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Blended Learning Approach to Mathematics Education Modules: An Analysis of Pre-Service Teachers' Perceptions

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Abstract. Changes in the higher education institutions curriculum for South African schools have ushered in a blended learning approach to support the education process and to meet the needs of students. This change revolves around a blend of the use of online learning and traditional approaches to improve on pre-service mathematics teachers' knowledge and academic performance. This paper explored pre-service mathematics teachers' perceptions of the need for using a blended learning approach to mathematics education modules in other to ascertain if they will want to use b-learning in their future teaching career. This research involved a mixed-method using convenient purposive sampling to sample 42 pre-service mathematics teachers enrolled for a mathematics methodology module in a selected South African higher education institution. Responses to the questionnaire were used to conduct a descriptive analysis of each question. Qualitative data analysis from a semi-structured interview was analyzed thematically. The main finding revealed that pre-service mathematics teachers were optimistic that blended learning improved their performance, and have therefore expressed their readiness to adopt it in their future teaching career. However, pre-service teachers still need training and support to engage meaningfully in this approach to learning.

Keywords: Blended learning; mathematics education modules; online learning; pre-service teachers' perception; traditional face-to-face method

1. Introduction

South African students' poor performance in mathematics being of great concern and is considered as a national crisis both in the educational and private sectors (Abramovitz, Berezina, Bereman & Shvartsman, 2012; Ndlovu & Mostert, 2018; SACMEQ, 2012; Ubah & Bansilal, 2018). Specifically, Ubah and Bansilal (2018) observed that prospective mathematics teachers' mathematical knowledge of teaching mathematics was quite poor among South African students. A solution

to this critical challenge revolves around the use of digital technology in the teaching and learning process (Stols, Ferreira, Perser, Olivier, Merwe, De Villiers & Venter, 2015). According to Subramanian, Thangarasu and Subramanian (2018), teaching and learning of mathematics using digital technology can make the teaching process more effective. The South African, Department of Basic Education (DBE), offers a new perspective and a good environment for the reorganization of the educational system (Fluck, 2018). This was to make progress at the same speed as inclusive educational principles as well as to aid in training proficient teachers. To accomplish this objective, the NHE through higher education institutions (HEIs) were required to apply digital technology in the training of pre-service teachers (Bennison & Goos, 2010) for productive teaching outcomes in South African schools (Green, Adendorff, & Bongekile, 2014). According to Borba, Askar, Engelbrecht, Gadanidis, Linares and Aguilar (2016), the use of digital technology in mathematics instruction is less significant in many developing countries including South Africa. The inclusion of Technical Mathematics as a subject in the Grade 12 South African curriculum is a good development for technology-based instruction (DBE, 2018). Certainly, the inclusion of technical mathematics into the curriculum does not guarantee the efficient use of digital technology for teaching and learning.

The research report of Stols, Ferreira, Pelser, Olivier, Van der Merwe, De Villiers and Venter (2015) has shown that many South African teachers failed to use the internet resources in their instructional processes even with the availability of internet facilities. Ngambi, Brown, Bozalek, Gachago and Wood (2016), as well as Kaptelinin and Nardi (2018), noted that teaching and learning of mathematics could be more enjoyable, interesting, and accessible to a diverse number of learners with the integration of digital technology. In addition, South Africa's HEIs have recorded digital progress in the area of pedagogical practices with respect to the use of digital technology for the past twenty years (Mahesh, 2017). From this discussion, it is obvious that research in South African HEIs struggled to make stride of reform in the world of digital technology. Hence, the need to encourage pre-service teacher education to take advantage of this technological revolution to make strides in the advancement of mathematics education in South Africa, to train teachers who are digitally literate enough, and to refresh the process of teaching and learning of mathematics in this digital age. Given these scenarios, well-structured research is required to explore pre-service mathematics teachers' perceptions of the need for using blended learning (digital technology) to mathematics education modules for improved academic performance in other to ascertain if they will want to use b-learning in their future teaching career.

Research Question

This research addressed the following questions.

(1) What were pre-service mathematics teachers' (PSMTs') perceptions of the need for using a b-learning approach in mathematics education modules?

(2) To what extent did PSMTs' perceptions determine their willingness to use b-learning in their future teaching career?

2. Literature Review

The availability of digital technology in and around the classroom and the development of pedagogy through technology integration led to the introduction of b-learning approaches in the educational proocess (Hong & Samimy, 2010; Schechter, Kazakoff, Bundschuh, Prescott & Macaruso, 2017). According to Sharma (2010), b-learning has been in practice for more than 20 years in developed countries, and contrarily to what people may think in the South African context. Several researchers (Christenson, Horn & Staker, 2013; Kintu, Zhu & Kagambe, 2017; Tayebinik & Puteh, 2012) defined b-learning as a mixture of pedagogical approaches that are rooted in online learning. B-learning offers complementary learning experiences in a digital environment, for effective and efficient use of traditional face-to-face learning methods in classroom instruction (Johnson & Haria, 2015; McGee & Reis, 2012; Means, Toyama, Murphy & Bakia, 2013; O'Byrne & Pytash, 2015).

With respect to varied definitions of b-learning raised by various researchers, this research defined b-learning as a combination of the online and face-to-face traditional methods of teaching and learning that accommodates different pre-service teachers' capabilities to learn at the ideal speed for oneself. Kekana and Corke (2015) observed that the 2015/2016 academic session in South African higher education institutions recorded a growth of b-learning in teaching, learning, and research. This development was as a result of the emergency of confusion and anxiety in HEIs during an undergraduate-led protest movement in South Africa (Allison, 2015).

In the United Kingdom, Tolley and MacKenzie (2015) observed that HEIs should offer suitable methods of teaching and learning support for teacher education. In South Africa, Bojuwoye, Moletsane, Stofile, Moola and Sylvester (2014) observed that supplementary support to face-to-face teaching methods addressed barriers to learning while Quinn and Aarao (2020) observed that a mixture of face-to-face learning activities with online learning improved academic performance. Siyepu (2018) observed that using Khan Academy to supplement traditional classroom interactions, prompted students to seek diverse solutions to problems during the classroom instructional process. Contrarily, Krishnan's (2016) study revealed that pre-service teachers' preference for the face-to-face traditional learning approach was because of the convenient and interactive way of learning mathematics with their peers. In addition, Ashby, Sadera and McNary (2011) revealed that college students that registered a b-learning mode algebra course did not perform better than the students that learned the same algebra course in a face-to-face mode.

However, the mere introduction of b-learning to the educational process is inadequate for proper technology integration rather it is the willingness to use it in future careers (Sinay & Nahornick 2016). In view of this, Cloete (2014) recommended that pre-service teachers' should learn their modules using a b-learning approach to equip them for an effective teaching career. The literature revealed various benefits of b-learning, the most prevalent advantage is flexibility (Medina, 2018) while students' ability to learn at their own pace, collaboration among peers, and improved academic performance were reported as advantages

of b-learning (Shand & Glassett Farrelly, 2017). However, literature also revealed some weaknesses of b-learning, the most prevalent weakness is the poor technical and organizational structure (Kaur, 2013; Mozelius & Rydell, 2017).

Fewer research studies focused on pre-service mathematics teachers' perception of the need for using a b-learning approach in their mathematics education modules. Thiyagu's (2011) survey research findings revealed that there was no significant difference in B.Ed. trainee's perception of the need for using a b-learning approach. In addition, Krishnan (2016) research revealed that students preferred the face-to-face learning approach than the b-learning approach. According to Varthis and Anderson (2018), students reported positive perceptions of using b-learning. Moreover, Umoh and Akpan's (2014) research findings revealed that there is a significant positive effect on students' perception of blended learning tools. Singh, (2015) observed that b-learning creates an opportunity for teachers to improve on their professional development as well as creating opportunities for them to see the need and value of b-learning in mathematics instruction.

Yilmaz and Malone's (2020) quantitative research on preservice teachers' perceptions in the b-learning science education methods course in Turkey, revealed a positive perception. Rifai and Sugiman (2018) research revealed that the participants had a positive influence on mobile b-learning using smartphones. Thomas, Doyle and Skamp (2019) research revealed that students had a high level of engagement with online learning through flipped classroom than over traditional face-to-face lectures. Graham and Spring (2017) revealed that 42.1% of all b-learning research concentrated on behavior and reasoning while 25.4% of research concentrated on student perceptions. An indication of limited empirical research on students' perceptions of the use of b-learning in higher education institutions modules.

In view of this, pre-service teachers need to use and also explore the benefits and weaknesses of the b-learning approach in their professional development to enable them to use b-learning in their future teaching career (O'Byrne & Pytash, 2015). Hence preservice teachers should employ a b-learning approach in their professional development to appreciate the merits and deficiencies of such an instructional design for proper use in their future teaching career.

3. Theoretical Framework

The theoretical framework is explicitly the researchers' entry point into research. Students understanding of how to obtain, develop, and perceive information in a b-learning environment was by examining theories of learning related to the b-learning approach. However, there was no particular theory that addressed students' perception of the b-learning approach (Picciano, 2017). However, the constructivist theory, which Jerome Bruner is one of the founding fathers formed the basis of this research (Nnachi, 2009). The constructivist theory is basically based on a scientific study about how students learn (Nnachi, 2009). Various teaching approaches were derived from constructivist theory, based on the fundamental assumption that a learner actively seeks novel facts, and is actively

engaged in the process of assimilation and utilization of knowledge (Stoblein, 2009). Varthis and Anderson (2018) encouraged social constructivism as a useful theoretical framework for a blended learning approach.

Social constructivism strongly influenced by Vygotsky's (1978) based on information and communication for the creation of knowledge is significant in this research. Vygotsky asserts that in social constructivism interactions, teachers help the learner to get to his or her own understanding of the content in an active manner. According to Zaretskii, (2009) the teacher is the facilitator of learning and is in charge of establishing a conducive learning environment to make sure that all students are actively participating in the learning process. However, extended engagement through computers offers students with more prospects for the enhancement of their critical thinking skills. This development will enable the students to improve on their higher-order cognitive skills and acquire more meaningful learning experiences than what is possible in a traditional face-to-face teaching and learning approach.

4. Research Methodology

Research Design

A mixed-method design was used to identify pre-service mathematics teachers' perceptions of the need for using a b-learning approach in their mathematics education modules. The mixed-methods design was chosen as most suitable for this research because of its great potentials to strengthen the rigor as well as enrich the analysis and research findings (Creswell and Plano Clark, 2011).

Data collection

Two instruments were used for data collection; first was a structured self-designed questionnaire and the second, a semi-structured interview. The questionnaire comprised of two sections; Section A consist of five yes/no responses to the questions, while Section B consisted 25 questions on a 5-point Likert scale with five possible responses ranging from 1 (strongly disagree) to 5 (strongly agree) used to measure pre-service mathematics teachers' perceptions of the need for using blended learning in mathematics education modules for improved academic performance in other to ascertain if they will want to use b-learning in their future teaching career. The authors did not follow a formalized list of questions to develop questions for the semi-structured interviews. The questions were asked in relation to pre-service teachers' views on the use of a b-learning approach in mathematics education modules. Two post-doc fellows in the mathematics education discipline and academic mentors ascertained the content validity of the instruments. They checked on the content relevance to the research and appropriateness of each question. Moreover, the psychometric property was tested using the Cronbach alpha technique which resulted in a coefficient of 0.88.

Selecting Participants

This exploratory research involved 42 pre-service mathematics teachers, purposively sampled from graduating pre-service mathematics teachers who enrolled for a mathematics education methodology module forming part of their

Bachelor in Education (B.Ed.) degree at a South African Higher Education Institution. This research used a convenient purposive sampling approach to sample participants with the purpose of selecting information-rich cases whose study would answer the question under research (Ratcliff, 2016). The internet and computers were available to the participants in the selected HEI lecture halls. The instructional approach for the module was a b-learning design. Based on participants' responses to the questionnaire administered, three pre-service teachers: Tom, Willy and Sammy were conveniently sampled for semi-structured interviews to highlight their views on the use of a b-learning approach in mathematics education modules. The interviews were audio-recorded and then transcribed in a verbatim manner by the first author. In order to ensure reliability, the transcripts were checked by the second and third authors against the original recordings. To ensure, credibility, member checking was adopted where participants were given the transcripts to check and correct errors that might have occurred during transcriptions (Korstjens & Moser, 2017). Likewise, dependability was ensured through a good recording of the interviews.

Data analysis

Analysis of data entailed the separation of the information gathered into smaller units to enable the researcher to answer the research questions (Sauro, 2015). Quantitative data were analyzed with descriptive statistics of frequency count using the software package, SPSS version 26 as illustrated in Tables 1 & 2, and Figures 1 & 2. The semi-structured interview data were organized and analyzed using thematic analysis, in order to get an overview of what it revealed. The data, however, did not contain sufficient general demographic information over time such as age, race, academic performance, and home language to conduct meaningful bivariate and multivariate analyses.

Ethical considerations

Permission to carry out research and an ethical clearance certificate was issued to the researchers by the HEI research office. The participants signed a consent form. The objective of the study was explained at the beginning of the research and the participants were aware that participation was voluntary. However, all the students that registered for the module were participants of the research. They were assured anonymity in the use of their questionnaire responses and the semi-structured interview data.

5. Research Results

Overall summary to responses of the questionnaire items

In reporting the results, Table 1 showed responses of participants to 'Section A' part of the questionnaire, while Table 2 showed the responses of participants' perceptions of the need for using a b-learning approach to mathematics education modules for improved academic performance in other to ascertain if they will want to use b-learning in their future teaching career.

Table 1: Responses to 'Section A 'part of the questionnaire

Item	Frequency of Yes Responses	Frequency of No Responses
Do you have a computer at home?	32	10
Do you have the internet at home?	22	20
Are you computer literate?	42	0
Did you acquire any skills in the use of technology in learning?	34	8
Do you prefer using blended learning in your mathematics modules?	38	4

The 42 participants that took part in this research had access to computers and the internet in the classroom. Thirty-two out of 42 participants indicated that they had computers at home, while 22 out of 42 participants had the internet at home (see Table 1). The table revealed a greater challenge to the use of digital technology in learning. However, all the students were computer literate while 34 participants acquired some technological skills. 38 participants responded that they preferred using a b-learning for their mathematics education modules, an indication of great excitement about the introduction of new technology in the learning mathematics. See Figure 1 for the graphical representation.

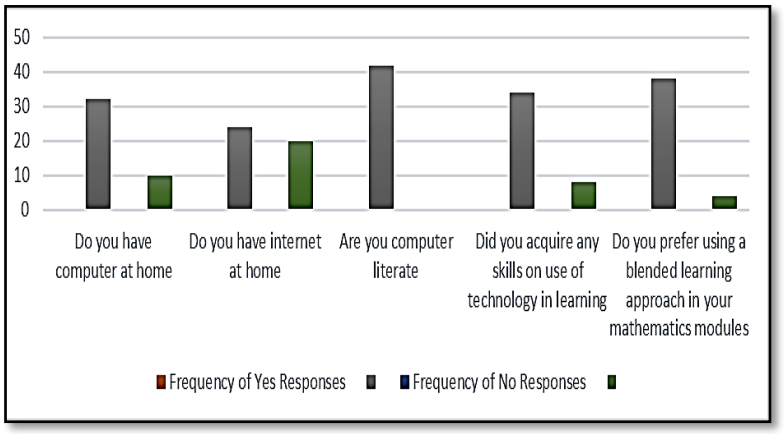

Figure 1: Graphical responses to 'Section A' part of the questionnaire

Figure 1, is the graphical representation of the result in Table 1. The graph showed that more than half of the participants preferred the b-learning approach. Table 2 showed the participants' responses to 'section B' part of the questionnaire. It is important to understand that '*N*' used in Table 2 stands for the number of questions in that section.

Table 1: Relevance of objectives of teaching subjects at the university

N	Questions	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
1	I asked more questions in a b-learning approach	0	3	4	7	28
2	B-learning provides opportunity for collaboration among peers	0	2	2	9	29
3	My ability to access information online was developed by the use of a b-learning approach	0	2	2	7	31
4	I have the opportunity to ponder on what I've learned through a b-learning approach	0	1	3	15	23
5	B-learning improved my academic performance	1	3	1	6	31
6	Generally, b-learning leads to a perfect grasp of the modules	0	1	3	7	31
7	Using b-learning in my studies could help me get a good degree at the end of my program	1	1	3	7	30
8	I will want to use b-learning in my future teaching career	0	1	2	3	36
9	Personal technology gadgets (e.g. android phone) aid me in b-learning	1	1	2	7	31
10	Facebook, Twitter aid me in b-learning environment	2	2	3	11	24
11	A social bookmarking site like digg.com aids in b- learning	3	3	4	6	26
12	Through b-learning, I enjoy the convenience of not coming to campus often for lectures.	0	0	6	1	35
13	B-learning approach results in improved time management skills	0	1	3	11	27
14	Am motivated to succeed in my academics through a b-learning approach	2	1	3	9	27
15	Resources for b-learning were being provided by my university	0	0	8	1	33
16	The technology component of b-learning approach has positive effects on the quality of interaction with other pre-service teachers when compared with face-to-face traditional method	1	1	4	7	29
17	The module content was too difficult to learn using b-learning	28	9	2	2	1

N	Questions	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
18	I am satisfied with using b-learning because it helps to improve on my zeal to study	0	0	4	3	35
19	Am flexible in accessing the course content online at all times	1	0	1	8	32
20	I desire b-learning that has the same mixture of face-to-face and online content	21	2	2	8	9
21	I adopt a b-learning approach mostly held in a face-to-face form with a small amount of online format	23	9	2	4	4
22	I prefer a blend that has wide use of the internet, but with limited face-to-face class discussion	4	3	1	2	32
23	I prefer entirely online with no face-to-face blend	31	1	0	10	0
24	I do not like the use of the web, I rather prefer entirely face-to-face lecturing room instruction	30	9	0	1	2
25	I do not have an interest in blended learning.	34	4	1	1	2

Table 2, showed that 34 and 4 of the participants strongly disagree and agree respectively with the question "I do not have interest in b-learning (question 25). Moreover, participants' response to question 22 (I prefer a blend that has wide use of the internet but with limited face-to-face class discussion) showed 34 participants' acceptance of a b-learning approach. This finding concurs with the response to question 5 in Section 'A'; where most participants agreed that they prefer b-learning in their mathematics education modules.

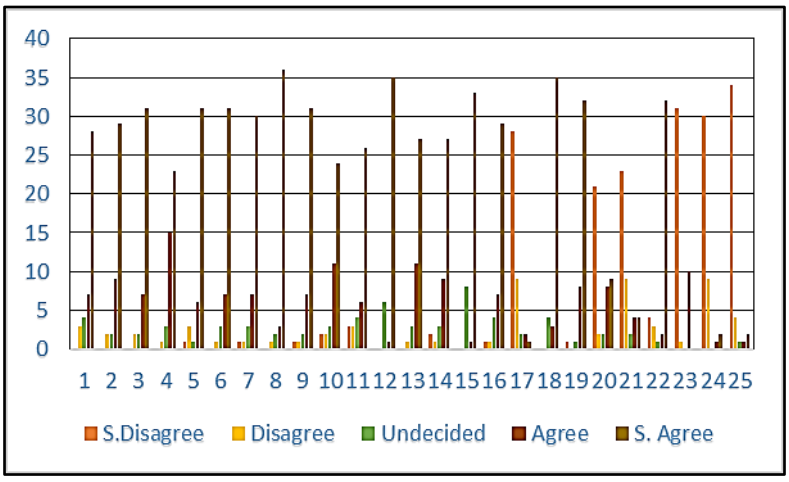

Figure 2: Graphical representation of participants' responses to 'Section B' part of the questionnaire

Figure 2 is the graphical representation of Table 2. The graph shows that all the positive questions revealed a tall bar chart for responses Agree and strongly agree. This is an indication that the b-learning approach improves on students' learning outcomes, opportunities to collaborate, flexibility in learning, and a better understanding of mathematics education modules; hence more than 36 participants' responded positively to question 8; that they will want to use b-learning in their future teaching career.

Results of participants' responses to semi-structured interview questions

Qualitative data analysis of the semi-structured interview questions was analyzed thematically. The objective of this research leads the researchers to permit the data to justify itself (Aspers & Corte, 2019). The extract from the semi-structured interview of three pre-service mathematics teachers; Tom, Willy and Sammy were shown below. Box 1 to Box 3 were dialogues between the first author (A) and Tom. Box 4 to Box 5 were dialogues between the first author (A) and Willy while Box 6 to Box 7 were dialogues between the first author (A) and Sammy.

Box 1: Dialogue between the first participant (Tom) and the author (A)

A: Hello Tom, do you think that the blended learning approach is good for learning your modules? Tom: Yes, because in a b-learning approach the students were engaged. We can learn through videos, do your assignment, and can even record the lesson and study at home with lecture notes made in the classroom. It gives us the opportunity to use different methods to learn a particular topic and is very interesting.

From Box 1, Tom was probed about the suitability of a b-learning approach in learning mathematics education modules. Tom's preference for the b-learning approach in learning his modules is based on the fact that such an approach considered different learning styles and is interesting. Tom fully obliged that b-learning be implemented in teaching and learning of mathematics. His reasons were revealed in the following extract:

Box 2: Dialogue between Tom and the author

A: Why did you prefer b-learning? Tom: Before I struggled to understand my mathematics modules but now I can comfortably study using my lecture notes and online tutorials and my marks have increased. A: Good. Do you get adequate support from the lecturers and peers? Tom: Not much as I expected from my lecturers but I collaborate with my peers often.

Box 2, showed that Tom preferred a b-learning approach because he could now get good grades in his modules. Tom's preference for a b-learning approach could be attributed to his collaboration among his peers.

Box 3: Dialogue between Tom and the author

A: As a prospective mathematics teacher, do you feel you will want to use a b-learning approach in your future teaching career?
Tom: Yes, and I will employ a b-learning approach so that mathematics will be fun and not fear.
A: What challenge(s) do you encounter when using a b-learning approach in your mathematics modules?
Tom: Finance, poor vision, and technical challenge.
A: What frustrations do you think you will encounter using a b-learning approach in your future teaching career?
Tom: None for now until I start my career but I will use all available resources to at least introduce b-learning since most learners use android phones.
A: Ok, what advice do you have for mathematics teachers teaching in schools?
Tom: My advice is that they should embrace the b-learning approach in mathematics instruction because it's an efficient teaching approach.

The extract in Box 3, showed that Tom's present satisfactory academic performance should be attributed to a b-learning approach. Tom recommends the use of b-learning for all mathematics teachers to create fun not fear in the cause of learning mathematics in schools. He identified finance and technical challenge as a weakness to his effective use of b-learning. Tom could not identify any challenge in his future teaching career but strongly believe he will use a b-learning approach as long as the learners have their android cell phones. Tom advised teachers to employ a b-learning approach because it is an efficient teaching and learning approach.

Another pre-service mathematics teacher 'Willy' indicated in the questionnaire that he enjoyed using b-learning in his mathematics education modules. This assertion was revealed in the interview extract below.

Box 4: Dialogue between second interviewee (Willy) and the first author (A)

A: Do you think that the b-learning approach is good for learning mathematics modules?
Willy: Yes, the b-learning approach is very good for learning mathematics education modules because each student learns at his/her own time and pace. It makes learning very interesting and easy. I can now do my assignments perfectly well and I get good grades.
A: Good. Do you get adequate support from the lecturers and peers in studying your modules through b-learning?
Willy: Yes, Lecturer X use to assist me when am having difficulty in uploading the assignments. I sometimes learn together with my friends at school.

The extract in Box 4, clearly showed that Willy is comfortable with learning mathematics modules using a b-learning approach. Willy is of the opinion that b-learning should be used in all mathematics instruction because it makes learning easy and interesting. He seemed to be comfortable with the support he gets from his lecturer and his peers with respect to any difficulty he might experience in the process of learning through a blended approach. Willy emphatically stated that

the b-learning approach is the reason why his grades improved. The author probed further on his intention to use b-learning in his teaching career.

Box 5: Dialogue between Willy and the researcher

A: Willy, as a prospective mathematics teacher that you are, do you feel you will want to use a b-learning approach in your future teaching career?
Willy: Sure. I will use b-learning after graduation when I start my teaching career.
A: What challenges did you encounter when using a b-learning approach in your modules?
Willy: The only challenge I encounter is how to organize my studies.
A: What difficulties do you envisage by using a b-learning approach in your future teaching career?
Willy: I need proper training on how to design my lessons through b-learning. However, I will use a b-learning approach to teaching mathematics to the learners.
A: Ok. What advice do you have for mathematics teachers?
Willy: I will advise them to use a b-learning approach in teaching and learning of mathematics because it will improve on learners' performance and interest.

From the extract in Box 5 above, Willy stated that his lessons as a practicing teacher will be interesting and easy for his learners to learn because he will use a b-learning approach. He advocated for training on b-learning design. Willy stated that his challenges will be on the lesson organization. Finally, he advised mathematics teachers to use a b-learning approach because it will improve learners' performance and interest in mathematics.
The third interviewee is 'Sammy'. His responses to the questionnaire showed a preference for the face-to-face traditional methods than the b-learning approach. The interview extract is as follows:

Box 6: Dialogue between Sammy and the author

A: Hello Sammy, from your experience, do you think that the b-learning approach is good for learning mathematics education modules?
Sammy: I do not think so, because I like seeing the teacher teach me one and one then online teaching
A: Have you ever tried online tutorials?
Sammy: Yes, I have watched a tutorial on YouTube once but I did not understand the lesson better. I prefer the traditional method of instruction.
A: What is your challenge with online tutorial lessons?
Sammy: (He laughed). The tutors are too fast and the English they are using is hard to understand. If it is in our local language, it could make sense to me.
A: Okay, but do you think b-learning should replace face-to-face traditional method?
Sammy: Not at all, because the traditional method is better than b-learning. I learn mathematics better using the traditional face-to-face method. Unlike online, face-to-face, we ask questions when the lesson is going on. We have direct access to the lecturer, who sometimes uses our local language to explain some facts, so the traditional method is good.

From the interview extract in Box 6, Sammy stated that b-learning is not good for learning because there is no physical contact with the lecturer at all times, unlike the strict face-to-face traditional method. Sammy said that an online tutorial, the tutors are fast and the language of instruction is hard and did not make sense to him. Moreover, Sammy stated that with the traditional approach, the lecturer could use local language for clarity. The author probed him further.

Box 7: Dialogue between Sammy and the researcher

A: As a prospective mathematics teacher, if you find yourself in a school that learners use a b-learning approach in learning and all resources were readily available, what do you do?
Sammy: Ok, if it is compulsory, then I will use it but use more of the traditional method in my teaching than online.
A: Well done Sammy. Finally, what advice do you have for mathematics teachers?
Sammy: mmm, my advice to them is that they should encourage their learners to study well. I advise the teachers to learn the best way to design their b-learning lessons so that the lesson will be interesting and improves on their learners' achievement.

Sammy's interview extract in Box 7, showed that he can employ b-learning in his future career if it is mandatory but insist he will use more of traditional-face-to-face than an online component in his teaching. Sammy advised practicing mathematics teachers, to use b-learning because it is no longer an option but a necessity for learners to improve their performance in mathematics.

6. Discussion

The results obtained from the research findings align with the purpose of the research. The major findings showed that pre-service mathematics teachers perceived that using the b-learning approach has positive impacts on their learning outcomes and hence, should be an effective tool for teaching mathematics in their future teaching career. The B-learning approach improves on students' learning outcomes, opportunities to collaborate, flexibility in learning, and a better understanding of mathematics education modules. The quantitative data also revealed that 38 out of 42 participants preferred using b-learning in mathematics modules. This assertion concurs with Bojuwoye, Moletsane, Stofile, Moola and Sylvester (2014), who found that the learning support services through b-learning improved academic performance. B-learning is a supplementary instructional approach that is interesting, improved performance, and most effective in teaching and learning Malm, Bryngfors and Morner (2011). Contrarily, Krishnan (2016) revealed that pre-service teachers preferred learning mathematics through traditional face-to-face learning methods, because of its interactive nature.

In addition, 34 out of the 42 participants acquired the technical skills required for the b-learning approach. An indication that many pre-service mathematics teachers possess the skills needed for a b-learning approach hence could be a reason for the preference of a b-learning approach. This finding is in line with

Rizki and Priatna's (2019) assertion that modern technology in teaching and learning requires the acquisition of technical skills. However, the challenges perceived by the participants is on access to computers and internets at home. This assertion concurs with studies of Hong and Samimy (2010) and Schechter, Kazakoff, Bundschuh, Prescott and Macaruso (2017), who revealed that the use of b-learning in the educational context emerged when we started accessing technology in and around the classroom.

The qualitative data revealed that the participants perceived the b-learning approach is good for effective mathematics instruction and should be used in their future teaching careers. This finding is consistent with Siyepu (2018), who used Khan Academy to supplement traditional classroom interactions, and showed that virtual learning stimulated pre-service teachers to make inquiries which lead to clarifications, efficiency in classroom discussions, and improved performance. Moreover, Sammy indicated that collaboration among his peers attributed to his improved academic performance through b-learning. This assertion concurs with Shand and Glassett Farrelly (2017) which stated that students' improved academic performance could be attributed to their collaboration among peers.

However, any variance in the participants' response to the use of the b-learning approach could be due to the online language of instruction as observed by Sammy during the interview. This observation calls for the need to introduce and use artificial intelligence in learning mathematics. Artificial intelligence will help to produce artificial tutors that could answer such questions required by Sammy during the online tutorials. This finding concurs with Yang and Zhang (2019) who observed that physically personified robots may bestow virtual interactions, promote psychomotor, affective, and cognitive learning outcomes as well as attainment of greater learning outcomes similar to those of human teaching.

7. Conclusion

This research explored the perceptions of 42 pre-service mathematics teachers of the need for using a b-learning approach to mathematics education modules for improved performance in other to ascertain if they will want to use b-learning in their future teaching career. The main finding of this research has shown that pre-service teachers are optimistic that b-learning is useful to them, and have therefore expressed their readiness to adopt it in their future teaching career. Above all, this research produced mathematics teachers that are ready to embrace digital technology and to make a difference in their future teaching careers and professional learning communities. As the research sample was limited to one HEI, caution should be applied to generalizations drawn from this research. Pre-service mathematics teachers should be adequately trained to take their place in the world by being inherent driven by digital technology. However, this research recommended that pre-service teachers need training and support to engage meaningfully in this b-learning approach to learning which research has shown. In this research, pre-service teachers demonstrated a deeper understanding of content and displayed higher-order thinking skills required for their future teaching career. In conclusion, one can say that using b-learning fits more

comfortably with today's teachers who are familiar with digital technology used in communication, finding solutions to question, and also used for play.

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Appendix A

A RESEARCH QUESTIONNAIRE ON PRESERVICE MATHEMATICS TEACHERS' PERCEPTIONS OF THE NEED FOR USING BLENDED LEARNING IN MATHEMATICS EDUCATION MODULES

Dear Participant,

This is an educational research questionnaire purposefully designed to identify preservice mathematics teachers' perceptions of the need for using a blended learning approach in mathematics education modules to make optimal use of technology through blended learning approaches for a future teaching career. Blended learning involved the practice of using both online and face-to-face traditional learning approaches. In a blended-learning course, traditional face-to-face teaching and learning will be supplemented by online learning experiences, and students would learn about the same topics online as they do in a traditional class setting Please respond honestly to the questionnaire items. Accept our highest assurance that the information you provide will be treated confidentially.

SECTION A: GENERAL INFORMATION

Pick the correct response and mark "X" in the chosen box.

1. Do you have a computer at home? **Yes** ☐ **No** ☐
2. Do you have the internet at home? **Yes** ☐ **No** ☐
3. Are you computer literate? **Yes** ☐ **No** ☐
4. Did you acquire any skills in the use use of technology in learning?

   Yes ☐ **No** ☐

5. Do you prefer using blended learning in your mathematics modules?

   Yes ☐ **No** ☐

SECTION B: PRE-SERVICE TEACHERS' PERCEPTIONS OF THE NEED FOR USING BLENDED LEARNING APPROACH IN LEARNING MATHEMATICS EDUCATION MODULES

Please mark 'X' in the appropriate place of your choice below. The keys are as follows:

SA [5] Strongly Agree
Ag [4] Agree
U [3] Undecided
D [2] Disagree
SD [1] Strongly Disagree

S/N	Questions	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
1	I asked more questions in a b-learning approach					
2	B-learning provides an opportunity for collaboration among peers					
3	My ability to access information online was developed by the use of a b-learning approach					
4	I have the opportunity to ponder on what I've learned through the b-learning approach					
5	B-learning improved my academic performance					
6	Generally, b-learning leads to a perfect grasp of the modules					
7	Using b-learning in my studies could help me get a good degree at the end of my program					
8	I will want to use b-learning in my future teaching career					
9	Personal technology gadgets (e.g. android phone, mp3 player) aid me in b-learning					

10	Facebook, Twitter aid me in b-learning environment					
11	A social bookmarking site like digg.com aids in b- learning					
12	Through b-learning, I enjoy the convenience of not coming to campus often for lectures.					
13	B-learning approach results in improved time management skills					
14	Am motivated to succeed in my academics through a b-learning approach					
15	Resources for b-learning were being provided by my university					
16	The technology component of b-learning approach has positive effects on the quality of interaction with other pre-service teachers when compared with face-to-face traditional method					
17	The module content was too difficult to learn using b-learning					
18	I am satisfied with using b-learning because it helps to improve on my zeal to study					
19	Am flexible in accessing the course content online at all times					
20	I desire b-learning that has the same mixture of face-to-					

	face and online content					
21	I adopt a b-learning approach mostly held in a face-to-face form with a small amount of online format					
22	I prefer a blend that has wide use of the internet, but with limited face-to-face class discussion					
23	I prefer entirely online with no face-to-face blend					
24	I do not like the use of the web, I rather prefer entirely face-to-face lecturing room instruction					
25	I do not have an interest in blended learning.					