Global Scientific JOURNALS

GSJ: Volume 9, Issue 4, April 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

THE EFFECT OF MANIPULATIVES ON LEARNER'S ACHIEVEMENT IN AREA AND VOLUME IN MATHEMATICS AT THE JUNIOR HIGH SCHOOL LEVEL IN ACCRA METROPOLIS, GHANA

Zakari Zunurain, Alberta Becky Amuakwa, Dennis Offei Kwakye, Samuel Redeemer Adornyo, Jude Anab Ayipala

Tutor, Department of Mathematics and ICT, Methodist College of Education, Akim Oda, Ghana, zakarizunurain76@gmail.comm
Teacher, Mathematics Department, Presbyterian Senior High School, Osu, Ghana, aaibertabecky@yahoo.co.uk
Tutor, Department of Mathematics and ICT, Enchi College of Education, Enchi, Ghana, dokwakye@enchicoe.edugh
Tutor, Department of Mathematics and ICT, Methodist College of Education, Akim Oda, samueladornyo@gmail.com
Tutor, Department of Mathematics and ICT, Methodist College of Education, Akim Oda, judegrey9@gmail.com

KeyWords
Manipulatives, Achieveemnt, Fractions, Teacher Trainees, Volume, Areas

ABSTRACT

The study investigated the effect of manipulative materials on the achievement of learners in mathematics. The sample consisted of 79 learners in two Junior High Schools in the Accra metropolis in the Greater Accra Region. These participants were drawn by convenient sampling. One of the main purposes of this study was to determine the effect of manipulative materials on the achievement of learners in mathematics at the JHS level. A mathematics achievement test with a reliability coefficient of 0.81 was the instrument used to collect the data which was analyzed using the independent sample t-test and the paired samples t-test. The analysis revealed the efficacy of manipulative materials in the teaching and learning of mathematics at the JHS level. There was a significant difference on learners' achievement in mathematics before they were introduced to the treatment and after the treatment. Specifically, there was a significant difference in mathematics achievement of learners taught with manipulative materials and those taught without it. By inference it was revealed that the use of manipulative materials in the teaching and learning of mathematics has significant improvement on learners' achievement. Based on the findings of the study, it was recommended that manipulative materials should be used in the teaching and learning of mathematics at the Junior High School level.

1. Introduction

Mathematics as a subject is an essential part of human development and school curriculum on the account of its educational values not forgetting the pervasive influence it has on our everyday lives and its contribution to the wealth of the individual. It equips learners with a uniquely powerful set of tools to understand and change the world. These tools include the ability to think in abstract ways, logical reasoning and basic skills of solving problem in their daily life. This presupposes that, mathematics as a subject taught at the high school level caters for the needs of humanity hence, without its people will find it difficult to live in this technological world of ours. Mathematics is often seen as an isolated experience area performed just in schools alienated from real life. In fact, mathematics is a systematic way of thinking that produces solutions to problems by modeling real-world situations. However, various authors have put an academic spin on what mathematics literacy is. The [22] defined mathematics literacy as an individual capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments, and to engage in mathematics in ways that meet the needs of that individual's current and future life as a constructive, concerned and reflective citizen. In other words, the study of mathematics is of paramount significance to every society. It is based on this fact that the lagging of either male or female in mathematics ability and skill must not be taken for granted because mathematics is a subject for all and not for only males of which females cannot study. Hence it is both a masculine and a feminine subject.

[9] found that for more than two thousand years a familiarity with mathematics has been regarded as an indispensable part of the intellectual equipment of every cultured person. Today, unfortunately, the traditional place of mathematics in education is in grave danger. The teaching and learning of mathematics have degenerated into the realm of rote memorization, the outcome of which has led to satisfactory formal ability but does not lead to real understanding or to greater intellectual independence. The concerns here are that students must learn how to critically analyze mathematical problems and produce effective solutions. This requires them to learn how to make sense of complex mathematics concepts and how to think mathematically [13]. Many mathematics curricula overemphasize memorization of facts and underemphasize understanding and application of these facts to discover, make connections, and test mathematics concepts. The dearth of textbooks and other instructional materials as many classrooms lack posters, wall charts, and many materials necessary to stimulate learning, force teachers to use lecture method which stresses on memorization of facts rather than the understanding of concepts [17]

The very nature of the classroom arrangement and the overcrowding conditions especially in Ghana results in whole-class teaching, which is a traditional approach in which a teacher lectures child arranged in rows of desks facing the front of the classroom. This common approach, more often than not, results in poor teaching and learning. [21] noted that teaching involves more than covering the material and keeping students actively engaged. The focus of teaching should be on students' achievements as well as on the learning process. Similarly, [20] emphasized that the purpose of instruction is to prepare learners to acquire and transfer knowledge and skills to different situations.

However, learners are frequently unable to transfer learned knowledge and skills to novel situations irrespective of the fact that mathematics is an aid to representing and attempting to resolve problem situation in all disciplines. The major concern of teaching and learning of mathematics in the Junior high school is to make secure and stronger the gains made in the primary school mathematics and to increase the standard of attainment in mathematics.

A lot of researchers have been attributing the low achievement of students in mathematics to various factors. [13] found that using small groups of students to work on activities, problems, and assignments can increase student mathematics achievement. This is due to the fact that students get the opportunity to negotiate meaning with peers and also these researchers noted that using whole-class discussion following individual and group work improves student achievement. Others also argue that the form of assessment strategies practiced in schools are contributory factors to the low achievement of learners [1]; [28]. According to the [19], assessment is a crucial component in mathematics achievement. Evidence for assessing problem solving is collected by observing students as they work and listening to students as they discuss and explain their thought processes for arriving at a solution. This presupposes that the introduction of different forms of assessment during teaching and learning enhances the learners' achievement as they are assessed in all areas of study.

Research in the United State of America emphasized differences in medium of instruction and language ability as a primary determinant of the gaps in educational achievement [27]. Research has also shown that teachers' instructional strategies and methods have a significant effect on the learners' achievement [30]. Instructional strategies and methods that provide students with learning situations where they can develop and apply higher-order operations are critical for mathematics achievement. Teachers are to provide meaningful and authentic learning activities to enable students to construct their understanding and knowledge of this subject domain [31]. In addition, it is emphasized that instructional strategies where students actively participate in their own learning is critical for success [2]. According to [6], instructional practices have impact on mathematics achievement as well as attitude toward mathematics. A supportive classroom and suitable teaching motivate students to become better mathematics learners [14]. Some research findings indicated that instructional practices have positive effect on students' mathematics achievement and attitude toward mathematics [6]. These studies show that instructional strategies shape the progress of students' learning and accomplishment. Hence instructional strategies should be adopted by teachers in the teaching and learning of mathematics to enhance learners' achievement.

Teachers who do not receive support in their work may be less motivated to teach and perform well in the classroom [23]. The teacher's role in students' motivation to learn should not be underestimated since it is a factor to the students' achievement. In helping students to be motivated learners and successful producers of mathematical knowledge, the teacher's main instructional task is to create a learning environment where students can engage in mathematical thinking activities and see mathematics as a subject requiring "exploration, conjecture, representation, generalization, verification, and reflection" [8, p.58]. The teaching and learning of mathematics require highly motivated students because it involves reasoning, interpretations, and problems solving. The challenges of mathematics learning for today's education are that it requires disciplined study, concentration and motivation. To meet these challenges, learners must be focused and motivated to progress. [3] examined the relationship between classroom motivation and academic achievement in elementary-school-aged children (122-first grade and 129-third grade participants). Consistent with previous studies, they found that for a higher level of mastery, motivation was related to higher mathematics grades. In another study, [18] investigated cognitive motivational variables that influence high school students' decisions to enroll in advanced mathematics courses. Their findings revealed that mathematics ability perceptions affect students' valuing of mathematics and their expectations for achievement. On their part, [15] also found that parents' socioeconomic status correlated with a child's educational achievement. Another study by [16] found that factors such as individual study, parents' role, and social environment had a significant influence on further education decisions and achievements of young students.

A growing body of research provides additional factors which could have an impact on students' achievement. Such factors include gender, family structure, parents' educational level, socio-economic status, parent and student attitudes toward school, and parent involvement [7]. These factors or predictors of mathematics achievement, are divided into sub factors: Demographic Factors (gender, socio-economic status, parent's educational level), Instructional Factors (teacher competency, instructional strategies and techniques, curriculum, school context and facilities), and Individual Factors (self-directed learning, arithmetic ability, motivation). Mathematics learning requires a deep understanding of mathematic concepts, the ability to make connections between them, and to produce effective solutions to ill-structured domains. The teacher's role is to engage students by helping to organize and assist them as they take the initiative in their own self-directed explorations, instead of directing their learning autocratically [29].

Research has also found a substantial relationship between the use of manipulative materials and students' achievement in the mathematics classroom. [24] stated that the use of concrete materials for a long time, especially in the primary education period, is positively related to increasing students' mathematics success. Using manipulative materials means that students are involved in the process of doing mathematics. This involvement is more than intellectual: the student is actively engaged in doing, or in seeing something done.

2. Theoretical framework

Learning theorists have suggested for some time that children's concepts evolve through direct interaction with the environment and materials provide a vehicle through which this can happen. This message has been conveyed in a number of ways: [25] suggested that concepts are formed by children through a reconstruction of reality, not through an imitation of it. On his part [10] argued for the provision of firsthand experiences in a child's educational programme; [5] indicated that knowing is a process, not a product; and [11] whose work specifically relate to mathematics instruction suggested that chil dren need to build or construct their own concepts from within rather than having those concepts imposed upon them.

The National Council of Teachers of Mathematics has encouraged schools nationwide to use manipulative materials in mathematical instruction to improve upon learners' achievement. The value of manipulative materials has been recognized for many years, but some JHS teachers are reluctant to use them in their lessons hence the low achievement of learners in mathematics.

3. Research question

In this research the study sought to find out whether the situation in Ghana especially in the Greater Accra region was different with regard to the effect of manipulative materials on the achievement of learners at the Junior High School level.

4. Methodology

2.1. *Research Design*

The research design for the study was quasi experimental of non- randomized pre-test-post-test control group design. This was used because the study attempted to show cause and effect of two methods of teaching mathematics. This was also to establish a base line data for decision making. This design is a study in which subjects cannot be randomly assigned to treatment conditions, although the researcher manipulates the independent variable and exercises certain controls to enhance the internal validity of the results. The quasi-experimental design was used because the study involved the manipula-

tion of an independent variable and also involved pre - existing groups of learners rather than assigning learners to treatment at random. It employed two groups of learners; an experimental group and a control group.
The research done in school setting may be difficult to randomly assign subjects to treatment. This is due to the fact that randomization disrupts the teaching programme in the schools. Junior high school classes exist as intact groups and school authorities do not normally allow the classes to be dismantled and reconstituted for research purposes (Fraenkel & Wallen, 2000). The quasi-experimental research also controls some of the sources of internal validity. Due to these conditions, quasi experimental research became more favorable as it allows some control without disrupting the teaching programme in the school. However, since the research took place in a natural setting, it may have wide applicability to other similar settings.

5. Results and Discussion

Hypotheses Testing

The means and standard deviations of the groups' pre-test scores are compared in Table 1.

Table 1: Means and Standard Deviations of the Pre-test Scores by both Groups

Group	Mean	SD	N
Experimental	31.1239	15.96427	39
Control	38.5208	17.55089	40

It can be seen from the data in Table 1 that the mean score of the experimental group was lower than the mean score of the control group and there was a difference of 7.3969 between the two means. The standard deviation was also slightly different. Both the Levene's test and the t test of independence were conducted to find out if the mean difference of 7.3969 was significant or the difference in means was due to chance.

Table 2: Shows the data on the independent sample t-test of the pre-test scores of the two groups.
Table 2: Comparison of Pre-test Scores between the Experimental Group and the Control Group

Comparison of Pre-test Scores

The results in Table 1 and 2 show the independent- sample t-test that was conducted to compare the mean scores of the experimental and control groups in the pre-test. The Levene's test indicated that equal variances assumed since $p > 0.05$ ($p = 0.366$). The result also showed that in the pre-test, there was no statistically significant difference between the mean scores for experimental group ($M = 31.1239$, $SD = 15.96427$) and control group ($M = 38.5208$, $SD = 17.55079$); $t(77) = 1.958$, $p = 0.054$. The result showed that the control earned higher in the pre-test than the experimental group and this may be due to chance since there was no significant difference between the control and experimental group scores. In conclusion, the mathematics achievement of the two groups was the same before the intervention. This indicated that the groups used in the study exhibited comparable characteristics and were therefore suitable for the study.
Data Representation of all Achievement Test Scores

Table 3 shows the data for the frequency distribution of the pre-test and the post-test scores of the two groups.
Table 3: Distribution of Scores in Achievement Test by Both Groups

	Pre-test Scores				Post-test Scores			
	Exptal		Control		Exptal		Control	
Scores	F^+	%	F^+	%	F^+	%	F^+	%
0-10	3	7.7	2	5.0	1	2.6	10	25.0
11-20	10	25.6	5	12.5	8	20.5	5	12.5
21-30	9	23.1	10	25.0	5	12.8	5	12.5
31-40	6	15.4	5	12.5	2	5.1	6	15.0
41-50	5	12.8	9	22.5	7	17.9	5	12.5
51-60	4	10.3	6	15.0	6	15.4	5	12.5
61-70	2	5.1			6	15.4	4	10.0
71-80			2	5.0	3	7.7		
81-90			1	2.5	1	2.6		
Total	39	100	40	100	39	100	40	100

Exptal - Experimental
F^+ - Frequency

Discussion of all Achievement Test Scores in the Study

The data in Table 3 shows the distribution of scores in the pre-test and post-test with their corresponding percent ages by the groups. The distribution in the experimental group showed that 3 (7.7%) had the least score (0-10) in the pre-test but 1 (2.6%) in the post-test and 2 (5.1%) had the highest score (61-70) in the pre-test but 1 (2.6%) had the highest score (81-90) in the post-test. The distribution in the control group showed that 2 (5.0%) had the least score (0-10) in the pre-test but 10 (25.0%) in the post-test and 1 (2.5%) had the highest score (81-90) in the pre-test but 4 (10.0%) had the highest score (61-70) in the post-test. This seems to suggest that the post-test scores of the experimental group were gener ally higher than those of the control group.

The distribution of the data in Table 3 showed the scores of the two groups in both the pre-test and the post-test. The scores of the experimental group in the pre-test were not all that encouraging but excelled in the post-test. On the oth er hand, the control group performed so well in the pre-test but did not excel in the post-test. In the pre-test the control group did slightly better than the experimental group but in the post-test the situation changed: the experimental group outperformed the control group. The differences might be attributed to several factors. The learners in the experimental group were put into groups and taught with manipulative materials which they manipulated to form the basic concepts. The group activities might have enhanced their understanding of the concepts since they had the opportunity to reason togeth er as they negotiated meanings. The group presentation also went a long way to solidify their understanding of the concepts as there was peer teaching among the learners.

On the other hand, learners in the control group did not have access to such opportunity as those in the experi mental group. They were taught by the lecture or the traditional method where the concentration was on how the formulae would be used in further calculations and not how to derive them. They never had any opportunity to utilize manipulative materials. This might have led to the use of inappropriate formulae in items which do not demand for their use. In addition, learners were not able to understand deeply, transfer and apply the mathematical knowledge in solving real life situation problems which were thought provoking. An important justification for hands-on learning, then, is that it allows learners to build functional understanding and to become independent learners and thinkers. The great improvement in the achieve ment of the learners in the experimental group was due to the intervention.

Conclusion

In conclusion, the intervention helped Senior High School students to work on area and volume and using manipu lative mateerials. Hence, teachers and instructors should keep using these mateials in the teaching and learning processs in the classroom.

Acknowledgment

The authors wish to thank the students of the Senior Hgh Schools we use for the sduy, all in the Greater Accra Metropolis. Not forget-ting the colleague teachers who supported us in one or the other.

References

[1] Assessment Reform Group. (1999). *Assessment for learning: Beyond the black box*. Cambridge, UK: University of Cambridge Press.

[2] Bloom, B. (1976). *Human characteristics and school learning*. New York: McGraw Hill, Inc.

[3] Cobb, P., Yackel, E., & Wood, T. (1992). A constructivist alternative to the representational view of mind in mathematics education. *Journal for Research in Mathe matics Education*, *23*, 2–23.

[4] Broussard, S. C., & Garrison, M. E. B. (2004). The relationship between classroom motivation and academic achievement in elementary-school-aged children. *Fami-ly and Consumer Sciences Research Journal, 33*(2), 106-120.

[5] Bruner, J. S. (1960). *The process of education*. Cambridge: Harvard University Press.

[6] Butty, J. A. M. (2001). Teacher instruction, student attitudes and mathematics achievement among 10 and 12 grade black and Hispanic students. *Journal of Negro Education, 70* (1/2), 19 -37.

[7] Campbell, J. R., Hombo, C. M., & Mazzeo, J. (2000). *NAEP 1999 trends in academic progress: Three decades of student achievement.* Washington, DC: National Centre for Education Statistics.

[8] Carr, M. (1996). *Motivation in mathematics.* New York: Hampton Press, Inc.

[9] Courant, R., & Robbins, H. (1996). *What is mathematics: An elementary approach to ideas and method* (2nd ed.). New York, NY: Oxford University Press.

[10] Dewey, J. (1938). *Experience and Education*. New York: Macmillan Co.

[11] Dienes, Z. P. (1969). *Building up mathematics*. London: Hutchinson Educational Ltd.

[12] Fraenkel, J. R., & Wallen, N. E. (2000). *How to Design and Evaluate Research in Education,* New York, NY: Mc Grawhill Companies Inc.

[13] Grouws, D., & Cebulla, K. (2000). *Improving student achievement in mathematics*. Geneva, Switzerland: International Academy of Education.

[14] House, D. J. (2004). Motivational Qualities of instructional strategies and computer use for mathematics teaching in Japan and the United State. *Internal Journal of Instructional Media, 32,* (1).

[15] Israel, G.D., Beaulieu, L.J., & Hartless, G. (2001). The influence of family and community social capital on educational achievement. *Rural Sociology, 66* (1), 43-68.

[16] Jensen, B., & Seltzer, A. (2000). Neighborhood and family effects in educational progress. *The Australian Economic Review, 33* (1), 17-31.

[17] Kochhar, S. K. (1985*). Method and Technique of Teaching*. Sterling Publisher. Pvt. Ltd New Delhi.

[18] Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its influence on young adolescent's course enrolment intentions and achievement in mathematics. *Journal of Educational Psychology, 82* (1), 60-70.
[19] National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics*. Reston, VA: National Council of Teachers of Mathematics, Inc.
[20] Nelson, K. (2006). A dynamic tricky mix theoretical perspective on educational interventions to support the acquisition of L1 and L2 spoken languages, sign languages, text, and art. *Studies in Language Sciences, 5,* 91-102.
[21] Nitko, A. J. (2004). *Educational assessment of students* (4th ed.). Englewood Cliffs, NJ: Prentice- Hall, Inc.
[22] Organization for Economic Cooperation and Development. (1999). *Measuring student knowledge and skills: A new framework for assessment.* Paris: OECD.
[23] Ostroff, C. (1992). The relationship between satisfaction, attitudes and achievement: An organizational level analysis. *Journal of Applied Psychology*, *77*, 963–974.
[24] Peker, M. & Mirasyedioglu, S. (2008). Pre-Service elementary school teachers' learning styles and attitudes towards mathematics*. Eurasia Journal of Mathematics, Science & Technology Education*, *4* (1), 21-26.
[25] Piaget, J. (1971). *The psychology of intelligence*. Boston: Routledge and Kegan.
[26] Ross, R. & Kurtz, R. (1993). Making manipulatives work: A strategy for success. *The Arithmetic Teacher*. *40,* 254–258.
[27] Schmid, C. L. (2001). Educational achievement, language-minority students, and the new second generation. *Sociology of Education, Supplement: Currents of Thought: Sociology of Education at the Dawn of the 21st Century,* 71-87.
[28] Stiggins, R. J., (2002) Assessment crisis! The absence of assessment FOR learning. *Phi Delta Kappan*. 83(10), 758-765.
[29] Strommen, E. F., & Lincoln, B. (1992). Constructivism, technology, and the future of classroom learning. *Education and Urban Society*, *24*(4), 466-476.
[30] Tatto, M.T., (2002). The value and feasibility of evaluation research on teacher preparation: Contrasting the experiences in Sri Lanka and Mexico. *International Journal of Education and Development*, *22* (6), 637-657.
[31] Wilson, B. G. (Ed.). (1996). *Constructivist learning environments: Case studies in instructional design.* Englewood Cliffs, NJ: Educational Technology Publication.