

LEARNING CIRCLE CONCEPTS IN THE ZONE OF PROXIMAL DEVELOPMENT AMONG JUNIOR SECONDARY SCHOOL II STUDENTS IN BAUCHI STATE

BY

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Abstract

The study was set to investigate how Vygotsky's notion of mediation tools in a teaching intervention can be used in learning circle concepts. A mixed method design was employed in this study. The data collected for the study include; pre and post-test on circle concepts, observation of students' actions, and level of progressions during the teaching intervention. One hundred JSS II students' randomly drawn from two schools in Azare metropolis constituted the sample for the quantitative study. Quantitative data was analyzed using percentage. On the qualitative data, observation of students' work was described. The findings of the study revealed that majority of the students' responses in the pre-test were within the categories of either attempted, but incorrect response or no response. After the teaching intervention, there was significant shift indicated by move from incorrect and no response to more students' providing correct responses. This indicated a significant move within the students' Zone of Proximal Development (ZPD). There was also a wide gap between the experimental and control group in the post test, with 76% of correct responses in experimental group and only 24% in the control group. Based on the findings of the study it was recommended that teachers should be using Vygotsky's idea of teaching intervention in the ZPD can enrich teaching practice by providing conceptual model for analyzing learning difficulties observed in the classroom.

Keywords: Learning, Circle-concepts, ZPD

Introduction

One of the instructional goals in Mathematics teaching and learning is to develop Mathematics concept and Mathematical understanding to the students (Mayer, 2008). The present time has been a time for much discussion about the influence of social interaction on the development of Mathematical understanding (Murray & Arroyo, 2002). The root of this research can be traced back to the seminal work of the social constructivist; Vygotsky, a Russian psychologist who highlighted the process of measuring and understanding learning gains using Zone of Proximal Development (ZPD). He was interested in how children conceptualize and understands Mathematical concepts. He also believed that the role of education is to give children experiences that are within their ZPD, thereby encouraging their individual learning. Vygotsky defined the ZPD as “a place for learning that is located somewhere between the child's

current understanding and potential understandings”.

However, the idea is that individuals learn best when working together with others during joint collaboration, and it is through such collaborative endeavors with more skilled person's that learners learn and internalize new concept. Roosevelt (2008) holds that the main goals of education from Vygotskian point of view is that there were four key elements to a child's learning mechanism:

- (i) The inter-subjective internalization (i.e. child's previous knowledge),
- (ii) The mediation - teacher intervention (mentoring),
- (iii) To keep learners in their own Zone of Proximal Development as often as possible by giving them interesting and actually meaningful learning, and
- (iv) Problems solving tasks that are slightly more difficult than what they can do alone, such that they will need to work

together either with another more competent peer or with a teacher to finish the task.

The idea is that after completing the task jointly, the learners will likely be able to complete the same task individually next time and through that process the learners ZPD for that particular task will have been raised. This process is then repeated at the higher level of task difficulty that the learner's new ZPD requires (Kuusisaari, 2014).

Moreover, the tasks assigned to the learner sometime fall outside the ZPD by assigning task that the learner can already do or tasks that the learners would not be able to do even with help.

Statement of the Problem

There was widespread agreement among researchers that students' difficulties in learning Mathematical concepts is not because of the nature of the subject, but rather students' understanding of the concepts had not fully developed (Tolstoy, 2007). For example, in Nigeria, the West African Examination Council chief examiner's report for over six years (WAEC 2002, 2004, 2005, 2007 and 2008) revealed that among the causes of general failure in Mathematics, was associated with students' confusion in understanding certain Mathematical concepts when trying to solve questions during examinations. This might arise because their understanding of the mathematical concepts which are not fully developed. Similarly, the same trend was evident in the students' end of term results of some JSS schools in Azare. The learning of circle concepts listed as part of the areas of Mathematical content that our students' in Nigeria had difficulties (Exams and Record). The problem of this study is therefore, would the use of teaching intervention drawn from the social constructivist view (Vygotsky, 1978) can support students' learning and development measured within their ZPD.

Aim and Objectives of the Study

The main purpose of this study is to investigate how the notion of ZPD can be

used to describe students' learning process of circle concepts at J.S.S II level. Specifically, the study seeks to achieve the following objectives:

1. To identify the students' initial level within their ZPD for learning circle concepts.
2. To investigate the role of teaching intervention based on socio-cultural perspective (Vygotsky, 1978), in raising the students' ZPD for learning circle concepts.
3. To compare students' performance of those in the intervention lessons with those in the traditional acquisition teaching method.

Research Questions

The following research questions were formulated to guide the study

1. What is the students' initial level for the learning of circle concepts at JSS II level?
2. What role can the teaching intervention play in taken the students from the initial level to the potential level in the ZPD on learning circle concepts?
3. What is the difference between the students' performance in learning circle concepts of the groups in the intervention lessons and those in the traditional method of teaching?

Scope of the Study

The study was delimited to the application of Vygotskian socio-constructivism idea of mediation, and ZPD for teaching, and measuring learning gains in circle concepts among Junior Secondary School II students in Bauchi State.

Methodology

Design of the Study

The figure below provides the diagrammatical representation of the research design.

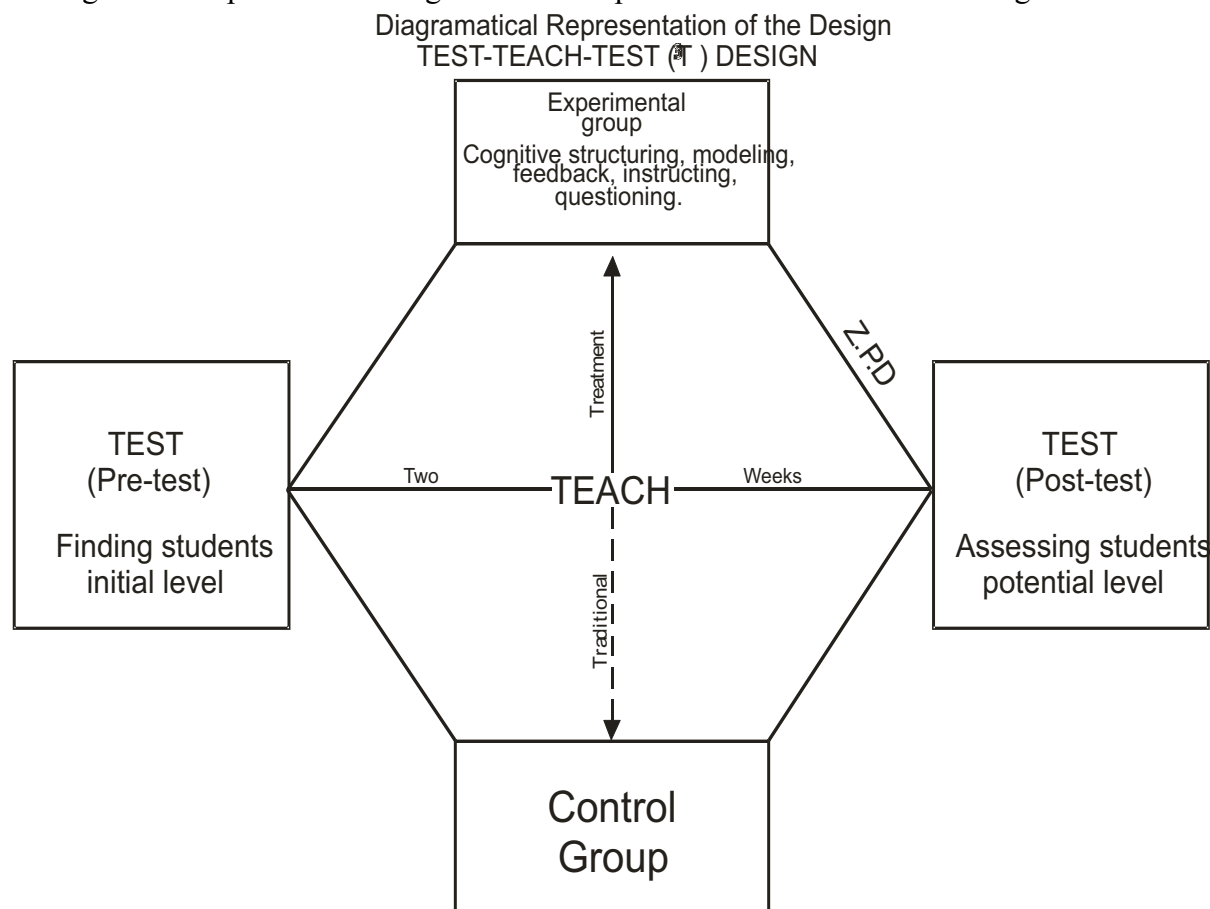


Figure 1: The Research Design

More specifically, as indicated in the figure 1 above, the design of the study was implemented in the following phases:

- **Phase 1 finding students' actual or initial level of circle concepts** - This is dependent on the Vygotsky's theory in determining the initial level and potential level. Therefore, the study started by determining the initial level of the students' involved in the study (both experimental group and the controlled group) before the treatment. Pre-test was given to both groups in finding students' initial level.
- **Phase 2 teaching intervention** This is the core of the study, and it applied to the experiment group. In teaching intervention, the roles of the researcher, teacher (i.e. research assistant), and students are important. The researcher explained the idea

of Vygotsky's mediation and the target of working with students' within the ZPD of the research assistant based on related studies conducted, and how to collaborate with the students' in social interactions during the class activities. Research assistant enacted the lesson with the assistance of the researcher. Observation scheduled is used for recording and documenting students' activities in the class during the teaching sessions.

- **Phase 3 finding potential level** At the end of the intervention, post- test was administered to the students, in order to evaluate the success of the treatment given, whether students' initial level reached the potentials level or not, so that it can be the initial level for their higher difficult task, that is what the individual is able to do with

assistance as he/she is able to do alone (without assistance).

Area of the Study

The area of the study is Bauchi state. The study was conducted at Junior Secondary Schools level II, within Katagum zone.

Population of the Study

Bauchi State divided its Educational administration into two zones, Bauchi zonal education office and Katagum zonal education office. And each local government has Local Education Authority under which junior secondary schools were operating. Therefore, the targeted population of the study comprised of about 16,000 JSS II students' (12-15years old) in the state. Katagum Local Government Education Authority has about 6,000 JSS II students from the 24 upper basic schools it has.

Sample and Sampling Techniques

The sample of the study comprised of 100 Junior Secondary School II students' drawn from two Upper Basic Secondary Schools in Katagum Local Government Area of Bauchi State. The area has 24 Upper Basic Junior Secondary Schools (Bauchi State Ministry of Education), and the two schools used for this study were chosen using stratified (cluster) random sampling technique. The sample students' of the selected schools were also selected at random from JSS II arms of the cluster school which makes a class of 50 students from one school as the experimental group, and the same technique was applied in the other cluster school that is controlled group with 50 students' in the class. And the two classes were named as experimental cluster class (ECC) and controlled cluster class (CCC) respectively.

Instrument for the Data Collection

Two instruments were used for data collection in this study, Test and Observational schedule. Their descriptions are as follows:

(a) Test (Pretest and Posttest)

The test has ten (10) questions items based on learning circle concepts which were extracted from students' notebooks and end of term 2014/2015 past examination question paper. Table of specification were considered in building the question items, and validated by some experts in the field of Mathematics Education.

(a) Observational Schedule

The observational schedule was adopted from Lawan (2010) in his work (thesis) relevant to the study. The observational schedule has two sections; section A and B. Section A contained information on students' personal data, while section B contained a framework for recording the developmental potential progress of students' in learning circle concepts in their ZPD, the strategies followed in applying Vygotsky's notion of mediation during the teaching intervention. Also it included students' actions, participation (positive or negative) and level of students' progression (high or low), all were recorded and discussed.

Validation and Reliability of the Instrument

Two experts from the Faculty of Technology Education A.T.B.U Bauchi, and two JSS Mathematics teachers validated the instruments (Circle concepts pre- and post-test). The reliability of the instrument was established using Split-half method which yielded a reliability index of 0.85.

Results and Discussion

The results of the pretest (i.e. the first test for finding students' initial level) and posttest (i.e. the second test for finding students' developmental potential level) were presented and discussed. And also the role of the research assistant (i.e. the mentor), students' developmental learning process and classroom observations were qualitatively discussed. The findings of the study were presented according to the research questions.

Research Question One: What is the Students' Initial Level for The Learning of Circle Concepts at JSS II Level?

In answering this research question, a test was established by the researcher which involved students' previous knowledge and examination questions based on JSS II syllabus on plane geometry, particularly circle concepts. The test was administered to measure the learners' initial level as an individual trait showing certain stability

across instructional setting, and on this basis, the area students' had problems about circle concepts was identified. The researcher came in with intervention and placement followed Vygotsky's notion of mediation. This provided the researcher with information about students' initial level and finding out where students needs assistance i.e. area of difficulties. The results of the test (pretest) were presented in the table below based on test items:

Table 1: Summary of Students' Responses to Pre-test from the Experimental Group

Q/No	Task	Correct Response	Attempted but Incorrect	No Response	Total
Q1	Definition of circle	03	15	32	50
Q2	Finding centre of a circle	15	14	21	50
Q3	Drawing radius of circle	14	17	19	50
Q4	No. of centre in a circle	36	14	0	50
Q5	Drawing of diameter	13	37	0	50
Q6	Drawing of tangent	12	10	28	50
Q7	Concept of π	0	15	35	50
Q8	Drawing of Sector	13	17	20	50
Q9	Identifying circle	12	23	15	50
Q10	Portions of a circle	02	08	40	50
TOTAL		120	170	210	
PERCENTAGE		24%	34%	42%	

Table 1 above shows the distribution of the 50 students' responses to the ten questions from the experimental group in the pre-test which were categorized as: correct response; attempted but incorrect; and no response. 24% of the students' responses were correct, 34% attempted, but incorrect responses, while 42% did not respond at all. The findings

indicated that majority of the test questions were not responded correctly by the students. Figure 2 below shows a sample of students' work in the pre-test indicating the kind of pattern of students' responses, with most of the items in the test attempted, but incorrect response.

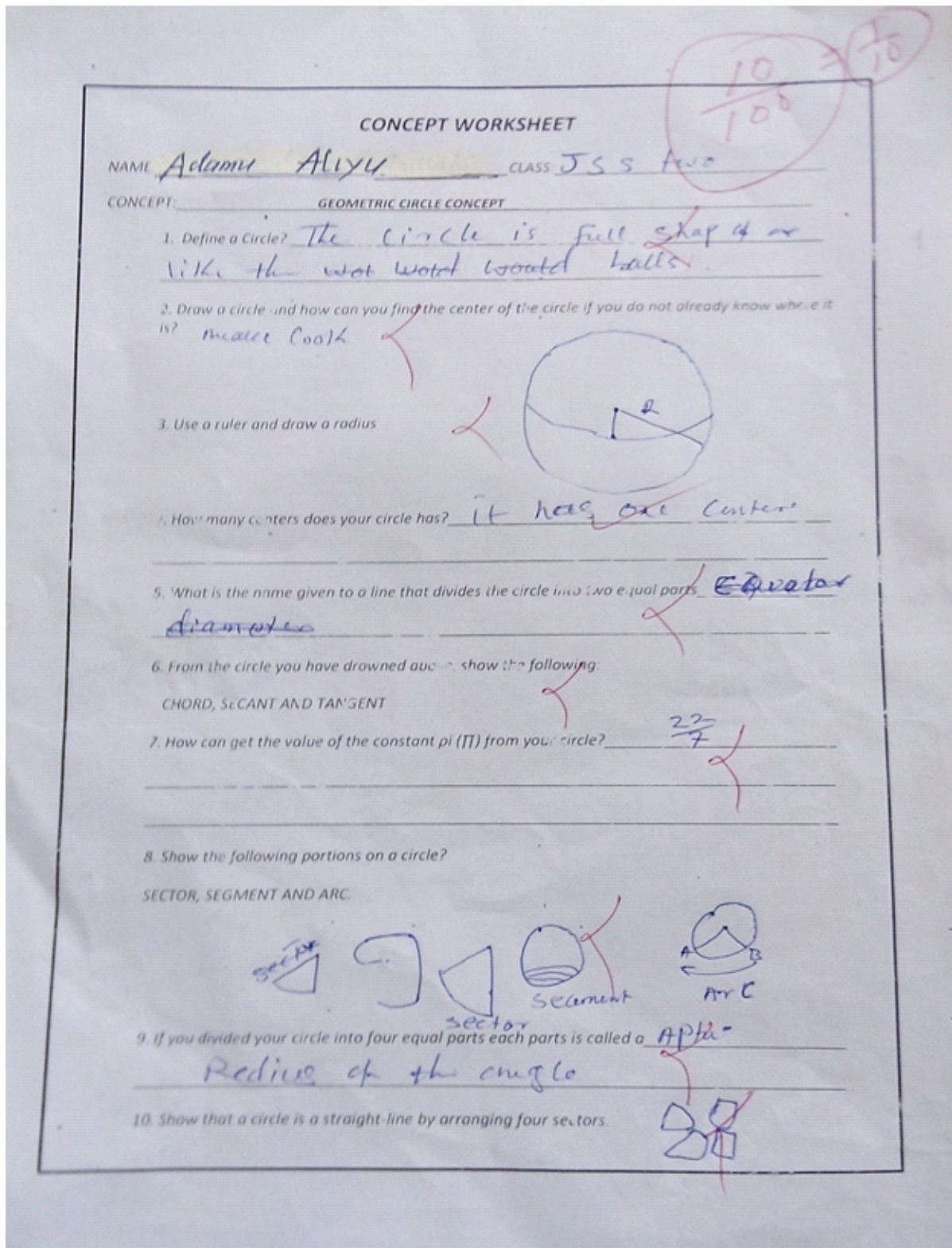


Figure 2: Sample of Students' Work in The Pre-Test with Most of the Items Attempted, But Incorrect Responses.

Table 2: Summary of Students' Responses to Pre-test from the Control Group

Q/No	Task	Correct Response	Attempted but Incorrect	No Response	Total
Q1	Definition of circle	05	10	35	50
Q2	Finding centre of a circle	11	16	23	50
Q3	Drawing radius of circle	10	15	25	50
Q4	No. of centre in a circle	25	15	10	50
Q5	Drawing of diameter	11	38	01	50
Q6	Drawing of tangent	16	10	24	50
Q7	Concept of pii (π)	0	13	37	50
Q8	Drawing of Sector	13	15	22	50
Q9	Identifying circle	15	22	13	50
Q10	Portions of a circle	04	06	40	50
TOTAL		110	160	230	
PERCENTAGE		22%	32%	46%	

Table 2 shows the distribution of the 50 students' responses to the 10 questions from the controlled group in the pre-test which was categorized as: correct response; attempted but incorrect; and no response. 22% of the students' responses were correct, 32% attempted, but incorrect responses, while 46% did not respond at all to the questions.

Findings from both experimental and controlled group indicated a similar pattern of performance at the initial level, with both groups; experimental (42%), and controlled (46%) of the test items with no students' responses. The findings indicated that majority of the test questions were not responded by the students. It also shows that all the students from the two groups were the same at the initial level.

Research Question Two

What role can the teaching intervention play in taken the students from the initial level to the potential level in the ZPD in learning circle concepts?

In answering this research question, the role of the following personnel in the intervention was considered in moving the students from initial level to potential level in the process of learning circle concepts drawn from the Vygotskian mediation ideas.

- i. The role of the researcher
- ii. The role of the teacher (research

assistance)

The Role of the Researcher

The topic under consideration was circle concept. The researcher found that the students' initial level on the circle concept was very low based on the result of the pre-test question items analysis. Therefore, Vygotsky's idea of mediation was applied in learning circle concepts, Mathematics teacher served as the research assistant in teaching circle concepts in order to raise students' initial level to potential level. The following concepts of a circle are considered.

- i. Concept of a center of circle
- ii. Concept of radius
- iii. Concept of diameter
- iv. Concept of the circumference of a circle
- v. Concept of a chord
- vi. Concept of a tangent
- vii. Concept of a secant

The Role of the Teacher (Research Assistant)

To teach in the Zone of Proximal Development is to response to the learners' current goals (initial level) and stage of development which is to provide guidance and assistance that enable him/her to achieve those anticipated goals so as to reach potential level for the future participation (Vygotsky, 1986).

Research Question Three

What is the difference in students' performance in Learning circle concepts and the groups in the intervention lessons and those in the traditional method of teaching?

In answering this research question, a test (i.e. post-test) which the teacher

administered was used after the teaching intervention in the experimental group, while controlled group based on conventional or traditional method of teaching. The test was marked and recorded, and analyzed using simple percentage. The figure below shows a sample of student's work in the posttest:

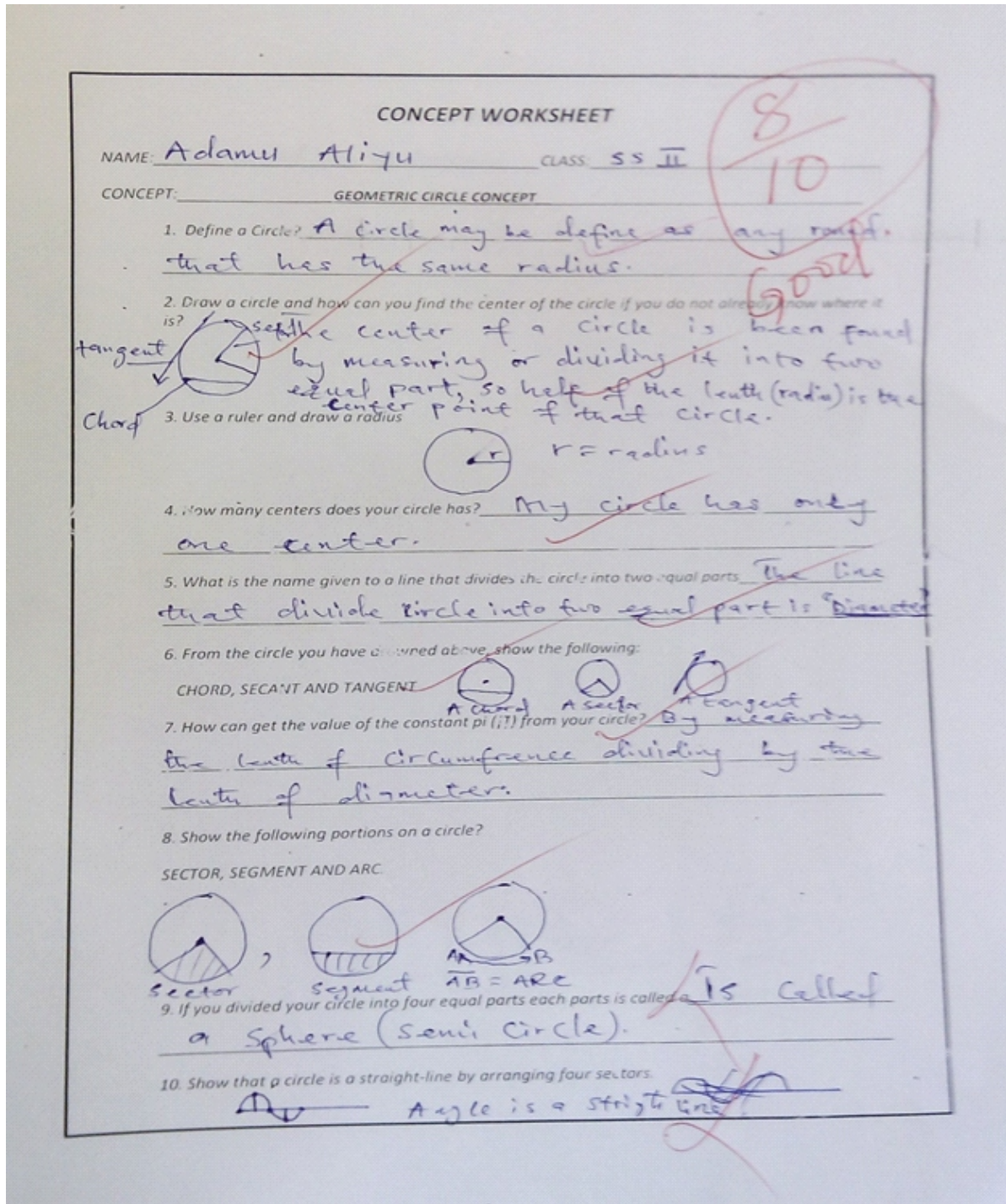


Figure 3: Sample of Student Work in The Post Test with Most of the Items Responded Correctly

Summary of the results were presented in the Table 3 below. Comparison between the experimental and controlled group indicated the difference in students' performance on learning circle concepts between the groups

after intervention.

Table 3 below showed the result of the post-test based on the question items that the students' answered and marked over ten (10).

Table 3: Summary of Students' Responses to Post-test by Experimental and Control Group

Q/No	Task	Correct Response		Attempted but Incorrect		No Response		Total
		Cont	Exp	Cont	Exp	Cont	Exp	
Q1	Definition of circle	03	38	15	10	32	02	100
Q2	Finding centre of a circle	15	29	14	11	21	10	100
Q3	Drawing radius of circle	14	35	17	13	18	03	100
Q4	No. of centre in a circle	36	50	14	00	00	00	100
Q5	Naming of diameter	13	40	37	03	05	02	100
Q6	Drawing of tangent	12	44	10	05	28	01	100
Q7	Concept of pii (π)	00	29	15	17	34	05	100
Q8	Drawing of Sector	13	39	17	08	20	03	100
Q9	Identifying circle	12	39	23	12	13	01	100
Q10	Portions of a circle	02	37	08	11	39	03	100
TOTAL		120	380	170	90	210	30	
PERCENTAGE		24%	76%	34%	18%	42%	06%	

Table 3 above showed the distribution of 100 students' responses from the control and the experimental groups to the 10 questions responded in the post-test. The responses were categorized as correct response; attempted but incorrect; and no response. In the experimental group, there were 76% of correct responses, while only 24% is seen in the controlled group. There were 34% of attempted, but incorrect responses in the control group, but only 18% in the experimental group. In the category of no responses, there were 42% in the control group, but only 6% in the experimental group (students) The results analyzed and presented above showed a wide gap between the experimental and the control group in responses to the post-test. This indicated that lessons delivered based on Vygotsky's mediation ideas provided more opportunities for raising students' initial level to potential levels within the ZPD than the traditional lecture method.

Discussion of Post-test Result Base on Students' Responses

The findings of this study categorically indicated that the application of Vygotsky's notion of mediation in learning circle concept among JSS II students' provided more opportunities for learning. The role of more knowledgeable person (mediator) to mediate, and to be committed in working within students' Zone of Proximal Development (i.e. being responsible to the student's current level and stage of development) has provided guidance and assistance that enabled students to achieve high level of progress and at the same time to increase their potential for future participation in learning (Bozhorich, 2009). Thus, to compare the results of pretest and posttest, it is clear that across all the questions answered by the students' there was an improvement in the performance of The mean scores of students' in the pretest and post-test was found 2.78 and 8.94 respectively. While the difference of the two groups; controlled and experimental in the

students' responses to the posttest indicates that majority of students' reached potential level which can independently worked out problems relating to circle concepts. This in turn, indicated that the needed target of raising their initial level to potential level of ZPD which has been attained in the experimental group.

Summary of Findings

From the analysis of the data presented and discussed above, the following finding were revealed:

- i. Students' initial level in learning circle concepts was found to be low from the percentages of students' responses in the pre-test. This was indicated by the majority of the items in the test were not responded by the students;
- ii. Findings from the pre-test was found useful in the planning of the teaching intervention, and in working within the students' ZPD for circle concepts;
- iii. The teaching intervention based on Vygotsky's mediation ideas, and working within students' ZPD was found to be effective in creating more opportunities for learning gains by the students;
- iv. Students' sometimes need the presence of a knowledgeable person or more capable peer to guide him/her into their potential level of ZPD, even at the primary school level.

Conclusion

The research was based on the illustration of the application of Vygotsky's

idea of mediation in a teaching intervention on learning circle concepts. Based on the findings of this research, it was concluded that teaching mediation following Vygotsky's ZPD improved students' understanding in learning circle concepts. It also concluded that teaching mediation in the students' ZPD played a vital role in moving students' from lower level of understanding to a potential level, which what he/she cannot do even with help became what he/she can do by self. Students' sometimes need the presence of a knowledgeable person or more capable peer to guide him/her into their potential level of ZPD.

Recommendations

Based on the findings of this research, the following recommendations are made:

- i. Using Vygotsky's idea of teaching intervention in the ZPD can enrich teaching practice by providing conceptual models for analyzing learning difficulties observed in the classroom
- ii. Mathematics teachers should be mindful of their students' responses and to reinforce such responses that facilitate the growth and development of Mathematical understanding.
- iii. In-house schools workshop/seminars in the application of Vygotsky's notion of teacher intervention (mediation) in the teaching and learning difficult concepts should be organized.

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