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Comparative effectiveness of commercial and customised it-enabled learning packages in enhancing achievement in mathematical skills of high school students

Dr. Brinda Nair S.

Asst. Professor, Karmela Rani Training College, Kollam

Abstract---The present study is designed to test the comparative effectiveness of an IT-enabled learning package prepared by the investigator and a commercially available learning package in enhancing the achievement of high school students in select mathematical skills. The study made use of a commercially available learning package, an IT-enabled learning package prepared by the investigator and a mathematical skills test for the study. The experimental study involved 90 students (45 each in the experimental and control group) and found out that the IT-enabled learning package prepared by the investigator is more effective than the commercially available learning package. The IT-enabled learning package prepared by the investigator can be utilised for imparting mathematical skills to high schools. It is also recommended that developers of commercial learning packages can incorporate the findings of the study by realising the importance of engaging teachers in the designing of these packages which will prove beneficial to both the developers and end users.

Keywords---IT-enabled learning package, commercial learning package, mathematical skill test, achievement in mathematics, ANCOVA.

Introduction

Mathematics is a subject which has considerable influence in everyday life of human being. Application of mathematical concepts is essential while fixing household budgets, deciding the duration of physical exercises, in using the right quantity of ingredients in cooking and in time management. It is one of the fundamental requirements in landing the right kind of career and people with superior mathematical skills are sought after in every profession. But due to

several reasons including maths anxiety, even people who excel in other subjects perform miserably in mathematics. ICT has completely transformed all facets of our life through faster communication and social interaction. In the educational field also, ICT plays a prominent role. The advent of multimedia capabilities in ICT played a crucial role in creating learner-friendly educational content rich in graphics and animation and mathematics learning has become a pleasurable and exciting experience instead of the conventional method which mainly relied on rote memorisation. As the technology has matured over time, several companies started evincing interest in creating ICT-enabled educational content and as a result, a vast number of commercial IT-enabled learning packages flooded the education market. The outbreak of Covid-19 also played a significant role in the mushrooming of commercial educational software content. Though this situation provided the students with so many IT-enabled learning packages to choose from, absence of a benchmarking system posed difficulties in choosing the right kind of package from among the numerous packages available.

Significance of the study

Mathematics is a subject which majority of the students consider as boring, difficult and impractical. The prevailing methods of teaching also make it uninteresting as it is mostly mechanistic which do not create interest in the learner. Studies as those of Koller et al. (2001), Varghese and Suthanthira Devi (2019) revealed that there is significant positive relationship between mathematical interest and achievement in mathematics. These studies show that creating interest in the learner is one of the essential prerequisites of teaching mathematics.

The use of information and communication technology in creating educational content has transformed the process of learning and the multimedia capabilities of ICT made the process of learning an interesting and enjoyable experience which could garner the attention of even the low achievers. The subject which has benefited most from ICT-enabled learning is mathematics as the commercial learning packages available in the market were rich in multimedia capabilities and removed the monotonous and unexciting nature of mathematics learning to a great extent. Realising this opportunity, several companies have introduced ICT-based commercial learning packages in mathematics among other subjects and at present, students find it difficult to choose the right learning package from among the numerous packages available commercially.

The investigator, as part of her Ph.D. research, has constructed a standardised IT-enabled learning package to enhance the mathematics skills of high school students and tested its effectiveness on high school students which revealed that the prepared IT-enabled learning package was more effective in developing the mathematics skills of the learners when compared to the prevailing method of instruction. Hassana and Woodcock (2010) pointed out that the failure of commercially available learning packages in meeting the needs of teachers and students is due to absence of end users in the designing stage. Besides this, most of these learning packages have a one size fits all approach which may not be suitable for students of different learning styles. To rectify this anomaly while preparing the instructional package, the investigator interacted with several high

school mathematics teachers to find out the inadequacies of the existing commercially available learning packages and the major inadequacies they mentioned are absence of enrichment sections, inappropriateness for enhancing mathematics skills, inadequacy to create interest and motivation among all types of learners and ineffective reinforcements. The investigator prepared the IT-enabled learning package by removing all these inadequacies mentioned by the teachers. To ascertain whether the prepared IT-enabled learning package is more effective than the commercial learning packages available, the investigator selected a commercially available learning package (the name of the package is withheld due to commercial interest and privacy) and tested its comparative effectiveness with the IT-enabled learning package prepared by the investigator in the development of certain mathematical skills in high school students. The major research question framed for this study was. Is the IT-enabled instructional package prepared by the investigator more effective in enhancing the mathematics skill of high school students when compared to the commercially available learning package? Through quantitative analysis, this study attempted to find out answer to this pertinent research question.

Objective

To test the comparative effectiveness of the IT-enabled learning package prepared by the investigator and the commercially available instructional package in enhancing the achievement in select mathematical skills of high school students.

Hypothesis

There is no significant difference between the experimental and the control groups in the mean adjusted post-test scores in select mathematics skills.

Methodology of the study

This experimental study used non-equivalent pre-test – post-test design for finding out the comparative effectiveness of the investigator prepared and commercially available IT-enabled learning packages in enhancing the select mathematics skills of high school students. A sample of 45 students each (total 90 students) was used for conducting the experiment. The IT-enabled learning package prepared by the investigator, a commercially available IT-enabled learning package and the mathematical skills test (MST) prepared by the investigator comprising 30 objective type items from the unit ‘Arithmetic Sequences’ of 10th standard Kerala state syllabus mathematics text book were the tools used for the experimental procedure. The initial and final mathematical skills of both the experimental and control groups were measured using the mathematical skills test. To test the comparative effectiveness of the commercial learning package and the IT-enabled learning package prepared by the investigator, the statistical technique of ANCOVA was used.

Analysis of data

Effectiveness of the IT-enabled Learning Package in Enhancing Select Mathematics Skills of High School Students Compared to Commercial IT-enabled Learning Package (Using ANCOVA)

The pre-test and post-test scores on the mathematics skills test of high school students in the experimental group taught using the IT-enabled learning package prepared by the investigator and in the control group taught using the commercial IT-enabled learning package were analysed using Analysis of Covariance to determine the comparative effectiveness of the both the IT-enabled learning packages in enhancing achievement in select mathematics skills of high school students. This was done in order to determine which of the two IT-enabled learning packages was more effective. Calculations were made to determine the sum of squares, mean square variances, and F-ratios for the pre-test and post-test scores of secondary school students in both the experimental group and the control group. The results of these calculations can be found in Table 1.

Table 1
Summary of ANOVA of Pre-test and Post-test Scores of Secondary Level Students in the Experimental and Control Groups

Source of Variation	df	SSx	SSy	MSx	MSy
Between Means	1	4.90	144.40	4.90	144.40
Within Groups	88	278.22	663.60	3.16	6.07
Total	89	283.12	808.00		

$$F_x = 1.55$$

$$F_y = 19.15$$

From table F for df 1/88

$$F \text{ at } 0.05 \text{ level} = 3.96$$

$$F \text{ at } 0.01 \text{ level} = 6.96$$

The relevance of the F-ratios for the two different sets of scores was investigated. The acquired F_x value is not significant even at the 0.05 level because the table value of F for df 1/88 is 3.96 at the 0.05 level and 6.96 at the 0.01 level. The value obtained for F_x is 1.55, and p is more than 0.05. According to the results of the analysis of the variance of the 'x' means, the pre-test scores of the experimental group and the control group are not significantly different from one another. The fact that a F_x value was able to be achieved indicates, among other things, that the random assignment of participants to the two groups was carried out effectively. Since the obtained F_y is greater than the table value when measured at the 0.01 level, the result can be considered statistically significant ($F_y = 19.15$; $p < 0.01$). The results of the analysis of variance on the means of the variable y suggest that there is a statistically significant difference in the post-test scores of the high school students who were in the experimental group vs those who were in the control group. The adjusted sum of squares and adjusted mean square variances for post test scores were computed, and the F ratio was calculated and given in Table 2 to correct the final y-scores for the difference in the pre-test scores. Table 2 also contains the results of these calculations.

Table 2
Summary of ANCOVA of Pre-test and Post-test Scores of High School Students in
the Experimental and Control Groups

Source of Variation	df	SSx	SSy	SSxy	SSyx	MSyx	SDyx
Between means	1	4.90	144.40	26.60	129.46	129.46	2.73
Within groups	87	278.22	663.60	67.73	647.11	7.44	
Total	80	283.12	808.00	94.33	776.57		

$F_{y.x} = 17.40$

From Table F for $df\ 1/87$

F at 0.05 level = 3.96

F at 0.01 level = 6.96

The $F_{y.x}$ ratio that was determined to have been attained is statistically significant ($F_{y.x} = 17.40$; $p\ 0.01$). After taking into account the initial variations in pre-test scores, the results make it abundantly evident that the final means, which are dependent upon the experimental variables and the control variables, differ significantly from one another. It was decided to compute the adjusted means of the post test scores of the students in both the experimental group and the control group. It was determined whether or not there was a significant difference in the adjusted y-means. Table 3 presents the findings of the adjusted means for post test scores obtained by high school students who participated in either the experiment or the control group.

Table 3
Adjusted Means of Post-test Scores of High School Students in the Experimental
and Control Groups

Groups	N	Mx	My	My.x (adjusted)
Experimental	45	12.09	22.60	22.54
Control	45	11.62	20.07	20.12
General Means		11.86	21.33	21.33

$t = 4.21$

From the table $df = 87$

t at 0.05 level = 1.99

t at 0.01 level = 2.64

It was determined whether or not there was a significant relationship between the obtained adjusted means for the post-test scores and $df\ 87$. The value of t that was discovered was 4.21, and it was significant at the 0.01 level. A large t -value indicates that there is a substantial disparity between the two means. This indicates that the mean adjusted scores of the experimental group and the control group are significantly different from one another. Because the mean adjusted score for the experimental group was greater than that of the control group, it is reasonable to draw the conclusion that the experimental group performed significantly better than the control group. The statistically significant difference between the two sets of adjusted mean scores demonstrates that the IT-enabled learning package developed by the investigator is more effective than the learning package that is available for purchase commercially in terms of improving particular mathematical skills among high school students. Because of this, the hypothesis that was formulated in this context, which stated that "There is no

significant difference between the experimental and control groups in the adjusted post-test scores in select mathematics skills," is not accepted.

Conclusion

The analysis of data revealed that the IT-enabled learning package is more effective than the commercial learning package enhancing select mathematics skills of high school students.

Recommendations

The IT-enabled learning package was found to be superior to the existing commercially available learning package in enhancing the achievement in select mathematics skills of high schools. Teachers can use this learning package in the development of mathematical skills of students of all achievement and interest level. Pre-service and in-service training should be given to student teachers and teachers to enable them to implement these kinds of learning packages effectively in classrooms. The findings of the study can act as a catalyst to educational software application developers in rectifying the anomalies pinpointed by teachers and create a better student-centred product which could cater to students of all achievement and intelligence levels. The study also highlights the fact that the teacher is the pivot person in the scheme of things while preparing educational packages. Commercial educational software developers should take adequate steps to ensure the participation of teachers in the designing of learning packages which could minimise the flaws pinpointed by teachers and result in learning packages which caters to students of all achievement levels and create interest and motivation in learners.

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