



Blended Learning as Methodology of Mathematics Instruction at the University of Rwanda in the Era of Covid-19 Pandemic

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Abstract: *This paper reports the findings of the perceptions and barriers of blended learning in the instruction of mathematics from the standpoint of lecturers and students at the University of Rwanda selected colleges during the Covid-19 shutdown. The paper is a comparative study done with twelve lecturers and seventeen undergraduate students selected from the College of Education (CE), and College of Science and Technology (CST) at level three (the third year of 2021), who were chosen using a simple random sampling method. Data was collected through a survey questionnaire that asked lecturers and students about their perceptions and problems of using a blended approach in mathematics instruction. To ensure the scientific validity of the study, SPSS edition 23 was used to examine the tool for coherence, and it produced a reliability coefficient of 0.717. The results were also analyzed using SPSS-23. Lack of access and an inconsistent internet connection was cited by students as barriers to using blended learning in mathematics instruction. The findings show that lecturers' and students' perceptions on the usage of blended learning are strikingly comparable. This research should be viewed as a realistic approach to the universities' willingness to implement blended learning methods in terms of curricula and instructional methodologies for mathematics instruction.*

Keywords: *Barriers, Blended Learning, ICT, Instruction, Mathematics, Methodology, Perceptions*

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1. Introduction

Owing to the COVID-19 outbreak, many academic instructors around the world have switched from traditional face-to-face to blended instruction (BL). This change in approach has given a chance to rethink ways technologies may be utilized to increase learner participation in mathematics courses. Blended learning is a teaching methodology that has risen in popularity currently around the world in academic settings (Oweis 2018). It combines traditional classroom approaches with multimedia technology available on the

internet, and it requires both instructors and learners to be physically present (Allison and Rebecca 2019). For a range of factors, the University of Rwanda (UR) recognizes BL as a novel approach to teaching and learning. However, BL is a challenging process to adopt because it requires a lot of time to prepare for teaching and learning (Antwi-Boampong 2021).

Rwanda's main public university (UR), comprises six independent colleges (University of Rwanda 2020a). The University of Rwanda officially announced that all students should return to their respective colleges on November 30th, 2020 for BL due to the lowering infection

rates induced by the Covid-19 outbreak. However, third, fourth, and fifth-year students had already reported to their respective colleges for face-to-face class sessions in October 2020 (Covid-19 Tracker 2020). The University of Rwanda administration instructed all lecturers and students in the six colleges to follow a blended learning approach that would enable them to learn digitally while attending face-to-face classes.

Due to the shift from traditional face-to-face to BL as a new mandatory mode of delivery by UR (University of Rwanda 2020b), numerous factors come into play, ranging from policies and organizational cultures, like ICT policy and leadership style, to individual characteristics of lecturers, such as ICT knowledge, classroom practices, willingness to adapt, and self-motivation. While blended learning has been in use at the University of Rwanda (Pavalam, Jawahar, and Akorli 2010), several factors and barriers have arisen in the process of implementing it as a mandatory mode of learning. The University of Rwanda adopted the BL approach due to the Covid-19 outbreak, which resulted in the country's education sector being completely shut down.

Research Questions

To achieve the objective, the study attempted to address the following questions:

- i. What are students' and lecturers' perceptions on BL in the CE and CST mathematics classrooms?
- ii. What are the barriers to using blended learning in mathematics instruction at the University of Rwanda's CE and CST?

2. Literature Review

The mathematics laboratory is thought to be the perfect setting for implementing a blended learning strategy. Blended learning is made possible by technologically improved resources like the internet, e-forum/e-mail networks, video on demand, animated video sharing, and PowerPoint presentations (Albano and Maresca 2010). These computer-enabled learning resources serve to improve mathematics instruction.

For example, Wang & Li, (2011), found that the ability of students to work on their projects whenever they want is provided by these resources. The authors argue that a more comprehensive definition of BL in the instruction of mathematics includes the use of both hardware and software, as well as teaching aids and the internet. These technology techniques are being used to further advance BL pedagogy in mathematics instruction. As a result, it is important to match Mathematics pedagogy and appropriate instructional frameworks with current technological advancements.

According to Mali and Lim (2021), when social relations are interwoven into lessons via face-to-face teaching, blended learning can become an effective method of instruction. However, according to (Moja 2021) there is a worry among learners that there is anxiety linked with instructional from face-to-face to BL. According to Saxena, Baber, and Kumar (2021), as a consequence of the Covid-19 pandemic, learners are more compelled to enroll in online learning environments to avoid potentially harmful physical encounters. The Covid-19 effect appears to be able to increase students' desire and interest in learning through a blended learning approach.

A considerable amount of literature has been published on the benefits of using a blended approach of instruction in mathematics (Ali, Buruga, and Habibu 2019; Antwi-Boampong, Freeman, and Muat 2019; Awodeyi, Akpan, and Udo 2014). These studies suggested that blended learning improves students' learning outcomes as compared to other methods. Additionally, using blended learning in mathematics teaching helps in enhancing teaching strategies while also exploring the advantages of internet technology in teaching mathematics. This can result in a decline in the number of students dropping out of college. The authors stress further that BL enhances learning opportunities for students who are unable or unwilling to attend a face-to-face course, lowers the cost of assessing and disseminating instructional content, and allows lecturers to manage more learners while maintaining the same level of learning outcome quality as face-to-face instruction.

Antwi-Boampong and Bokolo (2021), presented a comprehensive assessment of Ghanaian universities' traditional face-to-face form of instruction. According to the author, a gradual trend toward a blend of face-to-face and online instruction is taking shape. In certain cases, BL has assumed the place of traditional face-to-face instruction (Tawiah et al. 2019). Despite the prior achievement, a study by Bervell and Umar (2020), reveals that some mathematics lecturers have little or no experience in the utilization of information, and information technologies (ICTs) necessary to teach using a BL approach. Universities lack sufficient infrastructure, for example, Computer laboratories, projectors, lecture workstations, video conferencing facilities, and dependable internet access that facilitates BL (Asabere et al. 2017). However, if these infrastructures are in existence, universities may be more likely to embrace and adopt BL methods.

According to Freeman, (2017), effective mathematics teaching, requires continuous teacher professional development programs in the integration of technology in instruction. The authors found that mathematics teachers find the greatest challenge in utilizing modern technologies, rather than in other academic disciplines. They argue that technology advances throughout time, with new aspects emerging regularly. For instance, mobile

and online learning are not what they were a few years ago. The efficiency and possibilities of ICTs in mathematics instruction have risen, thanks to virtual reality, chatbots, and immersive apps. Teachers therefore must participate in ongoing professional development programs about the use of new digital tools and resources to meet the changing expectations.

Antwi-Boampong (2021) found similar results to those obtained by (Johnson 2002) by claiming that the most difficult element of incorporating blended learning in higher education is time commitment. He reports that designing and creating a blended learning lesson for large classes takes double the time it would take to create a similar lesson in a conventional format. It necessitates acquiring new teaching strategies, revamping a module to incorporate new teaching and learning methods, coordinating both digital and face-to-face course content. The author suggests that teachers need to review their educational objectives, develop blended learning activities to match those objectives, and efficiently consolidate blended learning activities with face-to-face teaching. Teachers should be ready to help students understand their role in a blended learning environment.

Blended learning, according to Medina, (2018), is cost-effective. Since the materials can be stored online and used at any time, the institutions' expenses are reduced. This allows a large number of students to attend lessons as the number of classrooms decreases. Students who stay long distances away from the university can attend a class, and do whatever they want since they can connect to the

internet without having to travel to campus. The author further argues that by adopting a blended learning approach, learners can unlock avenues to self-directed learning which will expose them to a variety of alternatives for accessing and producing content in synchronous and asynchronous formats, with or without the assistance of an instructor. Lecturers should therefore encourage learners to adopt e-Learning approaches, time, and skills more effectively and ensure that the module requirements are completed in the planned time frame.

3. Methodology

3.1 Research design

The research was a quantitative survey design. Descriptive statistics were used to answer the research questions.

3.2 Sample

The sample populations were mathematics lecturers and their undergraduate students of level three (third-year class of 2021) in the University of Rwanda who were chosen using a simple random sampling method from the CE, and CST. The study was conducted with twelve (12) lecturers, and seventeen (17) students of mathematics.

Participant's demography

The participants' demography, in this study, focused on college participation, and gender

Table1: Demographic characteristics of participants

Characteristic	Lecturers		Students	
	CE(%)	CST(%)	CE(%)	CST(%)
Participants	75	25	59	41
Gender of participants				
Male	73	67	70	86
Female	27	33	30	14

As shown in Table 1 above, 75% and 25% of the lecturer respondents were from the CE and CST respectively, while the remaining 27% and 33% were females representing CE and CST respectively, which reveals that there is a large variation in the composition of lecturers by gender. This confirms gender disparity in the mathematics departments of the two colleges. Table 1 above, reveals 59% and 41% of the students were from CE and CST respectively. The male student participants from CST were 86% as compared to 70% from CE. The females were represented by 14% and 30% from CST and CE respectively.

3.3 Instruments

The data was collected from the respondents using research questionnaires administered online about lecturer's and student's perspectives of the complexities of BL in Mathematics instruction. The lecturers' questionnaire had eighteen items, while the students' questionnaire had thirteen, all of which were linked to the perceived challenges of blended e-Learning in their

constituent colleges. To ensure the scientific validity of the study, SPSS edition 23 was used to examine the tool for coherence. It provided a detailed analysis on how to enhance each of the items. A Reliability Coefficient of 0.717 was produced and deemed adequate (Matheson 2019).

3.4 Data analysis

The questionnaire was divided into three sections; the demographic information of participants, for example, the participant's gender, college, and blended learning experience. The second section covered the perceptions of both lecturers and students in using blended learning in mathematics instruction; the third section was, challenges that can affect students' and lecturers' intention to use blended learning. Data were analyzed using descriptive statistics generated by Statistical Package for Social Sciences (SPSS) version 23.

3.5 Ethical considerations

At every stage of the study, research ethics were upheld. Permission was sought and granted from the University of Rwanda's Directorate of Research and Innovation Unit. The study's goal was presented to students and lecturers in the introductory part of the questionnaires, and they

were given the option of participating or not. In addition, no respondent's name has been revealed in this piece of work save for the name of the college where the research was done.

4. Results and Discussion

4.1 Lecturer perceptions on blended learning by colleges

When evaluating the lecturers' opinions, the aforementioned factors were taken into consideration: quality of training, preparation, availability of appropriate technology equipment and internet, usage of the e-Learning platform, commitment to implement modern technologies and blended learning strategy, and commitment to promoting the development of ICT infrastructure

Table 2: Lecturers Perceptions on BL by Colleges

Perceptions	CE		CST	
	Yes (%)	No (%)	Yes (%)	No (%)
Accessibility to equipment sets	100	0	100	0
I can use technology with comfort in teaching mathematics	87	13	75	25
Have access to the internet	33	67	56	44
Used internet in mathematics teaching before covid-19	67	33	100	0
Utilization of BL in teaching mathematics	67	33	100	0
Professional development training on BL	100	0	89	11
Can use of the e-Learning platform with ease	100	0	67	33

Lecturers were asked to evaluate their perceptions of BL. According to the data in Table 2, every lecturer in CE and CST has access to ICT equipment (100%) such as a computer or tablet. This demonstrates lecturers' willingness to support technology integration. It's worth noting that, as seen from Table 2 on average, lecturers from the two colleges are comfortable with blended learning. The CE reported 87% while CST reported 75% comfort level. The comfort level incorporates the use of technology equipment that is deemed appropriate.

Results from Table 2 show that 56% of the lecturers from CST reported having access to the internet as compared to 33% from CE. 100% of the participants from CST reported that they have been integrating ICT in mathematics instruction before the outbreak of the Covid-19 pandemic as compared to 67% from CE. One hundred percent (100%) of the lecturer respondents from CST reported that they use blended learning in teaching mathematics as compared to 67% from CE. This result can be interpreted that, most lecturers have adequate ICT skills and are anticipated to include blended learning into their

teaching. However, the low usage of blended learning by lecturers at UR-CE needs further research to ascertain the factors leading to this because the University of Rwanda's e-Learning platform is hosted by the College of Education.

The study investigated the impact of lecturers' level of preparation on blended learning in the two colleges. The respondents were asked to reveal if they had received training in the new and mandatory mode of teaching and learning (blended learning) before its integration into mathematics instruction. The responses in Table 2 show that 89% of the lecturers from CST were trained in the integration of blended learning in teaching mathematics as compared to 100% who are from CE. The results are consistent with the research as reported in the literature by Freeman, Becker, Cummins, Davis, and Hall (2017) who suggest that teachers should regularly participate in ICT training programs to help them improve their competence in using modern educational technologies in the classroom. However, the results do not reveal any significant variations that may explain differences in lecturers' e-Learning incorporation in teaching

mathematics depending on their colleges. According to the findings, most lecturers from the two colleges believe that the e-Learning platform is user-friendly, although 33% of CST lecturers believe it is not. The explanation for this is that their experience of ICT use is probably minimal.

4.2 Policies and procedures

There are policies and processes in place in the two colleges to encourage blended learning as seen from Table 3, although it is left to the lecturers to make blended learning a successful practice in their mathematics classrooms.

Table 3. Existing Policies and procedures to support BL and purpose of internet usage

Policies/procedures	CE		CST	
	Yes (%)	No (%)	Yes (%)	No (%)
College motivates blended learning	100	0	89	11
The college has proper infrastructure for blended learning	100	0	66	34
Purpose of internet Usage				
Research	33	67	56	44
Teaching	67	33	100	0
Communication	67	33	100	0

The findings in Table 3 show that the two colleges have the required infrastructure for blended learning. However, 11% and 34% of the participant from CST reported a lack of motivation and proper infrastructure respectively, by the college to use BL.

When asked what their primary reason for using the internet is, all the lecturers from CST and CE said they are using it for teaching and research. The communication intent met 67% utilization from CST compared to 100% from CE. As reported by Antwi-Boampong and Bokolo (2021), in the literature review, a large number of CE and CST lecturers are convinced of the benefits of blended learning, which include the expectation that it can help

develop mathematics calculation abilities, speed up teaching and learning processes, and be able to track and solve individual challenges. Other reasons put forth are, they use blended learning in assessments and to enter marks in the University central system, others say there is no motivation they use e-Learning because of avoiding the spread Covid-19 pandemic. Some lecturers say it is modernization and it was recommended by University of Rwanda management.

4.3 Students' perspectives on blended learning

Table 4. Student's perceptions of BL

Perceptions	CE		CST	
	Yes (%)	No (%)	Yes (%)	No (%)
Accessibility to equipment sets	100	0	86	14
Have access to the internet	90	10	86	14
I can use computer technology to form forums for discussion	67	33	33	0
I can use technology for solving basic mathematics problems	54	36	45	55
I can use technology for e-mail communication	100	0	100	0
I can use search engines to open and save files on a computer	68	32	57	43
My course uses blended learning in instruction	90	10	86	14
Can use of the e-Learning platform with ease	90	10	43	57
Willingness to embrace blended learning	50	50	57	43

In both colleges, as shown in Table 4 above, the number of students without access to ICT infrastructure is smaller than the percentage of students who have access to ICT infrastructure. The college of Education confirmed complete access to technology infrastructure, which supports the lecturers' viewpoint. 90% of the students from CE reported having access to the internet as compared to 86% from CST. This confirms the existence of proper infrastructure to support e-Learning. 33% of CST respondents said they can use platforms for rational discussion, compared to 67% of CE respondents, and 45% of CST respondents said they can use technology to address simple mathematics problems, compared to 54% of CE respondents. All CE, and CST students, said they use the internet for email correspondence

In comparison to 68% of CE student participants, 57% of CST student participants said they can use search engines to browse the internet. This confirms that e-Learning is already an acceptable mode of instruction in teaching mathematics in the two colleges, CST and CE. A majority of the student participants from CE and CST as seen from Table 4, reported that their program is primarily delivered in a blended environment. This is due to internet and information technology accessibility. Only 10% and 14% from CE and CST respectively reported otherwise. 90% of the students from CE consider the platform friendly compared to 43% from CST. 10% and 57% of the students from CE and CST respectively indicated that it is just not.

A significant number of students from both colleges as seen from the findings in Table 4 are enthusiastic about the idea of blended learning. According to their arguments, it gives access to a range of knowledge sources and methods of solving mathematical problems. They say that, as compared to conventional teaching, blended learning encourages student-centered learning based on knowledge access, it increases interactivity between lecturers and students, improves mathematics efficiency, and thus improves educational quality. These students believe that blended learning lowers the cost of learning, which is consistent with Medina, (2018) results in the literature.

4.4 Analyzing the different challenges faced in adopting blended learning by lecturers and students

Even though lecturers and learners are willing to integrate BL to teach and learn mathematics, several challenges are affecting its implementation. Lecturers agree that implementing student-centered learning takes a long time, which is consistent with the results in the literature by Antwi-Boampong (2021) that limited access to ICT facilities and resources, lecturers' attitude towards the use of ICT, lack of lecturers' ICT competence, and confidence, low bandwidth and unstable internet,

insufficient training in integrating BL into mathematics instruction, inadequate ICT experience and competencies among lecturers, and a lack of technical support for blended learning, lack of appropriate device for Lecturers for demonstration and proofs of propositions, and reluctance to adapt to modern technologies are some of the issues that have emerged as a result of inadequate preparation. From the viewpoint of the students, they reported unstable internet connections and less access time. The e-Learning department lacks the requisite facilities, and human resources to sustain the program, including e-Learning laboratories, equipment sets, and human resources. Some students don't have the facility to access internet connectivity. Others don't have devices (Laptops or smartphones) to follow lectures online and when it comes to uploading quizzes or assignments, they have to rent devices. Some of the students even don't have electricity in their living area and they are obliged to move from their home and rent a room near the campus.

4.5 Discussion of results

This research work is a buildup of my ongoing Ph.D. research in Mathematics Education. The study explored blended learning as the pedagogy of mathematics instruction at the University of Rwanda's CE and CST during the lockdown of Rwanda's Education institutions due to Covid-19 pandemic. A transition to a BL pedagogy was found to be beneficial for the educational continuity of all students of mathematics and other courses. The finding is consistent with those of Saxena, Baber, and Kumar (2021), who point out that, learners are frequently driven to enroll in online courses to avoid potentially harmful physical interactions due Covid pandemic.

Lecturers agree that implementing student-centered learning requires continuous professional development programs to gain experience and expertise to use BL in instruction. This is in line with the results in the literature by Antwi-Boampong (2021), that insufficient training in integrating BL into mathematics instruction is a challenge to instructors. It is further supported by Bervell and Umar (2020), whose study reveals that some mathematics lecturers have little or no experience with ICTs and hence lack the necessary foundation to teach BL. Students reported a lack of proper ICT infrastructure and digital gadgets to use for BL. The above finding is supported by Medina (2018) in literature who showed that the availability of ICT infrastructure allows students who stay long distances away from the university to attend classes in a blended style. Generally, the analysis shows that lecturers' and students' attitudes on the usage of BL from the CE and CST are strikingly comparable. This study should be interpreted as a practical response to the universities' readiness to adopt BL practices in terms of curricula and instructional methods towards mathematics teaching.

4.6 Limitations of the study

The low response rate of lecturers from the College of Education limited the study's findings. Because the University of Rwanda's e-Learning platform is hosted by the College of Education, this would have provided us with a valid conclusive insight into the inclusion of blended learning in other colleges. The study findings were also limited by using a questionnaire as the sole research tool. It is sufficient to state that not all the essential information was acquired as certain responses required follow-up questions via interviews. Another limitation of the study was that it only included two UR colleges. While the circumstances of other UR colleges may not be different from those of CE and CST, this methodology constraint makes it hard to extend the research findings to other contexts, particularly those that provide mathematics as a module or course unit.

Given these constraints, future studies should enhance the participation of the research by increasing the number of colleges teaching mathematics. Future studies must also provide insights into how BL might encourage mathematics teaching during and after the Covid-19 lockdown of the education sector.

5. Conclusion and Recommendations

Based on the results of the study, we can conclude that e-Learning is an excellent platform for student-centered learning. It aids in tasks like the distribution of course content, study materials, course work, and the sharing of information through platforms, and discussion forums among others. Online submission of coursework saves

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time spent composing, correcting, and compiling assignments and, as a result, improves life.

5.1 Conclusion

Since e-learning is in its infancy, certain technical issues persist. The university is well aware of these shortcomings, and steps are being taken to improve student and staff preparation. There should be regulations in place for BL as well. The usage and advantages of BL should be made more widely known among staff and students. The access time can be improved if the students can manage to buy their laptops.

5.2 Recommendations

In an attempt to provide lecturers and students with a good integrated teaching and learning experience, the University of Rwanda should promote course restructuring, which may include assessing which course goals can easily be accomplished through online learning experiences, which sections of the course can best be completed in the classroom, and how to combine these two teaching practices in the mathematics classroom. For educators, school education leaders, administrators, policymakers, and technologists, the findings of this study will serve as a reference and technological planning guide.

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