www.irss.academyirmbr.com December 2018
International Review of Social Sciences Vol. 6 Issue.12

Bagatrix: An Artificial Intelligence Application in Teaching Normal Distribution

PATRICK G. GALLETO
Jose Rizal Memorial State University, Dapitan City, Philippines
Email: patrick.galleto@yahoo.com
Tel: +639263836621

AMERICA M. PONGGAN
Manukan National High School, Zamboanga del Norte, Philippines
Email: aminerales33@gmail.com
Tel: +639275363709

Abstract

Mathematics softwares have been flooding in the web today. They are artificial intelligence which conceived to supplement students' understanding of various mathematical concepts primarily. The study attempted to find out the effect of Bagatrix Mathematical Software on students' performance in Normal Distribution of the Grade 11 Technical-Vocational-Livelihood Track students during the second semester of the school year 2017-2018. The study utilized the quasi-experimental utilizing the pretest-posttest nonequivalent group design. The experimental group with 59 students was exposed to the Bagatrix while the control group with 64 students was taught with the traditional method of teaching. The teacher–made test which comprised 35 items was used to determine the pretest and posttest performance of the students in both groups. Data were treated using the mean, standard deviation, z-test one sample group, t-test for independent samples, and t-test for correlated samples. The study revealed that Bagatrix was an effective tool in teaching Normal Distribution to Grade 11 students. The application of the mathematical software concluded a tremendous increase in the students' performance from the pretest to the posttest. The finding necessitates that the School Administrator of Manukan National High School in collaboration with the Department of Education particularly the Division of Zamboanga del Norte should allocate budget for the Bagatrix annual subscription and building adequate computer laboratory for the purpose. Training for Mathematics teachers in the utilization and application of the software should also be appropriated. Moreover, students should utilize and apply the Bagatrix mathematical software as a supplement to enhance and ensure higher performance not only in problem solving in Normal Distribution but in all Mathematics courses.

Keywords: *Mathematical Software, Students' Performance, Artificial Intelligence*.

Introduction

Mathematics education together with science and technology is the primary driver of the progress and transformations happening in most Mathematics classrooms. Today's Mathematics classrooms have dwelt with technologically exposed millennial learners. These learners frequently acquire skills through instruction and experiences in manipulating technology. The study claims that the massive developments of artificial intelligent mathematical softwares are instrumental in enhancing students' performance.

Houppi (2009) supported that the world is in a technological boom the reason why Mathematics classrooms have been flooded with electronic teaching tools. The most important of these changes is the utilization of Mathematics educational software (Colado et al., 2017). Edwards et al. (2008) pointed out that teachers and students today have developed a new sense of understanding in the classroom because of the visual nature of Mathematics educational software. Phillips (2008) asserted that Bagatrix Mathematical Software had become the right tool for independent exploration and experiments, and it supports the principle of skill acquisition to move quickly from rule-guided to experience-based (Dreyfus, 2004).

Importantly, the cost of personal computers has decreased, and more Mathematics classes are being taught using computers. Kilicman et al. (2010) posited that Bagatrix is an essential tool for learning because it, in most cases, does not explicitly solve a problem for the students. Instead, it exists as a device that assists the students in building conceptual knowledge. Seville (2016) stressed further that mathematical software features are uniquely suited to learning and teaching Mathematics courses in universities, colleges, vocational education and even in high schools. However, the effect of Bagatrix utilization in explaining Normal Distribution has not been studied at length.

In the study, an experiment was performed to determine the effect of the Bagatrix Mathematical Software on students' performance in Normal Distribution among Grade 11 students of Manukan National High School, Manukan, Zamboanga del Norte, Philippines during the second semester of the school year 2017-2018. It was achieved by administering the pretest before the treatment and the posttest after the treatment to the control group of students who were taught using the traditional method of teaching and the experimental group of students who were exposed to Bagatrix Mathematical Software. The study looked into the pretest and posttest performance of the students and measured their differences to reveal the effect of each of the treatments. Significantly, the study expected to construct possible corrective measures to enhance students' performance using the software and the performance among the Mathematics teachers.

Theoretical Consideration of the Study

This study is anchored on the "Theory of Skill Acquisition" of Dreyfus (2004). The theory states that human beings acquire skill through instruction and experiences and they do not show to leap suddenly from rule-guided "knowing that" to experience-based "knowing how." It also asserts that many skills could not easily be translated to "knowing that." It points out further that many are not conscious of their "knowing how" since they do not value their knowing-how at the higher level. A gradual process is indeed necessary for a learner to go through for him to reach the stage of expertise or knowing how. Thus, the theory illustrates the five clear stages that a learner goes through to evolve from knowing-that, novice, to knowing-how, expert. These stages include the novice stage, advanced beginner stage, competence stage, proficiency stage, and expertise stage.

Bagatrix as a mathematical software is a great example to use to describe the five stages of skill acquisition. The theory of skill acquisition strongly connects to the intention of the present study which delves into finding out the students' performance using the software. Learning to use the software involves stages relative to the five stages of skill acquisition.

Novice is referred to as the first stage. A novice involves some general ideas and is in the process of learning the rules, such as knowing the features, functions, and uses of the software. In the second stage which is the advanced beginner stage, the learner's performance improves better only after the novice has had enough exposure in understanding the real situation. For instance, after learning the features, functions, and uses of the Bagatrix Mathematical Software, the learner starts to show unique performance through personal experience.

In competence as the third stage, the learner starts becoming personally involved with the task. He begins to see more than one option from which he has to select the best option. For example, at some point, he realizes that he can either solve finding the z-score for the given probability using the Bagatrix Mathematical Software or use table method with the same software.

The fourth stage is the proficiency stage. The learner, while intuitively comprehend his task, still considers analytically about his actions. For example, despite having so much experience in the software, he might even have to think and discuss alternative methods in finding the z-score for the given probability by predicting what the best approach is going to use. The last stage is expertise. Generally, experts know what to do based on the mature understanding of the task. An expert has had so much experience with the work that the mastery of doing the job is a part of him. He acts upon correct intuitions without analytically thinking about his every method. For instance in Bagatrix Mathematical Software, he has had so much experience using that no matter what the operations are, it is highly likely that he has been in the same situation before and can decide what the right method to use for a short amount of time.

In general, the cited stages emphasize the fact that practice is required for the learner to maintain the knowing how. Without exercise, the learner will gradually lose his expertise and is most likely to regress as far back as the competence stage. The theory firmly connects to the intention of the study that the Bagatrix Mathematical Software is instrumental in maintaining the knowing how of the students making them experts and leading them to enhance their performance in Mathematics.

Research Design and Method

A quasi-experimental design utilizing the pretest-posttest nonequivalent group was performed to test the claim of the study. The design used two groups which were the experimental group with 59 students and the control group with 64 students. The experimental group was exposed to the experimental treatment using the artificial intelligence Bagatrix Mathematical Software while the control group was taught with the traditional method of teaching Mathematics.

The respondents of the study were the Grade 11 students enrolled in Statistics and Probability of Manukan National High School, Manukan, Zamboanga del Norte during the School Year 2017-2018. Lottery Method drew the two groups from the three Technical-Vocational-Livelihood (TVL) classes in Statistics and Probability under the supervision of the researcher, namely: TVL-1, TVL-3, and TVL-4.

Due to the unavailable standardized instrument, the researcher constructed a teacher-made test to measure the students' performance in Statistics and Probability specifically Normal Distribution. The researcher made a multiple choice type of test consisting of 35 items with the help of books and other teaching kits. The test items were crafted based on the topics treated in the experiment, namely: Finding Probability from a Normal Distribution, Finding a z-Score for a Normal Distribution, Approximating the Binomial using Normal Distribution, Finding Probabilities using the Central Limit Theorem, Finding the Probability of the z-Score Range, Finding Probability of a Range in a Nonstandard Normal Distribution, and Finding the z-Score for the given Probability. Five items were made per topic considering that the test was given for one hour only. Hence, the test instrument consisted of 35 questions in which 60 percent is easy, 30 percent is average, and 10 percent is difficult as established by the Department of Education per DepEd Order No. 8, series 2015.

This instrument was designed based on Bloom's Taxonomy of Learning (Acero et al. 2016) using the cognitive domain. The distribution and sequencing of items in the test were based on the table of specification which was also constructed by the researcher ahead of the research instrument. In the table of specification, knowledge, and comprehension in the cognitive domain of Blooms' Taxonomy of Learning were categorized by the researcher as the easy category, application and evaluation were under the average group, and analysis and synthesis were in the difficult category. The table of specification indicated the topics that were measured at the cognitive level, number of items per topic and the difficulty level, and the sequence of the items.

The Data were statistically treated using the mean, standard deviation, z-test one sample group, t-test for independent samples, and t-test for correlated samples.

The Research Process

The process that was involved in the experiment is presented in Figure 1. The figure explains that before the treatment was started, both the experimental and control groups were given the pretest (X_1 and Y_1) on the topics lined up for this experiment. The pretest instrument was a teacher-made test with a reliability coefficient of 0.901. The same pretest was administered to both the control and experimental groups in separate rooms at the same time. The researcher conducted the pretest in the experimental group while a co-teacher of the researcher proctored the control group. Session guides which were made by the researcher and validated by the adviser were used in the experiment. The curriculum guide in Statistics and Probability was used in constructing the session guides in the study. In the session guides for the experimental group, Bagatrix was used in all parts of the lesson. Lesson guides in the control group were constructed without applying any technology in conducting the class. Immediately after the interventions, both groups were given the posttest (X_2 and Y_2) on the subject matters covered during the treatment. The teacher-made test that was administered during the pretest was also used in the posttest.

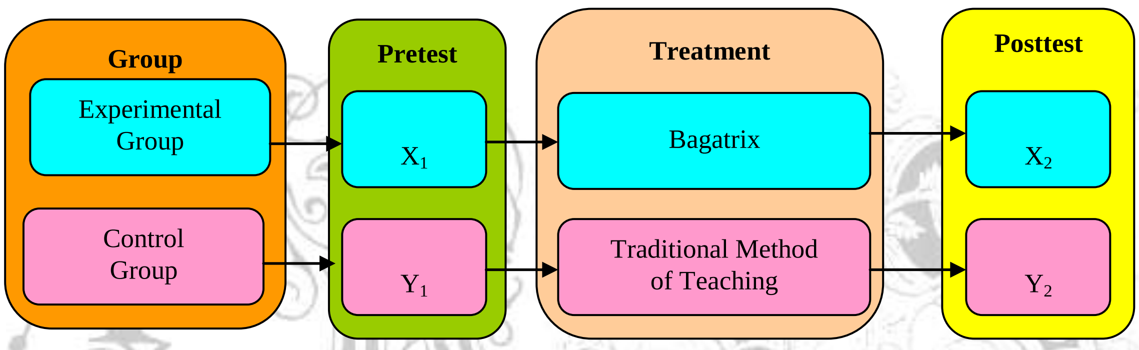

Figure 1. The Research Process

Results

Table 1. Pretest Performance Profile of the Students in the Control Group

Topics	H.M.	A.M.	SD	z-test	p-value	Description
Finding Probability from a Normal Distribution	3.75	1.234	0.7714	-26.09	0.00	Fair
Finding a z-Score for a Normal Distribution	3.75	1.015	0.7452	-29.63	0.00	Fair
Approximating the Binomial using Normal Distribution	3.75	1.031	0.7340	-29.63	0.00	Fair
Finding Probabilities using the Central Limit Theorem	3.75	1.047	0.862	-25.07	0.00	Fair
Finding the Probability of the z-Score Range	3.75	1.156	0.821	-25.28	0.00	Fair
Finding Probability of a Range in a Nonstandard Normal Distribution	3.75	1.156	0.801	-25.90	0.00	Fair
Finding the z-Score for the given Probability	3.75	1.141	0.7097	-29.41	0.00	Fair
Total	**26.25**	**7.781**	**3.369**	**-43.86**	**0.00**	**Fair**

Table 1 shows that the students obtained fair performance in the pretest in all areas of the test. Actual means were lower than the hypothetical mean. Scores obtained by the students were at the same distance from the means in all of the topics treated in the experiment. On the other hand, looking at the z-values and their corresponding p-values, the figures revealed that there were significant distances between the hypothetical mean and the actual mean scores of the students. It means that there were significant differences between the hypothetical mean and the actual mean scores of the students in the control group during the pretest in each of the five topics that were treated in the study. It implies that the pretest mean scores of the students in the control group during the pretest were significantly lower than the expected mean performance.

Table 2. Pretest Performance Profile of the Students in the Experimental Group

Topics	H.M.	A.M.	SD	z-test	p-value	Description
Finding Probability from a Normal Distribution	3.75	1.186	0.776	-25.37	0.00	Fair
Finding a z-Score for a Normal Distribution	3.75	1.016	0.75	-27.84	0.00	Fair
Approximating the Binomial using Normal Distribution	3.75	0.983	0.731	-29.08	0.00	Fair
Finding Probabilities using the Central Limit Theorem	3.75	1.05	0.879	-23.58	0.00	Fair
Finding the Probability of the z-Score Range	3.75	1.152	0.847	-23.55	0.00	Fair
Finding Probability of a Range in a Nonstandard Normal Distribution	3.75	1.152	0.927	-24.14	0.00	Fair
Finding the z-Score for the given Probability	3.75	1.152	0.715	-27.92	0.00	Fair
Total	**26.25**	**7.69**	**3.455**	**-41.25**	**0.00**	**Fair**

In Table 2, students in the experimental group also showed fair performance during the pretest. Actual means were also below the hypothetical mean. The spread of the scores was closely similar to that of the pretest of the control group. The z-values with corresponding p-values indicated that the actual means were all significantly below the hypothetical mean. It means that the actual mean per topic is substantially lower than the expected mean of 75% of the total number of items per topic.

Table 3. Test of Difference on the Pretest Performance Between the Control and Experimental Groups

Topics	Control	SD	Experimental	SD	t-value	p-value
Finding Probability from a Normal Distribution	1.234	0.771	1.186	0.776	0.34	0.732
Finding a z-Score for a Normal Distribution	1.016	0.745	1.017	0.754	-0.01	0.992
Approximating the Binomial using Normal Distribution	1.031	0.734	0.983	0.731	0.36	0.716
Finding Probabilities using the Central Limit Theorem	1.047	0.862	1.051	0.879	-0.03	0.980
Finding the Probability of the z-Score Range	1.156	0.821	1.153	0.847	0.02	0.980
Finding Probability of a Range in a Nonstandard Normal Distribution	1.156	0.801	1.153	0.827	0.03	0.980
Finding the z-Score for the given Probability	1.141	0.100	1.153	0.715	-0.09	0.926
Total	**7.78**	**3.37**	**7.69**	**3.46**	**0.14**	**0.889**

Table 3 showed that the computed t-values were too small to warrant a significant difference. It was also supported by the p-values that were too high to warrant rejection of the hypothesis. It is then safe to say that there is no significant difference between the control and experimental group of students during the pretest. It means that the scores of the students in the control and experimental group are comparable and at a similar level. It could be since both groups of students were new to the topics and had less grasp on the topics making them perform less during the pretest. This comparability of the pretest performance profile of the students in both the control and experimental groups is good to note as a benchmark on the selection of the respondents as they could be said to be of similar characteristics. The endpoint is to determine whether the treatment to be made in the experimental group is effective or not.

Table 4. Posttest Performance Profile of the Students in the Control Group

Topics	H.M.	A.M.	SD	z-test	p-value	Description
Finding Probability from a Normal Distribution	3.75	3.25	0.836	-4.79	0.00	Very Good
Finding a z-Score for a Normal Distribution	3.75	2.83	0.808	-9.13	0.00	Good
Approximating the Binomial using Normal Distribution	3.75	2.56	0.732	-12.98	0.00	Good
Finding Probabilities using the Central Limit Theorem	3.75	2.39	0.658	-16.54	0.00	Good
Finding the Probability of the z-Score Range	3.75	2.34	0.74	-15.22	0.00	Good
Finding Probability of a Range in a Nonstandard Normal Distribution	3.75	2.25	0.667	-18.00	0.00	Good
Finding the z-Score for the given Probability	3.75	2.08	0.741	-18.25	0.00	Good
Total	**26.25**	**17.71**	**3.37**	**-20.26**	**0.00**	**Good**

Table 4 revealed that students in the control group obtained a good performance. It means that the students in the control group have improved from fair in the pretest to good in the posttest. It implies that the traditional way of teaching is still working towards the improvement of the students' performance. However, the improvement on the performance of the students in the control group is not that big enough. There is no bigger gap between the fair and good performances but what is good to note is that the students have improved their performance during the posttest.

The computed z-values were all significant which means that there is no percentage of acceptance of the hypothesis between the hypothetical mean and the actual mean. It shows that the scores of the students in the control group were significantly far behind from the expected performance per topic and even in the whole test. It means that the scores of the students in the control group are still significantly far from the expected performance at 75 percent of the total number of items in the posttest. The students in the control group were still not able to make it at 75 percent which is the measure of expected performance. Though the students' scores in the posttest have improved this improvement does not prove to be at least near the expected 75 percent.

Presented in Table 5 were the excellent actual means obtained by the students in the experimental group during the posttest. The result showed that the performance of the students in the experimental group during the posttest had improved from fair to excellent. It reflects that Bagatrix Mathematical Software has changed the performance of the students tremendously. The software allows the students to gain much knowledge and understanding on Normal Distribution and raises students' return to greater heights.

Table 5. Posttest Performance Profile of the Students in the Experimental Group

Topics	H.M.	A.M.	SD	z-test	p-value	Description
Finding Probability from a Normal Distribution	3.75	4.93	0.253	-35.81	0.00	Excellent
Finding a z-Score for a Normal Distribution	3.75	4.86	0.345	24.79	0.00	Excellent
Approximating the Binomial using Normal Distribution	3.75	4.90	0.304	28.93	0.00	Excellent
Finding Probabilities using the Central Limit Theorem	3.75	4.63	0.584	11.53	0.00	Excellent
Finding the Probability of the z-Score Range	3.75	4.59	0.591	10.96	0.00	Excellent
Finding Probability of a Range in a Nonstandard Normal Distribution	3.75	4.46	0.625	8.70	0.00	Excellent
Finding the z-Score for the given Probability	3.75	4.42	0.622	8.33	0.00	Excellent
Total	**26.25**	**32.80**	**1.69**	**29.76**	**0.00**	**Excellent**

Shown in Table 6 is the test of difference on the posttest performance of the students between the control and experimental groups. The results showed that the computed values were all significant at .05 level. It means that there is a significant difference in the posttest performance of the students between the control and experimental groups. It implies that the scores between the control and experimental group of students are way too far from each other.

Table 6. Test of Difference on the Posttest Performance Between the Control and Experimental Groups

Topics	Control	SD	Experimental	SD	t-value	p-value
Finding Probability from a Normal Distribution	3.25	0.836	4.932	0.254	15.35	0.00
Finding a z-Score for a Normal Distribution	2.828	0.808	4.864	0.345	18.42	0.00
Approximating the Binomial using Normal Distribution	2.563	0.732	4.898	0.305	23.42	0.00
Finding Probabilities using the Central Limit Theorem	2.391	0.657	4.627	0.584	19.97	0.00
Finding the Probability of the z-Score Range	2.344	0.739	4.593	0.591	18.71	0.00
Finding Probability of a Range in a Nonstandard Normal Distribution	2.250	0.667	4.458	0.625	18.96	0.00
Finding the z-Score for the given Probability	2.078	0.741	4.424	0.622	19.07	0.00
Total	**17.70**	**3.37**	**32.80**	**1.69**	**31.73**	**0.00**

While the control group has only increased its performance by one step, the experimental group has improved its score by three steps which indicated very significant enough to warrant a return that is greater than the teachers' expectation at 75 percent. Bagatrix Mathematical Software manifests remarkable performance improvement of the students in the experimental group. The traditional way of teaching may have made the students' performance better for those in the control group but using Bagatrix in Normal Distribution instruction has paved the way towards not just a better performance but an excellent performance for the students during the posttest.

Discussion

Students in the control and experimental groups have a similar level of experience on the topics tested in the experiment. It means that students have little prior knowledge of the topics under study resulting in very low scores during the pretest. Further, the low ratings of the students could be attributed to the fact that probability and the rest of the topics are not very familiar in the lower levels. Hence, students find the pretest challenging to score better. The finding is corroborated by De Las Peñas and Bautista (2012) who found out that the control and experimental groups did not perform well during the pretest in their study. Galleto and Refugio (2012) also supported the finding.

On the contrary, Bagatrix Mathematical Sofware makes a big difference in the performance of the students during the posttest. It can be deduced that Bagatrix is a useful software that could penetrate the students' knowledge and understanding of Normal Distribution in Probability and Statistics course. It effectively improves the students' understanding and enhances their performance at a more significant pace. Van Voorst (2008) supported that softwares have an outstanding impact on many of the subjects that are done at schools and mostly Mathematics which is failed by many students. It is emphasized that softwares motivate students to learn and teachers to teach more effectively and efficiently.

According to Smith and Hardman (2014), the importance of technology does not only affect students but also teachers who adapt more teaching techniques which help them to teach more effectively. By integrating educational tools into their everyday teaching practice, they can provide creative opportunities for supporting students' learning and fostering the acquisition of mathematical knowledge and skills. On the one hand, gifted students can be supported more effectively than ever by promoting their interests and mathematical skills. On the other hand, weaker students can be provided with activities that meet their special needs and help them to overcome their difficulties. Additionally, students can develop and demonstrate a deeper understanding of mathematical concepts and can deal with more advanced mathematical contents than in 'traditional' teaching environments.

In general, it is concluded that Bagatrix Mathematical Software is an essential and useful tool in teaching Probability and Statistics specifically Normal Distribution to Senior High School Grade 11 students. Its application has manifested a tremendous increase in the students' performance from the pretest to the posttest.

Hence, the School Administrator of Manukan National High School in collaboration with the Department of Education particularly the Division of Zamboanga del Norte should allocate budget for the Bagatrix annual subscription and building adequate computer laboratory for the purpose. Training for Mathematics teachers in the utilization and application of the software should also be appropriated. Moreover, students should utilize and apply the Bagatrix mathematical software as a supplement to enhance and ensure higher performance not only in problem solving in Normal Distribution but in all Mathematics courses.

References

Acero, V.O. et al. (2016). Principles and Strategies of Teaching. Sampaloc: Rex Book Store, Inc.

Colado, Anibal Z., Vazquez, Ramon Ismael A., and Patron, Diana Elizabeth R. (2017). Evaluation of Using Mathematics Educational Software for the Learning of First-Year Primary School Students. www.mdpi.com/2227-7102/7/4/79/pdf

De Las Peñas, Ma. Louise Antonette and Bautista, Debbie Marie (2012). On Maximizing Technology Resources and Their Benefits In Teaching and Learning Mathematics. Ateneo de Manila University, Philippines. www.tsg.icme11.org/document/get/223

DepEd Order No. 8, s. 2015. Policy Guidelines on Classroom Assessment for the K to 12 Basic education program. http://www.deped.gov.ph/sites/default/files/order/2015/DO_s2015_08.pdf.

Dreyfus, S.E. (2004). The five stage model of adult skill acquisition. *Bulletin of Science Technology & Society*, *24*: 177. https://www.bumc.bu.edu/facdev-medicine/files/2012/03/Dreyfus-skill-level.pdf

Edwards, M. T., Meagher, M., & Ozgun-Koca, S. A. (2008). When is a good fit not a good fit? Dynamic regression with the TI-nspire graphing calculator. Mathematics Teacher, 102(4), 300-304. https://www.nctm.org/Publications/mathematics-teacher/2008/Vol102/Issue4/Technology-Tips_-When-Is-a-Good-Fit-Not-a-Good-Fit_-Dynamic-Regression-with-the-TI-Nspire-Graphing-Calculator/

Galleto, P.G. & Refugio, C.N. (2012). Students' skills in mathematical computation using graphing calculator. Paper presented at the proceedings of the 17th Asian Technology Conference in Mathematics, Thailand. http://atcm.mathandtech.org/ep2012/regular_papers/3472012_19901.pdf

Huoppi, David (2009). The Evolution of Technology in Mathematics Classrooms. www.math.harvard.edu/.../HuoppiTechnology

Kilicman, A., Hassan, M.A. Said Husain, S.K. (2010). Teaching and Learning using Mathematics Software "The New Challenge". Procedia Social Behavioral Science, 8, 613–619. https://www.sciencedirect.com/science/article/pii/S1877042810021907

Phillips, R. (2008). Pedagogical, Institutional and Human Factors Influencing the Widespread Adoption of Educational Technology in Higher Education, 2007. http://researchrepository.murdoch.edu.au/12209/

Seville, J.S.O. (2016). Mathematical Software Utilization: Effect on Students' Achievement in Algebra**.** https://www.google.com.ph/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwiNkoaC18DYAhUJQo8KHfOAAyAQFgglMAA&url=http%3A%2F%2Furuae.org%2Fsiteadmin%2Fupload%2F2428UH0516020.pdf&usg=AOvVaw0ioa8U7z6c70qKj9tU3XxN

Smith, G.S. and Hardman, J. (2014). The Impact of Computer and Mathematics Software Usage on Performance of School Leavers in the Western Cape Province of South Africa: A comparative Analysis. https://files.eric.ed.gov/fulltext/EJ1071194.pdf

Van Voorst, C. (2008). "Technology in Mathematics Teacher Education". http//www.icte.org/T99 Library/T99 54.PDF