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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, various platforms, applications, and software are available; however, they are not implemented or integrated into the class discussion as part of the teaching and learning process. SPSS, Jamovi, and even Microsoft Excel are some options that students may use for statistical data analysis. Students often lack the advantage of being equipped with technology in this kind of situation. They are becoming less competent compared to other students who possess the skills in using the various applications 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 matched-paired the scores in the pretest as a basis to form the students in the comparison group and those in the experimental group. The comparison group used the prescribed module 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 showed improvement in their performance, as revealed in their posttest scores. However, students who used SGAT had significantly higher performance than those who used the prescribed module, as indicated by 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 Self-guided analysis tool pack (SGAT) to address the need for supplementary material in Statistics.

In statistics, several statistical treatments exist 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. Although there are subjects such as Statistics and Probability, Practical Research 1 and 2, or Inquiries, Investigation, and Immersion, which also pertain to research, an in-depth discussion on how to treat data is still needed. In the Most Essential Learning Competency (MELCS), as the pandemic arises, the 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, various platforms, applications, and software are available; however, they are not implemented or integrated into the class discussion as part of the teaching and learning process.

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SPSS, Jamovi, and even Microsoft Excel are some options that students may use for statistical data analysis. Students often lack the advantage of being equipped with technology in this kind of situation. They are becoming less competent compared to other students who possess the skills in using the various applications mentioned above.

DO 21, S. 2019 discusses the Policy Guidelines on the K to 12 Basic Education Program. As stated, these learners are expected to be skilled and literate in integrating technology. 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. The integration of ICT in teaching/learning across all subject areas will be implemented as stated in DO 23, Section 2004. This matter presents an opportunity for the administration to secure and provide free access to the computer laboratory, which serves as 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 carry out most of the analytical tasks used in data analysis. One of the useful features is its ability to perform various statistical treatments, such as regression analysis, which utilizes both standard and user-defined model functions. It also supports weighted regression analysis. SDAT includes the following functionalities: Descriptive Statistics, Integration, Differentiation, Smoothing, Splining, Plotting, 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 feature, researchers can easily analyze their data.

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 the use of technology 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 have created supplementary material that is self-guided, known as the Self-Guided Analysis Toolpack (S-GAT). This supplementary material will assist students who have a research subject or course. Additionally, this determines the effectiveness of S-GAT as an innovation to address learners' needs in data analysis and data interpretation in statistics, utilizing the add-ins feature in Microsoft Excel.

Objectives:

Specifically, the following objectives are defined.

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

LITERATURE REVIEW

According to Gonda (2022), statistical literacy encompasses basic and significant skills that enable the comprehension of statistical data or research findings. One of the many basic skills is being literate in Statistics. Ability to master statistical concepts, capability to use different applications, perform statistical calculations, and interpret statistical results. However, there is a problem with the statistics subject that is measured unsatisfactorily. Students' literacy is in the low category. Similarly, students are still less able to utilize statistical software effectively, despite having good statistical literacy.

According to Jimenez (2020), one of the factors that motivates teachers to create supplemental learning materials is the encouragement of participation and ICT collaboration. However, some obstacles prevented teachers from creating supplemental learning materials, one of which is a lack of ICT knowledge and skills. Indeed, additional references and textbooks are essential for quality education.

Instructional technology has played a major role in covering up the effect of this pandemic on teaching-learning, as it is the only platform for instructional design, delivery, and assessment. With the global outbreak of COVID-19 emerging, 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; various subjects have different needs, and different subjects and age groups require distinct 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 shares similarities with the treatment group are compared. It identifies a comparison group that is as similar as possible to the treatment group in terms of baseline (pre-intervention) characteristics. This study implemented pretests and posttests to determine the effectiveness of SGAT in improving performance in Statistics among the experimental and comparison groups after its utilization.

Procedure

The match-pairing technique was implemented in the current study, wherein the researchers administered a pretest to both groups and selected their target participants based on the match scores of the two groups. This is why it is not included in the SOP, as it will utilize a pretest as part of the 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 that everyone in the treatment group 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 toward 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. The first is the preparation stage, wherein the instrument was validated by experts (subject group head, Statistics teacher, and Research teacher) from the aforementioned 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.

Additionally, the researchers obtained consent from the participants for data collection. 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 participation was voluntary and that the information provided would be confidential. The researchers then started to assess the participants.

The researcher provided a request letter to the Division office and the 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 explicitly changed, including the layout, 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 assumption that the same variables will influence future patterns as they have in the past. The statistical equations also establish the slope of the trend line (b) and the point (a) where it crosses the y-axis.

Instrument

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

One of the components in the 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's 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

The researchers employed appropriate statistical tools to obtain valid and accurate findings. These are essential to interpret the data gathered, as well as to make a sound inference of the population.

Students' performance on the pretest and posttest was evaluated using the 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 present the results for formative and post-test scores for the comparison and experimental groups.

Table 2. The Results in Formative and Post-Test Scores of Comparisons and Experimental Groups

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
27	12	24	21
27	16	33	19

Table 3. 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	2.2244	Poor
		Experimental	13.737	2.642	Poor

Legend: Overall Satisfactory 20-25; Good 14.75 -19; Poor below 14.75.
Legend: Satisfactory 5; Good 4-3; Poor below 3.

Table 3 displayed the formative mean scores of the Comparison and Experimental groups. The results show that both 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 typical of any pre-assessment. He mentioned that pre-tests, used at the beginning of a course, set a baseline for topic knowledge and are then linked to an exam at the end of the course to assess knowledge that has been added. Covering content that the instructor has not discussed 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 4. 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 for analyzing statistical data. 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 5. 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 5 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 Maliga (2018), who stated that before beginning the experiment, they 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 6. Difference of Pretest and Posttest Mean Scores Comparison Group

<table>
<tr><th>Test</th><th>Mean</th><th>sd</th><th>t</th><th>df</th><th>Mean-Diff</th><th>Cohen’s d</th><th>Interpretation</th></tr>
<tr><td>Pretest</td><td>1.632</td><td>1.300</td><td>-</td><td rowspan="2">18</td><td rowspan="2">-11.7</td><td rowspan="2">3.89</td><td rowspan="2">Huge</td></tr>
<tr><td>Posttest</td><td>13.368</td><td>2.543</td><td>17.0**</td></tr>
</table>

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

Cohen’s d <+19; Very Small, d<=0.49: Small, d<=0.79: Medium, d<= 1.19: Large, d <=1.9: Very Large; d>=2.0: Huge.

Presented in Table 6 is the result of the 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 scores 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 demonstrated when she showed 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 the Experimental Group

Table 7. Difference of Pretest and Posttest Mean Scores Comparison Group

<table>
<tr><th>Test</th><th>Mean</th><th>sd</th><th>t</th><th>df</th><th>Mean-Diff</th><th>Cohen’s d</th><th>Interpretation</th></tr>
<tr><td>Pretest</td><td>1.632</td><td>1.300</td><td>-</td><td rowspan="2">18</td><td rowspan="2">-21.5</td><td rowspan="2">6.89</td><td rowspan="2">Huge</td></tr>
<tr><td>Posttest</td><td>23.105</td><td>2.470</td><td>30.0**</td></tr>
</table>

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

Cohen’s d <+19; Very Small, d<=0.49: Small, d<=0.79: Medium, d<= 1.19: Large, d <=1.9: Very Large; d>=2.0: Huge.

As shown in Table 7, 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. 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 the Comparison and Experimental Groups

Table 8. Difference of Posttest Means Scores of the Students' Performance in Statistics

Test	Mean	sd	t	df	Mean-Diff	Cohen's d	Interpretation
Pretest	13.368	2.543	-12.0**	18	-21.5	6.89	Huge
Posttest	23.105	2.470					

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

Cohen's d <+19; Very Small, d<=0.49: Small, d<=0.79: Medium, d<= 1.19: Large, d <=1.9: Very Large; d>=2.0: Huge.

Table 8 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 groups. This implies that 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, proved that a digital copy of learning materials is way better than printed modules.

CONCLUSIONS

Given the findings, the Supplementary Material SGAT improves students' performance in statistics and is proven to be more effective than the prescribed modules. The deped module was found to be effective in enhancing the performance in Statistics. However, students still performed poorly. The use of supplementary material, such as SGAT, has a significant impact on improving performance in Statistics, resulting in satisfactory scores for students. 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 its benefits and limitations and to ensure that it is used responsibly and transparently.

Curriculum planners may consider the findings to keep in mind when reviewing and adapting the curriculum periodically in light of comments, new research, and advancements 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 to design lessons and activities that utilize technology-based instruction, especially in statistics, such as SPSS, Excel, or JAMOVI, which 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 to enhance students' performance in statistics, as there are limited additional resource materials 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 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 research in the future, considering additional characteristics not stated in the paper.

LIMITATIONS & FURTHER RESEARCH

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

REFERENCES

Antonio, R. Jr. O. (2022). Teacher-made offline video lecture (T-MOViLe): Its effect on students' performance in mathematics. *International Journal of Open Access, Interdisciplinary & New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR)*. 1(3). https://doi.org/10.0913/iJOINED.2022149270

Gonda, D. et. al. (2022). Implementation of pedagogical research into statistical courses to develop students' statistical literacy. *MDPI* https://doi.org/10.3390/math10111793

Halpern et. al. (2018). Scientific data analysis toolkit: A versatile add-in to microsoft excel for windows. journal of chemical education, https://doi.org/10.1021/acs.jchemed.8b00084

Ifamuyiwa, S. A. & Akinsola, M. K. (2018). Improving senior secondary attitude Towards Mathematics through self and cooperative instructional strategies. *International Journal of Mathematics Education*.

Jimenez, E. (2020). Motivating factors of teachers in developing supplementary learning materials (slums). *International Journal for Advanced Research (IJAR).* https://doi.org/10.21474/IJAR01/10912

Maliga, G. M. (2018). Content validity and effectiveness of supplemental learning materials in mathematics. *Research funded by Basic Education Research Fund (BERF)*, DepEd-Regional Office, Carpenter Hill, Koronadal City, Region XII, Philippines.

Owan, V.J. & Bassey, B. A. (2018). Comparative study of manual and computerized software techniques of data management and analysis in educational research. *International Journal of Innovation in Educational Management (IJIEM)*, 2(1), 35 - 46.

Pokhrel, S. and Chhetri, R. (2021). A literature review on impact of COVID-19 pandemic on teaching and learning. higher education for the future. https://doi.org/10.1177/2347631120983481