CONSTRUCTIVIST LEARNING MODEL WITH METACOGNITIVE STRATEGY IN TEACHING MATHEMATICS

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ABSTRACT: *Researchers have shown that teaching becomes very effective if learners are taught to construct knowledge rather than transform information, to monitor their own learning and progress, and to apply their learning and understanding authentically. It is therefore essential that the major implication of constructivism and metacognition should be reflected in classroom practices. This paper aimed to investigate the effectiveness of the constructivist learning model with a metacognitive strategy in teaching mathematics. A pretest-posttest quasi-experimental design was utilized incorporating both qualitative and quantitative techniques. Two intact-classes of Math 2 were the respondents of the study. The constructivist learning model with a metacognitive strategy has been applied to the experimental group while traditional methods of teaching were followed by the control group. An adapted test in Probability Theory was used as an instrument for both pretest and posttest to evaluate the student's performance. The hypothesis was tested at α= 0.05 using ANOVA. Findings revealed that the respondents were almost the same in terms of their mathematical ability based on their average grade in Math 1. Pretest mean achievements of the control and experimental groups have no significant difference. Meaning, the two groups were of equal competence before the treatment started. It was also found out that the two groups' mean achievements in the posttest have a high statistical difference favouring the experimental group. Hence, adopting a constructivist learning model with a metacognitive strategy significantly improved the students' achievements in the course as compared to using traditional teaching methods. Based on the above findings, it is concluded that the constructivist learning model with a metacognitive strategy has a positive impact on the mathematical teaching-learning process.*

Keywords: Constructivist model, metacognitive strategy, a traditional method of teaching

1. INTRODUCTION

Teaching mathematics nowadays is no longer regarded as only a simple and technical procedure involving teaching objectives and learning outcomes. Mathematics as a subject comprises a broad range of mathematical theories, formulas, and calculations. That is why teachers are a challenge to adopt multifarious teaching approaches/strategies that guarantee promising upshot to the field. Hence, the exploit of the constructivist learning model with a metacognitive strategy will be of great relevance.

Constructivists believe that learners should construct their own understanding of each mathematical concept so that the primary role of teaching is not to lecture, explain, or otherwise attempt to transfer mathematical knowledge, but to create situations for students that will foster their capabilities in making the necessary mental constructions [1]. With the constructivist learning model, learners build new knowledge and understanding from their prior cognitive structures in a step-by-step fashion. They explore possibilities, invent alternatives, collaborate with others, try out ideas and hypotheses, revise their thinking, and present the best solution they can derive.

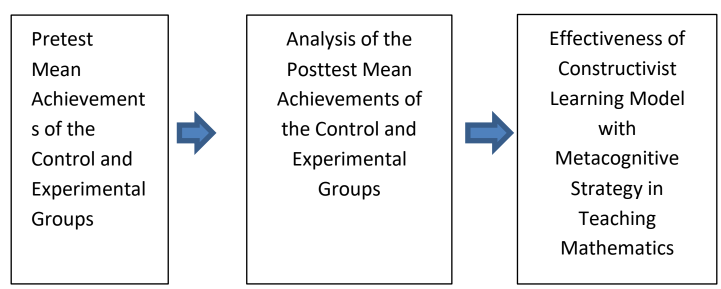
Analogously, the metacognitive strategy provides learners explicit teacher instruction for specific teaching-learning. Metacognition points higher order thinking which involves active awareness and control over the cognitive processes engaged in learning [2].

This study aimed to investigate the effectiveness of the constructivist learning model with a metacognitive strategy in teaching mathematics.

Specifically, the research sought answers to the following questions:

1. What is the average grade profile of the students in the control and experimental groups?
2. What are the pretest and posttest mean achievements of the control and experimental groups?
3. Is there a significant difference between the pretest and posttest mean achievement s of the students in the control and experimental groups?

This is the conceptual framework of this study



The diagram depicts the flow of the research study. To determine the effectiveness of the constructivist learning model with a metacognitive strategy in teaching mathematics, the analysis between the pretest and the posttest mean achievement was done. The data used for the analysis of the pretest and posttest mean achievements were based on the test result using an adapted test. Treatment was carried out after the pretest that involved two groups of respondents, the control and experimental groups.

This study draws its theoretical support from the theories of constructivism and metacognition. Constructivists believe that knowledge is the result of individual constructions of reality. Learning occurs through continual creation of rules and hypotheses to explain what is observed [3]. Their perspective emphasizes that learning occurs only when learners actively engaged their cognitive structures in schema building experience [4].

According to Founlas and Finnel [5], metacognition literally means big thinking. You are thinking about thinking. During the process, you are examining your brain's processing. Teachers work to guide students to become more strategic thinkers by helping them understand the way they are processing the information. Mathematics has a unique feature as a subject. Thus, the researchers were motivated to investigate how joint efforts of the constructivist learning model and metacognitive strategy will bring meaningful mathematics education.

From the perspective of constructivism, learners construct knowledge based on what they already understand as they make connections between new information and old information. Students' prior ideas, experiences, and knowledge interact with new experiences and their interpretations of the environment around them [6]. Arends [7] further asserts that in a constructivist perspective, knowledge is somewhat personal and meaning is constructed by the learner through experience. Learning is a social and cultural activity in which learners construct meaning that is influenced by the interaction of prior knowledge and the new learning events. He cited that the cognitive constructivist perspective [8] posits that learners of any age are actively involved in the process of acquiring information and constructing their own knowledge. knowledge does not remain static but instead is constantly evolving and changing as learners confront new experiences that force them to build on and modify prior knowledge.

Metacognition is one's ability to use prior knowledge to plan a strategy for approaching a learning task, take necessary steps to solve the problem, reflect on and evaluate results, and modify one's approach as needed. It helps learners choose the right cognitive tool for the task and plays a critical role in successful learning. (https://teal.ed.gov/tealGuide/metacognitive

According to Arends [7], the important goals for teaching students how to think are to increase their awareness of their own thinking and to develop metacognitive abilities and capacities to monitor and regulate their own learning.

Laz and Shafie [9] affirmed that the constructivist learning model in the teaching of mathematics has a great impact in the acquisition of concepts and theories that are based on building knowledge of the learners.

Dr. Rajendra Kumar Nayak's study [10] provided the empirical pieces of evidence to show that the students' learning in the constructivist approach did have some impact on students' performance in Mathematics in terms of their understanding and applicability where the students integrated their learned concepts to construct knowledge. He found out that teaching/learning through the constructivist approach has substantially improved the students' achievement in mathematics as compared to the teaching/learning through the traditional expository method.

A recent longitudinal study revealed that from 12 to 14 years of age, adolescents increasingly used metacognitive skills and used those more effectively in Math and history classes [11]. Moreover, Toit and kotze [12] concluded that metacognitive strategies could serve as a guide in ensuring effective teaching and assisting learners to study and learn mathematics effectively.

2 EXPERIMENTAL DETAILS

The study used the pretest-posttest quasi-experimental method of research for the purpose of analyzing the mean achievements and mean differences of students' performance on the new teaching methods in mathematics. The respondents of the study are the first-year college students of Surigao Del Sur State University-Cantilan who are officially enrolled in the Math (Contemporary Mathematics) course during the second semester of A. Y. 2016-2017.

Two sections were selected using purposive sampling wherein the BTTE-1 class was the control group while the BSED T.L.E.-1 class was the experimental group. The study made use of a 20-item adapted test in contemporary mathematics specifically the selected topics in probability theory covering the fundamental principle of counting, permutation, combination, and the basic concepts of probability. A pretest was administered to both groups at the onset of the investigation. The test was answered individually for an hour. Afterward, the treatment period followed. The experimental group was subjected to the constructivist learning model with a metacognitive strategy. In the constructivist learning model, the students were exposed to active and effective conceptual schemes building expertise associated with new positions. This model has four stages. 1. *The phase of the Call.* Students were invited in a variety of ways. Thought-provoking questions were utilized that recalled and related their past knowledge to the new lesson. 2. *Exploration and Innovation*. Students were challenged in searching answers generated through observation, measurement, and experimentation. Grouping and brainstorming were usually done in this stage wherein each group has a specific task of their own related to the subject matter. 3. *Proposed Explanations and Solutions*. Students proposed their findings and interpretations based on their discussed problems and solutions. Modification of their misconceptions was done in this stage through scientific processes. 4. Decision Point. Abstraction and formulation of practical applications were made. In concurrence with the constructivist learning model, a metacognitive strategy was utilized. Through the metacognitive strategy, the students' consciousness towards the lesson was monitored in a higher-order, determining whether the students were able to grasp the knowledge and skills taught to them.

On the other hand, the control group was exposed to traditional methods of teaching. It involved lecture-discussion and transitional expository methods.

The same topics were conducted to the two groups, based on the course syllabus used by the Math 2 instructor. Only the teaching strategies differed. The treatment period lasted for eight regular one-hour class meetings. A posttest was conducted after the treatment period. The test used in the pretest was the same test administered in the posttest.

RESULTS AND DISCUSSION

The analysis of the data revealed three different findings. The following tabular presentations and discussions were organized based on the problems of the study.

Table 1. Average Grade Profile of the Respondents

Respondent	Mean	S.D.	Description
Control Group	2.274.255		Good
Experimental Group	2.506.364		Good
All Groups	2.378.328		Good

Legend : 1.0 excellent 2.1 – 2.5 Good

1.1-1.5 Superior 2.6 – 3.0 Fair
1.6 -2.0 Very Good 3.1 and below Failed

Based on the grading standards of the respondents' institution, their performances are described both as good.

Table 2 . Pretest and Posttest Mean Achievements of the Respondents

	Pretest		Postest	
Respondent	Mean	S.D.	Mean	S.D.
Control Group	6.508	1.862	14.590	2.048
Experimental group	6.219	1.680	17.344	2.623

Table 2 reflects that both groups were relatively at the same level of knowledge in Probability before the treatment began. The experimental group shows a higher degree of variability compared to the control group. Meaning, the experimental group is more homogenous than the control group. Further, the table likewise shows that there is an increase of the mean achievements of both groups after the treatment. But it can be noted that based on the data, the experimental group performed better than the control group.

Table 3. ANOVA Summary Table on the Difference Between the Pretest and Posttest Mean Achievements of the Respondents

	Source	Sum of Squares	d.f.	Mean Square	F	p-value
	Between	1.797	1	1.797	0.566	0.455
PRETEST	Within	219.161	69	3.176		
	Total	220.958	70			
	Between	133.317	1	133.317	24.685	0.000
POSTTEST	Within	219.161	69	3.176		
	Total	220.958	70			

The table reveals that the respondents' pretest means achievement difference is not significant. Thus, both the experimental and control groups were of equal competence before the onset of the treatment.

On the other hand, the F-ratio 24.685 with a p-value of 0.000 is found to be statistically significant at 0.05 level, indicating thereby a significant difference in the achievements of both groups, favouring the experimental group. This asserts that the integration of constructivist learning model and metacognitive strategy in teaching mathematics is significantly better than the traditional method in terms of its impact on the overall academic achievement of the students in the experimental group, accordingly

The result is in concordance with the finding of laz and Shafie [9] that the constructivist learning model enabled students to apply the active and effective new situations in mathematics where their learning and transfer of knowledge took advantage in the construction of experiences associated in the subject. It is also corroborated by Nayak [10] that teaching/learning through the constructivist approach has substantially improved the students' achievement in mathematics as compared to teaching-learning through the traditional expository method.

Furthermore, the result correspondingly agrees with the outcome of Toit and Kotze [12] that with the integration of metacognitive strategy, effective teaching was ensured and learners were assisted efficaciously in learning mathematics. Accordingly, the components of metacognitive knowledge were positively and significantly associated with academic achievement and showed metacognition skills and their application in the teaching and learning process cause academic performance improvement [13].

CONCLUSION

Based upon the significant findings of the study, it is thereby concluded that the constructivist learning model with metacognitive strategy is a very effective method in teaching mathematics specifically, probability.

Recommendations

In light of the significant findings of the study, the following recommendations are offered.

1. Teachers should consider employing a constructivist learning model with a metacognitive strategy as methods of teaching mathematics.
2. Teachers should provide opportunities for all groups of students that will foster their knowledge construction process and to teach themselves how to think critically.
3. Learners are encouraged to do reflections and make portfolios.
4. Future researchers should conduct a study on the effectiveness of the constructivist learning model with another supplemental method other than metacognitive strategy in teaching mathematics.

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