Research Journal of Educational Sciences E-ISSN 2321-0508
Vol. **4(10),** 1-4, December **(2016)** *Res. J. Educational Sci.*

Constructivist-Based Approach in Teaching Mathematics: A Quasi-Experimental Study

Maria Lourdes D. Galia*
Mindanao State University, General Santos City, Philippines
lourdesgalia@yahoo.com

Available online at: www.isca.in, www.isca.me
Received 10th November 2016, revised 25th November 2016, accepted 1st December 2016

Abstract

The development of Mathematics skills has been one of the major aims of the school curriculum. To achieve this goal, progressive new ideas on teaching and learning strategies in Mathematics are constantly emerging. One of these strategies is the constructivist-based approach which views learners as active participants in the learning process. In this approach, the students' prior knowledge is carefully considered during instruction and the goal of instruction is to build ideas based on these prior knowledge. Students actively construct meanings as they interact with the environment and understand rather than recall, and analyze rather than memorize. This study focused on the effectiveness of constructivist-based approach in teaching Mathematics particularly in Calculus among second year college students using a quasi-experimental research design. Constructivist-based approach was used on the experimental group while the traditional lecture method was used on the control group. Pretest and posttest results were analyzed using ANCOVA and t-test for dependent samples. Journal writing was also undertaken to determine students' perception of the subject after being exposed to constructivist-based approach. Results of the study showed that both the constructivist based approach and the lecture method are effective in teaching Calculus based on the difference between the pretest and posttest scores. However, students who used the constructivist-based approach got significantly higher posttest scores than those taught using the lecture method, and some had improved perception and attitude towards Calculus based on the written journals. This led to the conclusion that constructivist-based approach is more effective than the lecture method and it is therefore recommended that this approach be utilized in the teaching of Mathematics and other Mathematics-related subjects.

Keywords: Constructivist-based approach, Lecture method, Effectiveness.

Introduction

Over the recent years, there have been a growing number of case studies which document the use of constructivist approaches in science education. Many researches that were conducted during the last decade were on constructivist-based approach. These include the empirical and theoretical works of Piaget and Vygotsky[1,2] and the works of researchers in science[3,4].

According to constructivist views, new knowledge is constructed by the person as he interacts with the environment and knowledge is acquired not by internalization of some outside given meaning but by construction from within of appropriate representations and interpretations[5]. Ideas constructed based on experiences provide personal meaning for the learner. The pedagogical practice of constructivism is student-centered. The students are encouraged to participate in problem formulation, testing, and argumentation. They are trained to be autonomous and responsible for their learning. Moreover, they are exposed to interactive situations where they can fully articulate their interpretations and explanations. In the constructivist view, learning is an active interaction between the learners' current knowledge and the new knowledge presented. Thus, learning depends not only on the learning environment in the classroom, but also on the current knowledge of the learner.

To constructivists, learning is not a passive activity[6]. It is not a passive accumulation of knowledge by learners. The key idea is that learners actively construct their meaning from interaction with the environment to explain new phenomena rather than just absorb or imitate the understanding of others. The learner, therefore, is an active participant in the learning process[7-9]. Meaningful learning takes place when the new knowledge presented is consciously integrated into the existing knowledge of the learner[10]. When new knowledge is not well-integrated into previously learned concepts, learning becomes short-lived and non-functional. Learning is a personal matter because the learner constructs meaning for himself according to his interaction with the environment[11]. Learning outcomes depend not only on the learning environment but on what the learner already knows.

Student discussions are often utilized in constructivist-based approach. Learning becomes active when students participate in class discussions[12]. During discussion, it is easy to gain insights into the views which students have on the given concept. Discussion helps produce a change in students' concepts

because this approach allows students to consider contradictions to their ideas. By verbalizing one's perception and then incorporating it with the perception of others, the understanding of concepts or learning is facilitated[13]. Students' discussion and giving detailed explanations to others in a group influences learning and helps improve achievement. Peer interaction provides a free atmosphere for students to express what is in their minds and can lead to effective learning among students[14].

Under constructivism, the teacher is not simply a transmitter of knowledge but a facilitator of learning. The teacher's role is not to ask questions but to facilitate and encourage interaction thereby establishing a cooperative environment in the class[15]. According to this view, the teacher's interaction with the students and asking questions can encourage students to fully express their interpretations and explanations, and use concepts in more extended manner. Moreover, interactive situations created by the teacher can lead the students to talk about relevant ideas on the lesson. Constructivist teaching helps develop cognitive skills because the learner plays an active role in the learning process[16]. Promotion of student autonomy, development of interactive processes, and regular practice of reflection can help students develop more powerful, effective and meaningful constructions resulting to better learning and understanding.

These ideas motivated the researcher to conduct a study on the effectiveness of constructivist-based approach in teaching Mathematics. The analysis of the various studies suggests that constructivist-based method can provide positive results for the academic performance of students in Mathematics.

Methodology

Two intact groups each consisting of 25 students from Mindanao State University – General Santos City were used in the study – the experimental group and the control group. The experimental group was taught Calculus using constructivist-based approach while the control group was taught using the traditional method of teaching. Topics covered during the study were delimited to theorems of differentiation and applications of the derivative.

Before the start of the experiment, a 30-item pretest in Calculus was administered to both groups. In the experimental group, constructivist-based approach was used. These included asking students prior ideas about the lesson and interactive teaching where the teacher only guided the discussion and the students dominated the discussion. Interactive situations were created by the teacher to encourage students to fully express their own explanations and interpretations. Students were also allowed to discuss the lesson in groups to conduct cooperative consultations among themselves. Students were given opportunity to explore mathematical problems and to look for patterns, make conjectures and form generalizations. Journal writing was also required from the students to determine what they learned, what difficulties they had, and what changes in their perception occurred after the lesson. For the control group, the traditional lecture method was used. Lectures were delivered by the teacher and discussions were mostly teacher-dominated. In case there were questions by the students, explanations and interpretations of concepts were unilaterally done by the teacher with no class participation. The students listened to whatever the teacher explained and took notes.

After the experiment, the posttest in Calculus was administered to both groups. This was used to compare the performance in Calculus of the experimental group and the control group after the experiment. The result of the pretest and posttest of the control group and the experimental group were analyzed statistically using One-way Analysis of Covariance (ANCOVA), and t-test for dependent samples. All tests were done at the .05 level of significance.

Results and Discussion

Pretest and Posttest Results of the Control Group and of the Experimental Group: The pretest and posttest results of the control group which was taught using the lecture method was analyzed and the results showed an improvement from a pretest mean score of *11.44* to a posttest mean score of *17.20*. The t-test for dependent samples indicated a significant difference between the posttest and the pretest of the group *(t=5.852, p=0.000*). The result indicates that with the use of the lecture method, the students significantly improved their performance in Calculus. Qualitatively, their academic performance improved from Fair level to Good level. For the group of students who were taught Calculus using constructivist-based approach, there was also an improvement from a pretest mean score of *12.16* to a posttest mean score of *21.76*. The result of the t-test for dependent samples on the pretest and posttest scores indicated a significant difference between the posttest and pretest of the experimental group *(t=9.324, p=0.000).* This implies that there is a significant improvement in the Calculus performance of the students. The higher posttest mean scores showed students learn more about Calculus when constructivist-based approach was used. Specifically, their performance improved from Fair level to Very Good level. These results indicate that both the lecture method and the constructivist-based approach are effective in improving performance in Mathematics.

Posttest Comparison of the Control Group and the Experimental group: The posttest scores of the experimental group and the control group were compared using One-way Analysis of Covariance (*ANCOVA*). This was performed to find out if the treatment (constructivist-based approach) on the experimental group yield a more significant improvement on achievement than the control group over and beyond their initial differences in pretest scores. The result of the analysis showed that when the covariate (pretest) was partialled out, there was a significant difference in the posttest scores of the two groups at

the *0.05* level. This is based on the *computed F* of *7.014* which has a probability of *0.011 (p<.05).* This implies that students under the constructivist-based approach had greater learning in Calculus as shown by their significantly higher posttest scores. This shows that constructivist-based approach is a more effective method than the lecture method in teaching Mathematics. These findings are similar to the research findings of Jong[17], Kurt and Becker[18] and Bimbola[19] regarding the effectiveness of constructivist-based teaching strategy as compared to the traditional method of teaching.

Constructivist-based approach help students develop deep understanding of Mathematics because this method involves explorations, discoveries, and reflective thinking about the nature of Mathematics concepts. Teachers using this approach do not provide the answers but only guide the students on their knowledge construction thereby making the students active participants in the learning process. In this approach, personal constructs or meanings are developed based on the learner's direct experiences and informal interactions with the physical world and these are acknowledged and used in building ideas during instruction. In the traditional teaching, however, there is less student-initiated questions and interactions. Teacher-dominated lectures are the main source of facts and students are forced to memorize resulting to poor understanding of content, low motivation, and lack of development of students' creative abilities. In constructivism, real meaning takes place because student's prior understanding or views about the lesson are considered and students are encouraged to analyze the new knowledge presented and consciously integrate them to their existing knowledge. Several advantages of this approach were also observed. Students displayed greater motivation for achievement, greater trust, and greater commitment to learning. There is more tutoring and sharing of resources, lower fear of failure, and more involvement in learning among class members. In view of this, constructivist-based approach is recommended to be integrated into the teacher's method of teaching Mathematics.

Effects of Constructivist-Based Teaching Approach on the Student's Perception of Mathematics: After using constructivist-based teaching strategies, the perception of some students towards Calculus improved as shown in their favorable responses on the journals. Students began to be more participative in discussing the solutions to the given problems while others asked for difficult problems. Some students who were initially bored with Calculus became interested with the lessons. There were manifestations that their perception about Calculus has improved. About 70% of the students wrote the following comments about the lessons on their journals: "Difficult but interesting", "Simple", "Important", "Interesting" and "Challenging". In general, constructivist-based approach in teaching has improved the perception of students towards Mathematics. In the end, they considered the topics to be interesting, challenging and not as difficult as they thought them to be. However, there were still few students whose perception did not change. They still consider most topics in Calculus to be difficult to understand.

Conclusion

Based on the findings of the study, it can be concluded that the constructivist-based approach and the lecture method are both effective in teaching Mathematics. However, more significant improvement in Mathematics performance was observed in the class where constructivist-based approach was used and this indicates greater effectiveness of this method than the lecture method. In addition, the constructivist-based approach has improved the perception of a number of students towards Mathematics. It is therefore recommended that constructivist-based approaches be integrated in the teaching of Mathematics and other related subjects.

References

1. Woolfolk A., Winne P.H. and Perry N.E. (2009). Social Cognitive and Constructivist Views of Learning. Educational Psychology (4th ed.) Toronto: Pearson Canada, Inc.

2. Ultanir E. (2012). An Epistemological Glance at Constructivist Approach: Constructivist Learning in Dewey, Piaget and Montessori. *International Journal of Instruction,* 5(2), 195-212.

3. Kumar M. (2006). Constructivist Epistemology in Action. *The Journal of Educational Thought,* 40(3), 247-261.

4. Marlowe B.A. and Page M.L. (2005). Creating and Sustaining the Constructivist Classroom. Thousand Oaks, CA: Corwin Press.

5. Powell K.C. and Kalina C.J. (2009). Cognitive and Social Constructivism: Developing Tools for an Effective Classroom. *Education,* 130(2), 241-250.

6. Richardson V. (2005). Constructivist Teacher Education: Building a World of New Understandings. London: Falmer Press.

7. Taylor P., Fraser B. and Fischer D. (1997). Monitoring Constructivist Classroom Learning Environment. *International Journal of Education Research,* 27(4), 293-302.

8. Khan S. (2013). Constructivism: An Innovative Inquiry-based Approach to Classroom Teaching. *Gyanodaya.* 6(1), 60-69.

9. Brooks J. and Brooks M. (1999). In Search of Understanding: The Case for Constructivist Classroom. Alexandria, VA: Association of Supervision and Curriculum Development.

10. Ausubel D.P. (1995). Educational Psychology: A Cognitive View. New York: Holt, Rinehart and Winston.

11. Fensham P.J. (1988). Development and Dilemmas in Science Education. London: Palmer Press.

12. Leikin R. and Zaslavsky O. (1999). Cooperative Learning in Mathematics. *The Mathematics Teacher* 92(3), 240-246.

13. Gillies R. (2006). Teachers' and Students' Verbal Behaviors During Cooperative and Small-group Learning. *British Journal of Educational Psychology*. 76: 271-287.

14. Galia M.L. (2015). Cross-age Peer Tutoring as Intervention to Cultural Minority Students with Learning Difficulties in Mathematics. *Journal of Teaching and Education.* 4(01), 327-332.

15. Choudry M. (2013). Constructivism: Ways to New Learning. *International Journal of Education and Management Studies.* 3(2), 276-279.

16. Sharma R. (2014). Constructivism-An Approach to Enhance Participatory Teaching Learning. *Gyanodaya*. 7(2), 12-17.

17. Jong S.K. (2005). The Effects of a Constructivist Teaching Approach on Students' Academic Achievement, Self-concept and Learning Strategies. *Asia Pacific Education Review,* 6(1), 7-19.

18. Becker K. and Maunsaiyat S. (2004). A comparison of students' achievement and attitudes between constructivist and traditional classroom environments in Thailand vocational electronics programs. *J. Vocational Education Research.* 29(2), 1-10.

19. Bimbola O. and Daniel O. (2010). Effect of Constructivist-based Teaching Strategy on Academic Performance of Students in Integrated Science at the Junior Secondary School. *Educational Research and Reviews*. 5(7), 347-353.