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Effects of Learning Log on the Statistics Performance of College Students

Cainne Dorothy F. Lines
University of the Philippines-Cebu, Cebu City, Philippines
Bulangsuran Integrated School, Bulangsuran, Cebu, Philippines

Author Email: linescainnedorothy@gmail.com

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Abstract. This experimental study evaluated the effects of learning logs as a formative assessment of the performance of the statistics. The study addressed the gap in research on effective formative assessments in statistical education. This was made through a pretest-post-test comparison of the performance before and after the intervention. The study took place in the College of Teacher Education in one of the state universities in Cebu. The findings showed that the pretest performance of the experimental group, which was subjected to a learning log, and the control group, which was subjected to conventional formative assessment, were Below Passing and did not meet the passing percentage set by the university. In the post-test, the students in the control group showed Below Passing while the students in the experimental group performed Above Passing. Statistical analysis revealed a significant improvement in the mean scores for both groups, with the experimental group showing a greater mean gain. According to the findings, learning logs helped students perform better in Statistics. These findings suggest that learning logs can enhance students' performance in Statistics. Further research is recommended to explore this intervention in greater depth over a longer period.

Keywords: Experimental study; Formative assessment; Learning logs; Performance improvement; Statistics.

1.0 Introduction

The educational system was greatly affected during the fight against the COVID-19 pandemic. The transition from face-to-face learning to online learning had a significant impact on the teaching and learning process. Given this impact, the Commission on Higher Education (CHED) encouraged higher education institutions (HEIs) to maximize the exercise of academic freedom by enabling them to utilize available flexible learning, e-learning, and other alternative learning modality to students and implemented policies in accordance to CHED prevailing policies (CHED, 2020). These policies include utilizing various learning platforms in a remote setup and conducting asynchronous and synchronous lectures with corresponding time-independent assessments/tasks. These modalities are designed to enable students to perform "self-paced learning," where students have complete control over how, what, when, and where they study.

The online learning environment encourages learners to study independently as they are fully engaged in the learning process. However, this independence in learning engagement appeals to cause certain concerns. Among these concerns is the validity of assessment measures. There seemed to be an increased avenue of cheating, where

students used the means and resources to do so. It is recognized that some students are too reliant on the internet to answer given activities and quizzes. Undoubtedly, this reliance affects student achievement.

The goal of formative assessment procedures is to help students make the most of their learning opportunities by providing frequent, relevant, and immediate feedback (Vonderwell & Boboc, 2013; Gizem Karaoğlan-Yilmaz et al., 2020). In this context, learning logs known for reflective thinking are effective teaching methods for this purpose (Gökbulut & Eren, 2018). This is where the learning log as a formative assessment comes in, as it lets the students keep track of what they are learning and could pose any questions during the process. At the same time, teachers monitor their progress toward mastery of the learning objectives as they provide relevant feedback along the way. The learning log contains the summary of learning, relevant examples, experiences, unanswered questions, and other relevant ideas related to the topic weekly.

Most recent studies showed the effectiveness of integrating learning logs in various courses such as Languages, Foreign Languages, English, Physical Science, and Mathematics (Gökbulut & Eren, 2018; Slezak et al., 2019; Brown, 1995). There has been little research on the use of learning logs, and they are out of date. Brown (1995) concluded in his study that the experimental group was superior in written mathematical communication and showed a more significant reduction in Math anxiety than the control group during the implementation of a writing paradigm (learning log) into high school Algebra classes. On the other hand, Gökbulut & Eren (2018) investigated the application of learning logs in the classroom among primary school learners, and they found that they help improve learning and positively boost the academic success of the mathematics course.

However, there appear to be gaps in the literature, as there are no similar works at the tertiary level, where studies on learning logs remain insufficient. Given those gaps, the researcher conducted this study to determine the effects of learning logs as formative assessments of Statistics academic performance among university students in an online learning environment, with the desire to narrow the literature gaps by contributing to them.

2.0 Methodology

2.1 Research Design

This study used an experimental method, specifically the pretest-post-test control group design. The experimental design is diagrammed as follows:

G_1	O_1	X	O_2
G_2	O_3		O_4

Where:

G_1 is the experimental group subjected to a learning log as a formative assessment,
G_2 is the control group subjected to conventional formative assessment,
$O_1$and O_3 are pretest,
X is the experimental intervention, which is the learning log,
O_2 and O_4 are post-tests.

2.2 Research Locale

The study took place in the College of Teacher Education in one of the state universities in Cebu. The institution is Level IV accredited by the Accrediting Agency of Chartered Colleges and Universities in the Philippines (AACCUP).

2.3 Research Participants

The participants of this study were college students from the College of Teacher Education during the second semester of the academic year 2021-2022. There were 31 students in the control group and 34 in the experimental group. The control and experimental groups were assigned based on the university's sectioning process, with students randomly placed in each section. Thus, the groupings were heterogeneous. Two sections were chosen using random cluster sampling. In choosing the participants for the control and experimental groups, a random

assignment was used to determine which section belonged to the control group and which belonged to the experimental group.

2.4 Research Instrument

This research involved two sets of instruments. The first instrument was the learning log, which was used as a formative assessment. The online platform for submitting learning logs was Google Docs. The logs were updated every Friday of the week, and feedback was given on Saturdays for 3-4 weeks. The second instrument was a 20-item test covering the topics of the lesson on Data Management. The subtopics were the following: Measures of Central Tendency, Dispersion and Relative Position, Normal Distribution, Linear Regression, and Correlation. Statistics is the focus subject of this study. An issued memorandum of the Commission of Higher Education that will support this study is CHED Memorandum Order 20, series of 2013. This is the General Education curriculum, whose purpose is to holistically develop the person. The General Education Outcomes are categorized into three categories: Intellectual Competencies, Personal and Civic Competencies, and Practical Responsibilities. The new GE curriculum is standard for all undergraduate students in private and public HEIs, regardless of their major. It exposes them to various fields of knowledge and ways of interpreting social and natural realities while strengthening intellectual and civic capacities. The following preliminary preparation was done to validate the researcher's data. The validity and reliability of the research instrument were assessed. Five experts in Statistics validated the second instrument. They were given the request letter for tool validation and a copy of the research instrument table of specifications. The split-half analysis was used to test the instrument's reliability.

2.5 Data Gathering Procedure

A letter was sent to the Dean of the College of Education asking permission to conduct the study, duly noted by the Mathematics Department Chairman, BSED Programs, and Research Proposal Adviser (see Appendix A). The students were given a pretest and a post-test. Their scores were used as data, which were interpreted and analyzed. The lessons during the research period were the same for both groups; the only difference was that the experimental group utilized a learning log as a formative assessment, while the control group used conventional formative assessments such as quizzes and oral recitations. The study was implemented for four weeks. During the first meeting, the control and experimental groups took the pretest on the lesson "Data Management."

2.6 Ethical Considerations

Through completion of the Research Ethics Checklist for Investigations involving Human Participants, permission to conduct this study was granted by the University of the Philippines Cebu Research Ethics Committee and Research Ethics Clearance Form. This was done to ensure the safety and confidentiality of all participants in the study. A letter was sent to the Dean of the College of Education requesting permission to conduct the study, noted by the Chairman of the Mathematics Department, the Chairman of the BSED Programs, and the Research Adviser. On the first day of the research duration, students were given an orientation on the nature of the study and how it would be undertaken. They were also given an informed consent form.

Additionally, a thorough verbal explanation was provided to the research participants via Zoom, assuring them that their names would not be made public, that the data would be kept private, and that the results of the pretest and post-test would not be recorded or reflected in the class record. Precautions were taken to ensure that the identities of the participants remained anonymous. All of the information was de-identified. It contained no personal information about the participants or unique personal identifiers that could lead to assumptions about those involved. Data that were no longer required were removed from the researcher's file.

3.0 Results and Discussion

From Table 1, the pretest performance of the control group had an average score of 9.19 with a standard deviation of 2.61. The pretest performance of the experimental group had an average score of 8.91 with a standard deviation of 2.63. Both groups did not reach the standard criterion set by the university, which is 60% of the total score. Since the total score is 20, hence the passing score is 12. The passing performance of the two groups below implied that the respondents might have little or no knowledge of the concepts since this was still a pretest and the concepts had not yet been discussed.

Table 1. *The pretest performance of the respondents*

Groups	Pretest Performance			
	n	Mean	Standard Deviation	Qualitative Description
Control Group (subjected to conventional formative assessment)	31	9.19	2.61	Below Passing
Experimental Group (subjected to learning log)	34	8.91	2.63	Below Passing

According to the results shown in Table 2, the control group's post-test performance had a mean score of 10.26, and the standard deviation was 2.92. Compared to how they performed in the pretest, the range of their scores was substantially wider here. The performance level of the experimental group in the post-test was 12.65, which is above passing. The control group had a performance score of 10.26, which is below passing. The control group's performance may indicate that some of the concepts were too difficult for them to grasp. This also implied that the students in the control group might lack understanding of Statistics concepts.

Table 2. *The post-test performance of the respondents*

Groups	Pretest Performance			
	n	Mean	Standard Deviation	Qualitative Description
Control Group (subjected to conventional formative assessment)	31	10.26	2.92	Below Passing
Experimental Group (subjected to learning log)	34	12.65	2.59	Above Passing

Langoban (2020) identified the underlying causes of students' difficulty with math learning. The causes of this problem are summarized by three primary themes: (1) delivery of instruction by the teacher/instructor; (2) learners' ability and experiences; and (3) school environment and facilities. Mamolo (2022) also discovered that while the online style of instruction appears complex, students' mathematical motivation and self-efficacy declined. This might be the case because since everything occurred online, students might find it difficult to approach their peers or teachers about their problems. The experimental intervention, a learning log, resulted in the above passing performance of the experimental group. The learning log assisted the students in monitoring their learning. With the assistance of the teacher's feedback, the students were able to achieve the university's criterion of 60% in the test items.

Table 3 shows that the control group got a mean gain of 1.07 while the experimental group had a mean gain of 2.40. Since the computed p-values of 0.04 and 0.00 were less than alpha = 0.05, this rejected the null hypothesis that there was no significant difference between the pretest and post-test of the control and experimental groups. This indicated that there was a significant improvement from the pretest to the post-test of students who were subjected to conventional formative assessment and those who were subjected to learning logs. The significant improvement of the experimental group could be due to the relevant and frequent feedback given by the teacher after the submission of the learning log. Although the post-test performance was below passing, the significant increase in learning of the control group might be because formative assessment aims to gather data to improve student achievement and make necessary changes in how teaching is delivered. However, it showed that it was not as effective as the intervention used in the experimental group.

Table 3. *College of teacher education students' mean gain in statistics from the pretest to the post-test*

Groups	n	Pretest Mean	Post-test Mean	Mean Gain	Standard Deviation	Test Statistics	
						Computed t-test	p-value
Control	31	9.19	10.26	1.07	2.92	-2.08*	0.04*
Experimental	34	8.91	12.65	2.40	2.59	-6.96*	0.00*

The control group's performance, which received conventional formative assessment, improved from the pretest to the post-test. However, it revealed that performance is still below passing, implying that conventional formative assessment was ineffective despite improving performance. This supported the findings of Hattie (2009) and Shepard (2019), who found that formative assessment enabled teachers to regularly modify instruction to help students improve using the assessment results. Teachers formatively use data when collecting test evidence to influence instruction and improve learning. These tasks provide teachers and students with feedback, allowing for modifying teaching and learning strategies in response to the findings. The teacher analyzed the results of formative assessments to pinpoint in-process academic areas that still need to be worked on since learners may be having trouble understanding concepts, picking up new abilities, or simply moving up a level.

Students' ability to be motivated and reflect on their progress may be a contributing factor to the effectiveness of learning logs in the experimental group. This supported the study of Upton and Hirano (2022), who found that "Self-Learning Logs" allowed students to improve their capacity for reflection, review, confidence, and motivation. Khalid (2020) also added that Mathematics students with reflective thinking tended to be more confident in their ability to solve Mathematics problems. Both students and teachers could track learning deficiencies and address them properly. Early identification of misconceptions and confusion in Mathematics leads to successful learning. The key factor in the teacher's role as a motivator, according to Tambuhan's (2018) study, is the indication of the delivery of learning objectives, comfort learning, and a range of learning methodologies, all of which had an impact on student's motivation to succeed in Mathematics.

As shown in Table 4, a difference of 1.33 was obtained in favor of the experimental group. Since the computed p-value is less than alpha = 0.05, we rejected the null hypothesis that there was no significant difference in the mean gains in Statistics score between the control and experimental groups. The result implied that students subjected to a learning log achieved better in Statistics than the control group. This result implies that students subjected to a learning log as a formative assessment showed better improvement in their Statistics performance compared to those subjected to conventional formative assessments. The result contradicted the finding of Slezak et al. (2019), which showed no difference between the students' learning gains in the experimental and control groups. However, the result supported the findings of Gokbulut & Eren (2018) that there was a significant difference between the total post-test scores in favor of the experimental group. It also demonstrated that learning logs were beneficial to students provided with relevant and immediate feedback. Furthermore, students reflect on their mistakes, reasoning, and overall learning progress.

Table 4. *College of teacher education students' mean gain in statistics*

Groups	n	Mean Gain	Difference Between Means	Test Statistics	
				Computed t-test	p-value
Control	31	1.07	1.33	3.47*	0.000*
Experimental	34	2.40			

Note: *Significant at $\propto = 0.05$

The higher performance exhibited by the experimental group subjected to the learning log affirms Jean Piaget's Cognitive Theory of Constructivism and John Dewey's Reflective Thinking, which emphasize involving students as active participants in the learning process. Also, engaging students' reflective thinking ability, examining what they know and still need to know, and how they bridge that gap in various learning situations (Satjatam et al., 2016).

4.0 Conclusion

Most students perceive mathematics as a complex subject. Experts in education, like Rawlusyk (2018), pointed out that assessment is one of the core elements of effective teaching and learning approaches for formal higher education. It is one of the most critical aspects of the learning process. Thus, teachers are encouraged to look for interventions that promote student engagement, boost their enthusiasm, and facilitate maximum learning and achievement in Mathematics. This study showed that a learning log as a formative assessment was an effective intervention measure in enhancing students' performance in Statistics. This study affirmed the theories of Piaget's Cognitive Theory of Constructivism and Dewey's Reflective Thinking, which emphasize engaging students as active participants in the learning process and engaging them in reflective thinking.

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The paper has only one author.

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7.0 Conflict of Interests

The authors declare no conflicts of interest about the publication of this paper.

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