Designing a Blended Teaching Environment in Higher Education:
A Case Study in Statistics

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Abstract

This study focuses on a challenging area in designing the blended teaching strategies for enhancing student learning of a statistics subject at the university. Findings reveal that to design an effective blended and flexible learning (BFL) environment, educators need to understand learners' attributes in detail, use appropriate pedagogical methods and teaching strategies, integrate different learning theories with technological and content knowledge, and align learning outcomes with teaching or learning activities and assessments. It also demonstrates a more holistic and state-of-the-art approach of BFL design in meeting the university's goals towards offering BFL-based online education to the local and global students.

Keywords: blended and flexible learning, statistics, information technologies, online learning, Vygotsky

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Introduction

Blended learning is defined as using information and communication technologies (ICTs) to enhance learning and teaching. (Bath and Bourke, 2010). Blended learning is realized in teaching and learning environments where there is an effective integration of different modes of delivery, models of teaching, and styles of learning, which results from adopting a strategic and systematic approach to the use of technology, combined with the best features of face-to-face interaction between teachers and students (Krause, 2007). New information technologies are increasingly used to introduce flexibility to production, distribution, and interactivity in education. Such use of ICTs brings the possibilities of education in a global markets (Nunan, 1996). In an effective teaching system, teaching methods and evaluation strategies are aligned with learning objectives in such a way that all aspects of this system support appropriate student learning (Biggs, 1996).

Typically, a well-designed blended and flexible learning (BFL) format allows students to gradually move from traditional classrooms to online learning in small steps (Hartley et al., 2005). Although online learning offers many benefits, effective BFL should include a combination of methods derived from both on-campus and distance learning. It should offer flexible opportunities for on-campus students by combining traditional face-to-face teaching with alternative strategies, such as resource-based learning and online facilitation. It should also accommodate rapid technological change. Thus it is essential that sufficient time be devoted to continuing professional staff development, including these three points:

1. Ongoing pedagogical and technical support through membership in a blended community of practice is a proven model that sustains such educator innovation (see, Garrison and Vaughan, 2008);
2. The importance of dealing with educators' fears of loss of control, lower student evaluation scores, and general uneasiness about the impact of online learning on classroom relationships should be considered (see, Vaughan, 2007); and
3. The impact on educators' workloads must also be taken into account. Generally, the high cost in terms of both institutional and teacher investment suggests the advisability of the creating shareable and reusable digital resources in an effort to ensure that blended learning is sustainable (see, Littlejohn and Pegler 2006).

Despite attempts to optimize the learning experiences of students through offering effective interactive teaching environments at the university and functional integration with what is taught and learned through practice based-education and BFL, these efforts have yet to become widely adopted in tertiary education (Rahman, 2018). In some fields this is especially obvious. For example, a recent report published by the American Statistical Association (ASA, 2015) demonstrates that research-based teaching designs are needed for academics to effectively teach statistics contents in science programs. Yet despite this need, no framework exists that describes efficient, activity-based content delivery in classes or outlines the pedagogical skills required to incorporate self-engaged practices into technical and professional subject content. The analytic framework proposed in the research under discussion here seeks to fill in such gaps by outlining a specific teaching and learning strategy.

Scientific statistics is a service subject at the Charles Sturt University (CSU) for students in science-related courses. This subject provides a foundation in the basic practice of statistics, defined as making decisions in the presence of variability, and covers both experimental and observational data with an orientation toward the natural sciences. The course emphasis is on understanding statistical concepts and applying acquired skills to data interpretation through the use of a modern software package.

This subject is offered in both distance education (DE) and internal modes at the CSU campus in Wagga Wagga, with internal modes in both the Bathurst and Orange campuses. Most of the internal students in the main campuses are high school graduates in their late teens or early twenties who do not work full-time, though a number work part-time. They attend both lectures and a one-hour tutorial/practical classes each week. To make this subject more flexible, the lectures are divided into two hours and one hour face-to-face sessions and all lectures are recorded by CSU Replay and then uploaded at the Interact site (an e-learning environment where students are provided with their subject outlines, study guides, lecture notes, and other learning resources) for both internal and distance students. Internal students also do the tutorial under the supervision of a tutor. In contrast, the DE students, who are mainly full-time workers, study the subject online and receive all weekly lectures via CSU Replay. Students can access the resources in their flexible and available times. Moreover, all students have access to CSU subject Interact site and student.csu.

There are more than 200 students studying scientific statistics each semester. Most of these students are based across Australia and a few come from overseas. Typically, students span different age groups, ranging from younger to more mature, and have a very low level of prior statistics knowledge. Statistics is a subject that can only be learned by regular and frequent practice in: (1) identifying the techniques required in particular scenarios; (2) performing the relevant hand or computer-based calculations; and (3) interpreting the results of those calculations. Many of the students enrolled in scientific statistics courses have inadequate background knowledge, and therefore only a minimal mathematical ability can be assumed. The curriculum has therefore been designed to offer a basic understanding of statistical concepts and techniques, and to provide a foundation on which to base later study of other subjects.

Students' personal lifestyle and education experiences and expectations are continuingly changing. Thus it is essential for university educators to understand these expectations by getting to know the students and attempting to align their learning expectations with actual outcomes, as well as by developing learning curricula that respond to a wide range of professional needs and demands.

According to Vygotsky (1978), in many cases people learn first by interacting with others. In thinking about learning, an educator can gradually withdraw the scaffolding until the student is performing competently on their own. The student performs at the level of a competent individual thanks to the support of an educator and the rest of the group. With that in mind, the key focus of this article is on designing the blended teaching strategies of the statistics subject "scientific statistics" for enhancing student learning at the university. The motivation largely derives from a Vygotsky-inspired development of an effective teaching plan for introducing the BFL component in the classroom and increasing students' proactive engagement in learning scientific statistics.

Proposed design

A challenging area within teaching scientific statistics is how to promote student engagement in both internal and online classes. An analysis of data from 235 students in a recent semester reveals that the overall fail rate in scientific statistics is around 36%, and the failure rate for DE students is approximately 4 per cent higher than the rate for internal students. The assessment tools for that particular semester were comprised of two assignments (5 marks for assignment #1 and 10 marks for assignment #2); five online quizzes (1 mark for each quiz); an online practical test (10 marks); and the final exam (70 marks). Of these:

- 8 students out of 235 did not attempt the online practical test.
- 222 students completed the assignment #1 (14 of them scored below 50%).
- 208 students completed assignment #2 (37 of them scored below 50%).
- 35 students out of 235 did not take the final exam.
- 89 students failed the final exam, but 33 students failed only marginally, with marks between 45% and 49%, and were permitted to take an additional examination (AE).

A total of 35 students (14.9%) out of 235 did not take the final exam, which contributed to the high rate of overall course failure. Of these 35 students, 8 did not engage at all in any learning activities at all, while 27 students engaged in some learning and teaching activities. In the first assignment, 14 of these 27 students scored above 50 per cent; 8 scored below 50 per cent; and 5 did not submit this assignment. In relation to the second assignment, only 5 of these 27 students scored above 50 per cent; 8 scored below 50 per cent; and 14 of them (51.9%) did not turn in the assignment.

The analysis above fairly demonstrates that student engagement is significantly lacking for the various learning activities in this subject. Although at-risk students are identified and advised to withdraw from the course during the first four weeks of a semester, one major challenge for scientific statistics is to help the remaining students become more engaged with various learning activities. Further investigation has identified several typical reasons for this lack of student engagement, as follows:

1. The students come from a wide range of backgrounds, but with a very low level of mathematics and statistics knowledge, and can easily feel that statistics is boring

and will not be useful in the future. Thus many of them try simply to pass the subject without making any sincere effort to learn statistical concepts.

2. The main teaching materials for this subject were printed materials, such as the study guide and tutorial manual. Sometimes students receive these materials late. Many DE students also struggle to use the resources from the Interact such as the statistical computing software, especially during the first several weeks of the semester.

3. It seems that the students are not especially interested in attending lectures. Although the tutorial/ practical attendance is compulsory for internal students, they do not actively prepare the tutorial in advance. The current design of the tutorial, which consists chiefly of computer-intensive individual work, thus seems ineffective in promoting student engagement. Students can easily jump to the Internet for their personal interest and/or fail to be engaged in class activities.

4. The subject is very technical. Sometimes students may feel it difficult to cope with understanding the weekly topic on their own, especially if they miss lectures and tutorials. As the topics are interrelated, failure to understand one topic can significantly affect study of the next topics. So sometime these students may think that there is no hope of learning this subject and they quietly abandon most class activities.

5. A high fail rate in this subject. Besides this, an exclusively text-based learning system, which was used previously, failed to attract students' interests for this subject.

6. A wide range of diversified resources is also lacking. Distance students mainly used the text-based study guide, and mainly did self-study. No live online

meetings and tutorial were provided. The students mainly communicated with the coordinator via emails and forum. Although the lectures are recorded via CSU Replay and provided to the students, the recording tools often performed poorly and/or did not work at all!

Given the overall situation, can we improve student engagement through designing an effective BFL learning experience in scientific statistics? It is important first to consider and deal with possible reasons for non-engagement. In particular, any online modules design should not be limited to the text information alone. A high quality of audio-visual information will be included on the modules, with topic-specific statistical games, quizzes, examples, and group activities. Students' interaction will be enhanced by using a mix of modes of communication, such as face-to-face lectures, tutorials and consultations, online meetings, online tutorials for the DE cohort, forums, chat rooms, and, obviously, email and telephone. We will also poll students online, encouraging them to choose which times would be most useful for online meetings and tutorials.

An initially proposed BFL design for students' weekly engagement in scientific statistics is presented in the Figure 1. Students in the distance education cohort have access to all internal lecture recordings except the tutorial class, since it is an individual student-based activity and therefore not recorded. In the meantime, it is becoming steadily more obvious that the students are not keenly interested in attending face-to-face lectures. This is reflected in the fact that a strikingly small number of students (fewer than 10 percent of the total internal enrollments) do in fact attend. Tutorials attendance is reasonably good, since it is compulsory for internal students. However, most of the students do not actively work on the tutorial activities due to a number of reasons, such as a poorly design tutorial activities. This issue must be addressed if we are to increase the students' engagement in learning and teaching activities, especially since the university is moving towards reducing the number of lectures and increasing BFL activities, including the tutorials. Hence it is important to focus on a BFL redesign of the tutorial activities for both internal and DE students to ensure the students' active participation and collaborative engagement in learning.

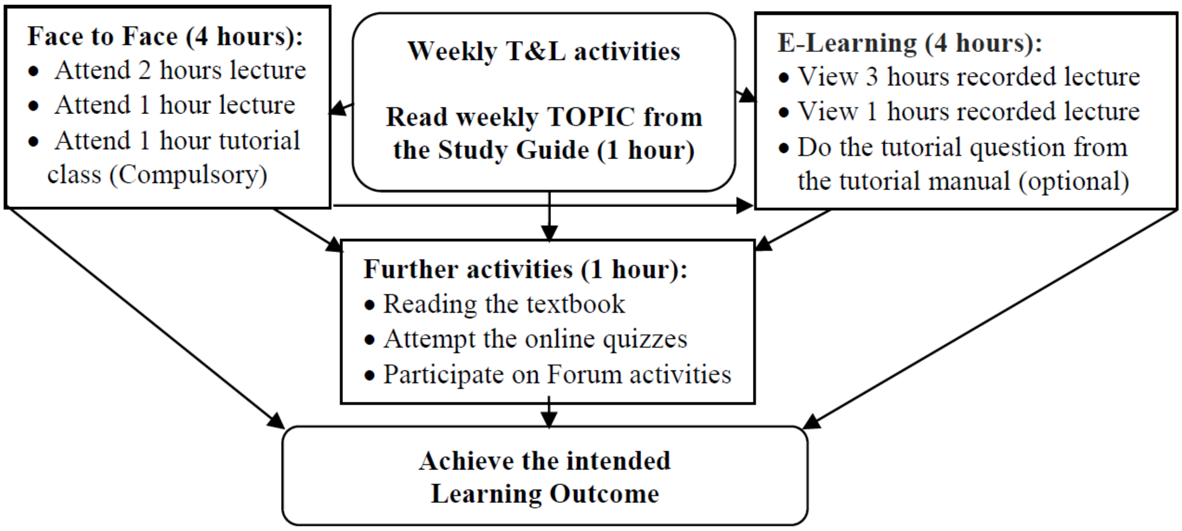

Figure 1: A flowchart for the students' engagement in scientific statistics

A wide range of resources (both hardware and software) are available for use in the design process of BFL, such as Bamboo Wacom, Adobe Captivate, Crossword Weaver, Exam View Test Generator, PowerPoint podcasts, Adobe Professional, Echo 360 Personal Capture, Frontcam, Camtasia, etc. Experts from the Learning and Teaching Services and educational designers are in place to work collaboratively with other teaching colleagues. Two internal and external critiques were also initiated in order to generate specific ideas about what to do for this proposed BFL design. Excerpts from these critiques are quoted as below:

<u>Critique by an internal expert colleague:</u>

"The students' engagement looks good to me. However, may I advise to include some group activities? The activities could be focused on the assessment items. This will also help to

enhance the collaborations among the students. The activities could be made more interesting if some kind of puzzle were included. For example, in one of my subjects, at the end of each topic I ask the students to solve a crossword puzzle, where the terms were learnt in that topic. Group discussion could be another way to increase the collaboration of the students."

Critique by an external expert educator:

"Your graphical representation looks very good and informative to me. You have interlinked a range of BFL components with specific time-lengths. However, it would be excellent if you could include weekly online meetings with students, which could further enhance student engagement. You can take the opportunity to discuss the assessment component and get feedback from students concerning what problems are student facing. I have been using it in my teaching activities and it is effective in the students' learning process. You can also add some more componens to your BFL design, such as online tutorial for DE students. Group-wise tutorial could be another way to enhance collaboration or team work among the students."

Based on this feedback and on consultation with other relevant colleagues, the BFL design flowchart for students' weekly engagement in scientific statistics was modified (see, Figure 2). The new design incorporates the *online meeting,* especially for distance education students, and *group activity* for both cohorts *(*i.e. *Online/F2F)*. The regular and live online meeting will help the students to discuss and work on the tutorial more effectively and collaboratively. Group activities will certainly stimulate student engagement. Besides this, the proposed redesign tutorial activities (described in the next section) for enhancing students engagement will require a 1.5 hours session rather than a one-hour tutorial. It would be also useful to reduce three hour-long lectures to two, given the unpopularity of face-to-face lectures among the students.

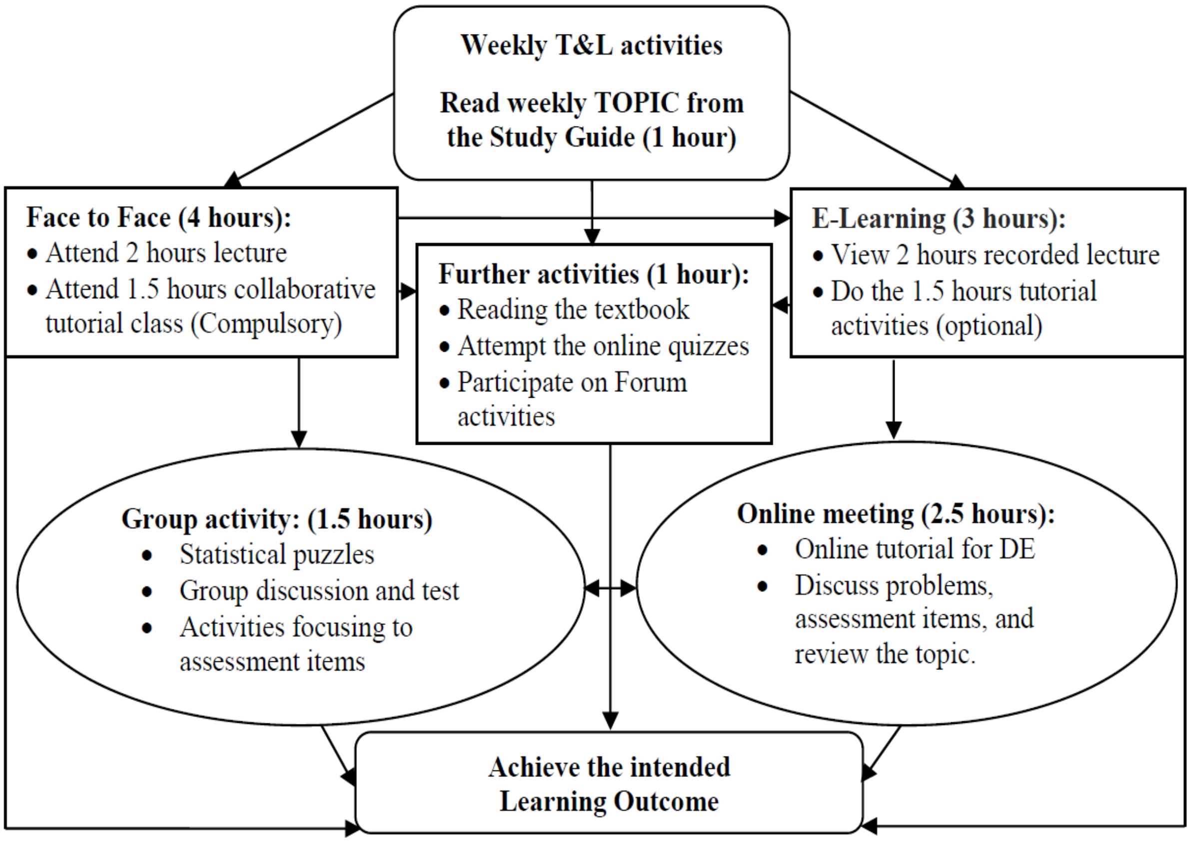

Figure 2: The modified FBL for the students' engagement in scientific statistics

A BFL teaching environment in redesigned tutorials

In scientific statistics, tutorials are traditionally designed as fully independent and computer-intensive activities. Students basically need to follow an instruction book called the tutorial manual and then use a computer to solve the assigned problems. If necessary, a student can ask for help from the class tutor. It is evident that very few students (like "academic" Susan in the Biggs' scenario—see Biggs, 2003)) are doing well with this structure of tutorials. However, it is also evident that many students (like "non-academic" Robert in the Biggs' scenario—see Biggs, 2003)) are not willingly engaged with the tutorial activities and not asking for help by doing nothing, since they are unmotivated for learning and can easily jump to the internet and browse social media to pass the time in tutorial. Perhaps most students find tutorial tasks less than less enjoyable. Thus, it is necessary to redesign the tutorial for scientific statistics in order to improve engagement and provide a more joyful learning experience for all students.

A proposed ideal situation: Good teaching practice with BFL for active student engagement and peer learning in scientific statistics.

Scientific statistics is a \service subject in which students enroll from a wide range of disciplines. However, there are currently no discipline-specific tutorial classes with profession-oriented empirical problems. In order to foster an active learning process in the classroom, the traditional tutorial classes could be converted into the BFL classes by designing a more interactive method that could be called "session leadership" in the tutorials, in which the class is divided into a number of small discipline-specific "syndicates" led by session leaders.

Thus each week, a particular syndicate would be allocated some predetermined tutorial exercises and the syndicate members would work out the best possible answer(s) to the question(s) through mutual face-to-face or online Forum discussions and interaction amongst themselves, if necessary using additional resources such as lectures, study guides, textbooks, etc. The session leader would then present a summary of their findings to the tutorial class. At the end of the presentation, all students in the tutorial should participate in a discussion of what they have just heard. Each group presentation and its related class discussion would be recorded and made available to all cohorts. In this way, the whole class would be involved in brainstorming to find the best possible answer(s) for the assigned exercise(s) with final input from the tutor.

Students would also feel more interactively engaged and stimulate each other's thinking in the process. This approach is applicable to both face-to-face and DE environments and could easily be recorded and made available to all students.

There are some systematic steps involved in the successful implementation of such a redesigned tutorial strategies. These might include (1) designing more interactive tutorial activities for students instead of relying on computing-intensive individual tasks; (2) comprehensively reviewing the revised tutorial materials by using feedback from various sources, including colleagues, teaching and learning support teams, and tutors, as well as students; and (3) implementing the proposed "session leadership" approach to learning activities in the profession/discipline-specific practical problems.

The redesigned tutorial, as indicated above, would have a significant positive impact on student engagement and learning, as well as meeting the overall goals of the course. Such a holistic approach is needed for a subject such as scientific statistics, which seeks to understand the complexity of blended settings and processes as a whole. It is also vital for educators to become skilful in ICT and design science as part of the university's professional practice and to articulate and share that pedagogic practice. For an example, to achieve optimal blends in learning, it would be vital to know the strengths and weaknesses of different new technologies and how they can best be integrated with on-campus teaching environments.

Results of student's reflection on the newly designed BFL environment

A pilot study of this new approach has recently been conducted in a residential school for the subject. Following the residential school period tutorial sessions, optional student feedback and evaluations were collected, within which the evaluations of the new BFL design and tutorials classes, including distance students, were assessed.

Students were asked to respond on a Likert-scale to the following propositions: *R1: "I found the updated BFL environments very useful for simulating my learning"* and *R2: "I found the combined/group-specific tutorial classes very useful for simulating my learning."*

Among the 28 participating students, 68% and 71% of the students indicated that they "very strongly agree" or "strongly agree" for *R1* and *R2* respectively (see, Fig. 3). Also in the reflection *R1,* 21% of the students (6 students) responded "agree," 7% students (2 students) responded "uncertain," and only one student responded "disagree." In reflection *R2,* 25% students responded "agree" and only one student responded "uncertain." No students chose to respond with "disagree," "strongly disagree," or "very strongly disagree." This is a positive outcome, indicating student enthusiasm about learning in a more interactive blended teaching environment, including the implementation redesigned tutorial classes.

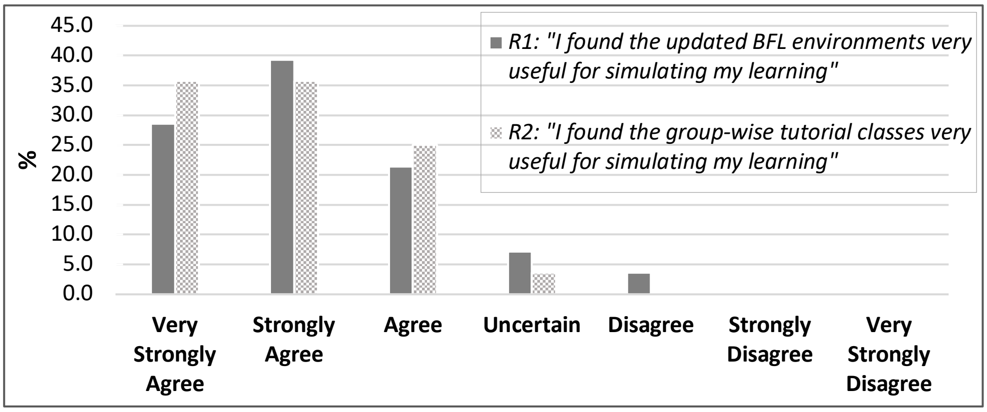

Figure 3: Students' reflections on the new blended teaching environment for scientific statistics, (n = 28)

Nevertheless, it is worth sharing one student's comment here: "*Both lecture + practice is good, but it is the interactive tutorial style that makes all the difference. An ability to put theory into practice is the true measure of the subject*." Another student commented: "*It is really good to have a regular evening-time online meeting and* *collaborative activities such as group tutorials. Availability of all recordings provides us a wider choice and flexibility to learn hard (at least for me!) statistics enjoyably in a busy lifestyle*." Further evaluations will be conducted in 2019, which will include more student feedback, peer reviews, and educational designer's opinions in order to finalize the process for full implementations in the coming year.

Conclusion

In conclusion, designing an effective blended teaching environment is an important topic in higher education and one of the priority areas of the Charles Sturt University's educational plan. Although it is challenging to design blended and flexible teaching strategies in a highly technical discipline like statistics, BFL must be incorporated with cooperative and improved teaching strategies in order to enhance student learning at the university. In this study, the design of a BFL teaching environment of a scientific statistics subject has been presented, illustrating the challenge of enhancing student engagement and peer learning in statistics.

Our overall findings indicate that the BFL design has provided flexibility in learning for both students and educators. Learners need to be encouraged to work within a group under the guideline of an educator and to use the scaffolding provided by that educator through the BFL environment. In addition, educators need to understand learners' prior background, use appropriate pedagogical methods and teaching strategies, integrate different learning theories, technological and content knowledge, and align teaching or learning activities and assessments with desired learning outcomes. Successful integration of the virtual and physical settings through BFL teaching strategies has enabled both educators and students to become learners. But this would be most effective and functional if there were adequate institutional support by providing better professional development and the opportunity for redesigning necessary subjects and/or courses for the most appropriate blend.

The promise of blended teaching in scientific statistics is supported by the students' reflections, wherein 90% of students involved demonstrated a very positive view. After further evaluations of this designed blended teaching environment with integrated tutorials in the coming sessions, we hope to be ready for full implementation from 2020 on in meeting the university's goals of offering BFL-based education to both local and global students. It is anticipated that the proposed BFL design will markedly reduce the high fail rate in scientific statistics. Future research will focus on how to generalize this blended teaching strategy to as to make it more applicable to other subjects, disciplines and faculties across the higher education.

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