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Utilization of Online Instructional Module in Biostat: A Tool for Enhancing the Performance of Biology Students in Statistics

Merilyn P. Juacalla and Bianca Mariel DP. Juacalla
Laguna State Polytechnic University, Philippines

Abstract

This study explored the effectiveness of the use of online instructional module in enhancing students' performance in statistics. Using one-group pretest-posttest design, the participants (N=58) were the BS Biology students enrolled in Biostatistics at the Laguna State Polytechnic University Sta. Cruz Campus during the second semester of the academic year 2020-2021. The modules were developed in accordance with the university's primer on facilitating flexible learning. Data collected were analyzed and interpreted using the mean, standard deviation, and paired t-test. The students rated the quality of content of the online instructional module with regard to its objectives, accuracy of content, language used, and evaluation activities as highly satisfactory. The students perceived that the module was very effective and has potential as a teaching tool. The students showed satisfactory performance in the pre-test and very satisfactory performance in the post-test. The difference between the students' pretest and posttest scores was found to be statistically significant. The study suggests that the use of online instructional module is an effective teaching tool during the pandemic. It is recommended that teachers use pretest-posttest design to assess students' performance level in any course and that modular learning approach be widely used even at the university level.

Keywords: online instructional module, modular learning, flexible learning, education in COVID-19 pandemic

Introduction

The COVID-19 outbreak strongly affected the lives of people around the world. The pandemic caused the largest disruption in educational systems (UN, 2020). Thus, governments urged the implementation of adaptive responses to emerging education challenges; and educational leaders developed plans for the continuation of education. Most educational systems turned to solutions like online learning or offline methods (Rasmitadila, 2020). The use of either of the two methods require increased flexibility in the curricula; each modality can contribute to an effective educational experience in a different way (Carrol & Burke, 2010). The use of web-based classroom is one of the best possible alternative tools and a good avenue for teaching and learning even in time of calamities (Francisco & Barcelona, 2020). Also, more and more schools adapt functional educational materials such as modules. Modular approach motivates students to learn at their own pace and develop interest in learning (Sadiq & Zamir, 2014). The use of instructional modules is a powerful strategy to bring about effective teaching and learning, as it helps convey more vividly instructional information to learners. However, the modules must be validated for quality assurance and students' progress should be monitored (Dangle & Sumaoang, 2020).

That is why, during the pandemic, educators adjust to distance learning education and their length of experience and specialization played a big part on their readiness to this mode of education (Alea et al., 2020). Educators in the new normal need to be technologically literate must possess the 3Cs: collaboration, commitment, and competence. The current situation necessitates them to use the acquired skills in writing modules and self-learning kits (Jamon, et al., 2021). According to Maloy et al. (2010), effective alternatives for math instruction should

be made available to students through structured practice and creative exploration using a blend of online and in-person learning activities. Research suggests that students signify approval of using modules as supplemental materials (Moradi et al., 2018). They showed significant improvement in knowledge (Torrefranca, 2017); but still need to prepare themselves to be physically and mentally capable of online learning (Baticulon et al., 2021). In Nuncio et al. (2020), it was found that there was an improvement in the students' e-learning knowledge and skill when exposed to e-learning environment.

The Laguna State Polytechnic University (LSPU) developed a system for the integration of flexible learning approaches during the pandemic. Modes of instruction are either synchronous, asynchronous, offline, modular, or a combination of these. At LSPU Sta. Cruz Campus, BS Biology students are exposed to instructional modules; part of their curricula is Statistical Biology (Biostatistics). Instructional modules contain an orderly set of instructions designed to facilitate students' learning. The researchers developed an instructional module in Biostatistics. It was evaluated by the BS Biology students in terms of objectives, content, language used, and evaluation activities. These components are vital in any instructional material as it carefully blends theory and practice, making students' learning more meaningful (Yazon, 2016). The students' performance was gauged on their scores in the pretest and post-test.

Instructional modules are evaluated based on learning objectives, its acceptability, effectiveness and skills acquired by the students (Guido, 2014). The content must be appropriate and highlights students' progress in cognitive abilities and understanding of the concepts. Instructional modules are assessed based on the quality of content, usability, and potential effectiveness as a teaching tool (Goode, 2003). The instructional modules must present opportunities for task-based learning and support self-directed learning. The content must be accurate, have clear directions, properly sequenced, and provides complete demonstration of the concept. In terms of potential effectiveness as a learning tool, the instructional modules identify pre-requisite knowledge, has activities that reinforce content, and must be efficient that the students can learn in a short period of time. Modules must be acceptable and its contents must be valid (Ambayon, 2020). The teachers should see to that learning units in the module are organized around related sets of objectives with clearly defined instructional activities (Larawan, 2013). After using modular approach, the teachers can directly assess students' performance. Through direct assessment, the pretest-posttest knowledge gain can be influenced by content and presentation of the course (Delucchi, 2014).

At the University level in our country, the undergraduate Biology program is generally categorized into education or non-education degree programs. One of the major objectives of the education biology program is to train and produce biology educators. On the other hand, the non-education biology program aims to produce researchers or scientists (Fauzi & Fariantika, 2018). The College of Arts and Sciences, Laguna State Polytechnic University is offering the non-education biology program. Of the various topics covered in biology program, Statistical Biology is reportedly one of the subjects often perceived difficult by students (Fauzi & Fariantika, 2018). Teaching strategies, student attitudes, lack of learning resources, along with learning habits are the cause of students having difficulty in learning Biology concepts (Etobro & Fabinu, 2017; Ichsan & Mulyani, 2018). The nature of the topic, the teaching style, the way of learning and students' habits, the negative feelings and attitudes of students on some biological topics, and the lack of learning resources are several main factors that make Biology become hard to learn (Çimer, 2012). Teacher-centered learning strategies, the low intensity of learning, and less supportive of learning infrastructure are some causes of student learning difficulties in Biology subjects (Fauzi & Fariantika, 2018).

According to National Research Council (NRC), in order to mold the future research biologists, an increased emphasis on interdisciplinarity in biology curricula, including more

emphasis on mathematics and statistics is needed (NRC, 2003). In considering how to best introduce statistics courses for students who will become citizens and professionals, and even non-professional statisticians, it was suggested that an effective learning takes place when content, pedagogy and technology reinforce each other in a balanced manner (Metz, 2008). In this approach, active learning, with components including laboratory exercises, group work, work with class-generated data, and student written and oral presentations, increases student enthusiasm for, and learning of, statistics. Furthermore, statistics instructors indicate that students are more motivated and better understand concepts when real and student-gathered data sets are used. It is also important to use technology such as statistics software to emphasize statistical literacy rather than tedious calculations (Moore, 1997; Garfield et al., 2002; GAISE, 2005; Metz, 2008).

In our traditional curriculum, statistics was a required course for the major, but it was not a prerequisite for any particular biology course. As a result, students took the course at greatly varying points in their curriculum, usually as juniors or seniors. Furthermore, because understanding of statistics was not consistently or uniformly stressed within the biology curriculum, students made few intellectual connections between their general statistics course (which uses examples from a wide range of fields, including economics, agriculture, medicine, sociology, and engineering) and the use of statistics in biology. To integrate statistics and biology and engage students in the use of statistics in their major program, there is a need to provide students with formal training in statistics as early as possible, provide them the opportunity to practice the use of statistics, and demonstrate the importance of statistical data analysis in biological research. In the course Biological Statistics, the first-year students were provided with online instructional modules that covers essential topics in statistics. They were provided opportunities to practice the learned concepts through engaging activities. The level of their understanding of the topics presented in the online instructional module were gauged through quizzes, performance tasks, and major examinations. However, in this study the students' scores in the pre-test and posttest were used to describe their performance in statistics.

This study aims to utilize the online instructional modules in Biostatistics and assess students' performance. Specifically, the study aims to: (1) assess the online instructional module in terms of quality of content with regard to objectives, accuracy of content, language used, and evaluation activities; (2) evaluate the potential effectiveness of the online instructional module as a teaching tool; (3) determine the students' performance in the pre-test and post; and (4) establish the effectiveness of the module by determining the significant difference on the students' performance based on their pre-test and post scores.

Methodology

The study used the one group pretest-posttest design. In this design, participants are selected, pre-tested, exposed to an educational intervention and then post-tested (Marsden & Torgerson, 2012). The participants of the study were the 58 BS Biology first year students enrolled during the second semester of the Academic Year 2020-2021. The students were given a pretest at the beginning of the semester. They were given a copy of the online instructional module and were provided opportunities to practice skills learned through engaging activities. Quizzes and major examinations were made available through Google Forms, from which the students can readily see their scores. Students were required to submit performance tasks in the Google classroom to monitor their performance. A post-test was administered to the students at the end of the semester. The online instructional module, developed in accordance with the university's primer on facilitating flexible learning, was reviewed by the University Cluster Curriculum Review Committee (UCCRC). It is composed of topics on basic concepts in statistics, sampling techniques, frequency distribution table, measures of central tendency and variability, and hypothesis testing.

The 50-item test, administered to the students before and after the use of online instructional module, is a multiple-type of test. The content of the test was validated by three instructors in the campus who also handle statistics. In the construction of the test, a table of specification was prepared that enlisted the objectives for each of the topics covered in the module.

Another instrument used was a researcher-made survey form designed to assess the quality of the content of the online instructional module in terms of objectives, content, language used, and evaluation activities and its potential effectiveness as a teaching tool. The survey form used Likert-Type Scale that gathered the students' perceptions and its reliability can also be determined (Gliem & Gliem, 2003). The reliability of the survey instrument was established based on 0.716 Cronbach's alpha, which is indicative of internal consistency that reached the arbitrary value of 0.70 (Taber, 2017). The mean, standard deviation, and paired t-test were the statistical tools employed to achieve the objectives of the study.

Results and Discussion

The students perceived that the quality of the content of the online instructional module, as seen in Table 1, was highly satisfactory in terms of its objectives (*M*=4.53), accuracy of content (*M*=4.46), language used (*M*=4.51), and evaluation activities(*M*=4.48). The overall average rating of 4.49 signifies that the online instructional module has highly satisfactory content. The students have shown strong agreement on all the items that referred to the quality of the content of the online instructional modules. Ambayon (2020) asserted that a module must be acceptable and its contents must be valid. The learning units in the module must be organized around related sets of objectives with clearly defined instructional activities (Larawan, 2013). On the other hand, Nuncio et al (2020) found that the use of online learning materials makes the students curious, excited and willing to learn. Also, Torrefranca (2017) cited that students enjoy using instructional modules with clear objectives, topics arranged in logical order, concise instructions, and enjoyable practice tasks. Finally, Lim (2016) asserted that modular approach is an applicable and effective teaching approach that could be used in teaching mathematics subjects.

The students rated the online instructional modules as very effective in terms of its potential effectiveness as a teaching tool, as indicated by the overall average of 4.45 (as seen in Table 2). The ratings ranged from 4.30 (stimulates to learn concepts) to 4.55 (supports self-directed learning, enough time to understand and complete performance tasks, overall satisfaction with the experience in using the module). Effective learning materials contain concepts and activities that stimulate students to further their academic interests, provide opportunities for task-based learning, and support self-directed learning (Goode, 2003). The activities in the online instructional modules promotes development of problem-solving and analytical skills among students and made them feel more engaged in the course (Moradi et al., 2018). In this way, learning takes place when content, pedagogy and technology reinforce each other in a balanced manner (Metz, 2008).

As shown in Table 3, the students showed satisfactory performance in the pre-test (*M*=22.29, *SD*=5.05) and very satisfactory performance in the post-test (*M*=34.90, *SD*=6.72). Test results indicate that the students had a better understanding of the targeted topics in Biostatistics. The findings also demonstrate that the use of well-designed online instructional modules can be effective in enhancing students' performance in Biostatistics. Since the students were exposed to online instructional modules, it was expected that they would improve their learning (Moradi et al., 2018) and reveal knowledge gain (Delucchi, 2014).

Table 1. Overall Mean Scores of the Students' Assessment on the Online Instructional Modules as to Quality of Content

Quality of Content	Mean	Qualitative Interpretation
Objectives	(*4.53*)	*Highly satisfactory*
a.1 Clear and concise objectives	4.55	Highly satisfactory
a.2 Clear outline expectations	4.39	Highly satisfactory
a.3 Relevance	4.64	Highly satisfactory
Accuracy of Content	(*4.46*)	*Highly satisfactory*
b.1 Correct content	4.42	Highly satisfactory
b.2 Use of pre-requisite knowledge	4.39	Highly satisfactory
b.3 Proper sequencing of topics	4.58	Highly satisfactory
Language used	(*4.51*)	*Highly satisfactory*
c.1 Use of clear and simple language	4.52	Highly satisfactory
c.2 Clear and concise instructions	4.48	Highly satisfactory
c.3 Information on the coverage and assessment	4.52	Highly satisfactory
Evaluation activities	(*4.48*)	*Highly satisfactory*
d.1 Opportunity for practice of new concepts	4.42	Highly satisfactory
d.2 Opportunity for formative feedback	4.42	Highly satisfactory
d.3 Appropriate assessment techniques	4.61	Highly satisfactory
Overall	4.49	Highly satisfactory

Table 2. Overall Mean Scores of the Students' Assessment on the Potential Effectiveness of the Online Instructional Modules as a Learning Tool

Potential Effectiveness as a Learning Tool	Mean	Qualitative Interpretation
Opportunity for task-based learning	4.52	Very effective
Supports self-directed learning	4.55	Very effective
Increased understanding of concepts	4.36	Very effective
Stimulates to learn concepts	4.30	Very effective
Efficient in terms of time covered	4.42	Very effective
Promotes development of problem-solving and analytical skills	4.48	Very effective
Development of one's academic interests	4.33	Very effective
Help improve practical and study skills	4.48	Very effective
Enough time to understand and complete performance tasks	4.55	Very effective
Overall satisfaction with the experience in using the module	4.55	Very effective
Overall	4.45	Very effective

Table 3. Students' Performance in the Pre-test and Post-test

Test	Lowest Score	Highest Score	Mean	Standard Deviation	Qualitative Interpretation
Pretest	13	33	22.29	5.05	Satisfactory
Post-test	18	44	34.90	6.72	Very satisfactory

The students' pretest and posttest mean scores indicate a substantial improvement in their performance (Table 4). The difference between means is statistically significant (t=-13.480, p<0.05), revealing considerable enhancement in test scores. The mean difference between the pretest and post-test scores equals 12.603. This indicates that the students' understanding of

concepts in Biostatistics was greater at the end of the semester than at the beginning of the semester.

Table 4. Comparison of Students' Pretest and Posttest Scores

Mean		Mean Difference	df	t-value	Critical t-value	Analysis
Pre	Post					
22.29	34.90	12.603	57	-13.480	2.002	***Significant***

*Significant at $p<0.05$ level

Conclusions and Recommendations

The study determined the effectiveness of online instructional module in enhancing students' performance in statistics. The students perceived that the quality of content of the online instructional module as highly satisfactory with regard to its objectives, accuracy of content, language used, and evaluation activities. The online instructional module is very effective and is a potential teaching tool; as it stimulates students to learn concepts and supports self-directed learning. The students were given enough time to understand and complete performance tasks and cited overall satisfaction with the experience in using the module. The students' showed satisfactory performance in the pre-test and very satisfactory performance in the post-test. The difference between the students' pretest and posttest scores was found to be statistically significant. The online instructional module enhanced the students' performance in statistics.

Teachers are highly encouraged to continue to experiment with their teaching methods. The use of pretest-posttest design is suggested in assessing students' performance level in any course and to evaluate the effectiveness of an innovative pedagogy. It is recommended that the modular approach be widely used even at the university level, as a substantial increase in the students' performance in statistics was noted. There is a continuing need to strengthen the capacity of the faculty members in developing online instructional modules. Possible replication of the study to cover other topics is recommended to further support the findings that emerged.

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