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Teaching statistics using a blended approach: Integrating technology-based resources

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Abstract

This paper presents the results of a study investigating the use of face-to-face components of teaching and technology-based resources in teaching statistics via a blended approach. The student perspective is the focus of investigation which involved 38 on-campus students who enrolled in an introductory statistics subject at University of Wollongong. Assessment items and the laboratory manual and tasks that precede assessment were found to be of greatest importance in assisting students to understand. Students' perceptions were that learning outcomes were positively impacted by both traditional and technologically based resources both in terms of student understanding of topics and increased their confidence in learning statistics.

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Teaching statistics using a blended approach: Integrating technology-based resources

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This paper presents the results of a study investigating the use of face-to-face components of teaching and technology-based resources in teaching statistics via a blended approach. The student perspective is the focus of investigation which involved 38 on-campus students who enrolled in an introductory statistics subject at University of Wollongong. Assessment items and the laboratory manual and tasks that precede assessment were found to be of greatest importance in assisting students to understand. Students' perceptions were that learning outcomes were positively impacted by both traditional and technologically based resources both in terms of student understanding of topics and increased their confidence in learning statistics.

Keywords: Blended learning, student learning outcomes, teaching statistics

Introduction

Nowadays statistics may be taught in a classroom equipped with a computer projected onto a screen, or may take place in a laboratory with students working at their own computers (Chance, Ben-Zvi, Garfield, & Medina, 2007). The style of teaching today with the using of Internet, web-based course, online discussions, collaborative tasks, electronic text and assessment materials has changed the way statistics teachers work and has thus been changing what and how we teach (Moore, Cobb, Garfield, & Meeker, 1995). Specifically, this style of teaching approach is commonly known as a blended learning. According to Matheos, Daniel, and McCalla (2005, p. 57) blended learning is "the best of the worlds from the integration of online and face-to-face teaching, resulting in an enhanced learning experience". Also, in literature the term blended learning is sometimes known as "hybrid" learning where the online learning becomes an advancement or extension of traditional face-to-face learning (Matheos et al., 2005; Swan, 2009).

One idea behind using a blended learning approach is to provide strategies to teachers and learning designers for acquiring the necessary skills and knowledge to allow teachers and learners to shift from a classroom-based learning to online learning in small stages (Matheos et al., 2005). Although students can improve their learning within technology enhanced learning environment (Collis, 2002), it is claimed that the blending of technology and face-to-face interaction is essential for students to experience their learning for proficiency and retaining their knowledge and skills (Singh, 2003). Thus, that is what blending learning was all about. The main advantages of the blended learning environment is that, through the technologies such as *WebCT* and *Blackboard* it allows students to have a wider, faster, and easier access to learning materials, tasks, and assessments provided by teachers with less restricted by time and place of the traditional classroom (Matheos et al., 2005; Swan, 2009). Students in the blended environment retain from the, traditional classroom regular, face-to-face interaction with the teachers and peers in addition to support within the lecture session. Certainly, research has shown that blended approach impacts on student learning and their engagement (Bergtrom, 2009; Chen, Guidry, & Lambert, 2009) and this finally leads to the improvement of student learning outcomes (Singh & Reed, 2001).

The main reason of implementing blended learning environment for any courses or subjects is to provide a wide range of learning resources and experiences for the students through a combination of technology-based learning and face-to-face or traditional classroom. Blended learning has been expanding rapidly. In 2004 more than fifty-percent of the United States institutions offered at least some blended courses for

both the graduate and undergraduate students, with not less than seventy-five percent of large public institutions providing blended classes (Swan, 2009). Matheos et al. (2005) argue that this approach revealed as an effective strategies particularly for campus-based traditional universities to improve teaching and learning in higher education, with blended learning becoming the focus of many research activities over the past fifteen years (i.e. Bergtrom, 2009; Collis, 2002; McVey, 2009). These studies continue to span many different technology tools and differ in functions. Although research has shown that blended learning can enhance student learning, engagement and improve learning outcomes, there is an issue on the implementation of technology in blended learning relating to how, what, why, and when this technology is appropriately and effectively combined with face-to-face or classroom learning. This is essential as Garrison and Vaughan (2008, p. x) note, "When blended learning is well understood and implemented, higher education will be transformed in a way not seen since the expansion of higher education in the late 1940s". Thus, in future study it is very important to highlight on the aspect of learning designs in the implementation of this approach as learning means, "different things to different people and it is a very broad concept" (Australian Flexible Learning Framework, 2008, p. 2).

Historically statistics is one subject area in need of improved teaching approaches. For many students statistics is perhaps the most anxiety-provoking, difficult, or critical subject within their courses of study (Baharun & Porter, 2009). Undoubtedly, many students say that the statistics subjects are "killer subjects". Consequently, students often delay taking this subject until the end of their studies and this may also lead to a failure to complete their studies on time (Onwuegbuzie, 2004; Rodarte-Luna & Sherry, 2008). Additionally, many researchers suggested that the level of difficulty of learning statistics is as similar as learning a foreign language (Lalonde & Gardner, 1993; Lazar, 1990; Onwuegbuzie, 2003; Schacht & Stewart, 1990). Furthermore, it was found that up to 80% of the graduate students experiencing uncomfortable levels of anxiety in learning statistics (Onwuegbuzie, Slate, Paterson, Watson, & Schwartz, 2000; Onwuegbuzie & Wilson, 2003; Pan & Tang, 2004). Thus, it is important for the teachers to find ways on how to teach statistics effectively for their students to learn and understand better in this subject. For instance, Song and Slate (2006) have investigated a case in their study that demonstrates how technology use and instructor attitudes can reduce student anxiety and positively impact on student motivation in learning statistics. This study, examines the online components and technology-based learning materials with face-to-face learning, from the perspective of understanding how this process or the blended learning can be used effectively to enhance the student learning in particular to facilitate and improve the student understanding and confidence in learning statistics.

Current study

The current study explored the student perceived impact of integrating technology-based resources in teaching statistics using a blended approach. This subject is known as "Understanding Variation and Uncertainty" and it is designed to include three hours of face-to-face lectures weekly and two hours of laboratory a week with the laboratory class beginning in the second week of session. Students are expected to attend each lecture although they are not compulsory, while attendance is compulsory for each laboratory class within a thirteen-week of session. All lecture notes, laboratory tasks and solutions, past examination papers, assessment, notices and other learning materials were available via the E-learning site. Students were encouraged to read any messages or notices posted for the subject in the E-learning site on a regular basis. They were encouraged to post any questions about their academic work in the forum on this website. Students were encouraged to respond and to mutually benefit from the questions and the answers provided. In terms of assessment, students were required to complete an assignment and several online laboratory tests conducted during the laboratory class or via E-learning site. The aim of this study is to find out which blended components of instruction have the potential to improve student understanding and learning as well as increase their confidence in learning statistics. More specifically, this study is investigating how effective the technology learning resources used within the subject in supports the students' learning of statistics.

Method

Participants

The participants were thirty-eight students who enrolled in a subject on introductory statistics offered by the School of Mathematics and Applied Statistics at University of Wollongong. They were on-campus based students, 17 female, 20 male, and one student's gender not provided. Eleven students were international and 27 were domestic students. The subject was offered at two campuses, Wollongong and

Loftus. Of the respondents 32 students were enrolled on the main campus Wollongong and six students were enrolled at the Loftus campus.

79 percent of participants reported spending not more than eight hours per week (most frequently cited time spent) for the first twelve weeks of session working on the subject. 21 percent of participants reported spending between nine to eleven hours of work per week. The participants were also asked to anticipate their grades to provide some indication as to the performance of students responding. Anticipated grades ranged from the lowest pass conceded through to high distinction grade where three percent of students expected to obtain a pass conceded, 26 percent expected a pass, 42 percent expected a credit, 21 percent expected a distinction, and eight percent expected a high distinction grade. However this contrast with the actual outcomes for the subject where from a total of 89 students, 24 percent of them failed, two percent obtained a pass conceded, 21 percent obtained a pass, 27 percent obtained a credit, 23 percent obtained a distinction, and three percent obtained a high distinction grade. None of the participants reported expecting a fail grade, and typically of the participants of such evaluations, those who did not respond are the most in need of providing comment (Porter, 2007). Thus, it was possibly either the students are excessively confident in anticipating their grades or better students are responding to the survey.

Questionnaire

A survey questionnaire was used to collect the background information about the students, including gender, the origin whether international or domestic students, campuses they were enrolled, and names for those who are willing to be personally interviewed in future. There were questions asked about the use of learning resources that consists of classroom-based and technology-based resources, assessments, confidence with the subject including several topic areas, changes in perspective after completing the subject, and areas for improving the subject. Types of responses to the questions were either open-ended responses or Likert scales.

Procedure

At the end of session in week 13, students were asked to volunteer to fill out a set of questionnaire via online in the E-learning website. The approach of using an online survey has been shown to increase disclosure (Locke & Gilbert, 1995; Rodarte-Luna & Sherry, 2008; Turner et al., 1998) and could produce a higher response rate. The response rate for this study was 43 percent (from a total of 89 students). The students were approached initially and informed about the purpose of the study through an information sheet delivered during laboratory classes in week twelve of session and through postings to E-Learning. In addition to the information sheet supplied to the students, they were asked to provide a permission slip giving their consent to participate in the study. The students were told that their participation was voluntary and that they were free to refuse to participate and to withdraw from the study at any time. The students would not be penalized for not participating in the study and they were informed that the outcome of the study should be beneficial for future students. Additionally, video resources were also provided to the students via E-learning site as one of the learning resources that were aimed to help either fail or pass students as to improve their learning outcomes in this subject.

Results

The use of learning resources

The first component of the survey sought information about the use of learning resources comprised of classroom-based and technology-based resources. When the students were asked about how they completed the lecture component within the subject whether online or face-to-face lectures, 40 percent of students responded they attended virtually all face-to-face lectures, 21 percent attended the lectures and worked through the online lectures, 21 percent worked through the online lectures as these were required for assessment, 13 percent worked through the online lectures on regular weekly to fortnightly basis, and five percent worked in some other manner. Further, when asked about how the students worked through the laboratory manual, 50 percent of students responded they started completing the tasks and downloaded to complete them, 32 percent responded they essentially completed all laboratory tasks and checked them from the worked solutions, 13 percent downloaded the worked solutions to most tasks, and only five percent responded they essentially completed all laboratory tasks.

In regards to the usefulness of learning resources, students were asked to rate these resources according to 4-point scale which were: 1=not applicable or rarely used, 2=little use, 3=moderately useful, and

4=extremely useful. As can be seen in Figure 1, most of the learning resources particularly assignments, laboratory manual, laboratory tasks, worked solutions, and online laboratory tests were found useful for the students to learn and understand this subject.

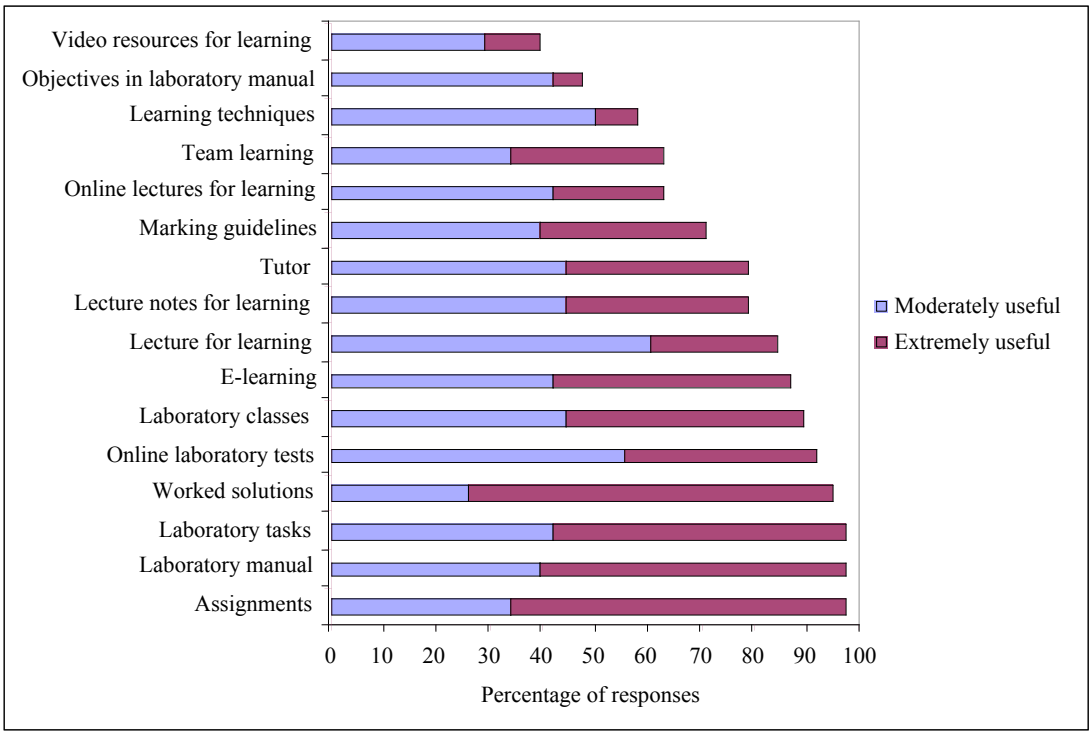

Figure 1: Value of learning resources for helping students learning and understanding

Students were also asked about their use of the video resources recently added to the E-Learning site. When asked about the average time student spent using these resources each week, the data revealed that 55 percent of students responded they never used it, 37 percent spent less than two hours a week, three percent spent between three to five hours a week, and five percent spent between six to eight hours a week. Further, when asked about their experiences of using these resources, 55 percent of students responded they did not used these resources at all, 11 percent found it was time consuming for them to use, 11 percent found it is difficult to use, and 23 percent found they can solved problems well when they use these resources. The lack of student access to these resources was identified which based on some of their comments as shown below.

- I did not use the video resources. More awareness to students not from the Wollongong campus should be made so that they know about these resources
- Tell the lecturers to remind students that they are available. I only discovered them a couple of days before the final laboratory examination
- It would be really useful if E-learning would indicate when a new video has been uploaded. I didn't know that the videos even existed until about 2 weeks ago
- I couldn't find them, maybe make them easier to access

Students were also exposed to a certain amount of theory review through tutor lead exercises included in the laboratory manual they worked on during laboratory class. When asked about their views of laboratory class theory review, 55 percent of students responded the amount of theory covered was well balanced with the time left to work on tasks, 37 percent responded too little theory review to help with the tasks, and eight percent responded there was too much theory review and not enough emphasis on the tasks. When the students were asked about the rationale of completing all laboratory classes effectively, rather than just copy and paste the solutions, 34 percent of students believed they would be well prepared for the exam, 32 percent believed needed only basic revision for the exam, 29 percent believed they still need to thoroughly review of all lecture material and write summary notes as they did not know what to expect in the exam, and five percent responded they did not have any time to study and they still have too much work to do.

Assessment

In this subject, students are required to complete their initial online laboratory tests in the laboratory class and later online tests and the assignment outside of class time. Thus, the second component of survey sought the information about how effective was the technology-based assessment system used for this subject. When the students were asked about the structure of the laboratory tests and when it is best to have these tests, 58 percent of students responded to have it as a mix of in class and done over two or three days out of class, 29 percent responded to do it over two or three days, and 13 percent responded to do it in class (as shown in Figure 2).

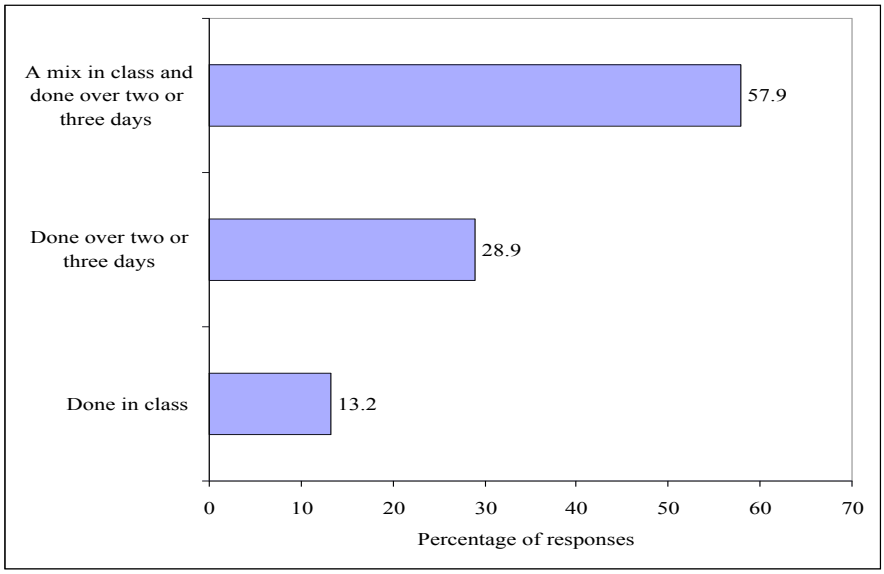

Figure 2: Students' responses on "when it is best to have the laboratory tests"

This survey also asked the students about the fairness of assessment system in this subject. Most of the students or 79 percent indicated the system was fair, eight percent found it was unfair, eight percent thought cheating occurred, two percent found marking was inconsistent, and three percent did not respond. Some of their comments were as shown below.

- Assessment system is fair, students earn marks for their own and others' works but overall it gives them the chance to go through the material, which is very helpful
- The assessment system was good for me because on the assignment I kept to just myself and my partner. With the laboratory tests and re-sit the system is fair as well as students should be able to improve
- Probably a lot of cheating
- I think it is unfair. If you do not pass the 70%... you will get 0 marks. I do not like it. Many times I just less 0.5
- Some laboratory tests needed to be out of more marks. And there may have been inconsistency in marking with different markers which makes a difference if one was to fail by 0.5 of a mark
- I think that the marking system is very fair it proves to people who have done well or need to do some revision... but in the laboratory test a pass mark should be enough as getting a mark 7 or higher is harder and that could come down to whether passing or failing the subject
- I think it is fair. At first I did not see why there was a min mark of 7. But now I understand and in the long run this actually encouraged me to improve my marks
- Yes I believe it is a fair system. By having to do the laboratory tests keeps you accountable for being up to date with your laboratory manual. Gaining feedback after failing a laboratory test is most helpful as you can see how you went wrong not just that you were wrong, end of story (figure out the mistake for yourself)

In regards to the importance of assessment in helping students to understand the subject, they were asked to provide their assessment marks which include laboratory tests and assignment. On average, the students performed well in their assessment with mean and standard deviation of marks (total marks of 100) for each assessment as shown in Table 1.

Table 1: Mean and standard deviation of student assessment marks

	Laboratory Test Week 4	Laboratory Test Week 11	Assignment
Mean	68.55	77.53	79.83
Standard deviation	14.88	12.55	17.54
Sample size,N	38	37	35

Impact on student learning

Student ability and learning progress

The third component of the survey sought information about the impact of technology-based resources on student learning in this subject. At the end of session, students were asked about their ability and learning progress after completing the subject. The students were asked to rate their ability and learning progress according to 4-point scale which were: 1=not at all, 2=I have made a limited progress, 3=I have made a moderate progress, and 4=I have made a great deal of progress. Majority of students believed that they have made a reasonable progress in most aspects of the subject particularly in writing meaningful paragraphs containing statistical concepts and reasoning, developing their ability to explore data in order to present improved solutions, and examining problems in context and the assumptions underlying statistical analysis (refer to Table 2).

Table 2: Student ability and learning progress in the subject

	I have made moderate progress %	I have made a great deal of progress %	Total %
Meaningful paragraphs Increased my confidence in writing meaningful paragraphs containing statistical concepts and reasoning	71.1	13.2	84.3
Improved solutions Helped me to develop my ability to explore data in order to present improved solutions	65.8	15.8	81.6
Examine problems Enabled me to examine problems in context and the assumptions underlying statistical analysis	78.9	2.6	81.5
Solve problems Helped me to solve problems	65.8	13.2	79.0
Logic Helped me to develop my ability to make choices in the analysis of data and logically justify these choices	68.4	10.5	78.9
Presentation Helped me to develop my ability to use technology to analyze, organize and present data as information	47.4	28.9	76.3
Teamwork Helped me to increase my capacity for, and understanding of, teamwork to support my own and the learning of others	39.5	21.1	60.6

Student perceived comfort with topics

In relation to student perceived competency with topics in the subject, at the end of session students revealed they were confident in most topic areas where 97 percent of them confident in doing basic exploration identifying and describing the centre, shape, spread and outliers of data, 82 percent confident in setting up a data in SPSS and produce the output, and 79 percent confident in setting up, testing and interpreting the hypotheses tests (refer to Figure 3). As can be seen in Figure 3, the lower perceived competency with working formulae reflects the lower emphasis on calculations particularly on interpretation of answers.

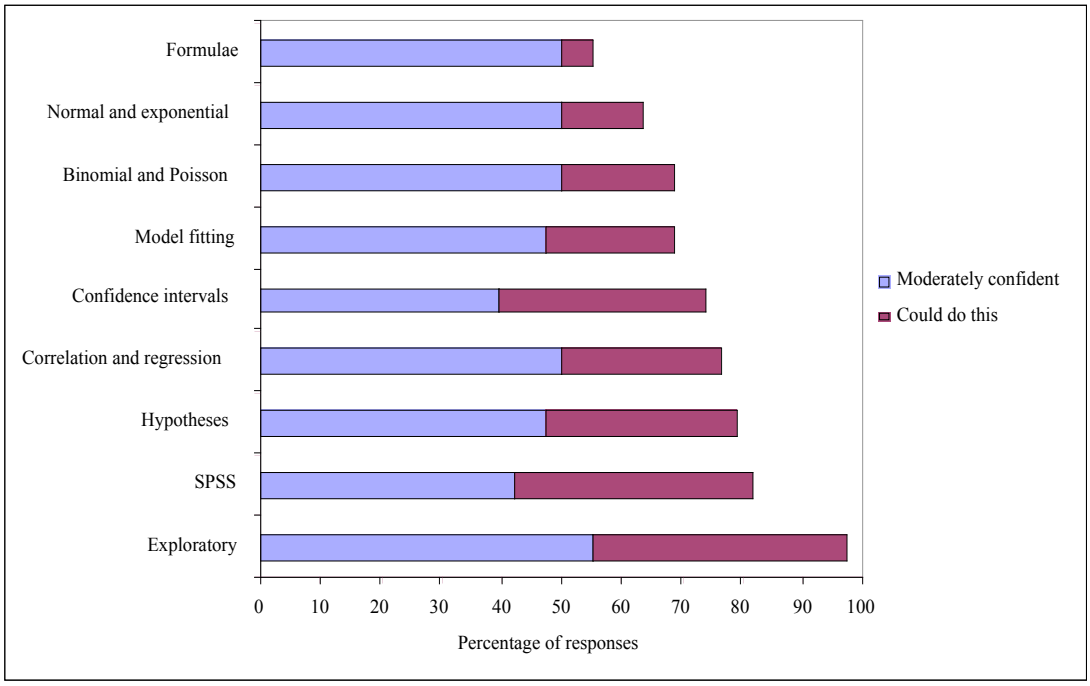

Figure 3: Student perceived competency with topic areas

Discussion and summary

Within the context of this study the researchers approached blended learning in terms of identifying what impact of integrating technology-based resources on student learning outcomes such as their understanding and confidence in learning statistics. In particular, this study was investigating the addition of a new resource, video clips to the blended system to see if they could be effectively used to support the student learning of statistics.

The data revealed that more students preferred classroom-based learning with the majority of students completing the lecture component of the subject by attending virtually all face-to-face lectures rather than online lectures. In terms of how students worked with the laboratory manual, the laboratory tasks and solutions which available in the E-learning site were found reasonably practical for the student learning with most of them completing the laboratory tasks and downloading the worked solutions in order to complete them. The findings do show that there was equal importance placed on the technology-based and classroom-based resources where more than 90 percent of students found the learning resources such as assignments, laboratory manual, laboratory tasks, worked solutions, and online laboratory tests were useful for them to learn and understand this subject. In relation to the design of assessment system, more than 70 percent of students found the structure of the laboratory tests useful and the majority of students preferred to complete these tests as a mix of individual work in class and completed over two or three days. Furthermore, they consistently favored the system which most of them indicated it was fair throughout the session. The newly introduced video clips were not as highly regarded as other resources. It is also noted that they were targeting the lower performing students. However the low usage of the video resources has led to questions about the effectiveness of the integration of this particular resource within the blended learning environment and the need for better learning designs when combining learning materials or resources.

The goal of blended learning approach is not to substitute face-to-face interaction naturally occurs in traditional classroom but to use the technology in numerous ways to enhance and expand the classroom that support student learning. Therefore, the choice and types of technologies implement in a blended learning environment should be well understood by examining the context in which it can be appropriately applied. The above results suggest that in a blended learning approach, the situation in which students are more likely to prefer classroom-based or technology-based learning depends on students' learning preferences or their choices of learning resources as well as the nature of content of a subject (Matheos et al., 2005). The findings are also consistent with the notion that assessment drives learning (Morris, Porter, & Griffiths, 2004).

In summary, this study revealed that blended learning approach is positively received by students, with students drawing upon both traditional and online components of the subject. In this study we could see that their perceived understanding, learning and confidence in learning statistics could be attributed to different component resources. However, making available different resources does not ensure that they are adequate or integrated appropriately into the blended program. Teachers need to understand how to integrate the technology effectively within classroom-based learning as to maximize its impact on student learning outcomes and support their learning.

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