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The impact of peer-peer learning and student-lecturer interaction on Biology pre-service teachers' achievements

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Abstract

Because of the outbreak of the COVID-19 pandemic, there was an emergency shift to online learning in tertiary institutions worldwide. Here, I aimed to determine the impact of guided peer-peer interaction on students' achievement. A Biology Achievement Test was used to collect data. I used a quasi-experimental design and analysed the data using the independent sample t-test and one-way ANOVA. A comparison of the experimental group mean marks before and after the lockdown did not reveal significant differences. However, the control group's mean mark was significantly higher before than during the lockdown period. Before the lockdown, the performance of the experimental group did not show any significant difference with that of the control group. There was a significant difference in performance between the two groups during the lockdown. Lecturer guided interaction had a significant impact while the digital divide did not have a significant impact on students' performance.

Keywords: online learning; tertiary institutions; peer-peer interaction; digital divide

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1. Introduction

The western world has been gradually introducing online learning and blended learning. In contrast, most African countries like Nigeria do not have smooth transition programmes, and learning is conducted merely through face-face interactions (Williams, 2020). The study in Spain observed only a small fraction of students who could not afford to buy technological devices (Ricoy, Feliz, & Couto, 2013). Hence, only a tiny proportion of the population in Spain had no expertise in technology use. In developing countries, poverty, lack of technology devices, and internet services variations due to geographical location result in digital divide (Saifuddin & Lykkegaard, 2016). Furthermore, Warren's (2007) study observed limited experience and efficiency in using computers in developing countries due to fewer computers in their homes. The problem of unavailability devices and technological expertise is more common in developing nations than in developed nations. This creates a digital divide between developing and developed countries. Digital divide refers to unequal opportunities to education between students who have access to technology and students who do not have access to technology. Rural communities have limited access to online learning opportunities due to expensive internet services and shortages of internet providers in remote areas in both developed and developing countries (Rye, 2008; Warren, 2007). Technology may impact increasing the existing inequalities in rural and urban communities due to variations in internet availability (Gorard, Selwyn & Williams, 2000). Madigan and Goodfellow (2005), cited in Tomei (2017), showed the need to prioritise device availability and internet accessibility before addressing technology literacy issues. When devices and internet are available, it is possible to engage in online courses to improve technological literacy and efficiency in accessing online learning opportunities (Tomei, 2017).

Many challenges accompany digital online teaching and learning in developing countries. Naidoo and Raju (2012) observed profound variations in technological competencies among South African students because of the difference in internet access and experience with the use of computers. Lane (2009) noted that the inadequate experience with computers is because of socio-economic challenges (thus social exclusion), which result in inaccessibility to technology devices due to its unaffordability. This, in turn, results in a lack of sufficient digital skills in using technology (thus, digital exclusion). Walan's (2020) study observed that assisting students during lessons to overcome skills deficiency in using technology results in loss of the teaching time.

Using technology has inherent advantages. According to Walan (2020), the use of technology allows students to present information in quizzes and group discussions and get immediate feedback. Walan (2020) also observed that different technology tools promote variations in teaching. Studies have showed that WhatsApp support collaborative learning where information is shared among students (in line with the social cognitive theory of learning), hence, increased access to educational resources regardless of distance (Rambe & Chipunza, 2013; Maphosa, Dube & Jita, 2020). Furthermore, WhatsApp provides a cheaper learning platform for students in poor communities. Maphosa et al. (2020) view WhatsApp as an application that can support the 21st century learning through the learner-centred approach.

Studies have shown that instructors cannot integrate technology in their teaching because of limitations in professional preparation programmes (Harris, Mishra, & Koehler, 2009; Vrasidas, 2015). Naidoo & Raju (2012) observed that South African students from secondary schools under-resourced with ICT devices enrol in higher learning institutions with limited ICT skills. They learn how to use ICT as they engage with their studies in the institutions of higher learning. Furthermore, studies revealed

that only 11% of South Africa households access the internet at home while 17% access it from work (STATSSA, 2017; Schwab, 2018). A small proportion (12%) of households access the internet through internet cafes and educational facilities (STATSSA, 2017; Schwab, 2018). It is against this background that this study intends to answer the following main research question: What was the impact of the shift from face-to-face learning, to emergency remote learning only on the performance of preservice teachers in a standard Biology course? The sub-research questions are: What element/s support student learning and performance? How do digital divide elements impact performance? This study's uniqueness is that it explores a new phenomenon (online learning only), which is new for both students and instructors, all over the world. Most instructors and students were more familiar with traditional face-to-face instructional methods than digital online learning.

Research Hypothesis:

1. H_0: There was no significant difference in the Life Science experimental group's performance before and during the lockdown period.
2. H_0: There was no significant difference in the Life Science control group's performance before and during the lockdown period.
3. H_0: The control and experimental groups' performance in Life Sciences were not significantly different before the lockdown period.
4. H_0: The control and experimental groups' performance in Life Sciences were not significantly different during the lockdown period.

2. Research Methodology

2.1. Research Design

In the study, a non-equivalent group quasi-experimental design was adopted. In the quasi-experimental design, the researcher does not randomly assign participants to groups because it is impossible to create groups for the experiment (Creswell, 2014). In this study, whole class WhatsApp groups that were created by the student class representatives were used before and during the lockdown period.

2.2. Participants

The population size was 42 for the experimental group and 133 for the control group students giving 175 from one rural university in South Africa. The experimental group comprised Post Graduate Certificate of Education students, while the control group consisted Bachelor of Education (BED) 4^{th}-year students. Initially, the researcher wanted to include all students. However, there was a need to have similar group sizes for the control and experimental groups since the group size affects each group member's participation. The group sizes resulted from the researcher's random allocation of the BED group of students into three similar groups. Thereafter, some students shifted to join their friends who were enrolled in different groups. The final BED class consisted of two groups of 40 and one group of 53 students. One group of 40 students was assigned, control group.

In contrast, the postgraduate class was assigned experimental group (35) after excluding seven students who did not meet the criteria because they did not write one or both assessment tasks. Figure 1. shows a diagrammatic presentation of the control and experimental groups. All students that were registered for a similar biological science course.

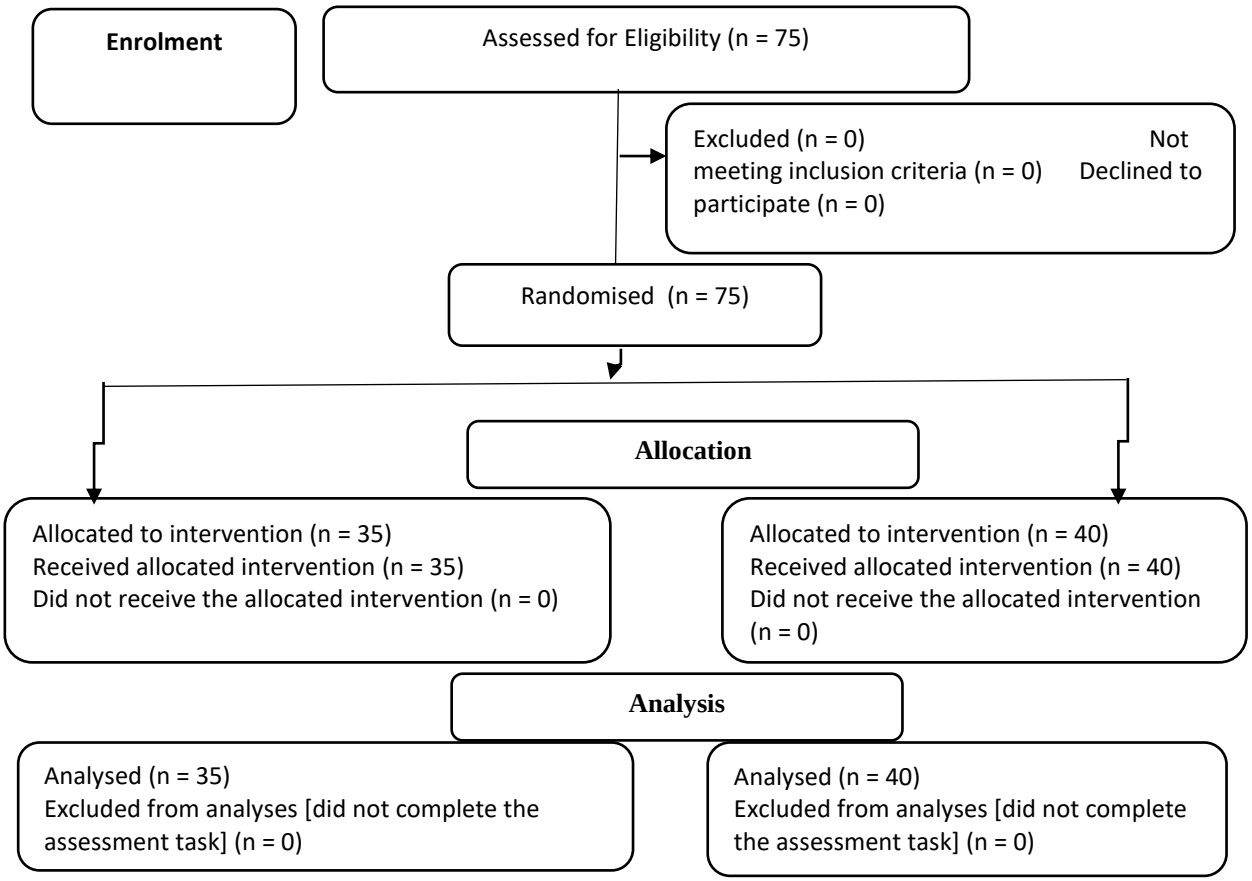

Figure 1. Flow diagram of the sampled participants.

2.3. Instruments for data collection

Two Biology Achievement Tests (pre-test and post-test) developed by the researcher were used to collect the data. The questions were of the same standard in terms of cognitive levels. Rubrics were used to assess the performance. Reliability was achieved through moderation of the test items by two subject experts. Furthermore, the rubric's reliability was checked by grading several performances with the rubric, and then regrading them after two weeks, without looking at the original ratings.

2.4. Development of learning package

Initially, four face-to-face lessons were presented to students over four weeks. These lessons included student-student interactions as well as a lecturer to student interaction during the normal face-to-face interactions. Powerpoint presentations with audio recordings were prepared and submitted through blackboard to both classes after each lesson. Students were then given two weeks to prepare for the Biology Assessment Test.

During online teaching, four one-hour lessons were presented using the blackboard collaborate for over four weeks. Powerpoint presentations with audio were prepared and submitted to both classes

through the blackboard. Similarly, students were also given two weeks to prepare for the post-intervention Biology Assessment Test. In the experimental group, there was peer-peer interaction guided by the lecturer through a WhatsApp group. There were four 30-minute sessions of guided peer-peer interactions for two weeks. Furthermore, students in the experimental group continued to pose questions and responses at their own free time, and the responses were kept in the learning platform throughout the entire two weeks. However, there were no interactions guided by the presenter in the control group, and coincidentally, students did not show any interest in academic discussions on the WhatsApp group. The second Biology Assessment Test was then administered to both groups under the same conditions. Figure 2 shows a schematic representation of the method.

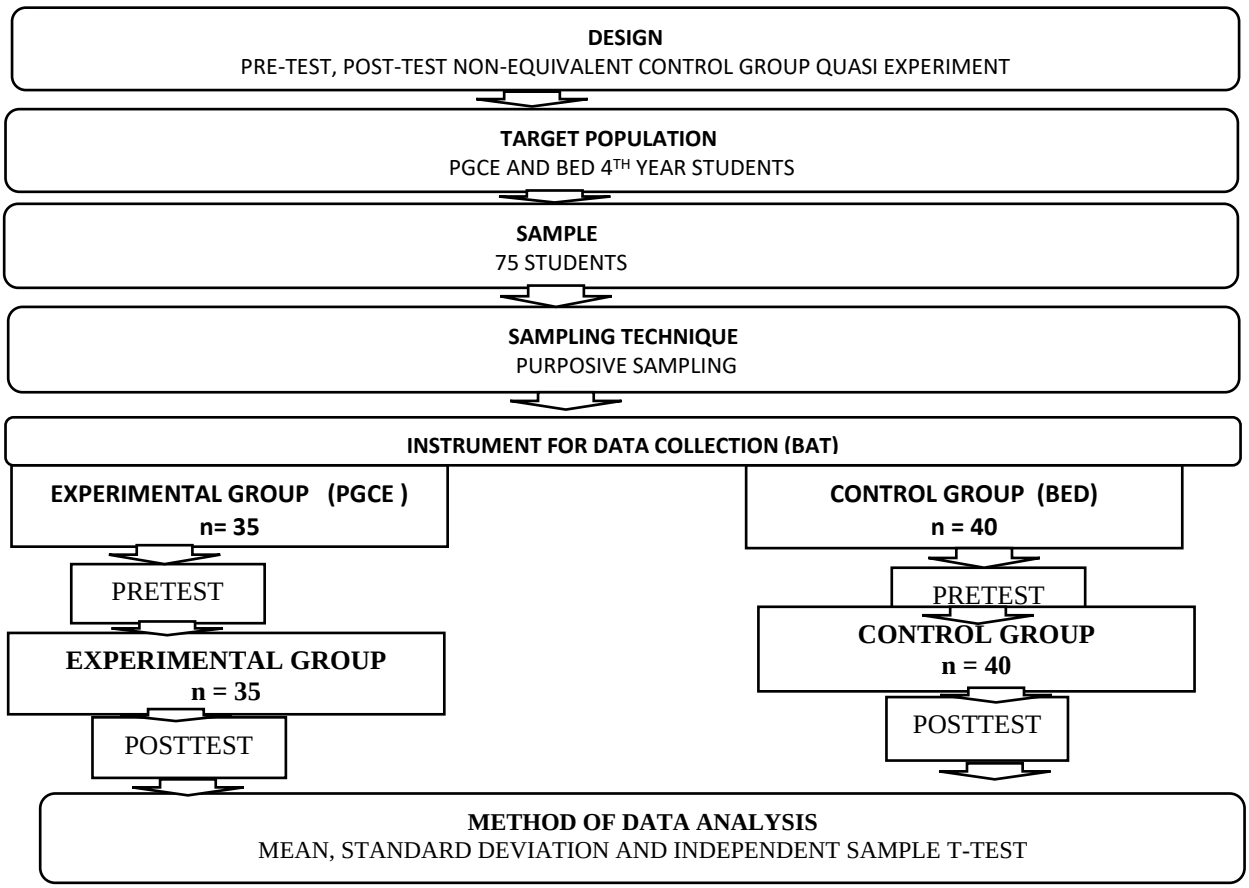

Figure 2. Schematic representation of the methods

Two Biology Achievement Tests (pre-test and post-test) developed by the researcher were used to collect the data. The questions were of the same standard in terms of cognitive levels. Rubrics were used to assess the performance. Reliability was achieved through moderation. Two experts from two Universities validated the assessment tasks. The experts examined the cognitive levels of test items based on Bloom's Taxonomy, clarity of questions. The experts modified the two tests' questions to ensure that the two tests were of a similar standard. Furthermore, the rubric's reliability was checked by grading several performances with the rubric, and then regrading them after two weeks, without looking at the original ratings. The rubric was modified until it yielded reliable results

The collected data was analysed using SPSS to find the mean and standard deviations. Independent sample t-tests were carried out to compare the pre-test and post-test results of the control and experimental groups.

Each student who signed a consent form to participate in the study was then asked to indicate the digital challenges that he/she encountered during online learning. Students' challenges were categorised for the control group: (1) no challenge, (2) network and data challenge, (3) network and device challenge, (4) network challenge only and (5) data challenge only. The categories that emerged for the experimental group are (1) no challenge, (2) network and data challenge and (3) network, device and data challenge. The mean marks and standard deviations for students in each category were calculated. One-way ANOVA was performed to determine any significant difference in performance among learners who had different challenges.

2.5. Ethical considerations

Ethical Clearance number: **UFS-HSD2019/0217/3007** was obtained from the University of the Free State. Informed consent was obtained from all participants who were assured that anonymity and confidentiality would be maintained. Participants voluntarily participated in the study and were free to withdraw at any part of the study.

3. Results

Table 1 Independent sample t-tests results for the experimental group and control group marks before and during the lockdown (SDEV = standard deviation).

		N	Mean Mark	SDEV	p-value
[a]**Experimental group**	**Before lockdown**	35	33.5	7.30	.39
	During lockdown	35	34.7	2.52	
		t(42.6) = 0.89, p = 0.39			
[b]**Control group**	**Before lockdown**	40	33.1	5.46	.00
	During lockdown	40	29.0	4.67	
		t(78) = 3.61, p = 0.00			
[c]**Before the lockdown**	**Experimental group**	35	33.5	7.30	.77
	Control group	40	33.1	5.47	
		t(62.4) = 0.29, p = 0.77			
[d]**During the lockdown**	**Experimental group (guided peer-peer interaction)**	35	34.7	2.62	.00
	Control group (no guided peer-peer interaction)	40	29.0	4.67	
		t(62.8) = 6.60, p = 0.00			

[bc]Levene's test for equality of variance was tenable (p = .08), equal variance was assumed
[ad] Levene's test for equality of variance was untenable (p = .00), equal variance was not assumed

The results in Table 1 compare the performance of experimental group and control group in one common Biology course. A comparison of experimental group's mean marks before the lockdown (M =

33.5, SD = 7.30) and during the lockdown (M = 34.7, SD = 2.52) did not reveal significant differences, t(42.6) =0.89, p = 0.39. On the contrary, the control group's mean mark (M =33.1, SD = 5.46) before the lockdown was significantly higher than their mean mark during the lockdown period (M = 29.0, SD = 4.67), t(78) = 3.61, p = 0.00.

Table 1 indicates a significant difference in performance between the experimental and control groups during the lockdown, **t** (62.8) = 6.60, **p** < .00. The experimental group's average performance score (**M** = 34.7, SD = 2.62) was significantly higher than that of the control group (**M** = 29.0, SD = 4.67). However, before the lockdown, the performance of the experimental group (M = 33.5, SD =7.30) did not show any significant difference with that of the control group (M = 33.1, SD = 5.46), t(62.4) = 0.29, p = 0.77.

Table 2. Average marks of the Experimental and Control groups and challenges experienced during the lockdown period

Challenges experienced by Experimental group	**N**	**Mean mark**	**SD**	**Challenges experienced by the control group.**	**N**	**Mean mark**	**SD**
No challenge	21(60%)	34.9	1.26	No challenge	21(52.5%)	28.5	4.61
Network and data challenge	10(28.6%)	34.6	1.65	Network and data challenge	6(15.0%)	29.0	3.79
Network, device and data challenge	4(11.4%)	33.8	3.17	Network and device challenge	9(22.5%)	29.2	5.78
				Network challenge only	1(2.5%)	28.0	
				Data challenge only	3(7.5%)	31.3	5.69

The control group's major challenges were unavailability of both network and suitable technology devices such as laptops (Table 2). More than 50 percent of the control group and experimental group students who participated in the study had no challenges in network, data, or technology devices.

A major challenge for the experimental group students was the unavailability of both network and data 10 (28.6%). The control group students' most significant challenge was the unavailability of data and technological devices such as laptops 9 (22.5%). The proportion of control group students with network challenges only 1 (2.5%) was lower than that of control group students with data challenge only 3 (7.5%). A small number of students had network, device and data challenges 4 (11.4%) while none in the control group had all three challenges.

Table 3. One-way ANOVA for Experimental group students experiencing different challenges highlighted in Table 2.

	Sum of Squares	**Df**	**Mean Squares**	**F**	**Sig.**
Between groups	4.16	2	2.08	.29	.75
Within groups	229.72	32	7.18		
Total	233.89	34			

Comparison of group means of Experimental group students who had no challenges, learners who had network and data challenges, and learners who had network, device and data challenges, using One-way ANOVA (Table 3), showed no significant differences at p < 0.05 level [F(2, 32) = 0.29, p = .75].

The average marks of experimental group students who had digital challenges were not significantly from the average marks of learners who did not have digital challenges.

Table 4: One-way ANOVA for control group students experiencing different challenges highlighted in Table 2.

	Sum of Squares	Df	Mean Squares	F	Sig.
Between groups	21.61	4	5.40	.23	.92
Within groups	829.37	35	23.70		
Total	850.98	39			

Comparison of group means of the control group students who had no challenges, learners with network and data challenges, network and device challenges, learners with network challenges only, and students with data challenge only, using One-way ANOVA (Table 4), indicated no significant differences at $p < 0.05$ level [$F(4, 35) = 0.23$, $p = .92$]. The average marks of the control group students who had digital challenges were not significantly different from those with no digital challenges.

4. Discussion

The test score results are consistent with the students' level of engagement in peer learning during online teaching and learning. The control group where one of the students uttered:

We did not enrol with UNISA we cannot engage in an online discussion.

The students did not want to engage in peer learning as they failed to understand that the outbreak of the COVID-19 pandemic imposed the situation. On the contrary, the experimental group students were guided in peer learning discussions in a Whatsapp group and displayed a positive attitude towards peer learning. Thus, there was a correlation between students who were very involved in lecturer guided peer-peer learning and higher performance rates. Through observation and from the student comments, one of the primary reasons for this is that peers motivated one another. Students who inspired one another and engaged in discussions through WhatsApp performed better than students who failed to engage in peer learning in a similar course. Peer learning enhanced understanding of critical concepts. The observations are consistent with the studies by Wang et al. (2015) and Ramesh et al. (2014), where students who interacted more on-task discourse about course-related content, had higher achievements. According to Maphosa, Dube and Jita (2020), WhatsApp can support 21st-century learning by promoting the collaborative and learner-centred approach. This increases the effectiveness of teaching and learning. Peers influenced the students' behaviour towards mobile learning consistent with the studies by Choukas-Bradley et al. (2015) and Helmer et al. (2016) who observed that their peers' attitudes influence students' behaviour According to Tomei (2017), mobile learning has multiple benefits. In addition to fostering peer-to-peer and student-to-teacher collaboration, mobile learning promotes higher engagement rates and self-paced learning. Furthermore, mobile learning provides access to research at a reduced cost. Previous studies (Hargis, 2005; Vesely, Bloom, & Sherlock, 2007) showed the importance of good relationships between students and teachers and the relationships between learners. However, Sergiovanni (1994) revealed the need for teachers to play a pivotal role in creating an environment that fosters a strong sense of community and bond students and instructors through shared goals and values. This assertion is consistent with studies that indicated the importance of the teacher's presence in improving students' online interaction (Cho & Tobias, 2016; Schallert et al., 2015). When the instructor

helps students understand that they matter to each other and the group and share common goals, problems, and purpose, learners will be able to keep their collective commitment to each other, therefore, guidance and counselling sessions may motivate students to recognise the importance of peer learning in the new learning model.

Regarding the digital divide, many students had challenges of unavailability of devices, network and data. Tomei (2017) claim that information technology can promote equity in education and indicated that there is a debate about whether information technology is introducing new inequities. Tomei (2017) indicated a digital inequality between students who own computers and are connected to the internet and students who do not own computers. This is consistent with the study's observations, where some students had no devices like laptops while others had. Furthermore, there was a digital divide between students who had access to the internet, and students do not have network access and the digital divide between students who had data challenges and those who do not. The digital divides in devices and network access, according to Tomei (2017), leaves some students at a disadvantage when they access online learning opportunities. The digital divide is consistent with Li's (2017) observation, where the differences in access to technological devices between Han students and minority students increased the inequity in educational opportunities. However, there was no significant difference in performance between students who had digital challenges and students who did not have challenges in this study. This was probably due to the support with printed material and PowerPoint with voice over that could be downloaded from the learning platform by students at any time.

5. Limitations of the study

The study made use of small class sizes from only one institution. The use of small class sizes and one institution make it challenging to generalise the results.

6. Conclusions and Recommendations

Lecturer guided peer-peer interaction had a significant impact on students' performance during the lockdown period. However, the digital divide did not have a substantial effect on students' performance. Lecturers should guide Peer-peer interaction to enhance understanding of concepts by students. However, more studies in different institutions with larger sample sizes need to be done to generalise results.

Conflict of interest

The author declares no conflict of interest.

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