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Research Paper

Self-Guided Analysis Tool Pack (S-Gat) Improved Students' Performance in Statistics: Experimental Approach

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Abstract

Nowadays, there are different platforms, applications, and software available, yet it is not implemented nor integrated into the class discussion as part of teaching and learning. SPSS, Jamovi, and even Microsoft Excel are some that may be used by the students for the statistical treatment of data. Students are lacking the advantage to be equipped with technology in this kind of situation. They are becoming incompetent to other students who have the skills in using the different applications as mentioned above. This study aimed to determine the effectiveness of the Self-guided Analysis Tool Pack (S-GAT) as supplementary material in improving students' performance in Statistics. The researcher used quasi-experimental research. The respondents were selected from Grade 12 students. Two sections were selected as the comparison and experimental groups. From these participants, the researcher match-paired the scores in the pretest as a basis to form the students in the comparison group and those in the experimental group. The prescribed module was used by the comparison group while the experimental group utilized SGAT. The statistical tools used were the weighted mean, Standard Deviation, Independent Samples t-test, and Paired Samples T-test. The researcher also utilized Cohen's d to determine the effect size. Findings revealed that S-GAT and the prescribed module improved students' performance in Statistics. Both groups had improvement in their performance revealed in their posttest scores, however, students who used SGAT had significantly higher performance than those who used the prescribed module as revealed in the posttest scores. S-GAT is effective and may be utilized as supplementary material in Statistics. Thus, the researcher encouraged other teacher-researchers to innovate technology-based instructional materials to enhance the student's performance in general.

Keywords *statistics, module, self-guided analysis tool pack (s-gat), supplementary materials*

INTRODUCTION

Knowledge and skills in Statistics have an important role in the conduct of research. Different statistical treatment tools are being utilized to analyze and interpret data. Statistical concepts are the basis of learning statistics and should be given extra attention by every educational institution. Numerous studies on statistical reasoning and its various subtypes, including reasoning about variation, distribution, and sample distributions, have shed light on how students learn to use statistical reasoning throughout their academic careers. In line with this, the researcher created a

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Self-guided analysis tool pack (SGAT) to address the need for supplementary material in Statistics. In statistics, there are several statistical treatments for hypothesis testing. Different considerations should be taken into, from what type of variable or data is given up to what formula to be used to solve specific problems in statistics. Even though there are subjects for Statistics and Probability, Practical Research 1 and 2, or even Inquiries, Investigation, and Immersion which pertain to research as well, it still needs an in-depth discussion on how to treat data. In the Most Essential Learning Competency (MELCS), as the pandemic arises, contents in the discussion are merged. Hence, correlation and regression analysis is the only lesson that could help students with future needs. This is one of the reasons why the researcher wanted to have an intervention for this matter. Nowadays, there are different platforms, applications, and software available, yet it is not implemented nor integrated into the class discussion as part of teaching and learning. SPSS, Jamovi, and even Microsoft Excel are some that may be used by the students for the statistical treatment of data. Students are lacking the advantage to be equipped with technology in this kind of situation. They are becoming incompetent to other students who have the skills in using the different applications as mentioned above.

DO 21, S. 2019 discusses the Policy Guidelines on the K to 12 Basic Education Program. As stated there those learners are expected to be skilled and literate in technology integration. These skills are embedded in subjects, especially in Mathematics. Also, Learning and innovation skills include among others creativity and curiosity, critical thinking, problem-solving, adaptability, managing complexity and self-direction, and sand reasoning skills.

There is a modification from teaching and learning about technology to teaching and learning with technology. Integration of ICT in teaching/learning across all subject areas will be implemented as stated in DO 23, S. 2004. This matter has a great move for the administration to secure and provide free access to the computer laboratory which is the school's centralized multimedia learning resource center to all teachers and students.

Scientific Data Analysis Toolkit (SDAT) is one of the versatile, and user-friendly data analysis add-in applications for Microsoft Excel (Halpern et. al., 2018). This application helps researchers to carry out most of the analytical tasks used in data analysis. One of the useful features is its ability to perform different statistical treatments like regression analysis that uses both standard and user-defined model functions. It also supports weighted regression analysis. SDAT includes the following functionalities: Descriptive Statistics, Integrate, Differentiate, Smooth, Spline, Plot, and Regression Analysis. Also, they stressed that it is easy to install, and instructors can encourage students to install it on their laptops or PCs. With this kind of feature, it can help the researchers to analyze their data and is easy to access.

However, according to the data from the latest survey of the Organization for Economic Cooperation and Development (OECD) Teaching and Learning International Survey (TALIS) in 2018, a large portion (47%) of teachers across 48 OECD countries were not letting students use "frequently" or "always" ICT for projects or classwork. It means that technology use in the classroom is dependent on teachers. Some factors influence the technology integration of teachers in the classroom.

With the emergence of the above-mentioned ICT integration in teaching and learning, researchers created supplementary material that is self-guided and it is named as Self-Guided Analysis Toolpack (S-GAT). This supplementary material will assist students who have a research subject or course. Also, this determines the effectiveness of S-GAT as an innovation to address learners' needs in data analysis and data interpretation in statistics with the use of the add-ins feature in Microsoft Excel.

OBJECTIVES:

Specifically, the following are the objectives.

1. Determine the effectiveness of SGAT in enhancing students' performance in Statistics.
2. Identify the performance of students under comparison and experimental groups.

LITERATURE REVIEW

According to Gonda (2022), basic and significant skills that can be used to comprehend statistical data or research findings are included in statistical literacy. One of the many basic skills is being literate in Statistics. Ability to master statistical concepts, capability to use different applications, perform statistical calculations, as well as interprets statistical results. However, there is a problem existing within statistics subject measured unsatisfactory. Students' literacy is in the low category. Similarly, students are still less able to use statistical software with good statistical literacy.

In the study of Jimenez (2020), one of the factors that motivate teachers to create supplemental learning materials is encouraging participation and ICT collaboration. However, some obstacles prevented teachers from creating supplemental learning materials, and one of these is lacking ICT knowledge and skills. Indeed, additional references and textbooks are essential for quality education.

Instructional technology has played a major role to cover up the effect of this pandemic on teaching-learning as it is the only platform for instructional design, delivery, and assessment platforms. With the emerging global outbreak of COVID-19, the use of technology in education is no longer an option but a necessity. And teachers who are the facilitators of online education are the main persons in helping learners to have access to knowledge. However, there is no one-size-fits-all pedagogy for online learning, there are a variety of subjects with varying needs and different subjects and age groups require different approaches to online learning. The use of suitable and relevant pedagogy for online education may depend on the expertise and exposure to information and communications technology (ICT) for both educators and learners (Pokhrel & Chhetri, 2021).

RESEARCH METHOD

Research Design

This study employed the quasi-experimental research design. This kind of quasi-experimental study is conducted on subjects who were not picked at random (Antonio, 2022). Matched comparison is one of these types wherein the treatment group and another group that has similarities with the treatment group. It identifies a comparison group that is as similar as possible to the treatment group in terms of baseline (pre-intervention) characteristics. Pretest and posttest were implemented by this study to determine the effectiveness of SGAT between the experimental and comparison groups in improving performance in Statistics after it was utilized.

Procedure

The match-pairing technique was implemented in the current study wherein the researchers administered a pretest to both groups and selected your target participants based on the match scores of the two groups and this is the reason why it is not included in SOP for it will use a pretest as part of selection process or methodology. Match participants in experimental research to make the two groups parallel. This is a procedure in which participants with certain traits or characteristics are matched and then randomly assigned to control and experimental groups (Jimenez, 2020). Matching methods rely on observed characteristics to construct a comparison group using statistical techniques. Different types of matching techniques exist, including judgmental matching, matched comparisons, and sequential allocation. Perfect matching would require everyone in the treatment group to be matched with an individual in the comparison group who is identical on all relevant observable characteristics such as age, education, religion, occupation, wealth, attitude to risk, and so on.

Forty (40) students had undergone match-pairing. Twenty (20) students were in the comparison group and another twenty (20) were in the experimental group. However, two pairs of respondents were eliminated since their scores did not match.

This study has two phases, first is the preparation stage wherein the instrument was validated by experts (subject group head, Statistics teacher, and Research teacher) of the above-mentioned school. A validation tool was used to determine the level of Format and Design, Content, Clarity, and Usefulness of the instrument. The second phase was the administration stage wherein the data were gathered. The letter of permission was signed by the School Division Office of Binan and the School Principal. Also, the researchers asked for consent from the participants, for data gathering. On March 16, 2023, the questionnaire was administered to student participants. After a week, on March 23, 2023, data were collected and tabulated by the researcher. The participation criteria were explained to the participants, and it was made clear that the participation was voluntary, and information given was confidential. The researchers then started to access the participants.

The researcher provided a request letter to the Division office and school principal asking permission to conduct the study. Also, the researcher provided a validation tool for the experts who validated the instrument. Since the validators provided feedback concerning the instrument, the researcher made sudden changes based on the comments. Based on the comments, the format and design should be changed specifically the layout and font style and size.

Trend Projection Method

It is a traditional business prediction style that considers how factors change over time. This strategy requires a large number of data points and the presumption that future patterns will be impacted by the same variables as past patterns. The statistical equations also establish the slope of the trend line (b) and the point (a) where it crosses the y-axis. As a result, the equation for a straight line is as follows:

INSTRUMENT

The researcher provided S-GAT with an embedded performance task to measure the performance of the participants in statistics. The instrument was validated by the subject group head and selected research teachers.

One of the components in Most Essential Learning Competency in Statistics and Probability in Quarter 4 Week 4-6 deals with computation for the test-statistic value (Independent Samples T-test, ANOVA, and Paired Sample T-Test) and solves problems involving correlation analysis (Pearson r). In SGAT, the researcher made five (5) topics dealing with the statistical tools mentioned with a total of 25 points to be answered by the selected participants.

The first topic in the instrument is Pearson r. The respondents determined the correlation of the given data. The second is One-way ANOVA Single-factor, the third is Two-way ANOVA with replication, and the fourth is paired t-test. The last one is the independent t-test. The Experimental group used S-GAT to answer the following task while the Comparison group used the DepEd module with the manual computation process.

Ethical Consideration

The ethical considerations observed in the conduct of the research were based on Republic Act No. 10173, also known as "The Data Privacy Act of 2012.

Treatment of Data

Appropriate statistical tools were employed by the researchers to arrive at valid and accurate findings. These are essential to interpret the data gathered, as well as to make a sound inference of the population.

Student's performance on the pretest and posttest were evaluated using mean, $\bar{x}$=(total number of correct items)/(total number of items), and their mean was interpreted using Figure 1. The researchers considered 75% as a passing score, as well as the 3-scale results of 33.33% in assigning intervals. It was adjusted to better interpret the mean scores obtained.

Table 1. Interpretation for Students' Performance in Pretest and Posttest

Level	Performance in Mathematics
Satisfactory	25 – 30
Good	18 – 24
Poor	0 – 17

Mean is the most common measure of central tendency and refers to the average value of a group of numbers. In this study, this was computed to compare the scores in the pretest, formative, and post-test; Independent Samples t-Test was utilized as a statistical tool to be applied to measure the difference of the mean scores in performance of the respondents between the experimental and comparison group.; and the Paired Samples t-Test was applied to measure the difference between the pretest and posttest scores of within the experimental and to the comparison group. Lastly, Cohen's d Effect Size was used to assess the effect size or quantify the size of the difference between the two test results.

FINDINGS AND DISCUSSION

The data below presents the results in formative and post-test scores of comparison and experimental groups.

Student	Formative 1	Formative 2	Formative 3	Formative 4	Formative 5	Formative Test (Comparison)	Student	Formative 1	Formative 2	Formative 3	Formative 4	Formative 5	Formative Test (Experimental)
3	2	1	1	2	2	8	12	4	3	3	4	4	18
6	3	2	2	3	3	13	16	4	2	2	3	3	14
11	2	2	2	3	3	12	1	4	3	3	4	4	18
4	4	3	3	4	3	17	32	3	2	3	3	2	13
19	2	2	2	2	2	10	17	4	2	2	2	3	13
10	3	3	3	3	3	15	28	2	2	2	3	2	11
30	3	3	2	3	3	14	7	2	1	1	3	2	9
13	3	2	3	2	3	13	5	2	3	2	1	2	10
31	2	2	2	2	2	10	34	3	3	3	2	3	14
38	3	3	3	2	2	13	8	3	4	3	4	2	16
9	3	3	3	3	3	15	20	2	2	2	2	2	10
14	3	3	3	3	3	15	21	2	3	3	2	2	12
2	2	2	2	3	3	12	29	3	3	3	4	3	16
15	2	2	2	3	3	12	18	3	4	4	3	3	17
23	2	3	2	2	1	10	35	3	2	2	3	3	13
25	2	3	3	3	3	14	26	3	3	3	2	3	14
36	3	2	3	4	1	13	22	4	3	3	3	3	16
37	2	3	2	2	1	10	24	2	3	3	3	3	14
27	3	3	2	2	3	13	33	3	3	2	2	3	13

Posttest			
Student	Comparison	Student	Experimental
3	10	12	23
6	16	16	19
11	10	1	25
4	17	32	17
19	11	17	25
10	15	28	22
30	15	7	25
13	9	5	22
31	13	34	25
38	14	8	24
9	16	20	25
14	17	21	24
2	12	29	25
15	13	18	25
23	10	35	24
25	14	26	24
36	14	22	25
37	12	24	21
27	16	33	19

Formative Mean Scores of Comparison and Experimental Groups

Table 1
Formative Test Mean Scores of Students' Performance in Statistics

Test	No. of Items	Group	Mean	SD	Interpretation
Pearson r	5	Comparison	2.579	0.607	Poor
		Experimental	2.947	0.780	Poor
ANOVA (Single Factor)	5	Comparison	2.474	0.612	Poor
		Experimental	2.684	0.749	Poor
ANOVA (Two-way)	5	Comparison	2.368	0.597	Poor
		Experimental	2.579	0.692	Poor
Independent Samples T-test	5	Comparison	2.684	0.671	Poor
		Experimental	2.789	0.855	Poor
Paired Samples T-test	5	Comparison	2.474	0.772	Poor
		Experimental	2.737	0.653	Poor
Overall	25	Comparison	12.579	2.244	Poor
		Experimental	13.737	2.642	Poor

Legend: Overall- Satisfactory 20-25; Good 14.75-19 Poor Below 14.75
Legend: 5-Item-Satisfactory 5; Good 4-3 Poor Below 3

Table 1 displayed the formative mean scores of the Comparison and Experimental groups. It shows that the Comparison (mean=12.579; sd=2.244) and Experimental (mean=13.737; sd=2.642) groups performed poorly on the formative test. Hence, it indicates that they don't have enough knowledge yet about the topic to be discussed. This result is found to be usual in any pre-assessment and this was mentioned by Berry (2008). He mentioned that pre-tests, used at the beginning of a course, set a baseline for topic knowledge, and then linked to an exam at the end of the course to assess knowledge that has been added. Covering content that has not been discussed by the instructor and that the learner is not expected to be familiar with. After using SGAT, comparing the learning gains will be highly significant to the findings and discussion of this paper.

Posttest Mean Scores of Comparison and Experimental Group

Table 2
Posttest Mean Scores of Students' Performance in Statistics

Group	n	Min	Max	Mean	sd	Interpretation
Comparison	19	9	17	13.368	2.543	Poor
Experimental		17	25	23.105	2.470	Satisfactory

Legend: Satisfactory 20-25; Good 14.75-19 Poor Below 14.75

Table 2 displayed the post-test mean scores of the Comparison and Experimental groups. It is shown that the Comparison (mean=13.368; sd=2.543) group performed poorly while the Experimental (mean=23.105; sd=2.470) group performed satisfactorily during the posttest. This means that supplementary materials, especially in Mathematics, are more helpful than traditional manual computation in analyzing data in Statistics. Ifamuyiwa and Akinsola's (2018) emphasis that traditional instruction restricts students' learning chances lends credence to the findings discussed above.

Difference Between Formative and Posttest Mean Scores of Comparison and Experimental Group

Table 3
Difference of Formative Test Mean Scores of the Students' Performance in Statistics

Test	Group	Mean	sd	t	df	Mean-Diff
Formative Test	Comparison	12.579	2.244	-1.46	36	-1.16
	Experimental	13.737	2.642			

Table 3 presented the result of the Independent Samples t-Test conducted to test the significant difference between the Formative test mean score of the Comparison (Mean=12.579, SD=2.244) and Experimental (Mean=13.737, SD=2.642) group. The researchers employed 5 Formative tests and the presented data is the summed score of those test scores. There was no significant difference between the Formative test mean score of the Comparison and Experimental group conditions [t(36)=-1.46, Mean-Diff=-1.16, p-value>0.05]. Since the test of difference was not significant, Cohen's d was not calculated. This implies that Formative assessments are most effective when they are used to track individual student progress over time. This was supported by the idea of Simpal (2016) and Maliga (2018) stating that before beginning the experiment, considered two groups with comparable levels of academic performance to ensure the validity of their findings.

Difference Between Pretest and Posttest Mean Scores of Comparison Group

Table 4
Difference in Pretest and Posttest Mean Scores Comparison Group

Test	Mean	sd	t	df	Mean-Diff	Cohen's d	Interpretation
Pretest	1.632	1.300	-17.0**	18	-11.7	3.89	Huge
Posttest	13.368	2.543					

*** - Test is Significant @ p-value<0.01.*

Cohen's d <=0.19: Very Small, d <=0.49: Small, d <=0.79: Medium, d <= 1.19: Large, d<=1.99: Very Large; d>=2.0: Huge.

Presented in Table 4 is the result of Paired Samples t-Test conducted to test the significant difference between the Pretest (Mean=1.632, SD=1.300) and Posttest (Mean=13.368, SD=2.543) mean score of the Comparison group. There was a significant difference between the Pretest and Posttest mean scores of the Comparison group conditions [t(18)=-17.0, Mean-Diff=-11.7, p-value<0.01]. Since the test showed significance, Cohen's d was calculated to determine the Effect size between the Pretest and Posttest mean score of the Comparison group. The computed Cohen's d was 3.89 interpreted as "Huge". This implies that there was a "Huge" difference between the Pretest and Posttest performance of the Comparison group. Similar findings were made by Paghubasan (2017) when she demonstrated that traditional education and testing didn't improve students' performance in mathematics. She also suggested that students be exposed to contemporary teaching and testing methods, such as game-based and activity-oriented learning and testing tactics, to enhance their problem-solving abilities.

Difference Between Pretest and Posttest Mean Scores of Experimental Group

Table 5
Difference in Pretest and Posttest Mean Scores Experimental Group

Test	Mean	sd	t	df	Mean-Diff	Cohen's d	Interpretation
Pretest	1.632	1.300	-30.0**	18	-21.5	6.89	Huge
Posttest	23.105	2.470					

*** - Test is Significant @ p-value<0.01.*

Cohen's d <=0.19: Very Small, d <=0.49: Small, d <=0.79: Medium, d <= 1.19: Large, d<=1.99: Very Large; d>=2.0: Huge.

As shown in Table 5, Paired Samples t-Test was conducted to test the significant difference between the Pretest (Mean=1.632, SD=1.300) and Posttest (Mean=23.105, SD=2.470) mean score of the Experimental group. There was a significant difference between the Pretest and Posttest mean scores of the Experimental group conditions [t(18)=-30.0, Mean-Diff=-21.5, p-value<0.01]. Since the test showed significance, Cohen's d was calculated to determine the Effect size between the Pretest and Posttest mean score of the Comparison group. The computed Cohen's d is 6.89 interpreted as "Huge". This implies that there is a "Huge" difference between the Pretest and

Posttest performance of the Experimental group. Escamilla (2019) emphasized that Computer Assisted Instruction improves the mathematics performance of students. This was supported by

Maliga's (2018) study that the use of supplemental learning materials increases academic achievement. This is possible if the students' contextualized educational materials include a variety of practical and hands-on work activities.

Difference Between the Posttest Mean Scores of Comparison and Experimental Group

Table 6
Difference of Posttest Mean Scores of the Students' Performance in Statistics

Group	Mean	sd	t	df	Mean-Diff	Cohen's d	Interpretation
Comparison	13.368	2.543	-12.0**	36	-9.74	3.88	Huge
Experimental	23.105	2.470					

*** - Test is Significant @ p-value<0.01.*

Cohen's d <=0.19: Very Small, d <=0.49: Small, d <=0.79: Medium, d <= 1.19: Large, d<=1.99: Very Large; d>=2.0: Huge.

Table 6 showed the result of the Independent Samples t-Test conducted to test the significant difference between the posttest mean score of the Comparison (Mean=13.368, SD=2.543) and Experimental (Mean=23.105, SD=2.470) group. There was a significant difference between the posttest mean score of the Comparison and Experimental group conditions [t(36)=-12.0, Mean-Diff=-9.74, p-value<0.01]. Since the test had shown a significant difference, Cohen's d was calculated to determine the Effect size between the mean score of the Comparison and Experimental groups. The computed Cohen's d was 3.88 interpreted as "Huge". This implies that there was a "Huge" difference between the Posttest performance of the Experimental and Comparison group. This implies that the use of S-GAT is more effective than the module. Owan and Bassey (2018) concluded that though both manual and computerized techniques are trustworthy and dependable, the latter is quicker and more effective at managing and analyzing data than the former. In addition, Antonio (2022), in his paper about the effectiveness of his innovation on offline video lectures, it was proved that digital copy of learning materials is way better than printed modules.

CONCLUSIONS

Given the findings, Supplementary Material SGAT improves the performance in Statistics of the students, and it is proven more effective than the prescribed modules. The deped module was found to be effective in improving the performance in Statistics. However, students still performed poorly. There is a huge effect of utilizing Supplementary material SGAT in improving performance in Statistics that made the scores of the students satisfactory. Technology-based supplementary materials can streamline the data analysis process by providing tools for statistical analysis, data visualization, and data interpretation. This can save time and reduce the potential for human error in the analysis process. It can be a valuable tool in analyzing data, but it is important to carefully evaluate their benefits and limitations and to ensure that they are used responsibly and transparently.

Curriculum planners may consider the findings to keep in mind to review and adapt the curriculum from time to time in light of comments, fresh research, and improvements in statistical techniques and technology. To keep the curriculum current and successful in educating students for statistical applications in the real world, continuous modification is essential. Education Program Supervisors in Mathematics/Research may provide necessary training and programs for teachers in designing lessons and activities that allow students to utilize technology-based instructions, especially in Statistics like SPSS, Excel, or JAMOVI that can enhance students' data analysis skills, and provide them with a more interactive learning experience. The school Head is encouraged to reproduce

SGAT as supplementary material as a means of enhancing the performance of students towards Statistics since there is limited additional resource material like this in the school. Mathematics/Research teachers may create assessments and performance tasks that make use of technology and tools for data analysis to speed up data processing and visualization. Students can efficiently examine and evaluate data with the aid of tools like spreadsheets, statistical software, and internet resources like data visualization platforms. They are also encouraged to continue discovering effective strategies in mathematics to help students to be more efficient in solving problems. Other subjects besides those considered in this study should be used in similar studies about the use of supplemental material in enhancing students' performance in other areas outside mathematics. Researchers may replicate the current study in the future, considering additional characteristics not stated in the paper.

LIMITATIONS & FURTHER RESEARCH

Since this study is limited to five (5) topics only, maybe future researchers may change the topics or may use another statistical tool to be analyzed with the use of SGAT. They may also consider one specific topic so that respondents could focus on one topic only. Provide more concise procedures and may not include unnecessary data from the output to be discussed.

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