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Integrating Mathematics Modular Worktext in Teaching Statistics: A Meta-cognitive Procedure

Razil M. Gumanoy
Associate Professor, College of Teacher Education, Surigao Del Sur State University, Philippines

Abstract:
Modular Worktext is one of the latest innovations in the educational system. This innovation in the modular approach contains a series of activities each of which start with teaching instructions addressed to the learners, explanation, exercises and generalizations. Modular worktext is applicable for enrichment, remedial work, absentee instruction and correspondence courses. Modules could be used for recurring, seasonal questions to maximize his time, or for small groups working without a teacher. The study investigated the result of pre-post-test on Statistics using the two teaching strategies on the academic performance of the students. This was conducted at Surigao Del Sur State University during the 1st semester academic year 2017-2018. The quisi-experimental research design method was used. A total of 60 students from the college of engineering and the college of teacher education were utilized as subjects of this study. Some 30 students were placed in the conventional group and another 30 students were assigned in the experimental group. The study examined the comparison of the performance of the students in Statistics between those who were exposed to conventional strategy and integrating mathematics modular worktext strategy. The study revealed that the results of the pre-post-test on Statistics showed the marks for the control group which gained a marginally higher mean than that of the experimental group. Modular worktext students got a significantly achievements in selected topics in Statistics. The findings also showed that there is a significant interaction effect in the achievement of students when they are exposed using the two teaching methods and when grouped according to their mathematical ability.

Keywords: *Modular worktext in statistics, academic achievement and mathematical level*

1. Introduction

Modular Worktext involves the division of the curriculum into limited units or modules of learning which are assessed at the end of that unit, with the student building up a degree through such learning being credited. Through this method, the teacher sheds the role of presenter, demonstrator, driller, and questioner, and now takes on the role of facilitator, initiator, monitor, coach, and coordinator. More importantly, it provides students opportunities to direct their own learning while they construct meaningful experiences about the concepts being taught (Torrefranca, 2017).Modular worktext is applicable for enrichment, remedial work, absentee instruction and correspondence courses. Modules could be used for recurring, seasonal questions to maximize his time, or for small groups working without a teacher (Guido, 2014)
Modular worktext promises a more efficient mass education by offering more effective individual instruction at a time when teacher is faced with a problem of producing learning in a large group all at the same time. It is a technique of self-instruction that involves the presentation of instructional materials to demonstrate their skills and comprehension (Aquino, 2011). The goal of the modules is to provide resources to instructors that will allow them to transform their classroomsinto active, student-centered learning environments. The following common characteristics of a module can be distinguished that it is self-contain, independent instruction unit, systematically organized, well defined have a means of evaluating the work (Kandarp Sejpal, 2013).

The strategy of learning modules has become a part of all level of teaching. A learning module is a self - learning package dealing with one specific subject matter/ unit. It can be used in any setting convenient to the learner and may be completed at the learner's own pace. Through modular instruction, more time could be used for the teacher's explanation instead of note-taking. With this, time is maximized for student learning by spending it more on students' facilitated interaction, buzz sessions, and other interactive strategies instead of spending more time on the delivery of lessons (Ali, 2010). However, this is so much affected by the ability of the teacher to systematically present the concepts for easier understanding. Using the usual lecture method in solving problems in mathematics is the most commonly used. This study was designed to determine the effectiveness of modular worktext approach on the academic performance of students of Surigao Del Sur State University who were exposed to the usual lecture method and using modules in teaching statistics.
Specifically, it sought to answer the following queries: significant difference on the achievement of students in Statistics when taught using Modular Worktext and Conventional method as a teaching approach; significant difference on the achievement of students in Statistics when taught using two teaching approach and when grouped according to their mathematical ability level; significant interaction effect on the achievement of the students when they were exposed using two teaching approaches and when grouped according to their mathematical ability level. Furthermore, the study identified a fitting approach in the teaching of Statistics. It focused on determining the learning effectiveness of Modular

Worktext in the cognitive development of the students in Surigao Del Sur State University. The study sought vital contributions of utilizing teacher made modular worktext to create successful and meaningful learning of mathematics. The subjects of the study were the 3rd Year BSED and engineering students of Surigao Del Sur State University who took Statistics for the Second semester academic year 2017-2018.

2. Theoretical/Conceptual Framework

This study is anchored on the theories on individualizing instruction through modules. According to Kemp and Smelie (1989), individualizing instruction plays a big role in modular instruction. Its main attributes include the individual assuming responsibility for their own learning, proceeding with activities and materials at their own level and studying at their own pace. This principle is in consonance with Thorndike's "law of readiness" which states that when a person is prepared to respond or act, giving the response is satisfying and being prevented of doing is so annoying. Thorndike's Law of Response of Analogy states that a person's response to a new situation is determined by innate tendencies to respond and by elements in similar situations to which he has acquired responses in the past. Edward Thorndike put forward a "Law of effect**"** which stated that any behavior that is followed by pleasant consequences is likely to be repeated, and any behavior followed by unpleasant consequences is likely to be stopped.

Individual instruction is backed by philosophy that every child is unique. People develop at different rates. Development is relatively orderly and development takes place gradually. Based on the theories of Jean Piaget (1896 – 1980) and Lev Vygotsky (1896 – 1934), every child is unique and has his or her own temperament and learning style. The child brings this uniqueness into each new experience and takes an active role in the process of learning through their engagement in these experiences. Children interact with peers, teachers, materials and the environment and relate each new piece of information to their already existing view of the world. These relationships are the basis of learning and as children explore and discover more about the world, these relationships become more refined and sophisticated. The construction of relationships in the child's mind is a prerequisite to the more complex skills of reading, writing and mathematical reasoning. Thus, giving children a wide variety of opportunities to actively explore, manipulate, question, and discover can best facilitate cognitive development.

Burrhus Frederic Skinner (1904-1990) theory on operant conditioning was heavily influenced by the work of John B. Watson as well as early behaviorist pioneers Ivan Pavlov and Edward Thorndike. According to Skinner, operant conditioning is "the behavior is followed by a consequence, and the nature of the consequence modifies the organism's tendency to repeat the behavior in the future." One of the principles of operant conditioning states that a behavior followed by a reinforcing stimulus results in an increased probability of that behavior occurring in the future. Another principle of operant conditioning is that a behavior no longer followed by the reinforcing stimulus results in a decreased probability of that behavior occurring in the future.

In social learning theory, Albert Bandura (1977) agrees with the behaviorist learning theories of classical conditioning and operant conditioning. However, he adds two important ideas: First, Mediating processes occur between stimuli and responses. Second, Behavior is learned from the environment through the process of observational learning. Unlike Skinner, Bandura believes that humans are active information processors and think about the relationship between their behavior and its consequences. Observational learning could not occur unless cognitive processes were at work. These mental factors mediate (i.e., intervene) in the learning process to determine whether a new response is acquired.Therefore, individuals do not automatically observe the behavior of a model and imitate it. There is some thought prior to imitation, and this consideration is called meditational processes. This occurs between observing the behavior (stimulus) and imitating it or not (response).

Robert Gagné (1916 – 2002) believes that learning occurs in a series of events. The learning events must be organized in a hierarchy of complexity and must correspond with deliberate instruction. The significance of the hierarchy is to identify prerequisites that need to be completed at each level. Each learning objective must be accomplished before effective learning of the next outcome can begin.

The conceptual paradigm of this study as reflected in figure 1 shows the schematic diagram of the study. As shown in the figure, the first box is the input of the study, the utilization of Mathematics Modular Worktext suited to their learning capacity. Also considered is the mathematical ability level of the students categorized as average, and low average. Many of the factors can be attributed to inadequacies in the school environment and the school process itself in terms of meeting the needs of students. These are factors that school can change through choosing the right instructional learning material that the students can comprehend well.

The second box is the covariate of the study, the pretest which is a continuous control variable that is observed rather than manipulated but can affect the outcome of the study.

The third box represents the output of the study; the mathematics performance of the students of Surigao Del Sur State University, using the Modular Worktext the teacher expects the students to have a higher math performance.

3. Research Methodology

This study utilized the pretest and posttest non-comparable quasi-experimental design to distinguish the effectiveness of the two teaching strategies. The design is the same as the classic controlled experimental design except that the subjects cannot be randomly assigned to either the experimental or control group. The illustration of this design is shown below.

Groups	Pretest	Treatment	Posttest
Modular Instruction	O_1	T_1	O_2
Lecture Method	O_1		O_2

The "T_1" represents the treatment of the study, which are the modules. The "O_1" represents the pretest and the "O_2" represents the posttest of both experimental and control groups. The broken line between the two groups suggests that there had been no randomization done to the respondents. This design involved the use of two groups namely; the experimental and control groups. The experimental group was taught using the instructional modules while the control group was taught using the traditional method.

To collect data for analysis from the subjects, a 25 multiple choice test instrument was used to indicate the level of achievement held by students. The multiple-choice test composed of topics in Statistics such as Measures of Central Tendency. The questions are based on textbooks generally covered in CHED curriculum guide for Statistics & Probability. A letter was sent to Senoc to obtain his permission for the use of his validated instrument. Permission to conduct the study was sought thru the recommendation of the Dean of College of Teacher Education. The Researcher who handled the classes under experimentation discussed on how the process starting from the pretest down to the posttest should be done. Two sets of tests were administered to both groups; control and experimental groups. The pretest was given before the experimentation began, and the posttest was administered after the instruction was conducted.

The study was conducted from November to March of second semester school year 2017 – 2018. After gathering the data, data were treated statistically, analyzed and interpreted. On the first day of the formal conduct of the study, an orientation was given to both classes. It was followed by the administration of the 25-item pretest. On the second day, the researcher presented the objectives of the lesson. The teacher asked the students about their previous lesson to find out how much knowledge they retained in their mind. This was done in order to motivate and enhance students.

Secondly, in the development of lesson, in experimental group, the teacher discussed the lesson thoroughly with the use of the modular worktext to further enlighten the doubts in the lesson. Meanwhile, in the control group, the teacher used the traditional method in development of the lesson. After the discussion, the teacher provided activity with the same guidelines and procedures. Afterwards, the students were given the generalization from the presentation of outputs. The conclusion served as a summary of the lesson. The teacher conducteda quiz to assess the knowledge learned from the lesson.

Then, teacher gave homework or assignment to facilitate and further assist their difficulties in the lesson. The teacher proceeded to the next topic following the steps. After all the topics were covered, post-test was administered to both experimental and control group to assess the learning of the students. The same questionnaire in the pre-test was used during the post-test. The result of the post-test was recorded and compared with the result of the pre-test to see if there was an increase in the scores of the students which in effect determined the achievement and performance of the students in Mathematics.

For analysis of the data, the following statistical tools were used: mean and standard deviation, one-way analysis of covariance (ANCOVA) and two- way analysis of covariance (ANCOVA).

4. Results and Discussion

Type of group	N	Pretest Mean	SD	N	Posttest Mean	SD
Experimental group	30	5.967	3.135	30	17.733	3.732
Control group	30	6.767	3.360	30	14.467	4.289
Overall	60	6.367	3.248	60	16.100	4.011

Table 1: Mean Scores and Standard Deviation Value of the Pretest and Posttest

Achievement of students in the pretest and posttest are presented in Table 2. The table shows that the experimental group obtained slightly lower mean than that of the control group in the pretest. This result indicates that both groups have almost the same schema before the conduct of the study. It means that they have similar foundations in mathematics. The table further reveals that the experimental group gained high scores in the posttest with a mean value of 17.733 compared to the control group having a mean value of only 14.467.The experimental group displayed higher mean value than that of the control group in the posttest because almost all of the students performed the task assigned to them. As observed during the conduct of the study, the students who were taught using modular worktext approach showed responsibility of learning by themselves. It helps the student improve his/her mastery and catch up with the missed lessons. Passive students were participative in the assigned task. Therefore, an increase in their mean scores of 17.733 in the post-test from 5.967 mean scores is evident.

On the other hand, the control group, having the same foundations in Mathematics that of the experimental group obtained lesser mean value in the posttest than that of the experimental group. This is because of the direct input of the teacher in the discussion process, but still the control group displayed increase in their mean scores from pretest of 6.767 mean scores to posttest of 14.467 mean scores. The lower value of the standard deviation of the experimental group shows that the scores of these students were closed to the mean compared with the scores of those students in the control group. This indicates that some of the students who were exposed to modular instruction strategy have almost the same level of understanding the concepts well, and that resulted to their high scores in the tests.

However, the control group has a high standard deviation and it explains that the test scores of the students in this group are scattered compared to the experimental group. It means that most of the students have almost different comprehensions about the lessons and the basic concepts which have been discussed by the teacher thoroughly. Furthermore, both groups increase the Posttest Mean and standard deviation which showed that learning took place using the two methods.

However, the students who were taught using the modular approached performed significantly better than the students exposed to traditional lecture method. This result relates with the findings of Garillos (2012) which shows that there is a significant increase in the pretest and posttest results of the students when an instructional material was introduced in the class. However, to test if there is a significant difference between the pretest mean scores of the control group and the experimental group, the One – Way analysis of Variance (ANOVA) was used. Table 2 presents the summary of the results.

Source of Variation	Type III Sum of Square	Df	Mean Square	F-value	P-value
Covariate	36.842	1	36.842	6.237	0.003
Main Effects	16.738	1	16.738	2.833	0.000
Explained	117.2388	2	58.644	9.927	0.000
Residual	313.092	53	5.907		

Table 2: Summary Table for the One – Way ANOVA of the Mean Scores of the Control Group and Experimental Group

The computed F-value is 2.833at P-value of 0.000, which is less than the set level of significance at $\alpha = 0.05$. Therefore, there is significant difference between the mean score of the control group and experimental group. It is implied that the use of learning modules as a tool in individualization of learning is an effective method of teaching and would help improve the performance of learners because the students only study when they are ready, they were never "forced" to learn, learning took place because they were ready. This is supported by Thorndike's Law of Readiness which states that a learner's satisfaction determined by the extent of his preparatory set, that is, his readiness for action. This result relates with the findings of Torrefranca (2017) which revealed that instructional modules brought out some sort of improvement in their knowledge, that is, the students learned from the modules and can go about it, with their teachers as facilitators of learning.

Source of Variation	SS	Df	MS	F-value	P-value
Covariates	37.566	1	37.566	5.900	0.019
Factor A (Mathematical Ability	15.738	1	15.738	2.421	0.126
Factor B (Strategy	497.005	1	497.005	78.051	0.000
A x B	1.292	1	1.292	0.203	0.654
Explained	831.535	4	207.884	32.657	0.000
Residual	7343.855	54	6.368		

Table 3: Summary Table for Two – Way ANOVA on the Performance of Students in Statistics When Taught Using Modular Worktext and When Taught without Using MW, When the Students Are Group According to Their Mathematical Ability Level

The F-value of 0.203 with p = 0.000 is lesser than the significant level at 0.05. This result reveals that the null hypothesis is accepted, which states that, "there is no significant interaction effect in the achievement of students when taught with modular worktext and the conventional method, and when grouped according to their mathematical ability levels. This implies that the teaching approaches and the mathematical ability level do not interact if taken at the same time. This finding further implies that the teaching approaches and mathematical ability has no significant interaction effect on the achievement test scores of students. The result further implies that the teaching approaches have no interaction on the ability level of the result. Hence, whatever teaching approach is applied by the teacher the average students could still get a better result on the achievement tests than low average student. Parallel result in the control groups shows that average students performed better that low average students. This result relates with the findings of Ali (2010) which indicated no significant exist interaction in the students' achievement when they are grouped according to their mathematical ability and the teaching strategies used.

5. Conclusions

The use of Modular Instruction in teaching Math specifically word problem solving, is an effective teaching approach. Effective in the sense that it helped the students develop their individual learning study habits and have better understanding on Probability. Though the results of this study showed that learning took place in both groups using the two methods of teaching, the students who were taught using the modular approached performed significantly better than the students exposed to traditional lecture method and it is concluded that modular instruction approach is an applicable and effective teaching approach that could be used in teaching mathematics subjects.

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