MAXIMIZING LEARNER SUCCESS IN MATHEMATICS WITH DIFFERENTIATED BLENDED LEARNING

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Abstract

While Covid-19 pandemic in 2020 saw all lessons moved online out of necessity, Singapore IHLs' leverage on the affordances of blended learning remains elevated when the safe management measures have been lifted. In this paper, the author will share his experience in implementing differentiated instruction with blended learning for 500 mixed-ability stage 1 learners in all IT-based diplomas in their learning of mathematics in the form of asynchronous online lecture and in-person tutorial. Differentiated learning during asynchronous online lecture is achieved with the use of bite-sized content, a mixed of media-like text, infographics and instructional videos where learners can view and review them at their own time and pace. This, augment with monitoring of learners' performance in learning-validation questions to address learning gaps at start of associated tutorial, help to ensure learners with mixed abilities are adequately and effectively prepared to partake and benefit from the active learning activities during tutorial. Through active engagement and interaction with learners during in-person tutorial classes averaging 20 learners, the tutor is able to further differentiate and monitor individual learner's progress to provide immediate feedback and to identify learners who needed more attention and provide them with the necessary help while the faster learners are given additional challenging questions to stretch them further. The use of ALERT (Assessing Learning in Real Time) system at end of most learning topics allows learners to provide feedback on what they have learnt and raise question they might still have, to enable instructor to follow up and respond to those who still need clarification or further assistance. The author will further share his recommendations for an effective and engaging differentiated blended learning which include using multiple types of instructional materials, leveraging on technology to identify online learning behavioural patterns and mixing up group composition in aspect of ability during in-person tutorials. The author reckons the education research paper will benefit technical institutes who wishes to implement differentiated blended learning in the teaching and learning of mathematics to mixed-ability learners.

Introduction

Differentiated learning, also commonly known as differentiated instruction, is an instructional approach which fits individual learners' needs using various techniques such as adjusting the content, the learning process, the learning environment or the product (expected learners' task or artefact to be generated) Tomlinson (2005), a leading expert in this field, defines differentiated instruction as a philosophy of teaching that is based on the premise that learners learn best when their instructors accommodate the differences in their readiness levels, interests and learning profiles. A chief objective of differentiated instruction is to take full advantage of learner's ability to learn (Tomlinson, 2001 & 2005). It presents an effective means to address learner variance as well as provides a crucial platform for all instructors of inclusive classrooms, to create opportunities for success for all learners (Tomlinson, 2000). Instructor can carry out differentiated learning though content, process, product and learning environment (Tomlinson, 2001). Research on the effectiveness of differentiation shows that differentiated learning benefits a wide range of learners, from those with learning disabilities to those who are considered high ability.

Blended learning is a kind of instruction that combines conventional, in-person instruction methods with online learning opportunities (Lawless, 2019). It is a combination of digital and face-to-face content delivery method (Graham, 2006), but on the continuum from face-to-face to online, the nature of its hybridness is still up for debate. The author construes blended learning as the combination of asynchronous online lecture (AOL) with in-person active learning to provide learners with more control over the time, place, pace and path of their learning. Studies have shown that the use of blended-based instruction allows more learners engagement and increases learners' participation (Bowyer & Chambers, 2017).

In this paper, the author explores and shares his experience on how blended learning can support the

implementation of differentiate learning to a cohort of 500 mixed-ability freshmen in School of IT, Nanyang Polytechnic in the teaching and learning of Mathematics.

Background

The School of Information Technology, Nanyang Polytechnic takes in approximately 500 freshmen (more commonly known as stage 1 learners) into its five IT-based diploma courses in every academic year. These learners are enrolled from different admission schemes which include but not limited to JAE (Joint Admission Exercises) for learners from secondary schools who took GCE 'O' level exam, JPAE (Joint Polytechnic Admission Exercises, for learners from ITE (Institute of Technical Education), PFP (Polytechnic Foundation Programme) for learners who took GCE 'N' level exam and spent a year in polytechnic doing foundation modules, EAE (Early Admission Exercise) which is an aptitude-based admissions exercise for learners from secondary schools and ITE, and DAE (Direct Admission Exercise) for learners from junior colleges who did GCE 'A' level exam or IB (International Baccalaureate) diploma programme or other equivalent post-secondary qualifications.

In the School of IT, Nanyang Polytechnic, mathematics is core for all stage 1 learners where they study Computing Mathematics in semester 1 and Business Statistics in semester 2. The different admission paths with corresponding varied mathematics exposure rendered a cohort of stage 1 learners with diverse abilities and needs, with topical weaker learners experiencing challenges in mathematics competency. Against this backdrop, the author implemented differentiated instructions with blended learning in the teaching and learning of Business Statistic in semester 2 of academic year 2022 to address the mixed-ability of these stage 1 learners which differ in their readiness, interests and learning profiles. With the experience gained and lesson learnt from this implementation, the author and his team will also be introducing differentiated blended learning in Computing Mathematics in the coming semester 1 of academic year 2023.

Pedagogy

Blended learning is an education strategy that features multiple teaching methods to help learners learn more effectively than one method on its own (Stauffer, 2022). In most cases, blended learning combines a mixed of online learning and traditional classroom learning. In our context, blended learning is the combination of asynchronous online lecture (AOL) with in-person active learning in tutorial classes, to provide learners with more control over the time, place, pace and path of their learning. In this blended learning approach, asynchronous online lecture is used to introduce and reinforce statistical concepts while the in-person tutorial is used to provide hands-on practice and collaborative learning through group activity to solve problem sums in statistics.

<u>Differentiated Learning in AOL</u>

Differentiated learning during AOL is achieved with the help of Brightspace, a web-based Learning Management System (LMS) where learners can view and review the bite-sized learning content at their own time, place and pace. The bite-size content consists of a mixed of media-like text, infographics and instructional videos that introduce statistical concepts, developed using Articulate Rise 360, a web-based course authoring software. Brightspace's Analytics Tools of Course Access, Content Report, Class Progress and Class Engagement were used to track the learners' progress and activity in log-in time and duration, access of content topics, participation in quizzes and assignment submission. The use of Brightspace's Course Tools of Intelligent Agents further helped to alert instructor on learners who were falling behind in their learning (e.g. Intelligent Agents automatically send notification to learners who has not log in the system for 7 days). More importantly, learners' performance is monitored through learning-validation questions embedded in every topic of AOL to allow instructor to address learning gaps at start of associated tutorial and to ensure learners with mixed ability were adequately prepared to partake in and benefit from the learning activities during tutorials.

<u>Differentiated Learning in In-Person Tutorial</u>

A hallmark of an effective differentiated classroom is the use of flexible grouping which accommodates learners who are strong in some areas and weaker in others. The instructor uses different group configurations over time, and learners experience many different working groups and arrangements (Tomlinson, 2001). Flexible grouping is a teaching practice that allows learners to team up according to ability, allowing the instructor to focus on certain learning objectives according to learner need to make differentiated learning possible (Miller, 2018). The average Business Statistics tutorial class size is 20 learners. By leveraging on differentiated learning tactic of flexible grouping, with each group consisting of 4 to 5 learners, instructor is able to use the differences in ability of learners to better accelerate learning of selected topics in tutorial. Depending on learning objective and topic, instructor organized learners into homogeneous groups (where learners are grouped according to their ability levels) to facilitate group-based differentiated learning or organized them into heterogeneous groups (where learners of all ability levels are represented in each group) to promote collaborative learning. In homogenous grouping, instructor assumed the role of facilitator and moved around in class to guide group that might need help or clarification and to encourage interaction and cooperation among group members. In heterogeneous grouping, each member of the group is responsible not only for learning what is taught but also for helping other group members learn. Learners work through the task of solving tutorial questions until all group members successfully understand and complete it.

While flexible grouping enabled learners of similar or complementary levels to work together and collaborate where they learned and progressed as a group, differentiated learning for individual learner continue to occur even when there is no group learning activity. Through active engagement and interaction with learners,

instructor was able to differentiate and monitor individual learning to provide immediate feedback and to identify learners who needed more help while faster learners were given additional challenging tutorial questions to stretch them further. Two differentiated learning tactics were deployed to allow mixed-ability learners to maximize learning during in-person tutorial: Tiered Activity which teaches the same statistical concept but at varying levels or degrees of challenge by considering the learners' ability, and Anchor Activity that learners performed when they have completed assigned task of solving tutorial questions or when the instructor is busy with other learners to provide time for instructor to offer specific help and instruction to learners requiring additional assistance.

The use of ALERT (Assessing Learning in Real Time) system at end of tutorial for many topics allowed learners to provide feedback on what they have learnt and raise question they might still have, to allow instructor to follow up and respond to those who still needed clarification or required further assistance. ALERT is a joint project developed by the polytechnics and Institute of Technical Education in Singapore to assess learning in real time and to provide timely response to the feedback. It solicits quick feedback from learners via QR code on three questions on lesson just conducted: percentage of content learner understood, a word best described how learner felt, and a specific question learner would like to ask. With the help of insightful dashboard, ALERT helps instructor to determine if a lesson is well understood and find out how to improve a lesson. More significantly, it enables instructor to provide targeted help to individual learner which is an important facet of differentiated learning for mix-ability learners.

Results and Discussion

In this section, the author shares the finding on the measuring metrics of learning effectiveness and learner satisfaction to appraise the level of success of implementing differentiated blended learning in Business Statistics. The success of a pedagogy does not rest solely on its ability to improve on learning effectiveness but also on learner satisfaction. For learning effectiveness, the author examined the passing rate and mean score of the module result of this semester vis-a-vis the previous semester when differentiated learning was not yet implemented. Learner feedback was conducted to measure the learner satisfaction using the Module Evaluation and Feedback System (MEFS).

The author compared the academic performance in Business Statistics module between academic year 2022 and academic year 2020 when differentiated learning was not yet implemented, focusing on the module passing rate (Figure 1) and the module mean score (Figure 2).
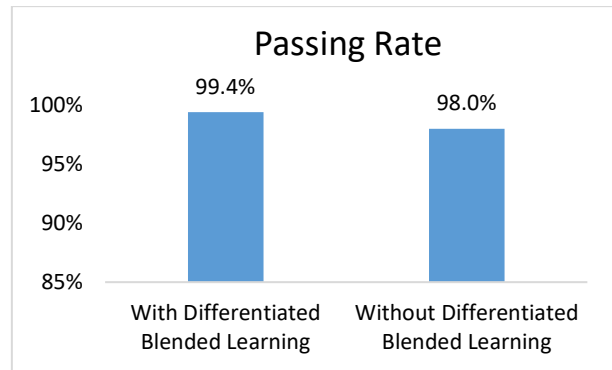

Figure 1: Comparing Passing Rate of Business Statistics when differentiated blended learning was implemented and when it has not been implemented.

Figure 1 above shows the result of the passing rate of Business Statistics when differentiated instruction in blended learning was implemented in academic year 2022 (99.4%) and when it was not implemented in 2020 (98.0%). From Figure 1, we can see that there is an improvement of 1.4% in passing rate of learners. The author also compared the mean score of Business Statistics between the aforementioned two years and the result is shown in Figure 2 below.
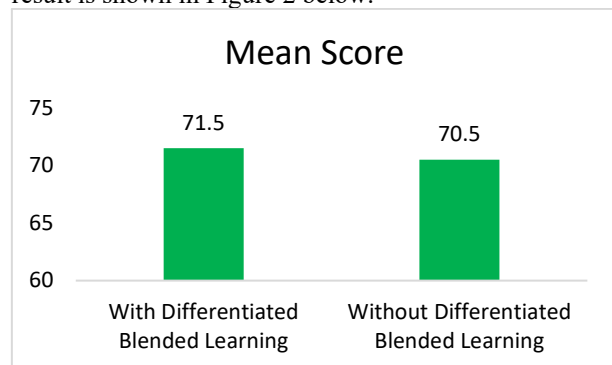

Figure 2: Comparing Mean Score of Business Statistics when differentiated blended learning was implemented and when it has not been implemented.

From Figure 2, we can see that the differentiated instruction in blended learning has mean score of 71.5 marks in 2022 over 70.5 marks in 2020, an improvement of 1 mark. The effect size of the mean score (Cohen's d) for measuring the magnitude of difference in mean between the two groups is computed to be 0.11, indicating a small effect of differentiated blended learning in the improvement of mean score.

The level of student satisfaction was based on the learner feedback collected via MEFS in the form of online survey. The result is shown in Figure 3 below.
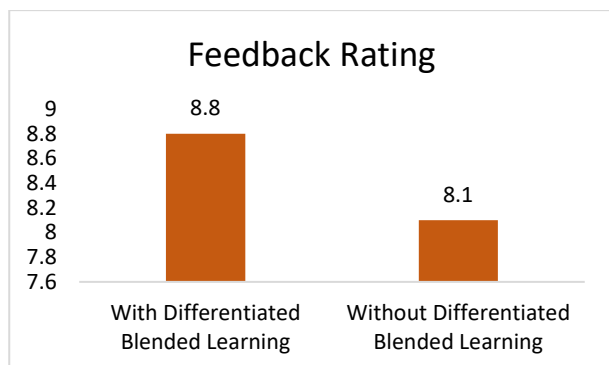
Feedback Rating

Figure 3: Comparing Learner Satisfaction in Business Statistics when differentiated blended learning was implemented and when it has not been implemented.

The effect size of the mean score (Cohen's d) for measuring the magnitude of difference in feedback rating between the two groups is computed to be 0.44, indicating a medium effect of differentiated blended learning in the improvement of learner satisfaction and learning experiences. Qualitative feedback comments from learners reveal that learners are very satisfied that the learning process and content are tailored to their learning pace and readiness. The improvement in passing rate and mean score as well as learner satisfaction, albeit small to moderate effect, can be attributed to the learning effectiveness of differentiated learning where learners can view and review the learning content at their own learning time, place and pace, the in-person active learning activity in tutorial with flexible grouping and differentiated learning tactic, as well as the timely and personalized feedback they received on their performance in AOL and during in-person tutorial.

Conclusion and Recommendation

The research established that differentiated instruction in blending learning supports mixed-ability learners as a community, accommodating differences and sameness. By addressing the differences of mixed-ability learners in their readiness, interest and learning profile, instructor can maximize their learning potential in the learning of Business Statistics. When learners were given more options on how they could learn, they took on more responsibility for their own learning and appeared to be more engaged in learning.

In AOL, the bite-size interactive learning content is delivered asynchronously where learners can view and review them at their own pace, time and place. This form of *process differentiation* has shown to be effective in meeting the needs of mixed-ability learners. It is essential to build in learning-validation questions in AOL to monitor the progress and performance of learners and to address the learning gaps, if any, at start of associated tutorial to ensure all learners are adequately prepared to partake and benefit from the individual and group learning activities during tutorial.

In in-person tutorial, the deployment of flexible grouping allowed learners to group based on their ability through homogeneous or heterogeneous grouping, allowing instructor to focus on certain objectives to make differentiated instruction possible for mixed-ability learners. However, it is imperative that the grouping is done discreetly in stealth mode so that learners do not know the difference. This is because many learners who are struggling with a new concept do not necessarily want their peers to know and will do anything to cover up the fact that they are lost. It is thus crucial for instructor to use appropriate classroom management techniques such as the one just cited to ensure a safe and positive learning environment for all learners. Flexible grouping, coupled with differentiated tactics of tiered activity and anchor activity, have shown to be effective and engaging as a *content differentiation* strategy that maximizes the learning success of mixed-ability learners. It is equally important to encourage and entice learners to provide feedback at the end of tutorial for selected topics (via ALERT system) to allow instructor to follow up and respond to those who still need clarification or further assistance.

With the successful implementation of process differentiation and content differentiation for blended learning in the teaching and learning of Business Statistics, the author will be looking forward to implementing *learning environment differentiation* for mixed-ability learners in the next academic year in Computing Mathematics to leverage on the newly available learning spaces that are equipped with flexible furniture arrangement and smart interactive boards to support individual work preferences and to facilitate collaborative learning, in addition to a safe and positive learning environment. Further research into *product differentiation* as a form of differentiated assessment could be look into as additional lever for learning differentiation to benefit the learners.

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