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Effect Of Using Symbolab Calculator In Teaching Simultaneous Equations On Students' Conceptual Understanding At The Elementary Level In Pakistan: Mathematics Attitude In Technological Corners

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Abstract

Technology has been proven useful to support and transform teaching and learning. It is helping students to understand, perform, learn and explore calculations in mathematics to enhance students' understanding, knowledge and visualization. Simultaneous equations are very are important in computations for analysis or to find solutions quickly of these equations, thus, increases the understanding in the subject. The 21st century has added a number of enhancements and impediments to teachers and students. The hyper-connected digital environment requires manifold decisions on the part of educational stakeholders. This quasi-experimental study with non-equivalent control group post-test only design was administered to explore the effect of free software called 'Symbolab Calculator' in teaching simultaneous equations on students' conceptual understanding at the elementary level in Pakistan. A total of 66 students of a private school participated in the present study. They were assigned into experiment and control groups. One group was taught simultaneous equations with Symbolab Calculator whereas the other group underwent learning with conventional way. Participants' mathematics achievement was measured using post-test at the end of intervention. Independent sample t-test was based on the syllabus of Oxford Cambridge Mathematics book. The findings of the study clearly revealed that the use of the Symbolab for teaching simultaneous equations was more effective as compared to a traditional method of teaching. Hence, the test scores showed that there was a significant difference in mathematics achievement. The results of the present study are expected to benefit schools, colleges, universities and teachers that are looking for the innovation in math education.

Keywords: Quasi-experimental Design, Mathematics, Pakistan, Simultaneous Equations, Symbolab Calculator

Introduction

During the past few decades, several researches focused teaching learning mathematics using digital technology to attract the students' attention. In addition, the advancement in technology over the decades has led to the

implementation of the smart pedagogical approaches to deliver the lecture effectively and to improve students' understanding, knowledge, participation and interaction (Jaafar, Nor, Norrulashikin, Kamisan, & Mohamad, 2022). The speed of learning and solving mathematical problems such as slope of a line, plotting 2D & 3D graphs, percentages, simultaneous equations, ratio and proportion, distances, conversions can be reduced or minimize to a higher level by teaching through smart approaches. The pace of learning math content through digital tools is far greater than the humans (Apsangi, Pawar, Khindkar, Dushing, 2016) for quick and correct calculations of math problems. One of the advantages of Symbolab software is that teachers can save time and observe the students'performance easily especially in a large classrooms. According to Tsou, & Brown, (2017), GeoGebra and Desmos are also free, interactive and only resources like Symbolab.

Chalk and board method is one of the old and common teaching methods, though in schools it is usually considered the primary approach at all educational levels. This traditional method, also known as Lecture method, is very convenient and usually makes sense, especially when there are large classrooms with many numbers of students (Saira, Ajmal, & Hafeez, 2021). It generally requires good writing and communication skills to present lessons effectively and may use chalk, black board, charts and sometimes worksheets. However, it takes much time and effort to understand concepts for all types of students. The pace of learning mathematics can be improved largely by the advancement in existing technology. This can be practical by supplying fast input and then calculating fast output. Output can be computed faster by improving the input speed (Apsangi, Et. al., 2016), which can only be feasible by the involvement of smart processing tools provided by the advancement of technology. Many subjects rely heavily on digital technology to enhance teaching and learning that is indeed useful in learning mathematics. This is the reason that more and more avenues of bringing change and innovation in teaching and learning have opened up. There are plethora of computer based technologies such as tablet, smart phones, smart boards, laptop and IoT (Internet of Things) (Lozada, Guerrero-Ortiz, Coronel, & Medina, 2021) that claim to support teachers of all levels of education to deliver instruction, interact with students, and provide feedback to them (Matos, Nipper, & Rigdon, 2022). The innovations are effective and convenient to use that included smart instructional approaches for teaching, since these creative resources can be extremely time saving, and more importantly, students were gravitating towards. In this paper, the authors investigated the effect of Symbolab Calculator for teaching simultaneous equations on students' conceptual understanding at the elementary level in Pakistan. The authors used Symbolab software to solve simultaneous equations created during mathematics class and made available to students. The pictures of lab lessons were taken as evidences. The activities and practice work using the 'Practice' feature on Symbolab app were also captured.

There are various innovative tools available on the Internet that allows users to learn, practice and explore mathematics topics. One of the primary tool is Symbolab Calculator that provides automated step by step solutions to algebraic, trigonometric and calculus topics covering from middle school through college (Symbolab, 2022). The tool includes topics like conversions, simultaneous equations, equations, graphs, inequalities, algebraic expressions, integrals, derivatives, limits, solving linear and quadratic equations, functions and many more. https://www.symbolab.com/ (Symbolab, 2022) is a website that provides various operations and functionality to solve and calculate mathematical problems. Solving simultaneous equations graphically help visualize and better understand the function of the equations. The software

generates accurate solution for the given input (Matos, Et. al., 2022). More complex, linear or quadratic, equations are also solved by the Symbolab app. with its graphical representation. However, the solutions were only available online that needs fast and smooth internet facility and for full functionality Symbolab requires large memory. Moreover, the operators, parameters must be entered one at a time. The paper assessed the solution of pair of simultaneous equations graphically on Symbolab application to find the common point of intersection and the point gives the solution of the equations. The values of the shared variables satisfy both algebraic equations simultaneously (Third Space Learning, 2022). For the entrepreneurs or the business to find out when supply, equals demand.

Research Related Work

Without an adequate level of competence, the conceptual understanding of students is limited; therefore, it is essential to integrate technology into mathematics teaching and learning process. Zeidmane, (2020) commented in his paper that Symbolab is the most popular math software as this smart tool not only give results, but also show the solution step by step. Studying mathematics with Symbolab is far greater useful to solve and understand problems conceptually, because students often even do not understand what they have solved at homework in traditional approach. Use of Symbolab in math classrooms enable students to visualize the content in ways that were previously not easily achieved due to its interactive nature. Utilizing digital software effectively for teaching mathematics has the potential to develop conceptual and geometrical understanding and a deeper approach to learning (Kumar & Kumaresan, 2008). However, Tsou, & Brown, (2017), in their survey study concluded that implementation of technology into mathematics involves a wide range of resources including various hardware, software, infrastructure, resources, educational packages and more. Further, they said that the interface is easy to use for both students and teachers to view solutions on the screen in real time. Hence, all these activities apparently motivate students' learning. To add more, the software can boost computational speed, accelerate results and ensures cost-efficiency. Ali, (2011) emphasized on providing opportunities for teachers to widen their content knowledge, of innovative pedagogies and strategies. He further said that the innovative instructional approaches for mathematics in Pakistan need to be adopted to make creative connections between content, pedagogy, and the appropriate tools. Some also stressed the need for more professional development of schoolteachers in terms of which technique work best to adapt technologies in math classroom for the efficacy to help students' learn conceptually.

Hypothesis

H_0: There exists no significant difference in traditional method of teaching simultaneous equations versus teaching with Symbolab for post-test achievement score of mathematics.

H_1: There exists a significant difference in traditional method of teaching simultaneous equations versus teaching with Symbolab for post-test achievement score of mathematics.

Objectives

To determine the significant differences in the mean scores utilizing Symbolab Calculator and traditional way for teaching simultaneous equations on student's conceptual learning in mathematics to grade 7.

To study the effect of Symbolab software on student's conceptual understanding in mathematics of grade 7 students.

Questions

What is the overall effect of Symbolab on students' conceptual learning compared to students without technological interventions?

Methodology

This section consists of the description of population, sample, instrument, design, discussion, data analysis and conclusion.

Participants & Sample of the Study

Data collected through the achievement test based on MCQs as instrument was organized and entered. To analyze the data, descriptive statistics was provided as a preliminary view into the research results and was used in describing the data set. Moreover, for the inferential statistics, t-test for significant difference in the mean scores was determined for teaching simultaneous equations with and without intervention on the learning improvement of grade 7 students in mathematics. Statistical Package of Social Sciences (SPSS) ver. 25 was used to analyze the data. The participants were the students of private school involved in this study. There were 2 Intact groups were selected, one group included 33 students for the control group and other 33 students for the treatment group. The investigator used pre-test post-test comparison group design for the paper. In both of the groups, pre-test and post-test was administered to commensurate the conceptual understanding due to the implementation of Symbolab Calculator. The instrument used in the study was Multiple-Choice items regarding simultaneous equations of Algebra.

Investigation Tool

The instrument was the achievement test consisted of 45 items regarding simultaneous equations. All items were multiple-choice conceptual based items to explore their learning on the subject using Symbolab. Forty items, which were distributed into 3 tests of 15 items each of the post-test. These 45 items were pilot tested on 8 students out of the sample of the study for making necessary changes for the final version of the instrument. The items were reduced from 50 items to 45 items after getting response from them with some content and grammatical changes.

Quasi- Experimental Design

Within this research design spectrum, pretest and post test control group design implemented to discover the research question of this paper which was used to test descriptive hypotheses. Two groups that were chosen for the intervention assumed to be as similar as possible before intervention (White, & Sabarwal, 2014). The present study focuses on conceptual learning of students by comparing pretests and posttests of the control and experimental groups. Difference in their performance was measured through conducting pretest and post-test and based on which the research hypothesis can be proven or disproven.

Data Analysis

The mean scores obtained by pre-test and post-test was analyzed by descriptive and inferential statistics respectively. Means of both groups were calculated and compared by applying t- test for independent sample (White, & Sabarwal, 2014). Both the control and experimental groups were given the pre-test to measure their understanding prior to the implementation of the Symbolab app. During the intervention, students were taught simultaneous equations to find out the point of intersection while teaching with the smart tool, and then, post-test was administered after to see the mean scores differences of their conceptual learning of the topics being assessed. Control group was not exposed to any kind of intervention and post-test was conducted after the completing lessons related to simultaneous equations with old lecture method strategy (Xu, Fralick, Zheng, Wang, Tu, & Feng, 2017). To add more, the said groups of students were not exposed to lecture or any related activities that will enable them to create a construct of conceptual understanding prior to exposure to the smart approach. In the analysis of the data, Paired and Independent t-test was conducted for comparing the significant

differences between the pre-test and post-test of the treatment group, and the posttest experimental group and posttest control group, respectively (Xu, Et. al., 2017). In line with this, descriptive statistics was done to explain the primary characteristics of the collected data such as mean, standard deviation, minimum and maximum value.

It was found that the groups who involved Symbolab-mediated instruction in their teaching and learning processes had higher academic outcome. The table clearly shows that there exists a difference in the lecture method and smart teaching method of teaching simultaneous equations in the subject of mathematics. Hence, alternative hypothesis, H_1 was accepted.

Results & Discussion

Descriptive Statistics for Pre-test & Post-test

Descriptive Statistics	Control Group (N=33)		Experimental Group (N=33)	
	Pre-Test	Post-Test	Pre-test	Post-Test
Mean	55.61	62.85	55.42	80.42
Std. dev.	14.684	11.898	-17.471	8.159

There was a great difference in the mean scores on the pre-test and post-test and the groups were close to each other at the base level. The table above depicts comparison of pre-test and post-test mean scores of mathematics subject using Symbolab and the traditional method teaching groups. Paired sample t-test was applied to check the significant difference between the pre and post-tests mean scores of groups. There is a significant difference found in the mean scores of pre-test and post-tests of control (55.61, 62.85) and experimental (55.42, 80.42) groups. However, the result would be considered significantly different if $p < 0.05$. For this, paired sample t-test was applied on the data. It was concluded that there exists a significant difference in traditional method of teaching simultaneous equations versus teaching with Symbolab for post-test achievement score of mathematics.

Table: Comparison of Pre-test and post-test scores of subjects in both groups.

Variables	**Teaching with Symbolab**		**Teaching without Symbolab**		**df**	**T-computed**	**P value***
	Mean	SD	Mean	SD			
Pre-test scores	55.42	17.471	55.61	14.684	64	.046	.964
Post-test scores	80.42	8.159	62.85	11.898	64	-6.998	.000

Paired Sample Statistics *****$p < 0.05$ significant

It is clear from the table that for post-test of the control group the mean scores are low which implies that the math achievement test was difficult for the students and further implies that they are facing some challenging problems. Under the pre and post-test scores of control groups, the test was difficult indicating that there was a slight effect to their level of achievement. For the experimental group, it may be inferred that there were several students who found it comprehended the concept of simultaneous equations well. It is also shown in the mean

scores that there is only a small difference between the pre-test and post-test of the control group. However, the implementation of Symbolab showed a tremendous increase.

	No Symbolab		Symbolab	
Mean	55.61	62.85	55.42	80.42
Confidence Level (95%)	.001		.000	
Independent Sample Statistics				

Independent sample t-test was applied to check the significant difference between pre-test and post-test results of both groups. Pre-test and post-test mean results showed that scores with Symbolab teaching method and without Symbolab teaching method along with their p-value is less than 0.05. Therefore, it can be interpreted that there exists a significant difference in lecture method versus smart intervention of teaching in math subject. Hence, alternate hypothesis (H_1) was accepted.

Main Finding and Conclusion

The current experimental research demonstrated that teaching simultaneous equations was a more effective method as compared to the traditional way of teaching mathematics. The results of the study showed that students who attended the Symbolab class for learning simultaneous equations graphically instead of choosing chalk board or lecture method obtained significantly higher score in MCQ's based achievement test. They learned conceptually more as compared to those who attended the same content-based lecture. Majority of students preferred teaching with Symbolab, as the marks scored by the students of experimental group were higher than the control group. Hence, Symbolab helps in better understanding of the math concept that helped students to understand the simultaneous equations better. Many studies have demonstrated that the combination of different teaching methods can be more effective than any single method of teaching (Rokade, & Bahetee, 2013). Hence, if we combine several approaches for math classroom, it can be more effective than a single method. In this paper, two methods were compared individually i.e. traditional method and teaching with Symbolab. Such research studies are recommended for future in order to evaluate the effectiveness of combined methods of teaching versus single teaching method. To conclude, there exists a significant difference in the effect of teaching with Symbolab and the traditional teaching way on students' conceptual understanding in mathematics. The results showed that the students taught through Symbolab scored better than the students taught without Symbolab Calculator.

References

1. Ali, T. (2011). Exploring students' learning difficulties in secondary mathematics classroom in Gilgit-Baltistan and teachers' effort to help students overcome these difficulties. Bulletin of Education and Research, 33(1), 47-69.
2. Apsangi, M. R., Pawar, A.N., Khindkar, V.S., Dushing, A.S., (2016). Detection Of Integral Equation By Image Processing And Generation Of Solution. International Journal of Engineering Applied Sciences and Technology, Vol. 1, Issue 7, Pages 153-155
3. Fabian, K., Topping, K.J. & Barron, I.G. (2018). Using mobile technologies for mathematics: effects on student attitudes

and achievement. Educational Technology Research and Development. 66, 1119–1139. https://doi.org/10.1007/s11423-018-9580-3

4. Jaafar, N.A., Nor, S.T.M., Norrulashikin, S.M., Kamisan, N.A.B., & Mohamad, A.Q., (2022). Increase Students' Understanding of Mathematics Learning Using the Technology-Based Learning. International Journal of Advanced Research in Future Ready Learning and Education. 27(1). Pg. 24-29. Retrieved from https://www.akademiabaru.com/submit/index.php/frle/article/view/4594
5. Kumar, A., & Kumaresan, S., (2008). Use of Mathematical Software for Teaching and Learning Mathematics. Retrieved from http://www.mathunion.org/fileadmin/ICMI/files/About_ICMI/Publications_about_ICMI/ICME_11/Kumar_Kumaresan.pdf
6. Lozada, E., Guerrero-Ortiz, C., Coronel, A., & Medina, R. (2021). Classroom Methodologies for Teaching and Learning Ordinary Differential Equations: A Systemic Literature Review and Bibliometric Analysis. Mathematics, 9(7), 745. https://doi.org/10.3390/math9070745
7. Matos, C., Nipper, K., & Rigdon, H.R., (2022). Students' Preferred Technology in an Ordinary Differential Equations Course. American Society for Engineering Education. Southeastern Section Conference. Clayton State University. Georgia, USA.
8. Rokade, S.A., & Bahetee, B.H., (2013). Shall we teach anatomy with chalk and board or power point presentations? An analysis of Indian student's perspectives and performance, Scholars Journal of Applied Medical Sciences. 1(6). pg. 837–842.
9. Saira, Ajmal, F., & Hafeez, M., (2021). Critical Review on Flipped Classroom Model Versus Traditional Lecture Method. International Journal of Education and Practice. Vol. 9, No. 1, pp. 128-140. DOI: 10.18488/journal.61.2021.91.128.140.
10. Symbolab (2022). "Integral Calculator," Retrieved from https://www.symbolab.com/solver/integral - calculator on 6th November, 2022.
11. Third Space Learning, (2022). Maths Tutoring for Schools. Guide to copyright. Retrieved Novmeber, 3, 2022, from https://thirdspacelearning.com/gcse-maths/algebra/simultaneous-equations/
12. Tsou, C., Brown, B., (2017). Implementing Technologies in the Mathematics Classroom at Ontario Colleges. Mathematics Education. Retrieved from: https://www.researchgate.net/publication/321443630_Implementing_Technologies_in_the_Mathematics_Classroom_at_Ontario_Colleges
13. White, H. & Sabarwal, S. (2014). Quasi-Experimental Design and Methods: Methodological Briefs - Impact Evaluation No. 8. Unicef.
14. Xu, M., Fralick, D., Zheng, J. Z., Wang, B., Tu, X. M., & Feng, C. (2017). The Differences and Similarities Between Two-Sample t-test and Paired t-test. Shanghai archives of psychiatry, 29(3), 184–188. https://doi.org/10.11919/j.issn.1002-0829.217070\
15. Zeidmane, A., (2020). Promotion of engineering skills using ICT in study process. Engineering For Rural Development. DOI: 10.22616/ERDev.2020.19.TF505.

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