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Empirical Use of Constructivism in Mathematics Classroom via some topics

By

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Abstract

The study was conducted to examine the practical use of the rule of constructivism in Mathematics classroom in the public primary school levels. As a quasi-experimental study which made use of three research questions and hypotheses, ten mathematics teachers with eight hundred and forty-two pupils were chosen through simple random technique in ten public primary schools in Lagos State, specifically the primary four pupils. 40 multiple choice questions that were adapted from some of the past questions of a notable public examination, cards system of different shapes to arouse the interest of students were cut in line with different topics under geometry in mathematics. Validation of instruments were carried out via the suggestions of some teachers outside the study; reliability of instrument ascertained to be 0.73 after the two consecutive administration of the cards system to set of twenty pupils. Findings showed that there was a significant difference in the pre-and post knowledge of the constructivism group (df = 419, -t-cal<-t-val;

P<0.05; and significant difference in the constructivism and non-constructivism groups (df = 840, t-cal>t-val; P<0.05) The implications of these findings towards meaningful teaching and learning of mathematics in our school system were analyzed in the paper

Key words: Affective, Acceleration, Mathematics, Lesson, Constructivism

Introduction

Learning is an exciting event when the learner understands the concept being taught under a consideration. The best practice to ensure a learner understands the concept which has already being taught is through proper evaluation to ascertain that learning has actually taken place. School subjects play important role in the transformation of an individual into useful element to oneself and to the society in general. This is why due recognition is given to different subject based on the contribution of such subject to the nation education's goal. Mathematics is one of the core subjects at the primary and secondary school levels that every student is expected to learn and make use in life. To this end it has been a compulsory subject to teach and learn for all the stakeholders to an extent that the premium position placed on it could be seen in the periodical allocation of its occurrence in the school time-table coupled with different centre across the nation to compliment its teaching. For instance the establishment of National Mathematics Centre (NMC) in Abuja is a witness to the importance accorded the subject, as the centre has been doing her best to facilitate the teaching and learning of mathematics via different activities such as seminar organization for the teachers, provision of instructional materials to aid teaching and learning, and organizing quizzes competition across all states of federation to promote the learning of mathematics at the grass level. Without any doubt one would have observed that these justification would have had much and pronounced impact on the life of students towards developing deep interest in the subject. Various studies conducted to ascertain the rationale for the non-justification of the students' learning outcome in

School Certificate Examination (WASCE), National Examination Council (NECO) to mention a few showed different reasons towards the perennial students' dismal performance. A report in one of the Dailies of February 22nd, 2009 that was credited to the WAEC Chief Examiner Dr Uwadiae posited that out of all the candidates that sat for the 2008 WAEC examination only 26% were able to get credit in English Language and Mathematics. What a dismal performance is this in spite of the compulsory nature of the subject! In fact table 1 below provides a rhetoric question as to the state of mathematics in the Nigerian Educational system

Table 1: 2008 WAEC Results in three subjects

Subjects	Total	Failure	Passes	Credit	Unavailable	% of Failure
English Language	1,276,025	401,948 (31.50%)	407,052 (31.90%)	446,609 (35.00%)	20,416 (1.60%)	829,416 (65.00%)
Mathematics	1,276,025	220,625 (17.29%)	304,077 (23.83%)	304,077 (23.83%)	447,247 (35.05%)	971,949 (76.17%)
Economics	1,215,245	204,161 (16.80%)	397,021 (32.67%)	596,685 (49.10%)	17,378 (1.43%)	618,560 (50.90%)

Source: Adapted WAEC Result

Going by the above analysis one is not sure if by one day mathematics classroom would not be declared as disaster zone for the learners, and this is inward approach of teaching and learning of mathematics through constructivism way is indispensable.

Theoretical framework on Constructivism

Constructivism could be traced to the Russian art movement in the early 20th century, and it had an important influence on the schools of art. Founded by the Russian sculptor and painter Vladimir Tatlin, its name was derived from the "construction" of abstract sculptures of miscellaneous industrial materials, such as metal, wire, and pieces of plastic. The tenet found its way into academic in the 20s, due to the firm position which it stood for, and as recognized by Vygotsky (1978). In general Constructivism stood for the ideals of abstraction, functionalism, and utilitarianism. Constructivism is first of all a theory of learning based on the idea that knowledge is constructed by the knower based on mental activity. Learners are considered to be active organisms seeking meaning. Constructivism is founded on the premise that, by reflecting on ones experience, one constructs ones

understanding of the world consciously one lives in. Each of everyone generates ones own 'rules' and 'mental' model which one uses to make sense of one experiences. Learning, therefore, is simply the process of adjusting one mental model to accommodate new experiences. Constructions of meaning may initially bear little relationship to reality as in the naïve theories of children, but it becomes increasing more complex, differentiated and realistic as time goes on.

Guiding principles of constructivism is based on the fact that knowledge is constructed, not transmitted, prior knowledge impacts the learning process, initial understanding is local and not global; and finally building useful knowledge structures requires effortful and purposeful activity.
Constructivist learning theory does not necessarily imply that one must follow a 'constructivist' pedagogical strategy but knowledge is constructed as it is found that main stream instructional designer do not adopt an instructional design that is labelled 'constructivist'. Typically, a constructivist teaching strategy is based on the belief that students learn best when they gain knowledge through exploration and active learning. Hands-on materials are used instead of memorizing and reciting facts. Education is centred on themes and concepts and the connections between them, rather than isolation information.

Under the theory of constructivism, educators focus on making connections between facts and fostering new understanding among students. Instructors tailor their teaching strategies to student responses and encourage students to analyze, interpret and predict information. Teachers also rely heavily on open-ended questions and promote extensive dialogue among students.

As result, constructivism calls for the elimination of grades and standardized testing. Instead, assessment becomes part of the learning process so that students play a larger role in judging their own progress.

Dougiamas (1998) describes the major 'faces of constructivism' separately. Each of these types of constructivism is a 'point of view'. perspectives loosely defined by a collection of writings of particula

individuals in each case. These include trivial constructivism which is the simplest idea in constructivism as corroborated by Dougiamas (1998) quoting Von Glaserfed, (1990) as personal constructivism or cognitive constructivism. In this principle, knowledge is actively constructed by the learner, not passively received from the environment.

Another form of constructivism is radical constructivism which adds a second principle to trivial constructivism (Von Glaserfed, 1990). This involves a process of dynamic adaptation towards viable interpretations of experience. The knower does not necessarily construct knowledge of a 'real' world.

Social constructivism or socio-constructivism refers to the social world of a learner that includes the people that directly affect that person, including teachers, friends, students, administrators, and participants in all forms of activity. This takes into account the social nature of both the local processes in collaborative learning and in the discussion of wider social collaboration in a given subject, such as science.

Another type is the cultural constructivism which goes beyond the immediate social environment of a learning situation which is in a wider context of cultural influences, including custom, religion, biology, tools and language. For example, the format of books can affect learning, by promoting views about the organization, accessibility and status of the information they contain.

Critical constructivism constitutes a kind of constructivism which looks at constructivism within a social and cultural environment, but adds a critical dimension aimed at reforming these environments in order to improve success of constructivism that is applied as a referent. In all cases constructivism occurs especially well when the learner is engaged in constructing something for others to see.

Tobin and Tippin, (1993) described the constructivist pedagogy theory as away of thinking about knowing, a referent for building models of teaching, learning and curriculum. This is to say it is a

learning philosophy and at the same time may become a teaching philosophy.

Some common tenets in constructivism connotes that learning is a search for meaning. Therefore learning must start with the issues around which students are actively trying to construct meaning. Meaning requires understanding of a whole as well as parts. And parts must be understood in the context of whole. Therefore, the learning process focuses on primary concepts, not isolated facts. In order to teach well, one must understand the mental models that students use to perceive the world and the assumptions they make to support those models. The purpose of learning is for an individual to construct his or her own meaning, not just memorize the 'right' answers and regurgitate someone else's meaning. Since education is inherently interdisciplinary, the only valuables way to measure learning is to make the assessment part of learning process, ensuring it provides students with information on the quality of their learning.

Constructivism can be used to indicate a theory of communication when one sends a message by saying something or providing information, and one has no knowledge of the receiver, then one has no idea as to what message was received, and one cannot unambiguously interpret the response. Viewed in this way, teaching becomes the establishment and maintenance of a language and a means of communication between the teacher and students, as well as between students. Simply presenting materials, giving out problems, and accepting answers back is not a refined enough process of communication for efficient learning. Some of the tenets of constructivism in pedagogical terms are as follow:

Students come to class with an established world-view, formed by years of prior experience and learning. Even as it evolves, a student's world views filter all experiences and affect their interpretation of observations. For students to change their world-view requires work. Students learn from each other as well as the teacher. Students learn better by doing. Allowing and creating opportunities for all to have a voice to promote the construction of new ideas.

A constructivist perspective views learners as actively engaged in making meaning, and teaching with that approach looks for what students can analyze, investigate, collaborate, share, build and generate based on what they already know, rather than what facts, skills and processes they can parrot. To do this effectively, a teacher needs to be a learner and a researcher, to strive for greater awareness of the environments and the participants in a given teaching situation in order to continually adjust their actions to engage students in learning, using constructivism as a referent.

As a result, Jonassen and Land (2002) suggest three cornerstones for constructivist learning environments namely Context, Construction and Collaboration. These can further be supported by the level of Instructional Design Model (IDM) in Technology (Milrad, 2002) through the under-listed steps:

(i)Authentic activities: present authentic tasks that conceptualise rather than abstract information and provide real-world, case-based context, rather than pre-determined instructional sequences.
(ii)Construction: learners should be constructing artefacts and sharing them with their community.
(iii)Collaboration: to support collaborative construction of knowledge through social negotiation, as supposed to competition among learners for recognition.
(iv)Reflection: fostering reflect the practice;
(v)Situating the context: enables context and content dependent knowledge construction; and,
(vi)Multi-modal interaction: providing multiple representations of reality, representing the natural complexity of the real world.

Statement of the problem

The study was carried out to find out the extent to which the rule of constructivism could aid the students' performance in mathematics as compared to the present state of dismal academic performance of the students. The study specifically sought answers to the under-listed research questions and hypotheses in order to nip in the bud the perennial academic syndrome in mathematics.

RQ_1: What are the pre and post knowledge of students in mathematics based on the rule of constructivism in mathematics?
RQ_2: What is the gender's difference in the academic performance of students after exposure to the rule of constructivism in mathematics?
RQ_3: What are the relationships between pre-test and post-test knowledge of students in mathematics based on the rule of constructivism in mathematics?
As a result the following hypotheses were generated for the study at significant level of 0.05,
Ho_1: There is no significant difference in the academic performance of pre and post knowledge of students in mathematics based on the rule of constructivism in mathematics
Ho_2: There is no gender's difference in the academic performance of pre and post knowledge of students in mathematics based on the rule of constructivism in mathematics
Ho_3: There is no significant correlation in the academic performance of pre-test and post-test knowledge of students in mathematics based on the rule of constructivism in mathematics

Method

Research Design

The study was a quasi-experimental study which tried to develop affective domain in students through an explorative manner as espoused by the rule on constructivism in mathematics learning.

Population

Population to the study included all the mathematics teachers and primary four pupils in all public primary schools in Badagry Local Government Area of Lagos State.

Sample and sampling techniques

Ten classroom teachers and eight hundred and forty-two pupils of primary four were chosen through purposive random technique in ten public primary schools of Badagry Local Government Area of Lagos State. In some schools a total of forty-four pupils and their classroom teachers were selected while in others the numbers were less than forty-four into the study, and having sought the permission of the

school Headmistress and Headmasters who were running a sandwich degree programme at the Lagos State University.

Instrument

Prior to the achievement test which made up of 50 multiple choice questions that were adapted from some of the past questions of a notable public examination, cards system of different shapes to arouse the interest of students were cut in line with different topics under geometry in mathematics. These shapes were to bring into life the meaning and scope of these shaped object ahead of the properties and applications of the object itself. For instance, in testing the student' s knowledge of triangle the idea might be in different directions like definition, area, perimeter or other properties just to mention a few. This is one the principle which the rule of constructivism emphasized that knower ought to have in mind the meaning of concept to analyze a head of the thing to solve, as this would further aid the mastery of the concept as a whole.

Validation of Instrument

Card systems of different shapes were constructed for the teachers' assessment of their names and various properties that could be ascribed to each. The suggestions of these teachers to the dismantling of some of these shapes towards passing their real meaning to the pupils were taken into considerations ahead of their administration to some pupils, requesting them to state the properties of each shape after careful observation and playing around with. Their responses were scored and later the same set of shapes though in different colours were represented to the same set of pupils to do what they earlier requested to in the last couple of weeks, and their responses were also scored.

Reliability of Instrument

The responses obtained from the two consecutive administration of the cards system to set of twenty pupils, requesting them to identify their properties were scored and subjected to the Cronbach Alpha formula which gave the coefficient number of 0.73 as consistent value of the instrument, which could be used to explore the rule of constructivism as far as mathematics learning was concerned.

Administration of Instrument

As a result of large number of pupils to be covered the instrument inform of card system of some shapes in geometry of mathematics were made and used for teaching the classroom teachers, whom the researcher expected the same teaching and rule to be used for the pupils in their various schools and classes. The teaching and learning of these shapes were to be run by the classroom teachers for the next four weeks, though in relation to the different mathematical concepts in geometry. Based on instruction the teachers were to explore an observation technique to pupils to use the card system and how effectively they could relate it to the topics in geometry, and thereafter apply these in test based on the rule of constructivism, earlier mentioned to apply.

Procedures

Every participated mathematics teacher was properly briefed on the rule of constructivism and the objective which the study was out to achieve though with caution that manipulation should be guide against the true reflection of the situation. Teachers were mandated to teach these students some topics in geometry of mathematics via card system, and that students' exploration of these card, which were in different shapes in relation to the concept to learn and understand be emphasized ahead of quizzes to determine the level of understanding and proper use of constructivism.

Data scoring and analyses

Ahead of the application of the rule of constructivism in the teaching of mathematics an achievement test which made up of 40 multiple choice questions was administered indirectly by the researcher to the students, such that the correct and wrong answer attracted one and zero mark respectively. This was to determine the entry knowledge of students in mathematics and to be able to distinct the contribution, if any, of the rule under consideration. At the end of the teaching by these mathematics teachers the original multiple choice questions based on the some concepts where the rule was adopted, were administered to the students in a form of quizzes, and this was marked by the teacher involved. The results in both administrations were

scored and analyzed via simple descriptive statistics mean and standard deviation and the t-test score at 0.05 significant levels.

Findings

RQ$_1$: What are the pre-test and post-test knowledge of students in mathematics based on the rule of constructivism in mathematics?

Table 1: Pre-test and post-test knowledge of Mathematics as measured by Achievement test

		Mean Scores		Standard Deviation	
		Pre-test	Post-test	Pre-test	Post-test
Constructivism	421	38.24	62.19	24.5	9.73
Non-constructivism	421	46.09	38.96	10.3	15.03
Total	842	38.65	41.08	15.3	16.20

With total number of 842 students that took part in the study equal number of 421 belong to the Constructivism and Non-constructivism groups. The pre-test mean scores of the Constructivism and Non-constructivism were 38.24 and 46.09 respectively. An indication that Non-constructivism group was better informed in Mathematics than their counterpart, but in the post-test mean score the reverse was the case. The constructivism group had an enhanced mean score of 62.19 while non-constructivism dropped to 38.96. The rate of deviation of each group was as shown in table 1 above.

RQ$_2$: What is the gender's difference in the academic performance of students after exposure to the rule of constructivism in mathematics?

Table 2: Gender pre-test and post-test knowledge of Mathematics as measured by Achievement test

			Mean Scores		Standard Deviation	
			Pre-test	Post-test	Pre-test	Post-test
	254	Male	40.08	65.55	24.76	9.38
	167	Female	35.45	62.04	23.95	10.18
	180	Male	46.89	39.68	10.11	14.90
	241	Female	45.04	37.85	10.54	15.20
	434	Male	44.63	52.96	13.21	9.87
	408	Female	39.50	41.08	15.11	16.20

Findings also described the influence of gender on the academic performance of students in the two categories where it was observed in the Constructivism group that male perform better than female with the mean score of 40.08 and 35.45, respectively, in the pre-test score; and 65.55 and 62.04 for the male and female, respectively, in the post-test score.

Similarly, findings revealed in the non-constructivism group that male perform better than female with the mean score of 46.89 and 45.04, respectively, in the pre-test score; and 39.68 and 37.85 for the male and female, respectively, in the post-test score.

On the whole, findings showed that male perform better than female with the mean score of 44.63 and 39.50, respectively, in the pre-test score; and 52.96 and 41.08 for the male and female, respectively, in the post-test score.

The main finding in this area lies in the improvement mean score of female students of the constructivism group from the rear to a remarkable point even though not as high as that of their male counterpart. This demonstrates that Mathematics is not exclusive for men as it was in the past, and that meaningful exploration of concept in mathematics as well as matching it with the immediate objects in an environment could spur knowledge of the subject further.

RQ$_3$: What are the relationships between pre-test and post-test knowledge of students in mathematics based on the rule of constructivism in mathematics?

Table 3: Relationship of pre-test and post-test knowledge of Mathematics via Achievement test

Variations	Count	Correlations	Remarks
Pre-test & Constructivism	421	0.958	Very strong
Pre-test & Non-constructivism	421	0.924	Very strong
Total	842	-	-

Table 3 described the correlations of achievements of pre-test scores of students with their corresponding groups. It was found that there were strong relationship between their pre-test scores and their post-test scores according to the groups. By implication this showed that both groups' entry knowledge in Mathematics enhanced their further academic or otherwise in the subject, though treatment given made one group to perform better than others.

As a result the following hypotheses were generated for the study at significant level of 0.05,

Ho$_1$: There is no significant difference in the academic performance of pre and post knowledge of students in mathematics based on the rule of constructivism in mathematics

Table 4: t-test of pre and post knowledge of Mathematics as measured by Achievement test

Variation	Count	df	t-calculated	t-value	Significant
Pre-test & Constructivism	421	419	-24.721		P<0.05*
Pre-test & Non-constructivism	421	419	0.713		P>0.05
Constructivism & Non-constructivism	842	840	22.660		P<0.05*

* Significant (P<0.05)

Table 4 described t-test of pre-test and post-test knowledge of Mathematics via the achievement test where it was found that there was a significant difference in the pre-and post knowledge of the constructivism group (df = 419, -t-cal<-t-val; P<0.05); there was no significant difference in the pre-and post knowledge of the non-constructivism group (df = 419, t-cal<t-val; P>0.05) but much significant difference in the constructivism and non-constructivism groups (df = 840, t-cal>t-val; P<0.05)

Ho$_1$: There is no gender's difference in the academic performance of pre and post knowledge of students in mathematics based on the rule of constructivism in mathematics

Table 5: Gender t-test of pre and post knowledge of Mathematics as measured by Achievement test

Variation	Gender	Count	df	t-calculated	t-value	Significant
	Male	254				
	Female	167				
	Male	180				
	Female	241				
	Male(C)	254				
	Female(N)	241				
	Male(N)	180				
	Female(C)	167				

Table 5 described the general effect of gender on the academic performance of students within the classified group as there was generally no significant gender difference in the academic performance of the students across all the two groups and even within.

Ho_1: There is no significant correlation in the academic performance of pre-test and post-test knowledge of students in mathematics based on the rule of constructivism in mathematics

Table 6: t-test relation of pre-test and post-test knowledge of Mathematics via Achievement test

Variations	Count	Correlations	Remarks	t-cal	t-val	Significant
Pre-test & Constructivism	421	0.958	Strong	1.837		0.067
Pre-test &Non-constructivism	421	0.924	Strong	1.956		0.051
Total	842	-	-	-		-

To estimate the level of relationship of the pre-and post test scores of the constructivism and non-c onstructivism groups relatively to their strong correlations study showed that there was no significant difference in the pre-and post knowledge of each group as any improvement recorded must been as a result of the treatment given to a particular group and not as a result of their entry knowledge/ scores, and as shown in table 6 above..

Discussions

In the analysis of epistemology as corroborated by Plato (428-347 B.C) reality is nothing but the activity of one's own mind and that nothing really exists or can be known to exist but one's own mind and

its thoughts. The mind, on the other hand, is active and, indeed, is able to produce and sustain modes of being that would not otherwise exist; that natural objects exist in human experience is affected by the activity of the mind, and attention to this influence is essential if inquiries concerning the world are to be scientific. For meaningful learning to take place at all human minds need to configure the real object ahead of translation into real life situation. It when an individual construct within his mind that other uses of what he has learnt could have meaning to his knowledge. For instance students that were exposed to concept like 'Triangle' need to configure three shapes object in min before subsequent teaching of properties, and other features of triangle are introduced. By these processes students would be in better position to manipulate any three sided object rather mere teaching of critical parts as against the configuration of the object towards proper understanding. This position was also shared by Vygotsky(1978) when analysing the state of mind relatively to the rule of constructivism.

Meanwhile, study has shown that much of the integration of the affective domain among the students could be enhanced when they are left to discover things by themselves and at the same time reduce much teaching from the teachers. The entire teacher needs to do is to make the learning environment conducive for the students to explore. Furthermore, one could observe that the application of the rule of constructivism could help along way to reduce if not totally eradicated the 'phobia' syndrome among the learners where the issue of gender are not perfectly pronounced to have made a significant impact on the academic performance of students so far all are exposed to the rule in the teaching. This is to say that much interest could be won from all liberal inclined students to show more interest in the studying of mathematics, and by extension meaning that caring for female is synonymous to wining a family. Finally, the much fasten of teeth to examination syndrome of evaluating students is reduced as students are judged on continuous practice which the teacher would grade in the end to establish the understanding or otherwise of the concepts taught/learnt as the case may be. In fact hearing of the on-coming examination in most cases does send jittering into the minds of many students, and as such make them to loose tracks of all what

they had learnt in the past. Hence, examination should not be sole instrument of evaluating the suitability or otherwise of students in any school activities, instead the continuous assessment should complement the development of human being.

Implication

Findings have shown that it not that mathematics is difficult as it could have been perceived in some quarters by students but that those to make the learning environment more meaningful do not actually understand that they are not knowledge dispensers instead that are knowledge facilitators. It is when the students are made to discover things by themselves that mathematics teacher would realize much sweat he has been engaged on the fruitless activities could translate to meaningful learning. More activities should be designed for the learners to explore and discover things by themselves rather than teaching to pass alone. This is to say that more attention should be given to the application of teaching aids that have close relationship with the immediate environment of the students and explored accordingly. This would reduce the compartmentalized knowledge assimilation that would make students not function at the end of the learning period.

Conclusions

In a bid to improve the academic performance of students in mathematics it is imperative for the mathematics teachers to see themselves as knowledge facilitators as against the knowledge dispensers. This would allow the students to construct the ideas within themselves so that teacher could bring the constructed ideas into real live situation. Mathematics teachers should not bombard the students with so many concepts at a time under guise that they wanted them to prepare them for a prescribed examination, instead they give students functional education that make these students relate the knowledge gained to practical life situation.

Recommendations

Sequel to the findings of the study it could be recommended that stepwise teaching of any mathematical concept should be the paramount aspect of teaching to all the teachers of mathematics. For

instance it would be wrong of a good mathematics teacher to start discussing the concept of 'Bearing' in mathematics to the students who had not been taught 'Trigonometry' that would be used as index topic to facilitate the understanding of the real topic of the day. Or what could someone expect of students that asked to understand the area of 'Scalene' triangle when they have not been taught the properties of triangle? Definitely nothing concrete could be achieved. As a result, it behoves on all the mathematics teachers to see mathematics as language which students could explore towards finding solution to their immediate needs instead putting it across to the as weapon of destruction. This in turn might make the classroom of mathematics a grave-yard which could spell doom for the development of science and technology as a whole. As soon as science and technology refuse to move then the existence of all and sundry remained stagnant going by the influence of the duo on the living standard and the corresponding geometric population. Finally, it is high time students should be made to see mathematics as manipulative instruments via teachers' exploration of environment that makes their minds configure the object to learn by themselves as against the presence cognitive saturation. Hence the need to emphasize quizzes in place of test/examination in mathematics at all time.

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