning is easy to incorporate revision and reflection during teaching and learning and also allows students to present their work to other people besides their classmates

Table 4. One-sample Wilcoxon signed ranked test for CPB (Test value=3 from 5-point Likert-scale & n=78)

Variables	TS	SE	Z	AS
CTL makes teaching math less stressful (C2)	1,162.0	120.354	2.788	.005
CTL helps students connect knowledge to real-life problems (C1)	1,368.5	146.763	2.017	.044
CTL makes basic math learning very easy (C3)	1,123.5	140.284	.823	.410
CTL makes students apply math in their daily decision-making (C4)	1,090.5	121.679	2.170	.030
PBL pushes students to become the drivers of their learning (D1)	1,236.0	144.014	1.361	.174
EM develops creativity based on new ideas on old ones (E1)	997.0	114.831	1.977	.048
TT arouses student desire for math lessons (B5)	1,568.0	158.525	2.492	.013
EM supports students to learn from each other (E4)	1,547.0	140.760	3.829	.000
EM provides math understanding of real-life experiences (E3)	1,764.0	150.815	4.366	.000
PBL incorporates revision and reflection during teaching and learning (D3)	1,296.0	134.117	2.613	.009
PBL pushes students to organize tasks around an open-ended question(D2)	1,138.5	131.011	1.473	.141
PBL allows students to present their work to others for assistance (D5)	1,306.0	129.571	3.018	.003
Overall CPB	2,145.0	196.857	3.269	.001

Note. TS: Test statistics; SE: Standard error; Z: Standard test statistics; & AS: Asymptotic Sig. (2-tail)

Table 5. One-sample Wilcoxon signed ranked test for TEM (Test value=3 from 5-point Likert-scale & n=78)

Variables	TS	SE	Z	AS
TT gets students actively involved in the lessons (B2)	2,141.5	175.984	4.495	.000
EM makes students actively participate in teaching (E5)	1,888.0	158.243	4.518	.000
The curriculum allows teachers to use multicultural materials with inclusive content when teaching (A2)	2,082.0	165.518	5.072	.000
EM helps with rational thinking and logical argument (E2)	1,773.0	147.706	4.519	.000
TT allows students to come out with good pictorial representation (B3)	1,683.0	155.535	3.279	.001
Overall TEM	2,224.0	177.839	5.117	.000

Note. TS: Test statistics; SE: Standard error; Z: Standard test statistics; & AS: Asymptotic Sig. (2-tail)

Table 6. One-sample Wilcoxon signed ranked test for DCP (Test value=3 from the 5-point Likert-scale & n=78)

Variables	TS	SE	Z	AS
TT makes the teaching of math very easy (B1)	839.0	151.688	-1.757	.079
CD allow and participate in event that is important to the communities of our school (A5)	553.0	137.316	-3.084	.002
CD helps develop lesson plans and notes that are culturally relevant for all students (A1)	1,348.0	153.898	1.358	.174
PB establishes the need to gain knowledge, and apply skills to answer questions (D4)	1,266.5	138.987	1.860	.063
CTL provides opportunities for meaningful learning (C5)	821.0	123.712	-.279	.780
Overall DCP	1,376.5	188.838	-.257	.797

Note. TS: Test statistics; SE: Standard error; Z: Standard test statistics; & AS: Asymptotic Sig. (2-tail)

Table 7. One-sample Wilcoxon signed ranked test for DTT (Test value=3 from 5-point Likert-scale & n=78)

Variables	TS	SE	Z	AS
CD allows teachers to recognize and respect the cultural protocols of our students and their family (A4)	1,757.0	159.619	3.443	.001
CD celebrate and participate in events that are important to the cultural communities (A3)	1,772.5	144.503	4.844	.000
Students understand the concept easily when using technology devices to teach math (B4)	1,476.5	147.040	2.748	.006
Overall DTT	2,267.5	188.287	4.475	.000

Note. TS: Test statistics; SE: Standard error; Z: Standard test statistics; & AS: Asymptotic Sig. (2-tail)

and teachers to seek understanding ($p \geq 0.05$). However, their views on problem-based learning to push students to become the drivers of their learning and also push students to organize tasks around open-ended questions were not significantly different from the neutral view ($p>0.05$). Apart from that, experiencing mathematics activities with an emphasis on projects which develop creativity based on new ideas on old ones, supporting students to learn from each other, and providing mathematics understanding of real-life experiences were all significant ($p<0.05$). In all, the contextual problem-based approach significantly enhances teaching and learning (T=2,145.0, Z=3.269, p=0.001<0.05).

Technology and Experiential Mathematics

The result shows that the JHS mathematics teachers had positive views on the use of technology to get students actively involved in lessons and also help them come up with good pictorial representation when teaching mathematics. They further admit that the curriculum allows teachers to use multicultural materials with inclusive content when teaching; experiential mathematics learning helps students to rationally think and make logical arguments while actively participating in teaching ($p<0.05$). The overall one-sample Wilcoxon signed rank test was significant (T=2,224.0, Z=5.117, p=0.000<0.05) (**Table 5**).

Diversity in Contextual Problem-Based Teaching and Learning

With the exception of cultural diversity allowing teachers to participate in events that are important to the cultural communities of their school, the teachers did not admit the subsequent facts. From **Table 6**, items like; technology makes the teaching of mathematics very easy; cultural diversity helps to develop lesson plans and notes that are culturally relevant for all students; problem-based learning establishes the need to gain knowledge and apply skills in order to answer mathematics questions; and contextual teaching and mathematics provide opportunities for meaningful learning, as all of them were not statistically significant ($p>0.05$).

Diversity and Technology

All question items that appeared under the cultural diversity and technology components (**Table 7**) were tested using a one-sample Wilcoxon signed rank showed positive (p=0.000<0.05) except students' easy understanding of the concept when using technology devices to teach mathematics (Z=2.748, p=0.060>0.05).

Mathematics Classroom Teaching Practices

Despite the several positive achievements of the mathematics classroom teaching practices, as per the result from a one-sample Wilcoxon Signed Rank, teachers listening to their students' voices or opinions in the classroom while teaching mathematics had a p-value greater than 0.05 (p=0.507). However, all the two factored components under the mathematics classroom teaching practices were significant with a p-value greater than 0.05 (**Table 8** and **Table 9**).

Overall Achievement of Factored Constructive Instructional Practices

A one-sample Wilcoxon signed rank test on the factored components, CPB, TEM, and DTT showed that the teachers rated their constructive instructional teaching and learning of mathematics to be significantly higher than neutral (either agreed or strongly agreed) ($p<0.05$). However, they see cultural diversity in CPB and learning as not significant as most responses were either strongly disagreed or disagreed (T=1,376.5, Z=-0.257, p=0.797>0.05) (**Table 10**).

The overall summary of the constructive mathematics classroom teaching practices prove to be very significant as most respondents

Table 8. One-sample Wilcoxon signed ranked test for DA (Test value=3 from 5-point Likert-scale & n=78)

Variables	TS	SE	Z	AS
I demonstrate models of math patterns in a classroom (F5)	1,416.0	118.440	5.218	.000
I use pedagogical way of asking student question (F6)	1,881.0	140.536	6.212	.000
I connect classroom math with students' everyday life (F13)	2,252.5	154.176	7.002	.000
I apply continuous assessment through different tools (F10)	1,894.0	144.776	5.899	.000
I give students math assignments to keep them busy at home (F9)	1,555.0	125.111	5.591	.000
I challenge my students with creative questions in problem-solving (F12)	988.5	93.931	4.264	.000
Overall DA	2,662.5	189.110	6.544	.000

Note. TS: Test statistics; SE: Standard error; Z: Standard test statistics; & AS: Asymptotic Sig. (2-tail)

Table 9. One-sample Wilcoxon signed ranked test for CP (Test value=3 from 5-point Likert-scale & n=78)

Variables	TS	SE	Z	AS
I consult textbooks while teaching any topic of math content in the JHS (F2)	1,449.0	141.375	3.119	.002
I use TLM to develop the level of students' thinking during math lessons (F4)	1,240.0	130.939	2.482	.013
I use the curriculum for planning lessons and activities to teach Math in the JHS (F1)	1,649.5	141.263	4.541	.000
I encourage the students to ask questions in the classroom (F7)	991.5	103.304	3.180	.001
I use technology to connect abstract concepts to real-life situations during math lessons (F3)	1,073.5	120.915	2.043	.041
I listen to my students' voices or opinions in the classroom while teaching math (F11)	1,035.0	134.882	.664	.507
I form groups of students when solving math problems (F8)	709.5	76.698	3.364	.001
Overall CP	1,975.5	177.992	3.716	.000

Note. TS: Test statistics; SE: Standard error; Z: Standard test statistics; & AS: Asymptotic Sig. (2-tail)

Table 10. One-sample Wilcoxon signed rank test constructive instructional approaches (Test value=3 from 5-point Likert-scale items & n=78)

Variables	CPB	TEM	DCP	DTT
Test statistic	2,145.000	2,513.500	1,376.500	2,267.500
Standard error	196.857	196.610	188.838	188.287
Standardized test statistic	3.269	5.147	-.257	4.475
Asymptotic Sig. (2-sided test)	.001	.000	.797	.000

Table 11. One-sample Wilcoxon signed rank test constructive classroom practices (Test value=3 from 5-point Likert-scale & n=78)

Variables	MCP	
	DA	CP
Test statistic	2,662.500	1,975.500
Standard error	189.110	177.992
Standardized test statistic	6.544	3.716
Asymptotic Sig. (2-sided test)	.000	.000

Table 12. Spearman's bivariate rank correlations matrix

Variables	CPB	TEM	DCP	DTT	MCP
CPB	1	.726**	.484**	.595**	.776**
TEM	.726**	1	.295**	.590**	.714**
DCP	.484**	.295**	1	.370**	.482
DTT	.595**	.590**	.370**	1	.511**
MCP	.776**	.714**	.482**	.511**	1

Note. **Correlation is significant at the 0.01 level (2-tailed)

either agree or strongly agree, showing a p-value less than 0.05 in the one-sample Wilcoxon signed rank test (**Table 11**).

Demographic Differences

The male-female ratio of 37:2 and professional teachers' dominance in both public and private schools could not permit the examining to show if there was a significant difference between male and female teachers on all the factored components using a Mann-Whitney U test. Likewise, for age, higher education level, and teaching experience, independent samples Kruskal-Wills test's multiple comparisons were not performed because the overall test did not show significant differences across the selected items.

Correlation Between CPB, TEM, DCP, DTT, and MCP

Spearman's rank correlations were used to study the association between factored variables CPB, TEM, DCP, DTT, and MCP that are non-normally distributed (**Table 12**). Per the results studied row-wise, the correlation analysis showed that CPB has the greatest association with MCP and the least associated with DCP (0.776 and 0.484, respectively). TEM showed a strong positive correlation with CPB (0.726) and a weak positive correlation with DCP (0.295). Interestingly, DCP shows a weak positive correlation with all the factored variables.

DTT also showed strong positive correlations with CPB (0.595) and TEM (0.590) but weak strongly associated with DCP (0.370). Mathematical classroom teaching practices (MCP) showed a positive correlation coefficient of 0.776, 0.714, 0.511, and 0.482 when associated with CPB, TEM, DTT, and DCP, respectively.

DISCUSSION

The overall data quality was very good and reliable. It was due to how the researchers made sure that only the targeted mathematics teachers responded to the questionnaire. This enabled the mathematics teachers to give out whatever experience and knowledge they had about the constructive instructional approaches and CP in the teaching and learning of mathematics at the JHS. Interesting enough, female mathematics teachers are minimal in these three districts as the number difference between them and men is very wide. The more female teachers join in the teaching of mathematics, the more it motivates female students as well in the study of mathematics. Teachers from the colleges of education are posted directly to the basic schools. That is why the majority of them have teaching experience of fewer than six years, with many having a diploma as their highest degree and being of a younger age. Interestingly, all the respondents were professionals, including teachers in private schools. This is because the majority of private schools have handed over their JHS to the government.

The findings revealed in support of ChoiKoh (2009) that teachers are greatly aware of how the mathematics curriculum allows them to use multi-cultural materials in their content and to use students' cultural knowledge in the classroom when teaching and learning take place but do not admit it to help in the development of lesson plans and notes. This to some extent affirms the work of Katwibun (2013) and Wiest (2001), who indicated the awareness educators provide in educating teachers on the need to recognize diversity in their respective classrooms. On the other hand, teachers are glad to celebrate and participate in events that are important to the cultural communities of their respective schools but fail to recognize and respect the cultural protocols of their students and their families when teaching them, which may undermine the demand for an integrated, constructive classroom as stressed by Harris and Alexander (1998).

It's worth noting that teachers disagree that technology makes teaching mathematics very simple, and they don't believe that using technological gadgets ensures that students learn mathematical concepts. This supports Borba et al. (2016)'s findings, which warn teachers against using the classroom as a space for augmentation and interpretation rather than direct instruction, raising concerns about the need to study the different blended learning teacher training options. However, they are of the strong view that it helps students to get involved in the lesson, which makes them come up with good pictorial representation and also increases their desire for mathematics lessons when it is being delivered with any technological device.

Contextual teaching and learning approaches were approved by the teachers as essential for learners to employ mathematics in their daily decision-making by relating their knowledge to real-life circumstances. As a result, they made mathematics less stressful to study. Nevertheless, they never admit it to create opportunities for meaningful learning and, as a result, make learning the fundamentals of mathematics quite simple.

These findings, confirmed by Hmelo-Silver (2004) and Wood (2003), indicate that teachers were very skeptical about problem-based learning, although they believed it to incorporate revision and reflection during teaching and learning and also permit students to present their work to other people beyond their classmates and teachers for assistance. The rest of the provided items were not significant and were rejected. This implies that it never pushes students to become the drivers of their learning. Neither does it help students to organize tasks around open-ended questions, nor does it establish the need to gain knowledge, understand concepts, and apply skills in order to answer driving questions. This goes contrary to Demirel and Dagyar's (2016) findings on problem-based learning to have a moderate positive impact on the students' mindset and attitude toward learning mathematics.

All the five items appearing under experience mathematics (EM) were well acknowledged, indicating the strength of activities with an emphasis on projects. The respondents believe supporting Cooney and Wiegel (2003) view that it makes students actively participate in the teaching and learning when the teacher is full of experience. It also develops creativity by using both new and alternative ideas through rational thinking and logical argument, and, as a result, provides a mathematical understanding of real-life experiences. project works. It is no surprise that Johnson (2012) emphasized how much fun it is for students to learn in their own environment and EM for themselves rather than just learning and taking notes.

The four components (CPB, TEM, DCP, and DTT) derived from the five constructive instructional learning approaches mashed up showed how teachers rated them to be significant, except DTT ($p=0.797>0.05$), which received a negative response from the respondents. More education, as stated by Katwibun (2013), must be given to our mathematics teachers to cautiously use the instructional strategies to connect through diversity with the aid of technology during the teaching and learning of mathematics.

Apart from that, teachers praised the combination of CPB and learning, technological experience in mathematical teaching and learning, and cultural diversity in problem-based teaching and learning approaches, which they believe should be considered when teaching mathematics in the frame of reference of well-organized and closely watched mathematics classroom teaching practices.

The spearman's rank correlations showed strong correlations between all the factored components, including the mathematics classroom teaching practices. It is possible for teachers to blend cultural diversity with other instructional approaches, as successfully done in South Korea as indicated by ChoiKoh (2009) for diverse students in mathematics education including multicultural education. However, teachers should be cautious when blending cultural diversity with any other constructive instructional approach as the matrix row of DCP recorded the lowest correlation coefficients with all the associated factor components, especially with TEM (0.295) and DTT (0.370).

Limitation and Strength

This is the first study of its sort in Ghana, with the goal of determining the constructive instructional mathematical teaching and learning approaches, as well as their CP, utilized by teachers in JHS. In addition to its originality, important results about the factored components were obtained, showing how well teachers have embraced constructive approaches in the teaching and learning of mathematics at the junior high level, except for diversity in teaching with technology. This study produced novel findings in the domains of CPB, technological experience in mathematics teaching, diversity in CPB, and diversity in technological teaching with regards to DA and CP.

Despite the study's strengths, there are a few caveats. Firstly, the study questionnaire prohibited participants from providing insights or justifications for their choices. Secondly, there was a lack of sample randomness, which could be the explanation for the lack of substantial demographic connections with the main components of the research, notably expanding the population area to include more female mathematics teachers in a future study. Finally, because of time constraints, this research employed a quantitative methodology, which might be augmented by a mixed-method research study to acquire a more thorough grasp of the study's major areas.

CONCLUSION AND IMPLICATIONS

This study looked at mathematics teachers' constructive instructional teaching and learning methodologies, as well as their mathematical classroom teaching practices, in three different districts of Ghana. The 78 mathematics teachers who took part in this study were chosen using a purposeful random sample procedure. The IBM SPSS-26 was used to run the non-parametric one-sample Wilcoxon signed-rank test, independent samples Kruskal-Wallis test, and Spearman's bivariate rank correlations test on the data. Female mathematics teachers are very rare in the JHS of the selected districts. Contextual problem-based, technological experience in mathematics, and cultural diversity in problem-based teaching and learning blended approaches were statistically significant and would be recommended to JHS mathematics teachers to adopt and implement them within a rich CP environment. Diversity in teaching with technology must be given a critical look in light of the study's factored components as the world has now become more diversified amid this technological generation. When integrating cultural diversity with any of the teaching and learning methodologies, especially with technology, mathematics teachers in junior high as well as other higher educational settings must pay close care, as they are like "water and fire," very valuable but potentially dangerous at times. The concern is, if the findings from junior high teachers are tempered by caution regarding the mixed constructive teaching strategy in light of diversity and technology, what might be the observations of mathematics teachers in higher education institutions? We suggest that future researchers broaden the studies to either the senior high or tertiary levels, using a mixed methods approach with a larger sample space, in a bid to address the gender inequality among mathematics teachers and ensure that opinions on their responses are well recognized as necessary for the findings to be very extensive.

Author contributions: All authors were involved in concept, design, collection of data, interpretation, writing, and critically revising the article. All authors approve final version of the article.

Funding: The authors received no financial support for the research and/or authorship of this article.

Declaration of interest: Authors declare no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

REFERENCES

Afni, N., & Hartono. (2020). Contextual leaching and learning (CTL) as a strategy to improve students' mathematical literacy. *Journal of Physics: Conference Series, 1581*(1), 12-43. https://doi.org/10.1088/1742-6596/1581/1/012043

Akhigbe, T. (2019). Cognitive-behaviourism, constructivism and humanism in paediatrics specialty training: From theory to practice. *International Journal of Medical Reviews and Case Reports, 30*(10), 628-631. https://doi.org/10.5455/IJMRCR.Cognitive-Behaviourism-Constructivism

Albeshree, F., Al-Manasia, M., Lemckert, C., Liu, S., & Tran, D. (2022). Mathematics teaching pedagogies to tertiary engineering and information technology students: A literature review. *International Journal of Mathematical Education in Science and Technology, 53*(6), 1609-1628. https://doi.org/10.1080/0020739X.2020.1837399

Aliakbari, F., Parvin, N., Heidari, M., & Haghani, F. (2015). Learning theories application in nursing education. *Journal of Education and Health Promotion, 4*(2), 2.

Alicia, J., & Dusing, S. (2020). *Encyclopedia of infant and early childhood development*. Elsevier.

Allen, D. E., Donham, R. S., & Bernhardt, S. A. (2011). Problem-based learning. *New Directions for Teaching and Learning, 2011*(128), 21-29. https://doi.org/10.1002/tl.465

Al-Rahmi, W., Aldraiweesh, A., Yahaya, N., Bin Kamin, Y., & Zeki, A. M. (2019). Massive open online courses (MOOCs): Data on higher education. *Data in Brief, 22*(1), 118-125. https://doi.org/10.1016/j.dib.2018.11.139

Arends, R. (2013). *Learning to teach*. McGraw-Hill Companies.

Bergen, P., & Parsell, M. (2019). Comparing radical, social, and psychological constructivism in Australian higher education: A psycho-philosophical perspective. *Australia Educational Research, 46*(1), 41-58. https://doi.org/10.1007/s13384-018-0285-8

Bernard, H. R. (2006). *Research methods in anthropology: Qualitative and quantitative approaches*. Altamira Press.

Berns, R. G., & Erickson, P. M. (2001). *Contextual teaching and learning: Preparing students for the new economy. The highlight zone: Research @ Work No. 5*. https://eric.ed.gov/?id=ED452376

Borba, M. C., Askar, P., Engelbrecht, J., Gadanidis, G., Llinares, S., & Aguilar, M. S. (2016). Blended learning, e-learning and mobile learning in mathematics education. *ZDM, 48*(5), 589-610. https://doi.org/10.1007/s11858-016-0798-4

ChoiKoh, S.-S. (2009). A research synthesis on mathematics education for students with diversity including multicultural education, language minority, and social economic status. *Journal of the Korean School Mathematics Society, 12*(4), 389-409.

Cobb, P. (1994). Where is the mind? *Constructivist and Sociocultural Perspectives on Mathematical Development. Educational Researcher, 23*, 13-20. https://doi.org/10.2307/1176934

Cooney, T. J., & Wiegel, H. G. (2003). Examining the mathematics in mathematics teacher education. In A. J. Bishop, M. A. Clements, C. Keitel, J. Kilpatrick, & F. K. S. Leung (Eds.), *Second international handbook of mathematics education* (pp. 795-828). Springer. https://doi.org/10.1007/978-94-010-0273-8_26

De Houwer, J., Barnes-Holmes, D., & Moors, A. (2013). What is learning? On the nature and merits of a functional definition of learning. *Psychonomic Bulletin & Review, 20*(4), 631-642. https://doi.org/10.3758/s13423-013-0386-3

Demirel, M., & Dagyar, M. (2016). Effects of problem-based learning on attitude: A meta-analysis study. *EURASIA Journal of Mathematics, Science and Technology Education, 12*(8), 2115-2137. https://doi.org/10.12973/eurasia.2016.1293a

Doolittle, P. E., & Camp, W. G. (1999). Constructivism: The career and technical education perspective. *Journal of Vocational and Technical Education, 16*(1), 23-46. https://doi.org/10.21061/jcte.v16i1.706

Drew, J. (2015). Using technology to expand the classroom in time, space, and diversity. *Integrative and Comparative Biology, 55*(5), 926-932. https://doi.org/10.1093/icb/icv044

Eisenberg, T. A. (1975). Behaviourism: The bane of school mathematics. *International Journal of Mathematical Education in Science and Technology, 6*(2), 163-171. https://doi.org/10.1080/0020739750060204

Ekanayake, K., Khatibi, A., & Azam, F. (2020). The impact of teacher education and English language education in fostering global citizenship education: A review of literature. *International Journal of Advances in Scientific Research and Engineering, 06*(07), 30-40. https://doi.org/10.31695/IJASRE.2020.33847

Fabian, K., Topping, K. J., & Barron, I. G. (2016). Mobile technology and mathematics: Effects on students' attitudes, engagement, and achievement. *Journal of Computers in Education, 3*(1), 77-104. https://doi.org/10.1007/s40692-015-0048-8

Flavin, E., & Hwang, S. (2022). Examining multicultural research in Korean mathematics education. *Research in Mathematics Education, 25*(1), 45-63. https://doi.org/10.7468/JKSMED.2022.25.1.45

Fox, E. A., Gonçalves, M. A., & Kipp, N. A. (2002). Digital libraries. In H. H. Adelsberger, B. Collis, & J. M. Pawlowski (Eds.), *Handbook on information technologies for education and training* (pp. 623-641). Springer. https://doi.org/10.1007/978-3-662-07682-8_39

Gagne, R. M. (1977). *The consition of learning*. Holt, Rinehart, and Winston.

Govindaraju, F. V. (2021). A review of social cognitive theory from the perspective of interpersonal communication. *Multicultural Education, 7*(12), 488-492. https://doi.org/10.5281/ZENODO.5802235

Hair, J. F., Gabriel, M., & Patel, V. (2014). AMOS covariance-based structural equation modeling (CB-SEM): Guidelines on its application as a marketing research tool. *Revista Brasileira de Marketing* [*Brazilian Marketing Magazine*], *13*(2), 44-55. https://doi.org/10.5585/remark.v13i2.2718

Harris, K. R., & Alexander, P. A. (1998). Integrated, constructivist education: Challenge and reality. *Educational Psychology Review, 10*(2), 115-127. https://doi.org/10.1023/A:1022169018926

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review, 16*(3), 235-266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

Hurtado, S., Dey, E. L., Gurin, P. Y., & Gurin, G. (2003). College environments, diversity, and student learning. In J. C. Smart (Ed.), *Higher education: Handbook of theory and research* (pp. 145-189). Springer. https://doi.org/10.1007/978-94-010-0137-3_3

Hwang, G.-J., & Wu, P.-H. (2014). Applications, impacts and trends of mobile technology-enhanced learning: A review of 2008-2012 publications in selected SSCI journals. *International Journal of Mobile Learning and Organisation, 8*(2), 1-8. https://doi.org/10.1504/IJMLO.2014.062346

Johnson, E. B. (2012). *Contextual teaching and learning*. Crown Press.

Johnson, R. T., & Johnson, D. W. (2018). Cooperative learning: The foundation for active learning. In S. M. Brito (Ed.), *Active learning–Beyond the future* (pp. 12-23). Intechopen. https://doi.org/10.5772/intechopen.73460

Johnston, M. (2016). What more can we learn from early learning theory? The contemporary relevance for behaviour changes interventions. *British Journal of Health Psychology, 21*(1), 1-10. https://doi.org/10.1111/bjhp.12165

Kamphorst, J. C. (2018). Multidisciplinary cooperation by students in a European university of applied sciences. *Journal of University Teaching and Learning Practice, 15*(1), 5. https://doi.org/10.53761/1.15.1.5

Kaplan, D. E. (2018). Behaviorism in online teacher training. *Psychology, 9*(4), 570-577. https://doi.org/10.4236/psych.2018.94035

Kara, M. (2018). A systematic literature review: Constructivism in multidisciplinary learning environments. *International Journal of Academic Research in Education, 4*(1), 19-26. https://doi.org/10.17985/ijare.520666

Katwibun, D. (2013). The need for preparing mathematics teachers for diverse classrooms in Thailand. *Procedia-Social and Behavioural Sciences, 93*(2), 756-761. https://doi.org/10.1016/j.sbspro.2013.09.276

Kay, D., & Kibble, J. (2016). Learning theories 101: Application to everyday teaching and scholarship. *Advances in Physiology Education, 40*(1), 17-25. https://doi.org/10.1152/advan.00132.2015

Krishnamoorthy, R. R., Prelatha, R., David, T. K., & Manikam, M. K. (2021). The implementation of behaviourism, constructivism, and information processing theory in instructional design practice activities–A review. *International Journal of Education and Pedagogy, 3*(2), 37-44.

Lachman, S. J. (1997). Learning is a process: Toward an improved definition of learning. *The Journal of Psychology, 131*(5), 477-480. https://doi.org/10.1080/00223989709603535

Lavicza, Z. (2010). Integrating technology into mathematics teaching at the university level. *ZDM-Mathematics Education, 42*(1), 105-119. https://doi.org/10.1007/s11858-009-0225-1

Masethe, M. A., Masethe, H. D., & Odunaike, S. A. (2017). Scoping review of learning theories in the 21st century. In *Proceedings of the World Congress on Engineering and Computer Science*.

Mohammed, K. K., & Elkhider, I. A. (2016). Applying learning theories and instructional design models for effective instruction. *Advances in Physiology Education, 40*, 147-156. https://doi.org/10.1152/advan.00138.2015

Mukhalalati, B. A., & Taylor, A. (2019). Adult learning theories in context: A quick guide for healthcare professional educators. *Journal of Medical Education and Curricular Development, 6*(1), 2382120519840332. https://doi.org/10.1177/2382120519840332

Orak, S. D., & Al-khresheh, M. H. (2021). In between 21st century skills and constructivism in ELT: Designing a model derived from a narrative literature review. *World Journal of English Language, 11*(2), 166. https://doi.org/10.5430/wjel.v11n2p166

Paris, S. G., & Winograd, P. (2003). The role of self-regulated learning in contextual teaching: Principles and practices for teacher preparation. *CIERA Archive*. https://files.eric.ed.gov/fulltext/ED479905.pdf

Radford, L. (2008). Theories in mathematics education: A brief inquiry into their conceptual differences. *International Mathematics Union, 1*(1), 1-17.

Rashid, A. H. A., Shukor, N. A., & Tasir, Z. (2015). Enhancing collaborative reasoning skills in online learning. In *Proceedings of the 2015 IEEE Conference on e-Learning, e-Management and e-Services* (pp. 103-109). https://doi.org/10.1109/IC3e.2015.7403495

Reigeluth, C. M. (1983). *Instructional design theories and models: An overview of their current status*. Lawrence Erlbaum Associates Publishers. https://doi.org/10.4324/9780203824283

Rocca, K. A. (2010). Student participation in the college classroom: An extended multidisciplinary literature review. *Communication Education, 59*(2), 185-213. https://doi.org/10.1080/03634520903505936

Sajedeh, S. H., Tajvidi, G.-R., & Kerremans, K. (2019). Social constructivism in translator education: The stakeholders' needs assessment. *Translation Studies, 17*(67), 39-57.

Schoenfeld, A. H. (1987). *Cognitive science and mathematics education*. Lawrence Erlbaum Associates, Inc.

Schoenfeld, A. H. (2006). Mathematics teaching and learning. In P. A. Alexander, & P. H. Winne (Eds.), *The handbook of educational psychology*. Routledge.

Smagorinsky, P. (2018). DE conflating the ZPD and instructional scaffolding: Retranslating and reconceiving the zone of proximal development as the zone of next development. *Learning, Culture and Social Interaction, 16*(1), 70-75. https://doi.org/10.1016/j.lcsi.2017.10.009

Stoilescu, D. (2016). Aspects of theories, frameworks and paradigms in mathematics education research. *European Journal of Science and Mathematics Education, 4*(2), 140-154. https://doi.org/10.30935/scimath/9460

Sukma, Y., & Priatna, N. (2021). The effectiveness of blended learning on students' critical thinking skills in mathematics education: A literature review. *Journal of Physics: Conference Series, 1806*(1), 012071. https://doi.org/10.1088/1742-6596/1806/1/012071

Syamsuddin, S., & Istiyono, E. (2018). The effectiveness of mathematics learning through contextual teaching and learning approach in junior high school. *AIP Conference Proceedings, 2014*(1), 020085. https://doi.org/10.1063/1.5054489

Tucker, L. R. (1955). The objective definition of simple structure in linear factor analysis. *Psychometrika, 20*(3), 209-225. https://doi.org/10.1007/BF02289018

van Es, E. A., & Sherin, M. G. (2021). Expanding on prior conceptualizations of teacher noticing. *ZDM-Mathematics Education, 53*(1), 17-27. https://doi.org/10.1007/s11858-020-01211-4

Wiest, L. R. (2001). Teaching mathematics from a multicultural perspective. *Equity and Excellence in Education, 34*(1), 16-25. https://doi.org/10.1080/1066568010340103

Williams, C. (2007). Research methods. *Journal of Bus. Economics Research, 5*(1), 65-72.

Wood, D. F. (2003). Problem based learning. *British Medical Journal, 326*(7384), 328-330. https://doi.org/10.1136/bmj.326.7384.328

Xie, C., Wang, M., & Hu, H. (2018). Effects of constructivist and transmission instructional models on mathematics achievement in mainland China: A meta-analysis. *Frontiers in Psychology, 9*(1), 1-18. https://doi.org/10.3389/fpsyg.2018.01923