Establishing Blended Learning Environment in Online Learning Mathematics for University Students.

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Abstract

The purpose of this study is to explore the possibilities that online learning and teaching offer for learning mathematics for university undergraduate students. The blended learning environment will be used to guide my investigation into how instructors perceive teaching online undergraduate mathematics courses. The expanding competition in advanced education due to technological development has brought paradigmatic shifts in higher education. For example, people can gather and preserve knowledge through technology. This has brought changes in education in general and in classroom structures. Nowadays, a person can engage in educational activities outside of school through planned or unplanned activities with the involvement of technology. There is a need for models of online learning methods to come up with an improved proposal that could help achieve better outcomes for learners. The blended learning model is a teaching and learning environment that integrates face-to-face and computer-assisted learning. This model offers the most effective elements from both traditional and e-learning mediums. The objective of this study is to gain critical insights into the key challenges in developing a curriculum plan for learners in a flexible blended learning environment that offers an understanding of their needs and the most salient enablers of success. Moreover, the blended learning environment is the most effective from both traditional and e-learning mediums. This will enable instructors to meet and understand sustainable development goals of mathematics course design that can shed light on instructional practices that support success and efficacy in introductory mathematics courses.

Introduction

Through this paper, I explore the possibilities that a Blended Learning Environment (BLE) offers for learning Quantitative reasoning for university students in a first-year mathematics class. While exploring the changes education has gone through due to technological development, Frick (1991) states that in human communication advancement in technology has brought paradigmatic shifts. For example, people can gather and preserve knowledge through technology. This has brought changes in education in general and in classroom structures. Nowadays, a person can engage in educational activities outside of school through planned or unplanned activities with the involvement of technology. Moreover, the rapid expansion of online technologies has the potential to transform traditional education (Bennet et al., 2009).

Currently, many educational institutions are struggling to provide affordable distance-mode education; however, the problem goes beyond affordable prices. People in rural and impoverished areas scarcely have access to PCs, the internet, and other technologies, yet they are expected to choose and review materials at their own pace (Eklund et al., 2003) and

be successful. Therefore, online technologies can only be considered tools for effective learning if they are accessible to students across borders and social classes.

Increasing connectivity can improve the opportunities of students with online learning centers efficiently, effectively, and economically (Van Dam, 2001); however, this is just one first step. Studies have shown that a number of people who partake in online programs express dissatisfaction with the platforms they have to interact (Ali & Leeds, 2009). Educators are analyzing different models of online learning delivery methods to come up with an improved proposal that could help achieve better outcomes for learners (Holley & Oliver, 2010). A blended learning model emerged as one viable solution to fulfill the need for a hybrid learning model that combines conventional and online learning (Rogers, 2001). BLM is a teaching and learning environment that integrates face-to-face and computer-assisted learning (Stracke, 2007). This model offers the most effective elements from both traditional and e-learning mediums.

In this paper, I explore the contributions that developing a curriculum plan for learners in a flexible blended learning environment offers. The paper is organized into four sections. Section one addresses BLE in educational settings; section two looks at assessment in BLE; section three addresses community in the BLE section, and finally section four discusses inclusion and Universal Design Learning (UDL) in BLE .

Literature Review

According to Garrison and Vaugham (2008), blended learning refers to integrating valuable aspects of both conventional and non-conventional methods of learning where the interaction between teachers and students can take place with or without the use of technology. Blended learning can combine different methods of learning (such as face-to-face and online methods) to create different ways of learning (Wu et al., 2010; Lim et al., 2014). Blended learning can "blend" different forms of instructional technology and classroom teaching. Tselios et al. (2011) claim that blended learning can integrate the advantages of online and traditional learning. According to various authors, blended learning goes beyond the simple integration of conventional and non-conventional methods of learning. Vaughan and Garrison (2005) argue that effective blended learning leverages the strengths of both conventional and non-conventional methods of learning to facilitate achieving the greatest learning outcomes for students. El Mansur and Mupinga (2007) argue that students enjoy certain aspects of blended learning, including schedule flexibility, interactivity, and availability of teachers. Garrison and Vaughan, (2008) extend this argument by saying that blended learning increases the quality and quantity of interaction among students and teachers. Further, Akhter (2016) believe that 24-hour online availability of a teacher combined with the physical presence of his/her in the classroom provides a new level of interaction with students. According to Li (2011), blended learning can bridge the gap between teachers and students and among students to enhance the learning experience of the students (Qiuyun, 2008). In addition, blended learning provides a learning community

with academic standards to produce positive impacts on student performance and decrease dropout rates in classes (Lopez et al., 2011).

TPACK Framework

For my project, I considered TPACK, a new piece of technology that adds technology to existing teaching procedures and structures. TPACK seems to be a promising tool. However, to make use of this tool, teachers need to understand how technology, pedagogy, and content interrelate to develop an integrated form of knowledge, i.e., technological pedagogical content knowledge (TPACK), can be successfully integrated with appropriate pedagogical methods and the content of subject matter (Mishra & Koehler, 2006). It describes how teachers teach any subject content using certain instructional methods with specific technology in particular contexts. TPACK supports the development of three cores of knowledge: technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK).

Content Knowledge (CK)

Teachers struggle to convey mathematics content knowledge to their students. The first step to accomplishing this difficult task is to truly understand the content in their discipline; a situation that does not always happen. As a math instructor, for me, the content knowledge of a course, level, unit, etc., could be considered as the mathematical knowledge that I needed to teach and analyze my mathematical ideas when implementing them in the classroom practice (Wagner et al., 2007).

Pedagogical Knowledge (PK)

Pedagogical knowledge means how teachers can teach effectively. Well-prepared mathematics instructors in their lectures develop pedagogical knowledge and practices that are capable to cultivate students' mathematical proficiency, including components such as conceptual understanding, procedural fluency, problem-solving ability, and facility with the mathematical processes essential for learning.

Technological Knowledge (TK)

This describes teachers' knowledge of, and ability to use, various technologies, technological tools, and associated resources. TK concerns understanding educational technology, considering its possibilities for a specific subject area or classroom, learning to recognize when it will assist or impede learning, and continually learning and adapting to new technology offerings.

After having a complete understanding and having stock of primary forms of knowledge, the ultimate goal for teachers is to be viewing lessons and strategy through the lens of TPACK. Thus, there is a need to look at

- ✓ ***Pedagogical Content Knowledge (PCK)***

Understanding the best practices for teaching specific content

- ✓ ***Technological Content Knowledge (TCK)***
  Knowing how the digital tool can enhance or transform the content, how it's delivered to students, and how my students can interact with it.
- ✓ ***Technological Pedagogical Knowledge (TPK)***
  Understanding how to use a digital tool as a vehicle to achieve learning outcomes and promote desirable experiences.

Digital Tool: PeppeR

This BLE is designed for undergraduate mathematics students to encourage more active learning, especially in first-year and high-enrolment courses. A number of studies have shown a low level of student engagement with the mathematics content because students can't see the mathematics connection with real-world problems. Therefore, this course BLE is designed with the flipped classroom model to address the issues of engagement and applicability of learning mathematics. "A flipped classroom reverses the traditional class structure of listening to a lecture in class and completing homework activities at home. Students in flipped classes watch a short lecture video online and come into the classroom to complete activities such as group work, projects, or other exercises" (Cleveland-Innes & Wilton, 2018, p. 16).

Cleveland-Innis & Wilton (2018) presented four principles when matching an LMS to a BLE course design. The first is to use technology in a way where students can use multiple learning strategies and practice agency since different students have varying levels of confidence in using technology in certain ways. The second principle describes that technology is not only used to help students learn about the course content, but also used to help students learn about technology in a 21st-century world. The third principle entails creating links between in-person and online learning activities that are visible to the students. Finally, the fourth principle states that creating an LMS can be used with many different types of technology (phones, computers, iPad, etc.).

The digital tool I use for my BLE is PeppeR. This is guided by the Technological, Pedagogical, and Content Knowledge (TPACK) framework. PeppeR enables me as an instructor to share various forms of course materials, create quizzes to check students' understanding of the learning content, and assign learning tasks with detailed instruction and examples; on the other hand, it enables my students to read/watch course materials at any time anywhere, participate in the discussion, and give/receive feedback from the instructor and other classmates. I keep the instructions simple and short for my students so they can easily navigate weekly tasks like reading materials and know the criteria to provide feedback to their peers during online discussions.

Participants

Each year millions of students enroll in first-semester mathematics courses almost everywhere in the world. Many of them end up abandoning their career plans in mathematics-related disciplines due to being discouraged by their experience in basic mathematics courses. However, it is assumed that today, the workforce in each profession requires mathematics both advance and basic as well. To be successful in mathematics, students face numerous challenges.

The purpose of this online course is to focus on distance education, for an undergraduate mathematics course. This course:

a) Will provide an understanding of concepts of basic mathematics concepts and provides experience with its methods and applications,
b) Will review multi-representational approach to mathematical problems, with concepts, results, and problems being expressed geometrically, numerically, analytically, and verbally,
c) Will provides a framework for thinking about connections among these representations,
d) Will assist students in developing mathematical skills appropriate to mathematics problems and relate these problems to the real world.

Content & Competencies

This course will expose students to various aspects of quantitative reasoning, including the use of quantitative arguments to analyze problems, critique arguments, and draw and justify conclusions; the recognition and evaluation of quantitative assumptions; and the detection and interpretation of trends and patterns in quantitative data drawn from real-world sources and case studies. The course will nurture basic skills in numeracy, arithmetic, and estimation. In the process, students will learn to use algebraic and statistical methods to solve problems and understand changing quantities. For some mathematical competencies, visual and technological tools are used to assist with calculations and analysis.

BLE Content

- Intro to quantitative reasoning (Millions, Billions, or Trillions),
- Percentages and
- Exploring Climate variability;

BLE Competencies

- Students will be actively involved in solving mathematical problems.
- Collaborative group work forms the heart of each lesson in the course,
- Frequent homework assignments to help support and reinforce the classroom sessions.
- Engagement with the material, group participation, critical thinking, and good

communication.

BLE Design & Justifications

BLE is based on a context-specific design, there is clearly no prescription, and no one size fits for its creation. Rather, it requires careful analysis of the in-person, classroom teaching and learning, along with the additional flexibility, access, and new modes of learning made possible through the use of technology, particularly the Internet. Because the primary purpose is to engage students in first-year mathematics lessons in meaningful learning activities through integrating communications technology by restructuring and replacing traditional classes.

The delivery of a course using both in-person and online activity for the student-designed with reference to the students taking the course, the amount of experience they have with different types of learning, and their access to technology. Finally, "instructional design considers the learner, learning outcomes, the content of what is to be learned, instructional strategies, and results of instructional interventions" (McGee & Reis, 2012, p. 17).

Key Principles and Practices of Effective Design for Blended and Online Students Learning

As a mathematics educator, I learned that it is most important to ensure that students are able to function well as learners with any delivery method, single-mode or blended, even if it is not their preference or the best situation for them. Moreover, teachers are valuable coaches for helping students to manage any learning situation; it is up to teachers and learning designers to offer blended activities that best suit the subject, the learners' needs, and the curriculum requirements. In addition, not all unique and interesting blended learning designs are a one-size-fits-all model. For my project I tried to consider the following steps:

Design

1. ***Students and Teachers Contact.***

   It is vital to encourage in designing for open communication and trust among students and teachers by:

   - ✓ Sending a welcoming email to students before class
   - ✓ Providing helpful instructor contact info
   - ✓ Holding virtual office hours for video/synchronous chats
   - ✓ Posting weekly video summaries of course/topics/what was learned
   - ✓ Emailing individual students throughout the semester to stay in touch
   - ✓ Posting timely notices, announcements, and inspiring messages for students to let them know you are there, thinking of them, etc.

2. ***Develop Cooperation Among Students***

   Following points could be considered for critical reflection and discourse to develop cooperation among students:

   - ✓ Create variety of mixed smaller discussion groups over course

- ✓ Foster discussions and sharing of ideas among students early on
- ✓ Post debate concepts to spark emotions, passion and interest
- ✓ Provide a student space to discuss, without instructor
- ✓ Ask students to complete profiles so they get to know each other
- ✓ Use wikis, blogs, journals, portfolios for students to work together
- ✓ Provide for peer assessment of activities and assignments
- ✓ Allow for synchronous video conferencing discussions

Facilitation

3. ***Encourage Active Learning Techniques***

It is vital to create a sense of community among students and this can be achieved by:

- ✓ Implement rich projects and reflective portfolios for demonstration of learning
- ✓ Engage students in authentic and meaningful learning activities outside of digital learning environment.
- ✓ Stagger release of content /activities when specific criteria are met
- ✓ Use the assignment tool for uploading work for assessment
- ✓ Use quizzes and self-assessments for developing mastery
- ✓ Use discussions, collaboration tools, wikis, blogs, classroom response systems/polling, shared documents for active learning
- ✓ Ask students to create new learning and content such as authoring their own textbook, producing a video, engaging in a community action project etc.

4. ***Give Prompt and Targeted Feedback***

It is necessary to provide prompt and targeted feedback to students and this could be done by purposeful inquiry. Such as:

- ✓ Timely and detailed in your feedback
- ✓ Return assignments within a week with focus on feedback and grade
- ✓ Give students personal video or audio feedback on work so they hear and see you
- ✓ Let students know frequently and in varied formats how they are doing, where they can improve, what are strengths
- ✓ Use rubrics (single point or varied) for grading assignments and projects
- ✓ Use low-stakes assessments to provide feedback

5. ***Emphasize Time on Task***

Time frame is essential for students to sustain collaboration. Therefore, there needs to define explicitly in the syllabus:

- ✓ How much time they should be spending on course activities, homework, and assignments, when activities take place, etc.
- ✓ Clearly outline learning outcomes for the course and alignment with the assessment

- ✓ Pay close attention to student progress and frequently share feedback with students
- ✓ Assist students in managing time, assessing learning strategies that work best, learning how to study etc.
- ✓ Create a checklist of weekly tasks to assist students in staying on track
- ✓ Break larger tasks into smaller chunks to allow students to be successful throughout the course/project
- ✓ Encourage students to brainstorm work for a project, build project plans for time and work etc.
- ✓ Share helpful digital tools for academic learning and building awareness of successful strategies.

6. ***Direction or Leadership:***

Communicate high expectations for inquiry moves to resolution thus;

- ✓ Be clear with students about expectations for learning (criteria, exemplars etc.) Especially about how much and how frequently they need to access the online environment, what participation looks like etc.
- ✓ Always provide clear explanations of modules, assignments, and assessments (create a video to explain)
- ✓ Develop suitable marking tools for demonstrations of learning
- ✓ Encourage students to self-assess on criteria before submitting work
- ✓ Be clear with the format and style of discussion forum posts, number, quality, and what a good post looks like

7. ***Respect Diverse Talents and Ways of Learning***

There is always a need to respect diverse talent and ways of learning through assessment as it is congruent with intended learning outcomes by:

- ✓ Providing course content and feedback in varied ways throughout the course
- ✓ Allowing flexibility in demonstrations of learning (e.g., writing an essay, doing a podcast, creating a website, undertaking a project they are passionate about, etc.) in multiple means and expressions
- ✓ Providing an option of tools and techniques for students to be able to complete an assignment or activity
- ✓ Encouraging students to develop new ways of personalizing their learning
- ✓ Releasing learning activities according to learning needs

Benefits of Blended Learning

- ➢ ***Deeper, More Meaningful Learning***

In-synchronous class guidance from the instructor combined with sequential online experiences provide greater opportunities for students to learn course content, practice

higher-order skills (e.g., critical thinking, inquiry, reflection), and integrate their learning.

There are more opportunities for students to receive feedback on their learning.

- ***Increased Student Engagement.***

The activities like group discussions, and feedback, allow students to engage with course content, each other, and their own thinking. These active learning experiences promote the participation of all students, allowing them to demonstrate their understanding.

- ***Meeting the Needs of Diverse Learners***

Leveraging web-based technologies can provide flexibility and increase access to learning opportunities and support resources for all learners. Students engage with learning resources and course content on their own time, pace, and place reducing cognitive load and increasing accessibility. They can review information and practice skills with greater frequency.

- ***Promote Student Ownership of Learning***

I believe that a blended approach provides students with opportunities to use the learning resources in customized ways which promotes the development of students' metacognition. Moreover, it develops students' self-directed learning skills.

- ***More opportunities to develop a learning community in the course***

In my perception, it provided more opportunities for students to interact and collaborate in online interaction. Moreover, students have much time to reflect on the material and make more meaningful contributions and connections across course content.

Learning Goals and Success Criteria

By the completion of this course (Quantitative reasoning), students will be expected to be able to:

1. Demonstrate quantitative reasoning to analyze problems, critique arguments, and draw and justify conclusions.
2. Accurately perform arithmetic operations involving fractions, decimals, precents, and signed numbers.
3. Recall and apply the standard order of operations.
4. Use proportional reasoning in solving applied problems.
5. Use statistical and probabilistic reasoning in solving applied problems.
6. Explain how quantities change, including multiplicative vs. additive and relative vs. absolute.
7. Use estimation skills to solve problems, detect errors, and check accuracy.
8. Interpret and use scientific notation.
9. Make comparisons of relative magnitudes and work with various representations of quantitative information: ratios, rates, percentages, conversions, indices, scales, etc.

10. Organize and summarize data using a variety of representations, such as tables, graphs, and formulas.

Success Criteria

Based on these learning goals, students are introduced to success criteria which are used to assess their learning in this BLE design. Success criteria describe what success "looks like", and when used to give descriptive feedback when assessing, provide both the teacher and the student information about learning. Success criteria are standards that students use to make judgments about the quality of performance.

1. Use variables to represent quantities.
2. Solve simple algebraic equations.
3. Read and interpret quantitative information from a variety of real-world sources.
4. Analyze and use quantitative information to support an argument.
5. Recognize, make, and evaluate quantitative assumptions.
6. Communicate quantitative results both in writing and orally using appropriate language, symbolism, data, and graphs.
7. Use technology appropriately as a tool for calculations.

Assessment

Conrad & Openo (2018) state that assessment is a vital piece of pedagogy and must be properly integrated into the learning cycle of students. Authentic assessment, a kind of assessment that look into the changes students have experienced in their learning journey, especially in blended and online learning contexts, fulfil important aims. It encourages students to take a deep approach to learning, provides necessary alignment for faculty to better determine the quantity and quality of student learning, and it provides institutions with the evidence to respond to external pressures that measure the institution's ability to evaluate student learning outcomes. However, much consideration should be given to technological factors since instructors believe technology is the most challenging component of a blended learning. As we know, not everybody has the ability to access technology all the time.

Assessments are an essential part in my BLE because they determine whether the learning goals of my mathematics lesson have been met. According to Avilés & Grayson (2017) assessments enable teachers to know how effective their teaching of concepts has been for students. For example, I need to react to the formative assessments' feedback to determine how the lesson proceeds and whether my students have any instructional needs. The application of backwards design enables me to plan the assessments from the desired learning outcomes to the beginning of the learning process. It is suggested to develop the summative assessment first, which guides the teacher to develop learning activities and other formative assessments that lead students towards attaining grades (Conrad & Openo, 2018). Therefore, this should be a main aspect to consider when planning to implement blended learning.

Cleveland-Innis & Wilton (2018) provide three main points about assessment in blended learning environments.

1. Use formative and summative assessment.
2. Assess student learning with activities that include application, problem solving, and creativity.
3. Implement graded activities that fosters collaboration and thought creation such as group projects, peer assessments, presentations, and academic debates.

Assessment Practices for the Blended Classroom

The four types of assessment: comprehension, discussion board, reflective-focused (e.g. Solve a world problem) and project-based (e.g. presentation or report) are recommended (Martin & Ndoye, 2016).

In my BLE environment, I use a discussion board (online discussion) as a formative assessment and a project-based as a summative assessment. Through online discussions, I am doing my class assessments for collaborative problem-solving, expressing individual thoughts, asking questions for clarifications, gain insights from peers and the instructor. Also, students need to write prompts, with the incorporation of some analysis of themself, interacting readings, discussions, and considerations from the course. For students to complete the course and receive a 'pass', the following features must be completed (note: there may be additional details added to this list on commencement of the course or I prepare a co-constructed rubric that incorporates these ideas):

1. Moderation of online discussion.
2. Responding to their colleagues and engaging in scholarly, collegial, timely, respectful, inclusive, and professional dialogue at all times.
3. Logging into the course on Pepper at least 2-3 times per week (please note that this is logged on Pepper)
4. Full participation i.e., posting discussion notes
5. Writing their prompts according to instructions

Finally, the project-based assessment is part of the summative assessment. Students will be required to give a presentation of their projects. This kind of assessment is also beneficial for students to develop good habits/skill in time management.

Grade and Feed Back

Once students have finalized their formative and summative assessments/ activities, they will receive their final grades and feedback from the teacher. According to Conrad & Openo "good feedback helps clarify what good performance is, encourages teacher and peer dialogue around learning, encourages positive motivational beliefs and self-esteem, provides opportunities to close the gap between current and desired performance, and can be used by instructors to help shape teaching" (2018, p. 15).

Details of Grades and Feedback

I will provide students with immediate feedback. The grades for online discussion activities are given based on students' participation, which could be seen as an external drive to increase students' online engagement.

A rubric is a learning and assessment tool that articulates the expectations for assignments and performance tasks by listing criteria, and for each criterion, describing levels of quality (Andrade, 2000; Arter & Chappuis, 2007; Stiggins, 2001).

Rubrics contain four essential features (Stevens & Levi, 2013)

1. ***A task description or a descriptive title of the task:*** students are expected to produce or perform;
2. ***A scale (and scoring):*** that describes the level of mastery (e.g., exceed expectation, meets expectation, doesn't meet expectation);
3. ***Components/dimensions:*** students are to attend to in completing the assignment/tasks (e.g., types of skills, knowledge, etc.); and
4. ***Description of the performance quality (performance descriptor):*** of the components/dimensions at each level of mastery.

Types of Rubrics

There are two types of rubrics and of methods for evaluating students' efforts:

***Holistic* rubrics:**

- Single criteria rubrics (one-dimensional) used to assess participants' overall achievement on an activity or item based on predefined achievement levels;
- Performance descriptions are written in paragraphs and usually in full sentences.

***Analytic* rubrics:**

- Two-dimensional rubrics with levels of achievement as rows and assessment criteria as columns. Allows you to assess participants' achievements based on multiple criteria using a single rubric. You can assign different weights (values) to different criteria and include an overall achievement by totaling the criteria;
- Written in table form.

For my BLE, I will consider *Analytic* rubrics. This rubric clearly states the dimensions that students have to work on and the quality of each dimension from poor to excellent. (Kulkarni et al., 2013).

Online Discussions Participation Rubric

Criteria	Excellent	Very Good	Satisfactory	Fair	Unsatisfactory
	A+/A 85-100%	B+/A- 77-84%	B/B- 70-76%	C 64-69%	FZ 0-59%
Responsiveness to discussion assignment prompt	All components of discussion prompt addressed in initial posting	All components of the discussion prompt addressed in multiple postings	90% of the prompt components addressed in one or more postings	75% of the prompt components addressed in one or more postings	50% or less of the prompt addressed in one or more postings
Application of assigned reading(s)	Very clear that readings were understood by incorporation into postings.	Somewhat clear that readings were understood by incorporation into postings	Somewhat unclear that readings were understood by incorporation into postings	Very unclear that readings were understood by incorporation into postings	Postings reflect no evidence of assigned readings
Responsiveness to group discussion	Multiple points from multiple participants built upon/ refuted in postings	At least one point from multiple participants built upon/ refuted in postings	At least one point from one other participant built upon/ refuted in postings	One or more points from one or more participants only vaguely built upon/ refuted in postings	No evidence that any other postings have been read/ Unwitting repetition of questions or points made by others
Timeliness of discussion contributions	Postings well distributed throughout the week	Postings somewhat distributed throughout the week	Postings neither distributed nor concentrated throughout the week	Postings somewhat concentrated during the week (i.e., all posted within a somewhat brief period)	Postings very concentrated during the week (i.e., all posted within a very brief period)
Quantity of contributions	Exceeded the minimum number of postings (original post and replies)	Met the minimum number of postings (original post and replies)	Less than the minimum number of postings (original post and at least one reply)	Original posting only	Replies only (regardless of number)

Quality of Writing (Language/ word choice, sentence structure, flow, transitions, grammar)	Demonstrates excellent writing ability (word choice, sentence structure, flow, transitions, grammar Demonstrates strong application of APA formatting guidelines.	Demonstrates good writing ability (word choice, sentence structure, flow, transitions, grammar Demonstrates good application of APA formatting guidelines.	Demonstrates adequate writing ability (word choice, sentence structure, flow, transitions, grammar Demonstrates adequate application of APA formatting guidelines.	Is satisfactory	Is unsatisfactory

Project Based Participation Rubric

This rubric assessment is designed for mathematics students. The main concern is understanding the role of definitions, and axioms in mathematical work.

Excellent (80-100%)	The reasoning is complete and fully explained. The results which are being used are clearly stated and the argument is well organized. All mathematical terms are used precisely, including symbols and words. Argument shows a solid understanding of mathematical structures.
Very Good (70-79%)	The overall argument is clear but may be missing some minor details. Most results used in the argument are stated. Mathematical language is used well, perhaps with occasional imprecision. Students may lack a broad understanding of how a problem or result fits into the bigger picture.
Satisfactory (60-69%)	Fundamental steps in argument are present but may lack clarity. Student rarely states axioms, definitions, and prior results. Precision in language and symbols may frequently be lacking. Student probably does not use larger structures or connections between ideas and results.
Questionable (50-59%)	Argument is flawed, either logically or in the way it is presented or both. Student does not state hypotheses or conclusions clearly and conclusions are sometimes incorrect. Argument shows little understanding of how the result in question fits into a bigger structure.
Unacceptable (below 50%)	Argument is incomplete or incorrect. Student does not explain reasoning adequately and language may be sloppy or incorrect. Work does not show an understanding of the material or of how to write a convincing, cogent argument.

Adapted from Centre for Teaching Excellence, Appendix B: Sample Analytic Rubric ("Rubrics: Useful Assessment Tools.

Furthermore, all of the feedback received in this unit would help me shape my teaching by evaluating specific elements of course design and structure, making revisions, and assessing the effects of those changes (Brew, 2008).

Inclusion of Universal Design Learning (UDL)

This study provides a design of flipped learning instructional model. The student body is diverse in Quantitative reasoning mathematics class. Therefore, as an instructor, I need to follow special teaching strategies and pedagogical materials and tools that respond to the special needs of a specific student or group of students, in fact for all students regardless of skills or situations to provide access to the curriculum.

While enhancing diversity in the classroom may lead to an enriched learning environment, this may also underscore the need for instruction to take into account the diverse learning needs of the students (He, 2014). For a learning environment to be inclusive of the needs of all learners, the learning materials and an understanding of the learning materials must be accessible to all learners (Sapp, 2009). To this end, the application of the Universal Design framework to education holds much promise in helping educators design learning environments that are maximally accessible for diverse learner populations. UDL is an adaptive learning program that allows equal opportunity for all students (Gerstein, 2012). It is beneficial for the average and students with learning and attention issues. In the classroom, UDL improves the learning experience for everyone and helps each student to expand his or her knowledge of the subject. UDL allows students to take in, digest, and express information in the way that is easiest for them.

In a BL environment, UDL is based on five core concepts (Ontario Ministry of Education, 2011)

Concept 1*: *Universality and Equity, draw on the strengths of all students, meet their unique needs, and extend their learning:

- Meet students' diverse needs. For example, interactive learning resources can be offered through text, audio, and/or video options. Students can select the option they prefer and that helps them learn best.
- Provide varied access to content. Courses are designed with cascading style sheets, alt tags, and video transcripts. This means text can easily be enlarged; screen readers can convey the content of all text, graphics, and charts; and content in videos may be accessed through text.
- Make differentiated instruction simpler. Students with different learning style with unique interests are facilitated by customized ready-made course content and with alternative materials.

Concept 2: Flexibility and Inclusion Flexible in teaching and assessment strategies, materials and media, response options, spatial arrangements, and time constraints so all students are included:

- Students can preview or review online content privately and repeatedly, at their own pace, which may reduce frustration and embarrassment.
- Many tools in the virtual learning environment have a built-in audio feature that allows students to record and re-record work.

Concept 3: Appropriately Designed Spaces; Ensure students have comfortable access to resources, sufficient space for assistance, and clear lines of sight.

- Allow access to learning, wherever students may be in the room. Depending on local circumstances, students may be able to access mathematics department devices (e.g., notebooks, desktop computers) and/or bring in and use their own technologies (e.g., smart phones, tablets, laptops) at university for learning.
- Allow access to learning outside of class. This may be especially important for students who have special medical needs or conditions that prevent them from attending class regularly.
- Encourage students to form more flexible learning groups within the classroom, particularly if computing devices are being accessed and shared for learning.
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Concept 4: Simplicity Avoid unnecessary complexity in communication, instruction, direction, and feedback

- Directions provided in the face-to-face setting may also be supplied in the virtual learning environment. News postings can include numbered lists, links to specific assignments, exemplars, or helpful tutorials. Complex tasks or assignments can be uploaded to the virtual learning environment so students can access or review it as required. Students can also communicate with their classmates outside of class hours to seek clarification on assignments.
- Interactive checklists can be created in the virtual learning environment. When students complete a specific task or fulfill a requirement, they can check the item off the list and proceed.
- Descriptive feedback can be provided through various tools in the virtual learning environment such as Pepper, Feedback may be offered both through text and audio. Additional files may also be attached (e.g., solutions, rubrics, screencasts).

Concept 5: Safety Provide a safe, caring, engaging, inclusive, and respectful learning environment for all students.

- Safe, password-protected, instructor-mediated, and secure. Some students may feel less tension communicating with others via technological means.
- *Supportive.* In addition to class instructors, educational assistants may be given access to the virtual learning environment to support and assist students with their work.
- *Inclusive.* When all students in a class use the virtual learning environment for learning, those who use computing devices to learn may feel an enhanced sense of belonging and inclusion.

UDL in my Course Quantitative Reasoning

For my Blended learning environment, I am interested to apply five core concepts of UDL

to facilitate inclusive technology-enhanced learning. In particular, utilizing UDL concepts in technology-enhanced course design is an effective way to reduce learning barriers and create flexible and personalized learning environments for each student. Moreover, I believe this format adds a philosophical structure to BLE and technology-enhanced courses to change the education landscape and create a more dynamic learning experience for all involved.

Blended learning is also called *hybrid or mixed-mode* learning. These systems of instructional design use many types of teaching and learning experiences and vary in design and implementation across teachers, programs, and schools.

In my class, I will create mixed-mode delivery. Such a model, blended presentation and interaction, has classroom engagement as its primary component, with support from out-of-class, online exercises.

Flipped Classroom

Flipped classroom pedagogy is a kind of blended learning that was first introduced by two high school teachers in Colorado, namely, Jonathan Bergmann and Aaron Sams in 2007. By using the PowerPoint, they first recorded their lectures and later posted them online for students who missed them.

Eventually, this gave birth to a new learning strategy wherein the traditional style of the classroom was "flipped". In this model, students get access to learning material (pre-recorded tutorials, readings, educational videos, etc.) online. They independently go through them and meet up either in-person or online in group meetings. Consequently, the role of teachers shifts from being "sage on the stage" to "guide on the side".

There are four pillars of the **"F-L-I-P"**:

- Flexible environment (self-paced learning)
- Learning culture (fosters independent learner-centric learning)
- Intentional content (the content is specially designed to fit the needs of the model)
- Professional educator (instructor for thorough guidance)

In this study a design and development of flipped learning instructional model in mathematics course based on Bloom's Taxonomy of cognitive domain. Using Bloom's taxonomy pyramid, we can see that with the flipped classroom models, a lower level of cognitive work like remembering is done outside of the class. Whereas, higher level of cognitive work like analyzing and creating is done in class with the help of the instructor. This is how flipped classroom primarily differs from the traditional didactic classroom.

In this paper, I will use UDL five core concepts to describe my efforts at creating an inclusive flip learning environment and meeting the students with disabilities requirements. I am most drawn to the UDL framework because of its emphasis on the learner and its roots in the neuroscience of learning. I consider this approach to offer maximum flexibility concerning the course material displayed or delivered and included methods of online-class instruction, use of the learning management system, and how students are asked to express

their understanding. This is intended to embody the overarching UDL principles of multiple means of representation, expression, and engagement. Pepper is used to post-record lectures and upload videos on the Teach floor for students to use. Alongside this, I will upload and share documents and other learning materials. Moreover, through Pepper, I can have a complete record of participant analytics to keep track of the students' performance. Also, students can interact with their fellow peers and help each other learn even better through peer review.

Synchronous Learning Methods

The job gets a little tricky with the second half i.e., in-person discussion sessions. Thanks to Platforms like Pepper. Through Pepper, I will share a zoom link so students can come together in the form of live cohorts and engage in real-time to fully enjoy the flipped classroom.

Limitation

No doubt flipped classroom models improve learning outcomes and student engagement. Besides, they also make learning fun for both students and teachers alike. However, making the shift from usual online learning to flipped classroom model can be a little challenging.

Make sure to focus particularly on the curriculum and students' expectations. These are key components that will determine the structure of a flipped classroom.

Similarly, another vital component is finding the perfect LMS that will support a flipped model. Make sure that the LMS ticks all of the teacher requirements, just like **PeppeR** does!

Conclusion

In conclusion, this final BLE mainly focuses on the assessments and the application of UDL guidelines along with a brief recap of learners, digital tools, learning goals, and success criteria. In addition, by applying TPACK framework and UDL guidelines, my BLE (with flipped classroom model) allows my students to read/watch course materials at their own pace, leaving more time for collaborative activity and reflection during the class, which is vital importance for mathematics learners. Online learning can also help to narrow the achievement gap among students as they can read/watch course materials and practice key concepts more times (Spires, 2018).

References

Akhter, F. (2016). Designing information technology framework of enriching e-learning pedagogies. *TEM Journal*, *5*(3),379-384.

Ali, R., & Leeds, E.M. (2009). The Impact of Face-to-Face Orientation on Online Retention: A Pilot Study. *Online Journal of Distance Learning Administration*, *12*(4). https://www.learntechlib.org/p/76604/.

Andrade, H. (2000). Using rubrics to promote thinking and learning. *Educational Leadership, 57*(5),13–18.

Andrei, E. (2017). Technology in teaching English language learners: The case of three middle school teachers. *TESOL Journal*, *8*(2), 409–431.

Arter, J., &J. Chappuis. (2007). *Creating and recognizing quality rubrics*. Upper Saddle River, NJ: Pearson/Merrill Prentice Hall.

Aviles, N., & Grayson, K. (2017). *Backward planning-how assessment impacts teaching and learning*. IDRA.https://www.idra.org/resource-center/backward-planning-assess

Bennett, Thomas, L., Agostinho, S., Lockyer, L., Jones, J., & Harper, B. (2011). Understanding the design context for Australian university teachers: implications for the future of learning design. *Learning, Media and Technology*, *36*(2), 151-167. https://doi.org/10.1080/17439884.2011.553622

Brew, L. S. (2008). The role of student feedback in evaluating and revising a blended learning course. *Internet and Higher Education*, *11*(2), 98–105. https://doi.org/10.1016/j.iheduc.2008.06.002

Christensen, C. M., Horn, M. B., & Staker, H. (2013). *Is K–12 Blended Learning Disruptive? An introduction to the theory of hybrids.* Clayton Christensen Institute. Retrieved from www.christenseninstitute.org

Cleveland-Innes & Wilton (2018), Guide to Blended Learning.
http://oasis.col.org/handle/11599/3095

Collins, A. (1991). The role of computer technology in restructuring schools. *Phi Delta Kappan*, *73*(1), 28-36.

Conrad, D. & Openo, J. (2018). *Assessment Strategies for Online Learning*. AU Press.

Daouk, Z., Bahous, R. and Bacha, N.N. (2016), Perceptions on the effectiveness of active learning strategies, *Journal of Applied Research in Higher Education*, *8*(3), 360-375. https://doi.org/10.1108/JARHE-05-2015-0037.

Edugains. About Innovation in Learning in Ontario. (n.d.). https://www.edugains.ca/newsite/21stCenturyLearning/about_learning_in_ontario.html

Edutopia. https://www.edutopia.org/article/how-forge-strong-community-online-classroom.

Eklund, J., Kay, M., & Lynch, H. M. (2003). *E-learning: Emerging issues and key trends*. Australian Flexible Learning Network.

Frick, T. W. (1991). *Restructuring education through technology*. Bloomington, Ind: Phi Delta Kappa Educational Foundation.

Garrison, & Arbaugh, J. (2007). Researching the community of inquiry framework: Review, issues, and future directions. *The Internet and Higher Education*, *10*(3), 157–172. https://doi.org/10.1016/j.iheduc.2007.04.001

Garrison, D. R., & Vaughan, N. D. (2008). *Blended Learning in Higher Education: Framework, Principles, and Guidelines*. Jossey-Bass.

George-Walker, & Keeffe, M. (2010). Self-determined blended learning: a case study of blended learning design. *Higher Education Research and Development*, *29*(1), 1-13. https://doi.org/10.1080/07294360903277380

He, Y. (2014). Universal Design for Learning in an Online Teacher Education Course: Enhancing Learners Confidence to Teach Online. *MERLOT Journal of Online Learning and Teaching*, *10*(2), 283-298.

Hirvela, A. (2006). Computer-mediated communication in ESL teacher education. *ELT Journal,* 60, 233-241. http://dx.doi.org/10.1093/elt/ccl003

Hockly, N. (2018). Blended Learning. *English Language Teacher*, *72*(1), 97-101.

Holley, D., & Oliver, M. (2010). Student Engagement and Blended Learning: Portaits of Risk. *Computers & Education*, *54*(3), 693-700. http://dx.doi.org/10.1016/j.compedu.2009.08.035

Hsu L-L. (2011). Blended learning in ethics education: A survey of nursing students. *Nursing Ethics.* 18(3), 418 - 430. doi:10.1177/0969733011398097 https://courses.lumenlearning.com/virtuallearningdesigndelivery/chapter/5-blended-learningdesign/

Kearsley, G. (2000). *Online education: Learning and teaching in cyberspace.* Wadsworth.

Koehler, M.J., Mishra, P., Akcaoglu, M., & Rosenberg, J.M. (2016). The technological pedagogical content knowledge framework for teachers and teacher educators. In M.R. Pani-grahi (Ed.), *Resource book on ICT integrated teacher education* (pp. 20–30). Commonwealth

Educational Media Centre for Asia.
Krause, C. (2020, April 15). *How to Forge a Strong Community in an Online Classroom*.
Edutopia. How to Forge a Strong Community in an Online Classroom | Edutopia
Kulkarni, C., Wei, K. P., Le, H., Chia, D., Papadopoulos, K., Cheng, J., Koller, D., & Klemmer, S. R. (2013). Peer and self-assessment in massive online classes. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *20*(6), 1-31. https://doi.org/10.1145/2505057
Lim, Morris, M. L., & Kupritz, V. W. (2007). Online vs. blended learning: differences in instructional outcomes and learner satisfaction. *Journal of Asynchronous Learning Networks JALN*, *11*(2), 27-42.
Lin. (2008). Preservice teachers' learning experiences of constructing e-portfolios online. *The Internet and Higher Education*, *11*(3), 194-200. https://doi.org/10.1016/j.iheduc.2008.07.002
López-Pérez, Pérez-López, M. C., & Rodríguez-Ariza, L. (2011). Blended learning in higher education: Students' perceptions and their relation to outcomes. *Computers and Education*, *56*(3), 818–826. https://doi.org/10.1016/j.compedu.2010.10.023
Mansour, B.E., & Mupinga, D.M. (2007). Students' positive and negative experiences in hybrid and online classes. *College student journal*, *41*(1), 242-248.
Margolies, R. (1991). The computer as social skills agent. THE Journal (Technological Horizons in Education), 18(6), 70-71.
Martin, F., Ndoye, A., & Wilkins, P. (2016). Using Learning Analytics to Enhance Student Learning in Online Courses Based on Quality Matters Standards. *Journal of Educational Technology Systems, 45*(2), 165–187. https://doi.org/10.1177/0047239516656369
McGee, P., & Reis, A. (2012). Blended Course Design: A Synthesis of Best Practices. Journal of asynchronous learning networks, 16,7-22.
Mishra, P., & Koehler, M.J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers' College Record*, *108*(6), 1017–1054.
Muilenburg, & Berge, Z. L. (2015). Revisiting Teacher Preparation: Responding to Technology Transience in the Educational Setting. *Quarterly Review of Distance Education, 16*(2), 93–105.
Rockinson-Szapkiw, A. J. (2012). The Influence of Computer-Mediated Communication Systems on Community. *E-Learning and Digital Media*, *9*(1), 83-95. https://doi.org/10.2304/elea.2012.9.1.83
Rogers E. M. (2001) The Digital Divide. *Convergence*. *7*(4), 96 -111. doi:10.1177/135485650100700406
Sapp, W. (2009). Universal design: Online educational media for students with disabilities. *Journal of Visual Impairment & Blindness, 103*(8), 495-500.
Sheingold. K. (1991). Restructuring for learning with technology: The potential for synergy. *Phi Delta Kappan*. *73*(1). 17-27.
Spires, H. A.(Ed.). (2018). *Digital Transformation and Innovation in Chinese Education*. IGI Global. https://doi.org/10.4018/978-1-5225-2924-8.ch007
Stevens, D. D., & Levi, A. J. (2013). *Introduction to rubrics: An assessment tool to save grading time, convey effective feedback, and promote student learning*. Stylus Publishing, LLC.
Stiggins, R.J. (2001). *Student-involved classroom assessment.3rded*. Upper Saddle River, NJ: Prentice-Hall.
Stracke, E. (2007). A road to understanding: A qualitative study into why learners drop out of a blended language learning (BLL) environment. *Re CALL*, *19*(1), 57-78. https://doi.org/10.1017/S0958344007000511
Tselios N., Daskalakis S., Papadopoulou M. (2011) Assessing the acceptance of a blended learning university course. *Educational Technology and Society*, *14,* 224-235.
Wu, J. H., Tennyson, R. D., & Hsia, T. L. (2010). A study of student satisfaction in a blended e-learning system environment. *Computers and Education*, 55(1), 155-164. https://doi.org/10.1016/j.compedu.2009.12.012
Your Alberta. (2018, April 10). *Making sense of universal design for learning* [Video]. YouTube. https://

youtu.be/PQSAQdxnQBY

Van Dam, N. (2001). Where is the future of learning? Blended learning is the ultimate answer. *E-learning*, *160*.