

Applied Research: Stats Iq Lab as an Outcome Based Education Tool in Statistics

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Abstract

Statistics are not only important for learning at various levels of educational institutions, but they are also important to be applied in one's daily life. In fact, it is knowledge that is very crucial when doing a study or research. Despite its importance, teachers are faced with issues when delivering the subject to students. STATS IQ LAB is an application developed to assist students in solving long statistical problems. This study is devoted to exploring the perception of students in relation to STATS IQ LAB. The sample of the study was 143 Semester 2 students from Politeknik Port Dickson who studied Statistics in 2022. They were asked to respond to a set of questionnaires that focused on the aspects of Content, User-access and also Applicability. Data was analyzed descriptively using SPSS software. The findings revealed that the highest mean was shown by the Applicability aspect, followed by User-access and Content.

Keyword: statistics, outcome based education, education tool

1.0 Introduction

Mathematics is foundational in many ways that informs people's decisions in various areas. Hence, there is an emergent need for students to develop their mathematics competence in order to function well in today's world. Teaching and learning mathematics is always at the heart of education. Given its importance, it is essential that everyone has the opportunity to learn the subject.

Statistics is one of the core courses for several programs in Polytechnic and other institutions. Despite it being one of the courses that must be taken by Business and Commerce students generally, their achievement for Statistics is not that encouraging. Studies by Maisurah, Noor 'Aina, Siti, & Fadzilawani (2017) and Hanapiah & Luvy (2020) for instance, confirmed that students have issues in understanding the questions and also finding the right solution. At the tertiary level, among the statistical topics with high error rates by students is the

topic of hypotheses (Kurnia, Melda & Tanti, 2019). Students made various types of errors while answering questions related to the topic. Among the reasons that contribute to the issue is the difficulty to understand the needs of the question. Correspondingly, the answers obtained are inaccurate. Errors are also identified in the work done as well as application of incorrect formulas. In addition to that, failure of students to conclude at the end of the question is also one of the factors contributing to the low performance in the statistics course. Finally, the long solution to a question not only takes time to complete but also requires considerable time to explain. In short, both student and lecturer are impaired by these flaws.

Innovation in the education sector is a critical element in ensuring that the Teaching and Learning process (TnL) is in line with the times and meets the needs and challenges of today's education. Briefly, innovation is defined as the modification and improvement to an existing product. Innovation results from the application of creative ability, especially in the renewal of concepts, ideas, methodologies, processes and functions that are able to make it more beautiful and quality (Normah, 2016). In TnL, innovation generally helps simplify a process of delivering information to the students. Innovation is crucial specifically to ensure improved understanding of a certain subject.

Effective and appropriate teaching and learning techniques are a key element in helping students improve their mastery of mathematics and statistics. One of the ways to seek the issue is by referring to Piaget's theory of Constructivist learning. It has a wide ranging impact on learning theories and teaching methods in education and is an underlying theme of many education reform movements in various countries. Malaysia is no exception. The Constructivist learning module was introduced by Malaysian Curriculum Development Center as early as the year 2001 (Zahra, 2013). This constructivist view of learning considers the learner as an active agent in the process of knowledge acquisition. Meanwhile, the role of the instructor is not to drill knowledge into students through consistent repetition, or to goad them into learning through carefully employed rewards and punishments. Rather, the role of the teacher is to facilitate discovery by providing the necessary resources and by guiding learners as they attempt to assimilate new knowledge to old and to modify the old to accommodate the new. To date, a focus on student-centered learning may well be the most important contribution of constructivism (Olusegun, S., 2015).

The aim of constructivism education is to develop students' understanding and make it possible for learners to have a practice on and improve their skills of thinking (Ahmad Ramli, 2002). Teachers who embrace constructivist beliefs would organize student-centered activities that promote independent learning, group discussion and student meaning-making (Brooks, 2002). In recent years, the positive effect of student-centered learning modes has been frequently discussed (Kong, 2015). Several studies have revealed that this learning mode can improve students' learning achievement and increase the interaction among

peers and teachers (Schultz, Duffield, Rasmussen, & Wageman, 2014). In short, student-centered learning has the ability to provide returns at a higher level. One method of student learning that can be used to add knowledge in a course is self-administered modules. As defined by Collins English Dictionary, modules are units of time in training or education. Sutikno (2015), added that self-regulation in learning is related to the regulation of cognitive efforts that occur with the help of cognitive and metacognitive tools (modules). Based on The British Psychology Society (2018), self-organized modules are a very effective learning technique.

Comparative analysis showed that students were able to do better with self-organized modules. Paulson and Feldman (1999) found that self-organized modules were more efficient in learning strategies and had good faith. Similarly, Kitsantas (2013) uses self-organized modules to enhance student learning with positive outcomes.

STATS IQ LAB was developed as a kit to solve statistical problems quickly and effectively. Through the usage of digital platforms, STATS IQ LAB provides a variety of statistical information required to solve a problem. This innovative product not only guides users in terms of providing quick problem-solving methods, it also focuses on provision of appropriate work path. With STATS IQ LAB, students are able to organize their own learning session anytime and anywhere to help enhance their performance. In addition, this product aids the lecturer by reducing the time taken to explain the solution to a question. This advantage helps to overcome the issue of limited teaching time faced by the lecturers.

STATS IQ LAB is an innovative product that embraces the concept of constructivist learning. It focuses on a student-centered teaching and learning technique. Undoubtedly, students are more interested in performing activities than just sitting and listening to the lecturer's explanation. Student-centered learning makes students more active in the classroom besides creating an active two-way exchange of ideas. This method will bring more benefits because students can better understand the course material, acquire critical thinking thus improve problem solving skills creatively and can also increase students' confidence. (Siti Noor Asyikin, Suliadi, Firdaus, Sufahani, Norazman, 2016).

2.0 Problem statement

Mathematics provides an effective way of building mental discipline and encourages logical reasoning and mental rigor. Despite its perks, many students are not into arithmetic. The long held view is that mathematics appears to be tough because it requires time and effort. Working on a mathematical equation requires immense focus besides involving meticulous steps. In addition, mastering it requires a tremendous amount of practice compared to other courses. This approach can seem frustrating and discouraging for many. Consequently, students tend to lose interest in the subject. Mathematics is normally perceived as being a tough, boring and hard subject at school.

Mathematics teaching and learning at secondary schools in Malaysia has been of great concern too many such as teachers, curriculum developers, parents, principals, learners, etc. One of the major causes of concern is poor performance among learners in problem solving tasks when dealing with mathematical concepts and problems. Alshatri, Wakil, Jamal, & Bakhtyar (2019) assert that Mathematics in reality, is a broad material which is full of rules and analyses that requires training, exercising and thinking. As such, it requires effort to facilitate the understanding of the subject.

Other issues pertaining to any mathematical subject including statistics concerns the difficulty in understanding the question. As raised by Maisurah, Noor 'Aina, Siti, & Fadzilawani (2017), failure of comprehension leads to students mistakenly applying the wrong statistical test. Apart from that, there are also times when students refer to the wrong statistical table or even apply the wrong data to solve the question. Eventually, this problem instigates the low achievement of students in statistics. This outcome is in line with the study by Hanapiah & Luvy in 2020 who conclude that the capability of students in solving statistical questions is still weak. This is true notably when it comes to presenting the workings. Further, insufficient time faced by the lecturers in elaborating the solution to the question enumerates the issue discussed.

A study by Alshatri, Wakil, Jamal, & Bakhtyar (2019) suggests that by using teaching aids, the difficulties in learning mathematics may be fixed. Teaching aids can help the teacher to facilitate a better understanding of the subject which discourages the act of confusion. It makes the subject and every aspect of the lesson very clear and makes them successful in learning Mathematics. Teaching aids make Mathematics an interesting subject thus students feel comfortable. Alshatri et. al. (2019) also reveals that teaching aids enable students to capture more information in less time. Consequently, notable improvement in students' understanding can be depicted.

Grounded on the problem encountered, this study focuses on evaluating an innovative self-regulated innovation called STATS IQ LAB that has the potential to cultivate the interest in statistics as well as to improve student's understanding in the subject. Evaluation is targeted at the aspect of user acceptance.

3.0 Research objectives

The study has four main objectives:

1. To evaluate the content of STATS IQ LAB.
2. To evaluate the user-friendliness of STATS IQ LAB.
3. To evaluate the applicability of STATS IQ LAB.
4. To determine the relationship among variables.

4.0 Literature review

Many students struggle with mathematics and become disaffected as they continually confront obstacles to engagement. This may lead to a negative attitude towards mathematics (Odette, Sarah, & Delia, 2018). Overcoming the issue, teachers are concerned with improving motivation, interest and knowledge of their learners in mathematics (Odette, Sarah, & Delia, 2018). In order to break this pattern, it is imperative for anyone involved with the teaching of this subject to seek effective mathematics teaching techniques.

Colgan (2014) argued that teachers could use resources and strategies that increase students' enthusiasm, excitement and concentration to improve their achievement. Applying multiple nontraditional activities and attention-grabbing resources could stimulate interest about mathematics and contribute to understanding the relevance of mathematics in everyday life (Colgan, 2014). According to Ahmed et. al. (2004), teaching aids encourage students to perform the activities on their own hence provides them with better understanding. A study by Wakil, Qaisar, & Mohammed in 2017 reveals that students' learning increased 22.9% after enriching the classroom by using new technology. On the same note, teaching aids enable students to capture more information in less time (Alshatri, Wakil, Jamal, & Bakhtyar, 2019).

Some other studies have shown that integration of technology in teaching mathematics (Moore, 2012) and statistics (Baharun & Porter, 2009) might improve students' understanding. When teachers used technology, especially the internet, in teaching and learning, they gained new insights into the different strategies that they could use in the classroom. Earlier, Chance, Ben-Zvi, Garfield, & Medina (2007) stated that effective use of technology in teaching and learning statistics has the potential to enhance student achievement and teacher professional development.

While statistics has always been portrayed as the most dreaded course in the social work curriculum (Marson, 2007), current findings in education and statistics demonstrate that the teaching of statistics need not have this unsavory reputation. Besides relying on teaching aids, Odette, Sarah, & Delia (2018) suggests that improved teacher explanations and providing more opportunities for practice can assist the students to understand the content better. In their study, these two factors provide the second highest suggestions in coping with the learners' struggles with basic concepts of mathematics. Meanwhile, Marson (2007) indicated that the strategy that had the greatest positive impact on statistics teaching was getting immediate feedback from the teacher. The aim of this strategy is twofold. First, students were in a position to immediately see their errors and were given an opportunity to contrast their mistaken reasoning to the reasoning for getting the correct answer. Second, it reduced the pressure to learn the material and the students could work at their own pace (Marson, 2007).

5.0 Methodology

This study uses a quantitative method to evaluate STATS IQ LAB. For data collection purposes, a questionnaire is used as an instrument. Questionnaire is

attached as Appendix 1. The set of questions was modified based on the work of Abtar Kaur (2004). The questionnaire was tested for its reliability before the survey. It was distributed to 20 randomly selected students who studied Statistics in the year 2022. The result showed that Cronbach's Alpha was 0.955 (>0.7) which represents the questionnaire is highly reliable. The questionnaire is divided into 4 sections A, B, C and D. Section A represents the basic information of respondents while section B has 15 questions related to aspects of the content of STATS IQ LAB. Part C displays 15 questions pertaining to user access to STATS IQ LAB while part D with 13 questions focusing on the usability aspect. The response is based on a 5-point Likert measurement scale displaying Strongly Agree, Agree, Moderate, Disagree and Strongly Disagree.

The population of this study was Semester 2 students from Diploma in Marketing who studied DPB 10033 Statistics at Politeknik Port Dickson in the year 2022. Based on the Sistem Pengurusan Maklumat Politeknik (SPMP) system, the population consists of 143 students. Meanwhile, according to Krejcie and Morgan (1970) table, the sample of the study should be 108 students. To avoid getting insufficient valid responses, the researchers have decided to distribute the questionnaires to all the students during lecture sessions. As a result, 134 questionnaires have been collected.

The data collected was coded, recorded and analyzed using the Statistical Package for Social Sciences (SPSS) program. The output of the data analysis is shown in the form of percentage and also mean score. The descriptive statistics portraying the value of mean for each construct were exhibited in various tables in the Results and Discussion section. The mean value is classified into different categories as shown in Table 1 based on Mohd Najib (2003).

Table 1: Category of mean

Mean score	Category
1.00 – 2.33	Low
2.34 – 3.67	Medium
3.68 – 5.00	High

6.0 Results and discussion

In general, the outcome of the study is encouraging with all the sections displaying high average mean scores.

Section B which looked at the content of STATS IQ LAB scored an average mean of 4.35. It encompasses 15 questions that look at the ability of the application to solve statistical questions. Based on Table 2, all the questions obtained a high mean score of more than 4.00. Basically respondents agreed that the application provides useful information required to solve statistical problems. With a mean of 4.83, this construct contributes the highest mean score for assessing the suitability of STATS IQ LAB content. Meanwhile, the least

mean score of 4.08 comes from the construct that is concerned about the ability of the apps to encourage discussion among peers. This result may be influenced by the basic concept of the application which focuses on the self-organized concept. Following that, the need for peer discussion is almost not evident.

Table 2: Section B: Content of STATS IQ LAB

No	Item	Mean Score	Level
1	STATS IQ LAB can motivate students to get feedback from lecturers.	4.12	High
2	The information provided in this application corresponds to the content of the topics studied.	4.53	High
3	STATS IQ LAB allows students to practice new skills.	4.28	High
4	Supporting activities such as taking notes, site links and learning videos can support the learning process.	4.35	High
5	STATS IQ LAB can provide guidance in solving statistical problems quickly	4.33	High
6	The self -assessment activities take into account the level of cognitive abilities of the students	4.21	High
7	STATS IQ LAB can give accurate answers in statistical problems	4.28	High
8	The content of STATS IQ LAB supports individual and group activities.	4.80	High
9	STATS IQ LAB provides useful information on statistical problems.	4.83	High
10	Activities in STATS IQ LAB can help users master the content of the lesson more effectively.	4.37	High
11	STATS IQ LAB encourages users to build a basic knowledge of statistical problem solving.	4.11	High
12	The reinforcement activities provided in STATS IQ LAB are useful in testing existing knowledge.	4.68	High
13	This app is student-centered.	4.21	High
14	The activities provided in STATS IQ LAB encourage discussion among peers.	4.08	High
15	The activities provided in STATS IQ LAB encourage students to seek information.	4.11	High
	Average Mean Score	4.35	High

Table 3 exhibits the results for Section C: Access of STATS IQ LAB. This section showcases 15 questions that scrutinize the accessibility of the application. Zahra, Khalid, & Javed (2013) posits usability is all about improving user experience as well as being user friendly. Section C recorded a slightly higher average mean score than Section B with the highest mean score being “STATS IQ LAB is easy to reach” (4.88). The average mean score of 4.38 proves that respondents agreed that STATS IQ LAB is easy to access regardless of time and place. Following that, users are free to explore appropriate information pertaining to statistical problems. The mobility aspect highlighted by STATS IQ LAB facilitates students learning even with the absence of the lecturers. Mobile application is crucial especially in coping with technological advancement. Furthermore, the ability to access the application around the clock adds to its strength. This means learning is not confined to the lecture room alone. Hu, Xiaohui, & Shieh (2017) suggests that the mobile aspect promotes after-class learning initiative. Students are able to do self-learning as well as self-reviewing of the exercises done after class. This practice ensures they continuously induce positive affection engaging in statistics learning so as to receive the maximum benefits (Hu, Xiaohui, & Shieh, 2017).

Table 3: Section C: User Access to STATS IQ LAB

No	Item	Mean Score	Level
1	The icons on STATS IQ LAB are very useful.	4.23	High
2	STATS IQ LAB has an attractive screen design.	4.08	High
3	The presentation of information in STATS IQ LAB is systematic.	4.32	High
4	The integrated information can attract attention.	4.35	High
5	The content is easy to follow in accordance with the learning objectives	4.37	High
6	The visual display in this app is interesting.	4.24	High
7	The font size is ideal for reading.	4.36	High
8	Users are free to explore the appropriate information.	4.76	High
9	The interface design has clear instructions.	4.40	High
10	Graphic presentation in the application is easy to understand.	4.26	High
11	Access to the content learning menu is quick	4.54	High
12	STATS IQ LAB is easy to reach.	4.88	High
13	The STATS IQ LAB menu icons all work well.	4.32	High
14	STATS IQ LAB can attract interest to obtain additional information.	4.14	High
15	Users are free to explore information at any time.	4.58	High

	Average Mean Score	4.38	High
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Ease of usage is also one of the factors that attract the interest of the user. Undoubtedly, users emphasize this element when considering using any application. Featuring 15 questions, Table 4 displays the outcome of the analysis for Section D: Applicability of STATS IQ LAB. The highest value of mean recorded at 4.75 is given by item 4 “Provide a work path that can enhance students' understanding”. It promotes self-learning and becomes very handy especially when students are doing revision. The results demonstrate the highest average mean value of 4.55 as compared to the outcomes from Section B and C. The high value is in agreement with the user preference in opting to use any application. STATS IQ LAB displays clear self-guiding features that made the usage of the application easy among the respondents. In addition, students who are of Gen Z find modern learning techniques more attractive as compared to traditional types. This outcome supports the work of Wakil, Qaisar, & Mohammed (2017) and Alshatri, Wakil, Jamal, & Bakhtyar (2019) that proves applying teaching aids helps to instill the interest in statistics.

Table 4: Section D: Applicability of STATS IQ LAB

No	Item	Mean Score	Level
1	STATS IQ LAB promotes self -directed learning.	4.62	High
2	Able to explore the contents of STATS IQ LAB with ease.	4.73	High
3	Students are clear with what they want to achieve.	4.68	High
4	Provide a work path that can enhance students' understanding.	4.75	High
5	STATS IQ LAB allows users to perform activities repeatedly as needed.	4.34	High
6	STATS IQ LAB provides a method of reviewing lessons outside of study time.	4.61	High
7	The use of STATS IQ LAB is appropriate for the level of learning.	4.44	High
8	Help users access information as needed.	4.68	High
9	Users are free to opt out of using STATS IQ LAB if necessary.	4.72	High
10	Users can use the application according to their suitable learning time.	4.33	High
11	The app encourages direct involvement by users.	4.42	High
12	Learning strategies through the use of STATS IQ LAB take into account the characteristics of active learning.	4.62	High

13	Active interaction exists through communication with other users.	4.21	High
	Average Mean Score	4.55	High

In addition to carrying out descriptive analysis, this study also looks at the strength of the relationship between variables being studied. Accordingly, a Pearson correlation test has been carried out. This test is able to provide insights into real-world relationships, assists researchers in theory development and finally makes predictions. The test is evaluated based on the rule of thumb by Hinkle, Wiersma, & Jurs (2003) which is displayed in Table 5:

Table 5: Rule of Thumb for Interpreting the size of a Correlation Coefficient

Size of correlation	Interpretation
0.90 to 1.0 / -0.90 to - 1.0	Very high positive (negative) correlation
0.70 to 0.90 / -0.70 to -0.90	High positive (negative) correlation
0.50 to 0.70 / -0.50 to -0.70	Moderate positive (negative) correlation
0.30 to 0.50 / (-0.30 to -0.50)	Low positive (negative) correlation
0.0 to 0.30 (0.00 to -0.30)	Negligible correlation

The outcome of the test is exhibited in Table 6.

Table 6: Pearson’s Correlation

		Content	Access	Applicable
Content	Pearson Correlation	1	.031	.028
	Sig. (2-tailed)		.719	.749
	N	134	134	134
Access	Pearson Correlation	.031	1	.074**
	Sig. (2-tailed)	.719		.393
	N	134	134	134
Applicable	Pearson Correlation	.028	.074**	1
	Sig. (2-tailed)	.749	.393	
	N	134	134	134

** Correlation is significant at the 0.01level (2 tailed)

The results generally suggest a very low positive correlation coefficient between variables. In other words, this result literally indicates that both variables

increase or decrease at the same time. However, the correlations do not necessarily imply causation. For instance, although the correlation between the applicability of Stats IQ Lab and accessibility is positive, it may not mean easy access to the function will lead to its high applicability.

7.0 Conclusion

Technology in the guise of apps is helping those looking for some newness in the universe of learning. In addition to the feel of novelty, apps add an element of fun and involvement to the learning process. In the technology era, apps-learning process has sustainability. Completing a lesson with an app is much more effective as it is learning from experience rather than from compulsion. STATS IQ LAB that was developed has proven to have a positive impact on many parties in improving the knowledge and the calculation of Statistics questions. In line with the advancement of technology, the application can also be developed as a mobile application to widen its applicability.

A survey was also done to see the user acceptance of STATS IQ LAB. Outcome of the evaluation for all the elements of STATS IQ LAB received a high average mean score. The highest score was shown by the Applicability element (average mean = 4.55), followed by the User Access (average mean = 4.38) and the lowest score comes from the Content element (average mean = 4.35). When the applicability element stands out from the rest of the elements, it proves that STATS IQ LAB is user-friendly. Despite the low average mean score displayed by the Content element, it is still gaining recognition by the users. In a nutshell, STATS IQ LAB is an interesting application that is practical not only to those students studying Statistics but also to academicians teaching the subject. The outcome of this study can be enhanced and enriched by looking at its effectiveness in improving the students' achievement in Statistics.

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