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Teaching of Construction of Common Angles in the Junior High School: An Interventional Study

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Abstract: Common angles are one of the geometric constructions in Mathematics that contribute to pupils at Mother of Mercy Junior High School performing poorly on both internal and external examinations. Action research was employed to assist the pupils of Mother of Mercy Junior High School Form Two in overcoming their difficulties in constructing common angles. An Activity-based learning, as opposed to asking pupils to simply listen and take notes, was sought to remedy pupils' difficulties constructing common angles. There were teaching and learning resources used in a well-structured class. To determine the impact of the interventional teaching tactics, assessments at the pre- and post-testing phases were used. A whole-class sampling technique was used to sample the pupils of Mother of Mercy Junior High School Form Two. Observation, interviews, and tests were the research instruments used in obtaining the data for the study. On the pretest, which revealed the degree of the pupils' poor performance in the abstract manner of teaching before the study's intervention, 78% (a total of 39) of the fifty pupils scored below the average mark of 5-7. However, the posttest findings show that 92% of pupils (a total of 46) got the average mark of 5-7, and above following the intervention, which involved pupils undertaking practical exercises and tasks. The posttest results revealed impressive performances. The study found that by using activity-based teaching strategies and instructional materials effectively, pupils' level of performance significantly increased. The study inspired a recommendation that the educational governmental organisations and non-governmental organisations in Ghana should share mathematical sets (instructional material) with the junior high school pupils at the onset of their studies and not on the day of examination. This will help improve their general performance in the examination when it comes to common angles in geometry.

Keywords: Abstract, Activity-Based Learning, Common Angles, Constructions, Geometric

1. Introduction

Due to a dearth of sufficient Teaching and Learning Materials (TLMs), teaching the construction of angles as a sub-topic of geometric construction has historically proven difficult in many Ghanaian high schools. A pair of compasses and a ruler (straightedge) are the two necessary instruments needed to make an angle. Despite the fact that students in industrialized nations have had varied experiences with the arrival of computers, these tools continue to be essential when discussing geometric building as a topic in mathematics in Ghana. Students in industrialized countries make use of geometry learning-aided computer software like GeoGebra, and it helps improve their understanding of the various concepts in geometry, including angles [9, 10]. The method of measuring angles is absolutely necessary and critical for creating angles [5, 6].

Such methods are expected to realign and rearrange in a more efficient way as conceptual understanding advances [10]. Although structures are a crucial component of geometry instruction, they also serve other purposes. Some pupils might find some geometric ideas to be a little abstract. However, when geometric architecture is properly taught and linked to the actual construction of common angles like 60°, 90°, and 360°, the idea becomes more concrete in the students' minds. Only a pair of compasses, a straightedge (ruler), and a pencil are required for these creations [19]. These tasks have an impact on pupils because they focus their attention on a certain topic and show them how to absorb information [7].

According to [8, 12] the three cognitive processes that make up the cognitive approach to geometry are: reasoning processes, construction processes (using tools), and visualization processes, such as the visual representation of a geometrical proposition (notably discursive methods for knowledge expansion). Early angle education, according to [15, 16] should foster a growing awareness of angle in various circumstances. The West African Examination Council (WAEC), who conducts the Basic Education Certificate Examination (BECE) every year, revealed that Junior High School (JHS) pupils in Ghana perform poorly in geometry compared to pupils in other countries, demonstrating the appalling performance in mathematics among JHS pupils [4, 20]. Ghanaian Governmental Organisations and Non-Governmental Organisations (NGOs) donates mathematical sets to the BECE candidates on the day of examination to help improve pupils performance [1, 11, 14, 17] yet the 2019 Chief Examiner's report of BECE on candidates' weaknesses include their inability to find angle in triangle which is a sub-topic in geometric constructions in Mathematics. It has been proven that the best way to foster successful learning is through excellent interventional design. The cognitive processes or techniques that are essential for learning should be provided by instructional approaches [21]. It has also been established that the Concrete Representational Abstract (CRA) intervention is an effective educational tool for introducing students to mathematical concepts and procedures and motivating them to solve problems in mathematics [2]. It is challenging to successfully develop and implement CRA interventions in the regular classroom to improve students' mathematical learning due to the lack of methodological guidelines or instructional design support for instructors [23]. These difficulties led to the introduction of a different interventional design (the conventional teaching approach). The conventional instructional approach, or "classroom teaching," focuses on abstract concepts and makes use of a few images and sketches on the chalkboard or whiteboard. The structure of the regular method of instruction is as follows: offering pertinent material, presenting pertinent information, having student develops exercises, and providing ongoing feedback from the teacher [13, 23].

Reasoning abilities are a crucial part of education, and understanding mathematics in particular requires them. They also provide a crucial method for developing concepts. The capacity to create and express a specific mathematical issue as well as to defend and explain the answer or argument is known as mathematical reasoning. If abstract teaching is reduced, mathematics education can be improved. The impact of the mathematics lesson is larger than that of relational learning when students participate in a variety of classroom activities. And the activity-based learning will contribute to students' great performance in the geometric construction of common angles through proper use of the pair of compasses and ruler [6].

The Difficulty of Pupils in Learning the Common Angles: Pupils' performance is directly impacted by the pedagogical strategy teachers use to engage junior high school pupils in thinking, reasoning, and problem solving. Teaching and learning are challenging in our classroom, though, because of the high-class size and inadequate or nonexistent of teaching and learning materials (such rulers, compasses, et cetera) [3, 18, 24].

The concepts of using a ruler and a pair of compasses were beyond the comprehension of the pupils. This was demonstrated by how well they did on the pretest (Table 2). Lack of TLMs and an abstract teaching style are to blame for pupils having trouble drawing angles. The insufficient supply of relevant TLMs has significantly hampered pupils' ability to comprehend how to generate common angles [22]. It is impossible to exaggerate how crucial effective TLMs are for teaching a topic like geometry, which serves as the basis for engineering and technological development. In order to determine if pupils at Mother of Mercy JHS will understand how angles are constructed, this study used the right resources and teaching strategies.

2. Materials and Methods

For eight (8) days, a case-control interventional investigation was carried out. A pre-intervention test (pretest) was conducted on the first day, and a post-intervention test was conducted on the last day (posttest). The survey included all the fifty (50) second-year pupils from Mother of Mercy JHS in Kassena Nankana West District Assembly. They were 19 (38%) girls and 31 (62%) boys.

2.1. Pre-Intervention

The pre-intervention phase is the first in the intervention process. The abstract technique of instruction was used to help pupils answer questions during a lesson in the classroom about the concept of angles in order to present a clearer perspective.

Responses from pupils were appalling. It was clear that the children had difficulty drawing angles. Using a test as a data collection instrument, the degree of the pupils' conceptual difficulty with common angles was assessed.

2.2. Pretest

A teacher-made pretest was used to gauge the pupils' understanding of how to construct angles using a ruler and a pair of compasses. Consequently, the fifty (50) pupils were given ten questions. The exam was graded and given a final grade of ten (10). A printed question sheet and an answer sheet were distributed to each pupil. The test took the pupils forty-five (45) minutes to complete. The pretest was taken by all of the pupils. Due to the subpar performance of the pretest results, pupils' workbooks were examined to determine their level of topic knowledge and comprehension. To determine the reasons behind the pupils' poor performance, Mother of Mercy Junior High School's regular teachers were interviewed.

2.3. Intervention

Having followed the trend of affairs that led to the development of Mother of Mercy JHS Form Two finding it difficult to construct common angles, an action research was carried out to improve the pupils' performance. The duration of the research intervention was six (6) days. Daily lessons lasted for one hour was carried out. Before the activities were carried out during the intervention of the study, lesson plans for the topic, "construction of common angles," was planned. To encourage pupils' participation in the classes, drawing tools such as rulers, a pair of compasses, and a pencil were used during the lesson delivery.

The activities that were carried out are as follows:

2.3.1. Day One

As an introductory lesson, the aim of the lesson was to help people get the concept of angles, the meaning of an angle and situations in which angles are formed. Pupils had learnt the concepts of lines, so pupils' relevant previous knowledge was used. The day's lesson was started by asking pupils questions related to the topic, 'lines'. For example,

1) What is a line?
2) List the different types of lines.
3) What is the use of lines?

The pupils were guided to brainstorm the meaning of an angle and situations in which angles are formed. The pupils were then given an exercise on the topic "Lines" and were marked.

2.3.2. Day Two

The aim of day two lesson was to take the pupils through the types of angles and their various meanings. The lesson was introduced by asking pupils questions related to the previous topic, "Lines". The pupils were guided to state the meaning of the basic types of angles. Included in this list are acute, obtuse, reflex, right, straight, complementary, and supplementary angles. The pupils were then given an exercise on the topic "types of angles" and were marked.

2.3.3. Day Three

The aim of day three lesson was to help pupils explain common angles and give some examples. Prior to starting the class, questions about the preceding subject, "angles," were posed to the pupils. Before beginning the class, questions about various types of angles were posed to the pupils. The pupils were assisted to brainstorm the meaning of common angles after which an exercise on the topic "common angles" was given and marked.

2.3.4. Day Four

The aim of day four lesson was to help pupils identify drawing instruments and their uses. The lesson was introduced by asking pupils questions related to the previous topic, "common angles". The pupils were assisted to brainstorm "drawing instruments and their uses". The pupils were then given an exercise on the topic "drawing instruments and their uses" and were marked.

2.3.5. Day Five

The aim of day five lesson was to help pupils sketch angles to hone their skills in drawing. The lesson was introduced by asking pupils questions related to the previous topic, "lines". Free-hand sketches of some common angles (60°, 90° and 45°) shown in Figures 1, 2, and 3 were made on the chalkboard for pupils to observe and made same unto their workbooks. The pupils' workbooks were checked marked.

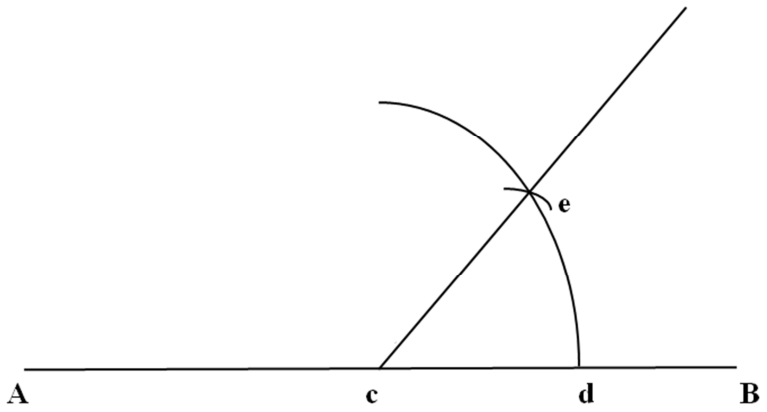

Figure 1. *Construction of angle 60 degrees.*

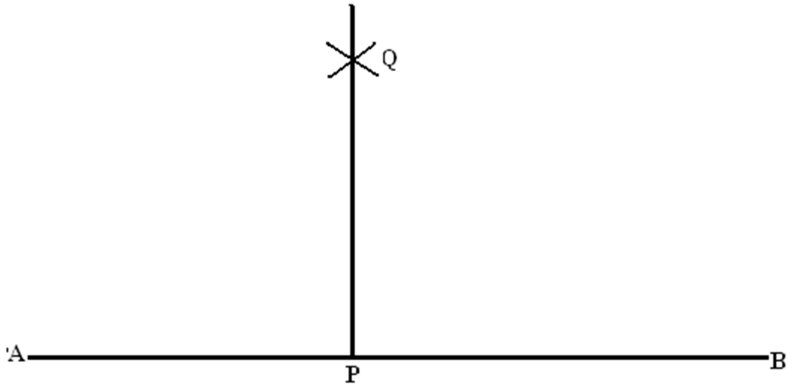

Figure 2. *Construction of angle 90 degrees.*

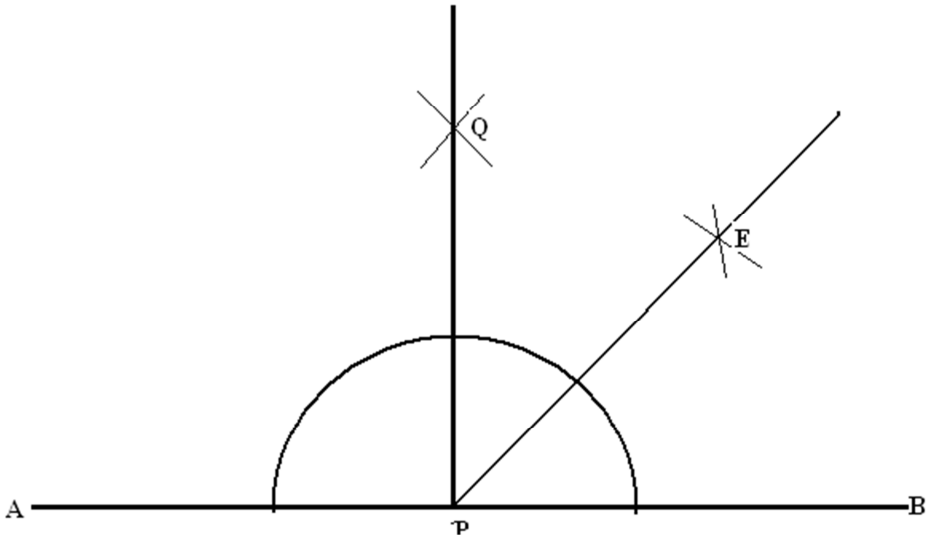

Figure 3. *Construction of angle 45 degrees.*

2.3.6. Day Six

The aim of day six lesson was to help pupils draw the common angles sketched previously. The lesson was introduced by asking pupils questions related to the previous topic, "uses of lines". The pupils were guided to draw the common angles in their workbooks using drawing instruments.

2.4. Post-Intervention

Posttest was conducted after the intervention to ascertain how effectiveness of the activity-based method. The posttest was conducted using a different test that had the same guidelines and prerequisites as the pretest. The posttest was completed by all the fifty (50) pupils of Mother of Mercy JHS.

The results obtained from both pretest and posttest were analysed using excel and frequency distribution table.

3. Results

The distribution of pretest scores for the creation of common angles is shown in Table 1.

None of the pupils received more than 8 marks. Table 2 displays a summary of Table 1 pretest performance. According to Table 2, out of the fifty (50) pupils, 37 pupils representing 74% had grades that were below the average scores of 5-7 for the abstract mode of instruction. Four (4) pupils representing 8% scored higher than the average mark, whereas nine (9) pupils representing 18% scored the average mark of 5-7.

Table 1. *Shows the distribution of pretest results for the construction of common angles.*

Marks	Pupils	Percentage (%)
0	5	10
1	19	38
2	4	8
3	5	10
4	4	8
5	3	6
6	3	6
7	3	6
8	4	8
9	0	0
10	0	0
Total	50	100

Table 2. *A Summary of Pupils' Pretest Results.*

Marks	Number of pupils	Percentage (%)	Remarks
0-4	37	74	Below average
5-7	9	18	Average
8-10	4	8	Above average
Total	50	100	

Table 3 presents the posttest scores distribution on the construction of common angles. The overall posttest results for Table 3 are shown in Table 4. After using the activity-based method to teach the construction of common angles, twenty (20) pupils representing 40% of the fifty (50) pupils, scored the average mark of 5-7, whereas twenty (26), representing 52%, got over the average mark, which ranged from 5-7.

Table 3. *Posttest score distribution on construction of common angles.*

Marks	Pupils	Percentage (%)
0	0	0
1	0	0
2	0	0
3	2	4
4	2	4
5	4	8
6	10	20
7	6	12
8	4	8
9	20	40
10	2	4
Total	50	100

Table 4. *Summary of Pupils Posttest Performance.*

Marks	Number of pupils	Percentage (%)	Remarks
0-4	4	8	Below average
5-7	20	40	Average
8-10	26	52	Above average
Total	50	100	

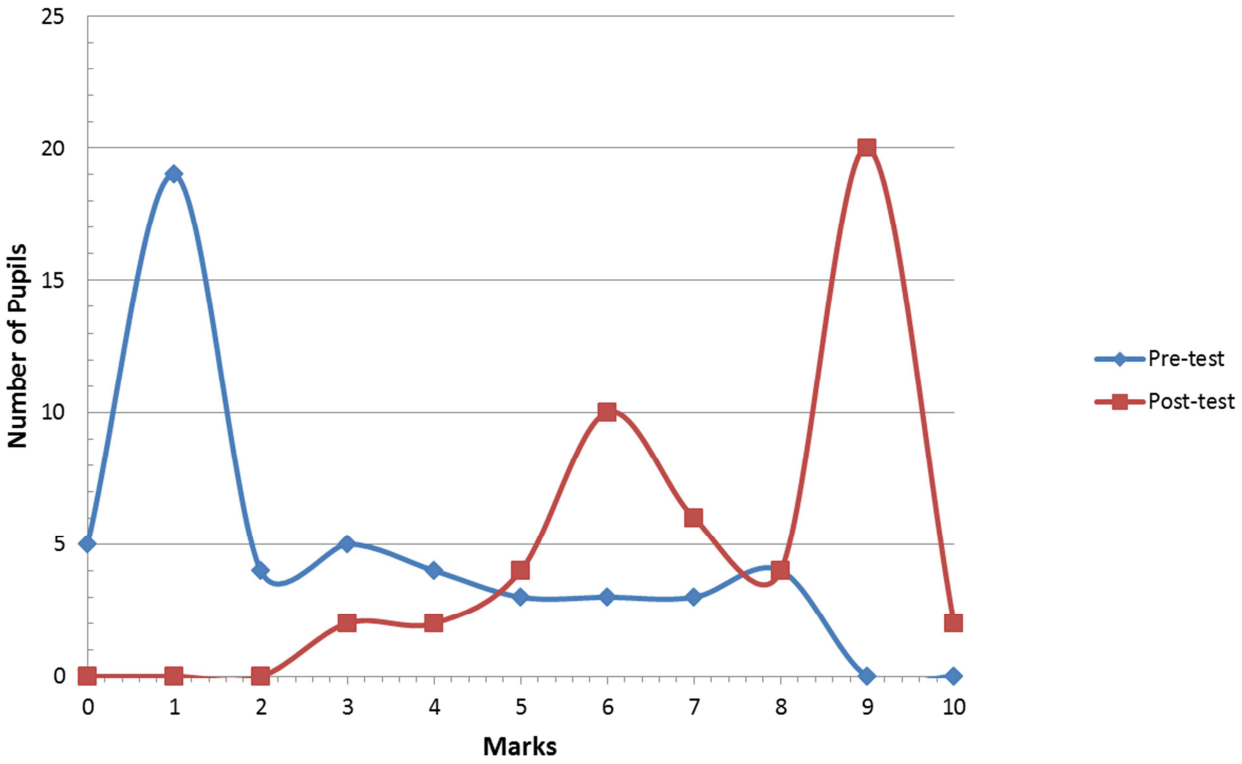

Figure 4. *Experimental analysis of pupils' performance using abstract and activity-based methods of teaching.*

4. Discussion

The pretest results (Tables 1 and 2) revealed the pupils' appalling performance when taught abstract content without the use of teaching and learning resources. Pretest results showed that out of fifty (50) pupils, 37 pupils representing 74% scored 0–4, which is below the average mark of 5-7. 18% representing nine (9) pupils had the average scores of 5-7, and only a small percentage, 8% representing four (4) pupils, had above the average scores of 8-10. The pretest results have confirmed [13] that abstract learning in mathematic is often difficult to acquire knowledge and even more difficult to apply to novel situations. This proves that the pupils of Mother of Mercy Junior High School on average were very challenged to grasp the concept 'construction of common

angles after they were taught abstract, Hence, abysmal performance of the pupils. Action research was devised to remedy the situation.

An Activity based method of teaching was adopted during the intervention to teach in which the Mother of Mercy Junior High School Form Two pupils participated actively. The posttest results showed that more than half of the pupils, thus twenty-six pupils representing 52%, scored above the average marks of 8–10. 40% of the pupils representing twenty (20) pupils scored the average marks of 5–7, and a few of them, thus 8% representing four (4) pupils, scored below the average marks of 0–4. Figure 4 depicts both the pretest, the pupils' performance before the intervention, and posttest, the pupils' performance after the intervention, results of the Mother of Mercy Junior High School Form Two pupils. Figure 4 clearly shows that the pupils perform well after the intervention activities were carried out as compared to before the intervention after the researchers carried out the intervention with the suitable teaching and learning materials. After the intervention, the lowest mark was three (3) and the highest was ten (10), whereas before the intervention, the lowest mark was zero (0) and the highest was eight (8). Figure 4 demonstrated that the six-day intervention was quite successful because 52% of pupils scored an above-average mark of 8 to 10 following the intervention, compared to 8% of pupils who did so prior to the intervention. Based on the findings, this study supports [20] finding that activity-based learning improves academic performance at the junior high secondary level by increasing pupils' motivation. The Mother of Mercy Junior High School pupils were motivated and their academic performance increased for better learning outcomes. Thanks to the utilization of teaching and learning materials and an activity-based approach.

5. Conclusion

One of the most crucial aspects of geometry is the construction of angles, especially common angles, which is the most basic type of geometric construction. Drawing precise shapes, lines, or angles using mathematical tools is referred to in geometry as construction. Pupils in junior high school have trouble constructing common angles. This could be related to the pedagogy used by the instructors. When taught utilizing an activity-based method with the use of a pair of compasses, a protractor, a ruler (straightedge), and a pencil, the pupils appeared to have mastered the idea of common angle building. The posttest results revealed that the performance of the pupils at Mother of Mercy Junior High School in Kasena-Nakana East, Upper East Region, Ghana, had significantly increased after the intervention process was carried out by the researchers. As a result, this study has demonstrated that the activity-based approach to teaching is a style of instruction that gives pupils a better learning experience when learning how to construct common angles than the abstract approach. Therefore, it may be said that activity-based instruction had a better effect than abstract instruction.

6. Recommendation

It is recommended that the educational governmental organisations and non-governmental organisations in Ghana should share mathematical sets (instructional material) with the junior high school pupils before the examination day. day. Preferably at the beginning of Junior High School education. This will give the pupils ample time to become very good with the tools, if not connoisseurs, of the mathematical set (especially the rulers and a pair of compasses) before taking the Basic Education Certification Examination.

Further study can be done by utilizing learning tools like the iPad for their geometry studies. It is no doubt that young ones are fascinated by the advent of technology, and there is various geometry computer software available which has been designed to galvanize gaiety in the learning process.

References

[1] 1,426 BECE candidates in six communities receive mathematical sets, pens, (2022). Retrieved from https://www.businessghana.com/site/news/general/272423/1-426-BECE-candidates-in-six-communities-receive-mathematical-sets-pens. Retrieved on 10/11/2022.

[2] Adolphus, T. (2011). Problems of teaching and learning of geometry in secondary schools in Rivers State, Nigeria. *International Journal of Emerging Sciences*, *1* (2), 143-152.

[3] Anderson, L. W. (2000). Why should reduce class size lead to increased student achievement. *How small classes help teachers do their best*, 3-24.

[4] Baffoe, EMMANUEL, & Mereku, D. K. (2010). The van hiele levels of understanding of students entering senior high school in Ghana. *African Journal of Educational Studies in Mathematics and Sciences*, *8*, 51-62.

[5] Becker, J. P. (1986). Studies in Mathematics Education: Volumes 1, 2, & 3.

[6] Chikwere, P., & Ayama, K. (2016). Teaching of geometric construction in junior high school: An intervention. *Journal of Elementary Education*, *26* (1), 139-146.

[7] Doyle, W. (1983). Academic work. Review of Educational Research, 53 (2), 159-199.

[8] Duval, R. (1998). Geometry from a cognitive point of view. *Perspectives on the Teaching of Geometry for the 21 century*.

[9] Gökçe, S., & Güner, P. (2022). Dynamics of GeoGebra ecosystem in mathematics education. *Education and Information Technologies*, *27* (4), 5301-5323.

[10] Hiebert, J., & Carpenter, T. P. (1992). Learning and teaching with understanding. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 65-97). New York: Macmillan.

[11] *Hon. Woyome supports 2022 BECE candidates with exams materials*. Retrieved from https://coverghana.com.gh/hon-woyome-supports-2022-bece-candidates-with-exams-materials/. Retrieved on 10/11/2022.

[12] Hraste, M., De Giorgio, A., Jelaska, P. M., Padulo, J., & Granić, I. (2018). When mathematics meets physical activity in the school-aged child: The effect of an integrated motor and cognitive approach to learning geometry. *PLoS One*, *13* (8), e0196024.

[13] Kaminski, J. A., Sloutsky, V. M., & Heckler, A. F. (2008). The advantage of abstract examples in learning math. *Science*, *320* (5875), 454-455.

[14] *Ledzokuku MP donates 3800 Mathematical Sets to BECE Candidates*. Retrieved from https://gna.org.gh/2022/10/ledzokuku-mp-donates-3800-mathematical-sets-to-bece-candidates/. Retrieved on 12/11/2022.

[15] Mitchelmore, M., & White, P. (2004). Abstraction in mathematics and mathematics learning. In M. J. Hoines & A. B. Fuglestad (Eds.), Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education (Vol. 3, pp. 329-336). Bergen, Norway: PME.

[16] Mitchelmore, M., & White, P. (2007). Abstraction in mathematics learning. Mathematics Education Research Journal, 19 (2), 1-9.

[17] NUGS distributes mathematical sets to BECE candidates of some selected schools, (2019). Retrieved from https://www.adomonline.com/nugs-distributes-mathematical-sets-to-bece-candidates-of-some-selected-schools/June 8, 2019 9:48 am. Retrieved on 04 /11/ 2022.

[18] Panthi, R. K., & Belbase, S. (2017). Teaching and learning issues in mathematics in the context of Nepal.

[19] Rogers, V. L. C. (1995). Teaching geometry in the elementary classroom.

[20] Sarfo, F. K., Eshun, G., Elen, J., & Adentwi, K. I. (2014). Towards the solution of abysmal performance in mathematics in junior high schools: Comparing the pedagogical potential of two designed interventions. *Electronic Journal of Research in Educational Psychology*, *12* (3), 763-784.

[21] Star, J. R. (2005). Re-conceptualizing procedural knowledge. Journal for Research in Mathematics Education, 36 (5), 404-411.

[22] Subaar, C., Asechoma, J. A., Asigri, V. N., Alebna, V., & Adams, F. X. (2018). Towards the Solution of Abysmal Performance of Fraction in Navrongo Presbyterian Primary School: Comparing the Sets of Objects and Paper Folding Designed Interventions. *Education*, *2011*, 8.

[23] Witzel, B. S., Riccomini, P. J., & Schneider, E. (2008). Implementing CRA with secondary students with learning disabilities in mathematics. *Intervention in School and Clinic*, *43* (5), 270-276.

[24] Yelkpieri, D., Namale, M., Esia-Donkoh, K., & Ofosu-Dwamena, E. (2012). Effects of Large Class Size on Effective Teaching and Learning at the Winneba Campus of the UEW (University of Education, Winneba), Ghana. *Online Submission*.