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Assessing Pre-service Science Teachers' Perceptions about Online Teaching and Learning

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***Abstract*:** The unique nature of online teaching and learning has its own affordances and challenges. The purpose of this study was to assess science pre-service teachers' perceptions about efficiency of online teaching and learning in science after experiencing it first-hand during the hard lockdowns due to Covid-19 pandemic. Mixed methods approach, with closed and open-ended questionnaires, was adopted to establish: What perceptions the pre-service teachers have about online teaching and learning in respect of effective teaching and effective assessment? What correlations can be drawn from pre-service science teachers experience of online teaching and learning with their perceptions? And to what extent this mode of teaching prepared these pre-service teachers to use it in their teaching practice? Descriptive statistics and content analysis of data revealed that participants rated online teaching and learning low and had a challenging experience in terms of collaboration, access to material and making meanings out of some science concepts. Participants reported low confidence relating to perceived ease of use and perceived usefulness of online teaching and learning. The study concludes that the harsh experiences were the main contributing factors to the observed perceptions of participants as neither the lecturers nor these student-teachers were prepared for this mode of teaching and learning. Therefore, this study recommends that support mechanisms for students should be made available for online teaching and learning even under emergency situations. Pre-service teachers should also be given a chance to experience online teaching and learning under normal circumstances if they are to incorporate it in their teaching.

***Keywords**:* Pre-service Teachers, Perceptions, Online teaching, Online Learning, Science, Technology Acceptance Model.

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Introduction

Online teaching and learning (OTL) is a form of remote teaching and learning mode which is usually conducted through digital media including internet enabled platforms. It has attracted considerable research interests recently as it becomes more of an integral part of education systems (Al-Salman & Haider, 2021), more so since the advent of Covid-19 which disrupted the normal face-to-face teaching and learning (Önal & Özdemir, 2021; Pal & Patra, 2021). In its pure form, OTL has all interactions occurring virtually asynchronously or synchronously. Depending on the mode used, online learning offers opportunities such as flexible study schedules, accessibility by wider population not restricted by space (Zylfiu & Rasimi, 2020; Mukhtar et al., 2020; Khan et al., 2021). It is also said to be cost effective when compared to face-to-face teaching and learning as learners and teachers do not have to converge on the same venue. Furthermore, it enables teachers and students to acquire technological skills necessary to cope with digital space and experience many of its benefits (Farrah & Al-Bakry, 2020; Zylfiu & Rasimi, 2020) like sharing of resources across different platforms (Khan et al., 2021). It also allows collaboration for discussions (Farrah & Al-Bakry, 2020). It is a potential alternative avenue for continuous professional development in new environment (Alvarez & Corcuera, 2021), as well as development of 21st century skills (Corcuera & Alvarez, 2021).

However, OTL is not without limitations. There are concerns about its feasibility to address challenges of subjects involving practical and technical aspects such as engineering and medicine (Hassan, 2021) which have some elements similar natural sciences. Teachers and students can feel isolated from each other and not able to engage with critical emotions due to absence of cues enjoyed in physical classrooms (Mpungose & Khoza, 2021; Umit & Sezginsoy, 2021). Research studies have argued that OTL promotes technology divide because infrastructure and trainings are not accessible to everyone (Zylfiu & Rasimi, 2020; Mpungose & Khoza, 2021; Twesige et al., 2021; Corcuera & Alvarez, 2021; Samortin, et al., 2022). Authentic assessment is also one of the challenging aspects of online learning making it difficult for teachers to respond to learners' individual needs so that they can adjust instructional activities accordingly (Teo, 2010).

In an attempt to minimise limitations of pure OTL, hybrid forms such as blended learning (Yuhanna et al., 2020), which involves physical contact classes and remote online classes are used (Al-Salman & Haider, 2021). Blended models addresses the need for practical work and physiscal interaction between instructors and students which is necessary in science. In some instances, virtual laboratories can be used or learners be given assignments to carry out experiments at home (Dolenc et al., 2020). However, despite these efforts other studies still maintatin that online learning is more compatible with arts and humanities courses than sciences (Al-Salman & Haider, 2021).

Research studies have established that the kind of experiences during preparation of pre-service teachers has a bearing on their perceptions about teaching, confidence, efficacy, commitment and quality of practice when they get to the field (Darling-Hammond et al., 2002). In instances where technology is used as a tool for teaching and learning, theories such as Technology Acceptance Models (TAM) have been used to provide theoretical background on how people develop perceptions and how such perceptions have a bearing on their attitudes and adoption of technology (Davis, 1989; Al-Salman & Haider, 2021). TAM makes important propositions, of which this study aknowledges that people have varying beliefs when faced with some technology, namely; perceived ease of use (PEU) and perceived usefulness (PU) which dictates their attitude towards technology and intention to use it (Davis, 1989).

Problem

Pre-service science teachers and many other students in one local University, who had little to no experience in online learning had no choice but to take courses remotely during the pandemic of the Covid-19. There was an abrupt shift from normal face to face teaching and learning to online modes due to the Covid-19 pandemic and associated lockdowns. The disruptions of normal teaching and learning caused a lot of unanticipated changes to modes of teaching and learning to be adopted through online platforms in many institutions across the globe (Herkulaas & Oosthuizen, 2020; Feldman, 2020; Pal & Patra, 2021; Alvarez & Corcuera, 2021; Samortin et al., 2022; Umit & Sezginsoy, 2021). One local University, the only public university in teaching of science-related subjects, was no exception to this disruption. Lecturers and students had to quickly navigate their way through tensions of covid-19 pandemic through online modes and some limited face to face interactions later on after a long period of no interactions. Since the University's mode of teaching and learning used to be face to face, it was not known how the abrupt shift had influenced pre-service science teachers' perceptions towards online teaching, learning and assessment regarding its efficiency particularly in learning of science. Researchers were aware that almost all students in science and other faculties had similar experience, but the focus was on Pre-service science teachers. Pre-service science teachers' perceptions are important during this time when OTL proliferation is at high level as most institutions adopt it in their main stream activities (Cobanoglu & Cobanoglu, 2021). This is particularly so for pre-service teachers who are expected to employ the same technic post qualification. Research studies have reported that even academics who have some experience in OTL still show concerns and scepticism towards it (Kalaycıoğlu et al., 2022), which warrants a need for studies exploring how those with no prior experience perceive OTL.

Purpose of the Study

The purpose of the study was formulated around three objectives. First, the study aimed to capture the perceptions of pre-service science teachers (PSTs) about their experience of OTL. Secondly, it sought to assesses PSTs overall perceptions towards OTL and their readiness to employ it in science. Lastly the study sought to compare PSTs' perceptions about their experience and the overall perceptions regarding effectiveness of OTL in science. Among the students, the pre-service science teachers were chosen as their training in addition to content, has equipped them with skills to be able to assess the effectiveness of teaching and learning as opposed to the students in other programs of study (pure sciences) who may not be adequately conversant with education principles and aspects. The study has a potential to shed insights into the kind of perceptions evoked in pre-service teachers as a result of their experience of the OTL. Evaluations drawn from students' perspectives are crucial in informing feasibility and productivity of academic institutions practices (Nsibande, 2019; Cobanoglu & Cobanoglu, 2021). To achieve its purpose, this study responds to the following research questions:

a) What are the perceptions of the pre-service science teachers of the online teaching and learning in respect of effective teaching, learning and assessment of science?
b) What relationships can be drawn between pre-service science teachers experience of OTL and their perceptions?
c) To what extent has this mode of teaching prepared the pre-service teachers to use it in their teaching practice?

The PSTs were exposed to online learning only during the hard lockdown (July 2020 to May 2021), then later (July 2021 to May 2022) on to blended learning in which some theoretical aspects of the courses were offered online and experiments offered physically on campus. As a result, they had experienced a full spectrum of teaching and learning modes, from pure face-to-face to hard online as well as the blended learning approaches. However, the focus of this study was mainly on the time when no physical interactions were allowed i.e. during the hard

lockdowns, when only OTL was allowed. It follows on studies which outlined some challenges of online learning such as lack of technical know-how for students, socio-economic constraints, institutional-contextual systems limitations as key factors influencing OTL (e.g. Makafane & Chere-Masupha, 2021; Mpungose & Khoza, 2021; Twesige et al., 2021).

Theoretical Background and Literature Review

This study draws its theoretical background from TAM model which provides understanding of how people's perceptions regarding available technology tool or its applications influence adoption or actual use of such as technology (Chuttur, 2009). TAM model unveils some factors that play a major role in technology acceptance as well as inherent beliefs; perceived ease of use (PEU) and perceived usefulness (PU) regarding online mode. This study makes the assumptions with reference to TAM, that pre-service teachers are likely to have positive perceptions provided they find online learning and teaching as less strenuous while at the same time able to achieve desired results than face to face encounter. For instance, participants in one study held positive perceptions in terms of ease of use as well as ease of usefulness reportedly because of necessary support and experience they had with online learning (Teo, 2010). Furthermore, in another study the exposure to online learning was responsible for considerable levels of confidence and self-efficacy in learning online and also in teaching online (Ardiyansah, 2021).

However, if participants had an unpleasant experience, it is likely that they will develop negative perceptions about online teaching and learning (DeCoito & Estaiteyeh, 2022). For instance, if instructors are not well equipped with (lack) technological content and technical and pedagogical skills (technological pedagogical knowledge) necessary to facilitate and promote meaningful OTL, they are likely to impart negative perceptions to learners leading to the perception that online learning is not useful (Teo, 2010). DeCoito & Estaiteyeh (2022) noted that the root cause of negative attitude and scepticism towards online learning was due to bad experiences the learners had due to factors such as lack of clear guidelines from school authorities, lack of technological expertise, and lack of infrastructure to support teaching and learning all of which are common in the current study given how OTL was introduced in this instance.

Perceptions on effective online teaching, learning and assessment

Online teaching and learning is becoming indispensable (Cobanoglu & Cobanoglu, 2021) due to, among others, many challenges confronting the education fraternity contemporarily. The advantages of OTL include; learning flexibility in terms of space and time, learners having some reasonable control on the pace of their learning and promotion of self-directed learning and individual research (Teo, 2010; Zylfiu & Rasimi, 2020; Farrah & Al-Bakry, 2020). Comparatively, online learning is more economical than face to face learning (Yuhanna et al., 2020). It minimizes issues of disruptive behaviour from some students which is common in face-to-face classrooms (Alexander et al., 2012). Materials which are shared online can be accessed any time at the convenience of the learners (Khan et al., 2021). Online learning promotes use of digital tools for learning and offers potential for feedback to be directly tailored to the needs of individual students (Zylfiu & Rasimi, 2020). There could be virtual interactions between students and also with the instructor at convenient times (Arbaugh, 2005; Farrah & Al-Bakry, 2020). Teachers get a chance to acquire crucial skills to use technology when engaged with online lessons (DeCoito & Estaiteyeh, 2022), consequently it is not only beneficial to learners but to teachers as well.

However, online teaching and learning does not only come with positive credentials, there are some setbacks recorded in literature. Online learning has been classified as a mode

favouring intrinsically motivated students. It leads to possibilities of easy miscommunications, it is prone to technology glitches, it is prone to limitations regarding teacher presence and disruptions by other online communications such as social media sites (Alexander et al., 2012; Zylfiu & Rasimi, 2020; DeCoito & Estaiteyeh, 2022). Regardless of how students engage with technology, they may still experience isolation from physical classroom cues and assurance that the instructor is readily available to attend to their problems (Hassan, 2021). Online learning is also prone to overloaded courses, ill-structured activities and lack of meaningful assessment (Zylfiu & Rasimi, 2020) as well as challenges of plagiarism (DeCoito & Estaiteyeh, 2022). Economic constraints make it hard for some students to acquire necessary gadgets and to access relevant information and material on the internet making it difficult to cater for all students (Feldman, 2020; DeCoito & Estaiteyeh, 2022; Mpungose & Khoza, 2021; Yildirim, 2022). These promote digital divide as OTL requires Information and Communication Technology(ICT) infrastructure which is normally a challenge for rural areas (Zylfiu & Rasimi, 2020). Moreover, some students with special needs may require additional support, which may not be readily available at home to attend online classes. (Hassan, 2021). Institutions may have adequate infrastructure while the majority of learners may not have access to compatible devices at their disposal which makes it challenging to achieve meaningful teaching and learning (Hassan, 2021; Mpungose & Khoza, 2021). Other practical huddles (Feldman, 2020; Önal & Özdemir, 2021) that still need to be addressed for OTL to achieve meaningful learning in sciences include the fact that consumables and science kits may not be readily available to all learners in their homes (Dolenc et al., 2020). Teachers also find it challenging to find content that is relevant to achieve objectives. This compels teachers to work long hours trying to adapt content they get from the internet (DeCoito & Estaiteyeh, 2022).

A big question is whether the integrity of the nature of science could still be preserved through online teaching and learning (Mukhtar et al., 2020; Dolenc et al., 2020) since science involves practical component as an integral part. Research studies have shown that it is very challenging to offer practical activities online especially where groundwork has not yet been done (Mukhtar et al., 2020; Hassan, 2021). Furthermore, it has been recorded that students have some doubts about the efficacy of online learning when it comes to practical subjects such as engineering and medicine (Hassan, 2021) which share a lot of similarities with science. It may therefore, be argued that students' participation in OTL may be affected by this kind of scepticism. Generally, it transpires that more is yet to be done and known about the feasibility of online teaching and learning with regard to science. One recommendation is adoption of blended learning for subjects which require a lot of hands-on activities, collaborations and interactions such as science as blended modes combine face to face and online teaching and learning encounters (Al-Salman & Haider, 2021).

Methodology

This study sought to understand how the pre-service science teachers experienced OTL and to assess their overall perceptions about effectiveness of OTL of science. The study adopted a mixed methods (MM) approach to gather and analyse data (Creswell, 2014). MM approaches subscribe to pragmatic paradigm and take advantage of both qualitative approaches and quantitative approaches in answering research questions (Teddie & Tashakkori, 2009) in a much broader way (Cohen et al., 2005). MM approach was adopted in this study in order to have a better understanding of how PSTs experienced OTL and how their experiences may have influenced their overall perceptions about OTL in science. MM takes various typologies and for this study, a concurrent design was used whereby both quantitative data and qualitative data were collected concurrently, analysed separately and then related for interpretations (Creswell, 2014). This study did not involve any manipulation of variables (Bordens & Abbott, 2011) and

therefore, closed and open ended questionnaires were found to be appropriate data collection tools.

Population of the Study

The population of this study was made up of Fourth year (Final) year student-teachers (pre-service science teachers) enrolled in pure sciences and education at One Local University, in Southern Africa. For convenience, the researchers focused on those students who were taking chemistry as a teaching subject together with any other science subject including mathematics. These students experienced OTL for a period of whole academic year and some-what blended for another one year towards the completion of their academic training in June 2022. The pre-service science teachers register for additional education related courses to the pure sciences which prepare them for teaching of these pure science subjects upon completion of their training. The arrangement of offering courses is such that all students who major in any natural science subject register for it in the Faculty of Science and Technology while those who register for any teaching courses like curriculum studies and teaching methodologies take those courses in the relevant department of the Faculty of Education.

Sample of the study

Purposive and convenient sampling of fifteen (n = 15) Fourth (final) Year pre-service science teachers (PSTs) registered under the Bachelor of Science with Education who took chemistry as one of their science subjects, was done on the basis of their experience of face-to-face teaching and learning, blended mode as well as full OTL. For anonymity, names of the pre-service teachers have been withheld and only references have been used in place of their names: (e.g. PST-1 which refers to Pre-service science teacher 1). The objectives of the study were communicated to PSTs as well as the assurance of treating their views with due confidentiality and ethical considerations. Only those who offered their consent to participate formed the sample of this study. As already alluded to earlier, the PSTs had gone through courses that prepared them for teaching and learning profession on how to achieve meaningful teaching and learning. They are also aware of practices that can constrain teaching and learning processes. Therefore, the sample was selected on the basis of its potential to provide rich and useful data on online teaching and learning in science better than students in the other programs (pure sciences) who may not be aware of some critical conceptual issues in teaching and learning. The researchers were aware that the sampling technique will provide useful insights for the purpose of the study and similar contexts even though findings may not be directly generalized to wider populations (Cohen et al., 2005).

Data Collection Instruments and Methods

Quantitative data were collected with a close-ended questionnaires while qualitative data were collected with open-ended questionnaires from participating PSTs. The questionnaires were concurrently administered as printed documents to participants after securing their consent to participate in the study. The purpose of close-ended questionnaires was to get insights on how the OTL happened and the nature of experiences the PSTs had during their training in relation to chosen categories such as, (i) availability and access to resources (ii) status of interactions and, (iii) modes of assessment. The purpose of open-ended questionnaires was to capture PSTs perceptions about OTL in science after their first-hand experience. Open-ended questionnaires have the advantage of providing rich and diverse data without restricting participants on their responses. However, the researchers were aware that open ended questions may be ambiguous to respondents (Bordens & Abbott, 2011). To take care of the possibility of ambiguities in the questions, the researchers categorized the questions into the following broad areas on which respondents would state their perceptions:

a) Perceptions about effective teaching and learning.
b) Perceptions about effective assessment.
c) Perceptions about preparation for pre-service science teachers to use OTL in their teaching post completion of their program.

The questionnaires were developed with reference to the above mentioned broad areas by authors who scrutinized their suitability for collecting relevant data to the research questions. This was done as a way to enhance content validity (Cohen et al., 2005). Questionnaires were also shared with colleagues who were not part of the study to assess if they captured all elements related to research questions as a way to ensure internal validity (Cohen et al., 2005). Feedback from colleagues was incorporated into final version of questionnaires that were distributed to participants in printed form. Participants handed in the questionnaires in the following week which gave them ample time to complete the questionnaires without any pressure.

Analysis of Data

Both quantitative and qualitative methods of data analysis were employed. The first part of the analysis was on measurement of perceptions on five-point Likert scale assessing the status of OTL that was experienced by PSTs. The second part involved evaluation of PSTs perceptions via the open ended questionnaires through qualitative content analysis (Mayring, 2014). For closed ended questionnaire from five-point Likert scale, Microsoft Excel was used to generate descriptive statistics while content analysis enabled the researchers to have in-depth understanding of data, to code, to categorise and make meanings about PSTs perceptions (Mojtaba & Sherrill, 2019). Key words that served as coding framework were derived from research questions under the areas relating to: perceptions about PSTs' experience of OTL, PSTs perceptions about teaching and learning of science through OTL mode, PSTs perceptions about assessment and PSTs readiness to facilitate OTL in their future teaching vocation. The iterative nature of content analysis allows for more than one step to be applied to data to make sure that data meaning is preserved in the final descriptions (Schreier, 2014). Data presentations of qualitative data included thematic meanings, anchoring categories as well as reference data excerpts.

Findings

The first part of the findings is quantitative showing PSTs ratings on how they experienced OTL in terms of how accessibility, teaching and learning and assessment were implemented. The second part reports on how PSTs perceived the effectiveness of OTL in relation to science. Both first and second part were based on the responses on 5-point Likert Scales for each analysis are noted below corresponding Tables.

How PSTs Experienced OTL

Results on how PSTs experienced OTL are shown in Table 1 with regard to how materials were made available, how these materials waer accessed as well as how teaching and learning processes generally took place.

Table 1
PSTs perceptions' ratings on how they experienced OTL

Statements	Modal rating	Average perception	*SD*	%*RSD*
Lecture notes were deposited online for us to access at own time	Always (*n*=67%)	4.69	0.61	13.01
Live discussions with the lecturer we held	Sometimes (*n*=40%)	2.61	1.33	50.96
Lecturers used online platforms e.g. telegram, zoom (please state which ones)[1]	Often enough (*n*= 40%)	3.38	1.49	44.08
Animation and recorded lectures (video) were made available/accessed	Minimal (*n*=53%)	2.07	0.57	27.54
Audio recordings were provided	Often enough (*n*=40%)	3.00	1.18	39.33
Information was disseminated in time	Often enough (*n*=40%)	3.20	0.89	27.81

*(5: Always, 4: Often enough, 3: Sometimes, 2: Minimal, 1: Not at all).

From Table 1 majority of PSTs agreed that lecture materials were deposited online (*M*= 4.69, *SD*= 0.61), with the modal rating of perceptions by majority of 67% for their access at their convenience with very infrequent live discussions with the lecturers (*M*=2.61, *SD*= 1.33). However, supplementary multi-media resources were shared to a minimal extent (*M*= 2.07, *SD*= 0.57) except for some audio recordings (*M*= 3.00, *SD*= 1.18).

How PSTs Experienced Online Assessment

On the issue of assessment, PSTs were reportedly given individual online assessments in various forms with varying frequencies as shown in Table 2.

Table 2
The experience of the PSTs regarding the assessment aspect of teaching and learning

Statements	Modal rating	Average perception	*SD*	%*RSD*
Tests were conducted fully online	Sometimes (*n*=46%)	3.69	0.82	22.22
Tests were done frequent enough	Often enough (*n*=53%)	3.31	0.99	29.91
Assessment was done through take-home assignments	Sometimes (*n*=40%)	3.08	1.21	39.29
Modes of assessment were clearly stated	Often enough (*n*=40%)	3.62	0.92	25.41
Assessment covered all topics adequately	Sometimes (*n*=33%)	3.31	1.49	45.02
Students were assessed individually	Always (*n*=47%)	4.08	1.38	33.82
There was no cheating in the assessments	Sometimes (*n*=33%)	2.85	1.19	41.75
Feedback was given on time	Sometimes (*n*=40%)	2.77	1.19	42.96

*(5: Always, 4: Often enough, 3: Sometimes, 2: Minimal, 1: Not at all)

Table 2 shows that tests were sometimes given online (*M*= 3.69, *SD*= 0.82). The frequency of the tests is rated at sometimes (*M*= 3.31, *SD*= 0.99) which could be a sign that in

other topics, no tests were given. Assessment through take-home assignments was sometimes done with less frequency also (*M*=3.08, *SD*= 1.21). PSTs felt instructions were not always made explicit enough (*M*= 3.62, *SD*= 0.92) and the coverage was also not always extensive (*M*= 3.31, *SD*= 1.49). Individual assessment was rated high, close to always (*M*=4.08, *SD*= 1.38) by the majority of PSTs. PSTs also held perceptions that assessments were sometimes affected by malpractices (*M*= 2.85, *SD*= 1.19). However, PSTs noted that provision of feedback was at a low frequency (*M*= 2.77, *SD*= 1.19).

Overall Perceptions of PSTs about effectiveness of OTL in science

Having captured PSTs perceptions about their experience of OTL as well as how online assessment was done, the following section presents PSTs overall perceptions about the effectiveness of OTL and online assessment in science. Online teaching (OT) and online learning (OL) have been placed under one sub-heading (OTL) because of cross-cutting elements in them. Table 3 presents results from closed-ended questionnaires rated on a 5-point Likert scale.

Table 3
PSTs perceptions about the effectiveness of OTL in science on the basis of their experience

Statements	Modal rating	Average perception	*SD*	%*RSD*
Increases motivation to study	Disagree (*n*=33%)	2.08	0.92	44.2
All learners can participate well	Disagree (*n*=73%)	2.00	0.39	19.5
Allow interaction between teachers & learners	S. Disagree (*n*=40%)	2.08	1.14	54.8
Subjects content can be meaningfully taught	Disagree (*n*=33%)	2.31	1.00	43.3
Access to study material is easy	Agree (*n*=60%)	3.31	1.07	32.3
Effective learner-cantered approaches possible	Disagree (*n*=33%)	2.38	1.17	49.2
Learner stay in contact with instructors always	Disagree (*n*=40%)	1.92	1.00	52.1
Learners can collaborate easily through online	Disagree (*n*=33%)	2.54	1.22	48.0

*5: Strongly agree, 4: Agree, 3: Not sure, 2: Disagree, 1: Strongly disagree)

Results Table 3 show that the majority of PSTs disagree that OTL can; motivate learners (*M*= 2.08, *SD*= 0.92), allow all participation of all learners (*M*= 2.00, *SD*= 0.39), offer a platform for meaningful interactions for meaningful teaching and learning experience (*M*= 2.08, *SD*= 1.14), allow meaningful content delivery (*M* = 2.31, *SD*= 1.00), allow adoption of learner-centered approaches (*M*= 2.38, *SD*= 1.17), allow instructors to stay in contact with students for most of the time (*M*= 1.92, *SD*= 1.00) and enable students' collaborations (*M*= 2.54, *SD*= 1.22). However, PSTs agree that access of material online is easy (*M*= 3.31, *SD*= 1.07).

PSTs Perceptions about OTL and Supporting Details Captured from Open-Ended Questionnaire

This section presents results from open-ended questionnaires that were used to further probe PSTs' perceptions without limiting them to pre-determined questions. PSTs were expected to elaborate as much as possible to support their perceptions about the effectiveness of OTL in science.

Theme 1: OTL has some limited scope for science teaching and learning

Majority of the PSTs, in agreement with results in Table 3, make assertions that criticise OTL as not an effective option for science subjects. This corroborates their ratings on closed ended questions shown in Table 3. The PSTs highlight issues related to perceived usefulness (PU) as well as perceived ease of use (PEU). The following categories of their responses emerged: (i) some science concepts are so abstract that teaching them online may not be fruitful; (ii) OTL may fall short of impact for complexity demands of some concepts; (iii) OTL may not adequately address all areas of science especially practical aspects (especially where substitute resources are not available; (iv) OTL may not offer opportunities for interactions between students and teachers as well as among the students themselves. For instance, one participant mentioned:

> "Online teaching of science is not effective at all since science, especially biology and chemistry deals with a lot of mechanisms that needs a physical interaction for demonstration. Like in organic chemistry, there are lots of chemical equations with complex mechanisms and can only be understood if demonstration is done on the board by lecturer. Also experiments or practicals for biology and chemistry provide deeper understanding of the material learned in class".

Theme 2: OTL may overlook/downplay learner diversity and nature of science

To further substantiate their perceptions about limitations of OTL towards science, different PSTs made submissions related to perceived ease of usefulness (PEU) as well as PU of OTL. Their perceptions yielded several categories: (i) OTL is characterized by a lot of work done in short space of time (PST-10); (ii) OTL promotes digital divide; (iii) it may dampen learning motivation and encourage reproduction of work not understood; (iv) it may be challenging to tailor it to individual students' needs; (v) selective teaching of theory over practical (PST-9); (vi) it works for intrinsically motivated students, (vii) it is said to be dissociated from nature of science; (viii) it is difficult to retain a lot of information in a short space of time. One went as far as asserting that *'[O]nline is the death of science.… there are tutorials [online] to guide students, but watching videos is not the same as doing the practical/experiment by ourselves'*. Another one shares the same sentiments and asserts that '*we can't produce doctors, engineers who studied online. They have to be in practicals, labs field learning, observe nature, and everything related to science*.'

The following extracts (for PST-9 and PST-5) provides more details on how PSTs argued against feasibility of OTL in science where majority described it as partially responsive to needs of science.

> "In my opinion science is 70% practice and 30% theory, Online learning is very good when it comes to teaching theory. Yes, if we were doing theology online wouldn't be that much of a problem. How can a chemist in their 3rd or 2nd year of study towards their degree not know what a spatula is! Online is the death of science. Yes, there are tutorials to guide students but watching a video is not the same as doing the practical/experiment by ourselves. MIT study shows that for effectively understanding concepts form a video it has to be less than 6-minutes so how many 6-min videos will be produced to cover the whole content of a single subject?" PST-9.

PST-5 also points to the issue of work overloads *"...lecturers tend to produce a lot of notes which are not always comprehensible".*

The PSTs further cited some science related careers to argue their dissatisfaction with OTL in science as shown in the extract that follow.

> "For other subjects, yes online might work, but not for science as a whole. These kids need to go physical in science. We can't produce Doctors, Engineers who studied

> online. They have to be in practicals, labs, field learning, observe nature and everything related to science" PST-5.

Theme 3: OTL need to be conceptualised in constructivists view

Few PSTs had some counter arguments that OTL can still be an effective mode of teaching science provided some practices are made to take care of the nature of science. PSTs suggested perceptions gave rise to the following categories: (i) OTL should be offered by teachers with relevant training (established technological knowledge content); (ii) videos should be used in cases where real experiments cannot be done; (iii) OTL promotes independent research which is a vital ingredient in science learning; (iv) OTL offers flexibility to learn at own pace and it is not restricted by space; (v) OTL helps students to embrace technology and develop communication skills; (vi) it is easy to share information (See the inserts for PST-1 and PST-9).

> "Online teaching can be very effective if done properly. I say so because, I personally believe that even the shy teacher can feel free to teach online since the audience is not with him/her. I say if done properly because some lecturers often mistaken online learning with 'sending the notes to learners…online learning can be very effective if used properly. This is because the lessons can be recorded both verbally and visually and thus give the learner an opportunity to go through the lesson as many times as possible or needed" PST-1.

> "Students are able to study on their own pace. If reading materials are attached, then students find extra source to make or have a better understanding of the content. Help students to learn how to use technology in learning. Some students are parallel to technology therefore this gives them force to learn it. Students develop communication skill. In a Telegram class one is urged to state his/her response thus improving his ability to talk reason and share ideas". PST-9

PSTs Perceptions about Effectiveness of Assessment in OTL

When asked about how they perceive effectiveness of assessment in OTL, PSTs cumulative rating scores on perceptions were found as shown in Table 4.

Table 4
PSTs perceptions about effective assessment in OTL

Statements	Modal rating	Average perception	*SD*	%*RSD*
Meaningful assessments can be achieved in online mode	Disagree (*n*=40%)	2.38	0.92	38.7
All science topics/ content can be assessed online	S. Disagree (*n*=40%)	2.31	1.38	59.7
Online mode allows for timely feedback	Agree (*n*=33%)	2.69	1.26	46.8
Reflections on feedback are done meaningfully online	Disagree (*n*=47%)	2.46	1.08	43.9
Formative assessment is easy using online mode	Agree (*n*=33%)	2.85	1.10	38.6
Summative assessment is easy on online teaching	Disagree (*n*=33%)	2.38	1.27	53.4

*(5: Strongly agree, 4: Agree, 3: Not sure, 2: Disagree, 1: Strongly disagree)

Results in Table 4 show that PSTs disagree that assessments in OTL are; meaningful (*M*= 2.38, *SD*= 0.92), can cover all topics (*M*=2. 31, *SD*= 1.38), allow timely feedback (M= 2.69, SD=1.26), enable meaningful reflections to be done (*M*= 2.46, *SD*= 1.08). Moreover, PSTs disagree that both formative (*M*= 2.85, *SD*= 1.10) and summative (*M*= 2.38, *SD*= 1.27) assessments can be done easily in OTL.

The responses of PSTs to open-ended questionnaire on their perceptions about effectiveness of assessments of science in OTL are presented in the following section.

Theme 4: OTL assessment for science is susceptible to quality and authenticity concerns

PSTs were asked to state their perceptions about online assessment and support them with details. The following categories of their perceptions were recorded with a high proportion of PSTs disregarding online assessment of science: (i) It lacks authenticity as it does not cater for all aspects of assessment and its prone to examinations' malpractice issues like copying; (ii) susceptible to strict regulations and difficult questions as means of trying to preserve assessment integrity which unfortunately leads to many students failing; (iii) online systems troubleshooting issues may affect students; (iv) may be suitable for theoretical aspects but not practical aspects of science.

The extracts from PST-10 and PST-2 are shown below.

> "Effective to some courses but others not so effective because we will be assessed based on theory only. How can we say a student has learnt the subject when all they have done was copy and paste someone else's work? Online learning to science students is the death of humanity because doctors, engineers, chemists and biologists who know nothing but just theory will be leading in those different specialities" PST-10

> "It is not effective. In real life example, one of the biology courses is failed by many students and may be only 2 managed to obtain D which is the highest symbol in the class. Lecturers are so strict and ask questions that they too, cannot interpret well. Furthermore, we are not given enough time for tests and that lead us to submit unfinished work since we will be typing which we are not used to". PST-2.

Theme 5: Online assessments have potential to promote research and wider content coverage

A few PSTs advocated for OA in science with careful consideration of how it is done in order to ensure its effectiveness towards achievement of assessment objectives. Two categories of perceptions were recorded about OTL in science: (i) allows for coverage of more content and (ii) a good mode to ask research-based questions. For instance, PST-5 mentioned

> "Online assessment, this is not effective because the teacher will be able to ask every question in relation to the course he/she teaches, so the students will be able to answer questions through researching process. For instance, the teacher asks learners about the stages and or steps to be followed in water purification, so the learners will watch videos online and be able to answer the questions" PST-2.

Relationships between PSTs perceptions about their experience of OTL and their overall perceptions about effectiveness of OTL in science

The following part of results was to compare PSTs experience of OTL to how they perceive its effectiveness in science teaching and learning. Four statements from experience perceptions ratings and four parallel statements from overall perceptions were used. Figure 1 shows the results. The comparison was based on 5-point Likert scales: Experience ratings (E) were (5: Always, 4: Often enough, 3: Sometimes, 2: Minimal, 1: Not at all) while Perceptions (P) ratings were (5: Strongly agree, 4: Agree, 3: Not sure, 2: Disagree, 1: Strongly disagree).

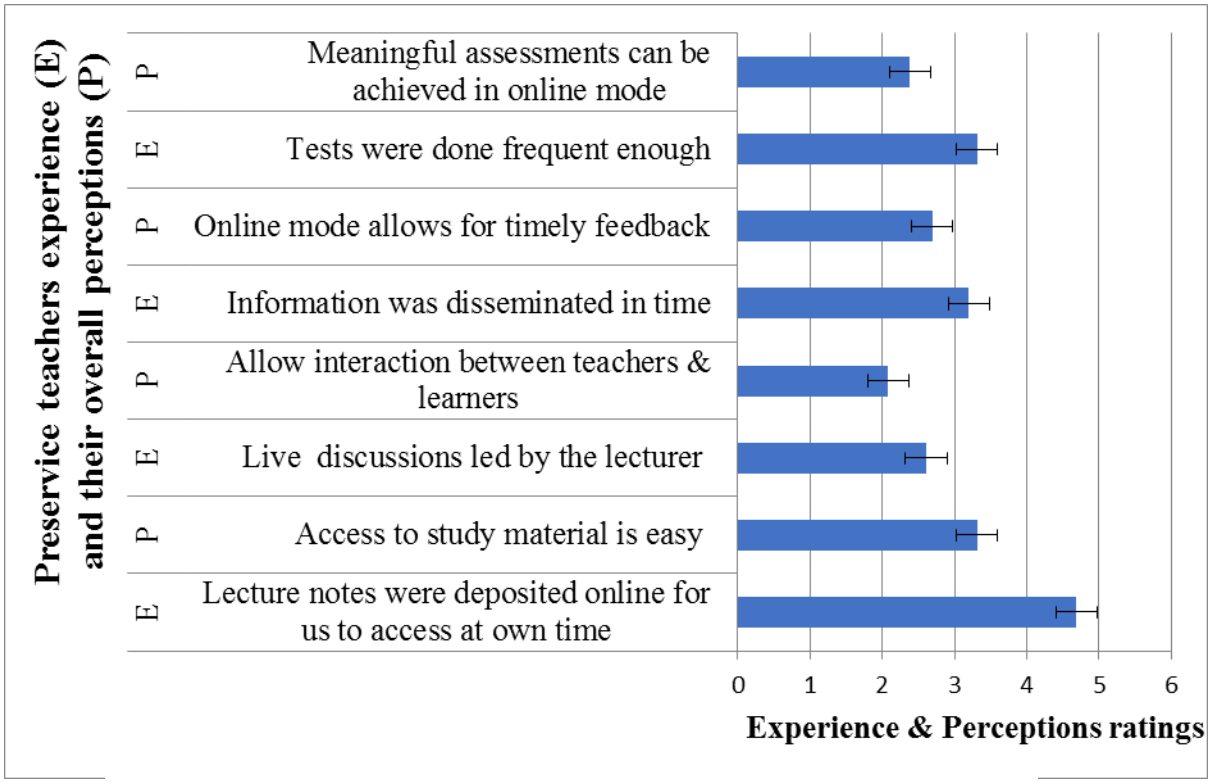

Figure 1. How experiences of PSTs compare with their perceptions about OTL

The results in Figure1 show that in cases where pre-service teachers rated their experience perceptions low, their overall perceptions ratings were also low in relation to effectiveness of OTL in science. However, availability of material shared online was rated high (above Often enough by majority) whereas accessibility was rated low. This could be attributed to other factors which hindered pre-service teachers from accessing available learning material such as internet connectivity, data cost, etc. that have nothing to do with the availability but accessibility of such teaching and learning material.

PSTs' Readiness to teach online (RTO)

The last part of this study was to assess PSTs perceptions about their readiness to employ OTL in their teaching vocation having experienced it first-hand as students. The results are in the following section.

Theme 6: OTL demands special training for teachers as much as it equips students with digital skills

PSTs were ultimately asked if they were ready to teach science online and to describe any acquired skills for OTL. They do not feel that the exposure to OTL has in a way provided them with adequate skills for OTL. Three categories of their perceptions were recorded. (i) Vicarious experience is not adequate to equip PSTs with necessary skills for OTL, training tailored for OTL is necessary; (ii) It involves a lot of time planning and organizing materials so it's tedious; (iii) Scepticism and inherent beliefs influence decision of PSTs towards OTL. The extract from PST-10 below demonstrates some concerns related to PEU and PU of OTL.

> "[T]his process of online teaching and learning needs the teacher who is well advanced towards teaching and learning process" PST-5 and "...it is tedious...to assess even a small group of students using gadgets. Online learning does not offer students

> to understand and perform the practical part of the course and in some courses some concepts are only better understood through practice" PST-10.

There were however, counter perceptions by some few PSTs that some basics have been developed which they can use to practice in OTL. Three categories of perceptions were identified (i) preparation of online presentations (e.g.) recorded slides, (ii) identification of available educational web-resources, (iii) knowledge of advantages and disadvantages of OTL (See excerpt from PST-1 below).

> "Having participated in online learning, I can say that I am equipped with all the information needed to participate in online teaching and learning since I have learned effective and cheap software and applications that are used. From there, I have learned all the cons and pros of online teaching and learning" PST-1.

Discussions

This paper reports on a study that intended to elucidate perceptions of the science students, particularly PSTs, about online teaching and learning after having had a first-hand experience of OTL. Again this study aimed at assessing PSTs perceptions about their readiness to use OTL mode in their future careers as teachers. The study problem emanated from the reality that PSTs who had no to little experience of OTL had to abruptly access their courses through online modes during tensions of covid-19 pandemic. There were no prior institutional arrangements for students' teaching and learning activities to be done remotely because the University operated on face-to-face modes before the pandemic-caused disruptions. It was a concern in relation to how the emergency-induced change may have affected learning of sciences in light of literature reports that the success of OTL depends largely on the status of infrastructure, technical know-how, implementation practices and recipients' level of PU and PEU (Ardiyansah, 2021).

In the current study, regarding the status of OTL, a sizable number of PSTs highlighted that learning material were made available through several platforms such as the institution's learning management system, social media platforms and emails. However, discussions were not frequently done and PSTs had to navigate their way without much anticipated assistance. These results corroborate some reports that teaching materials can be shared easily (Alexander et al., 2012). Much as learning resources were made available, some huddles which posted a challenge to meaningful learning were experienced. Minimal live discussions could have made some PSTs to feel disconnected, isolated from both teacher presence and other learners' presence. Lack of live discussions with instructors is likely to perpetuate segregation between extrinsically and intrinsically motivated students (Alexander et al., 2012; Zylfiu & Rasimi, 2020). The arrangement also did not allow ways to harness affordances of OTL in promoting classroom-talk (Dolenc et al., 2020) or meaningful interactions between students and with instructors (Arbaugh, 2005; Farrah & Al-Bakry, 2020). Absence of meaningful interactions has been regarded as a situation which downplays the importance of knowledge sharing (e.g., Khan et al., 2021). On average, and in agreement with the assertions by Zylfiu & Rasimi (2020) that OTL is susceptible to inadequate assessment procedures, PSTs in this study made strong assertions that assessments were not frequently given and the feedback was also not so frequent (see Table 2). This finding is in agreement with similar reports by Twesige et al., 2021). Moreover, respondents reiterated observations from previous studies that OTL is sometimes characterised by high workloads squeezed within limited time (Zylfiu & Rasimi, 2020). PSTs argued that the amount of work shared with them was far more than the time that was available. Therefore, PSTs found OTL arrangements during their learning not favouring their perceived ease of usefulness (PEU) as they had to do a lot of work within a short time and for a better part of the time, with minimal interactions with instructors. Infrequent feedback and lack of

interactions qualified PSTs arguments that their experience did not meet their expectations with regard to perceived usefulness (PU) of OTL. Nonetheless, without any reference to what happened during face-to-face, it is difficult to blame OTL for the 'infrequent' feedback. Generally, it surfaces that level of support for teaching and learning which is crucial to promote students' positive perceptions in terms of PEU and PU (Teo, 2010) was to a less extent.

A large number of the PSTs in this study collectively held strong negative perceptions about general feasibility of OTL of science (see Table 3). This finding is in contradiction to the finding by Cobanoglu & Cobanoglu (2021) who recorded positive perceptions. For instance, collective arguments of PSTs in this study are against reports that OTL can increase motivation for independent learning (Teo, 2010), collaboration and meaningful interactions (Farrah & Al-Bakry, 2020) as well as a platform for meaningful learner-centred approaches (Dolenc et al., 2020). Surprisingly, the PSTs' collective response on access to study materials was rated around average (see Table 3) on the Likert scale which does not match their previous response that materials were always deposited online. This perception may signal that, even though materials were made available online, access by students was still not without challenges that could include lack of suitable gadgets, costs of data, connectivity issues and limitations of gadgets used (Makafane & Chere-Masupha, 2021; DeCoito & Estaiteyeh, 2022; Mpungose & Khoza, 2021; Twesige et al., 2021; Samortin et al., 2022). Some research studies have further illustrated how demographic disparities adds to challenges experienced by students in OTL with those in rural areas being the most hit-hard group (Twesige et al., 2021; Yıldırım, 2022). Resources constraints, such as absence of virtual laboratories and no means of doing experiments, have been cited by PSTs as evidence that OTL is still clouded with pedagogical challenges which affect teaching learning of science through practical activities (Mukhtar et al., 2020; Hassan, 2021). Hassan (2021) further refers to the necessity of planning so that OTL can be effective. However, despite the fact that PSTs in this study had an unplanned emergency OTL experience some few PSTs still had positive perceptions about OTL, as being a flexible and technologically driven mode, arguing that instructors need to be well trained and resources be put in place for both teachers and students. The observation of mixed views of PSTs, with majority showing scepticism toward OTL and minority showing some hope, bring insights to practice that experience plays an important role in development of perceptions (DeCoito & Estaiteyeh, 2022). It may be argued that PSTs developed negative perception towards OT because of being part of abrupt implementation of OT due to the then prevailing circumstances when both instructors and learners did not have enough time to prepare for OTL (Önal & Özdemir, 2021) and some had challenges related to resources (Umit & Sezginsoy, 2021).

Reporting on their perceptions concerning online assessment feasibility for science, PSTs held strong beliefs that online assessment cannot adequately meet demands of meaningful assessment of science; both summative and formative assessments. PSTs made assertions that online assessment of science may lack authenticity as some skills may not be adequately assessed virtually and the practical aspects suffer the most. They further argued that online assessment is highly susceptible to malpractice and technological clichés which negatively affect its administration. They further highlight challenges with reflection on tasks when online mode is adopted for science. These findings are in agreement with Zylfiu & Rasimi (2020; Yıldırım, 2022) who highlighted that meaningful assessments may be a challenge during online teaching. Therefore, it may be helpful to engage a variety of assessment modes for OTL that would meet demands of science encompassing theoretical as well as practical aspects. However, as Yıldırım, (2022) pointed out, some PSTs optimistic notions argue for improvement of online systems and gatekeeping procedures when administering online assessment for it to be as meaningful as physical assessment.

Analysis of PSTs perceptions about their readiness to teach online after their emergency participation in OTL revealed a low self-efficacy for almost all them. Their most cited

arguments were that they did not have adequate time to fully understand how to determine if it would work for teaching of science; they anticipate it to be a highly specialised mode that needs special form of training. These findings are in contradiction to Ardiyansah, (2021) who reported that participants' exposure to online learning was responsible for their high levels of self-efficacy to study through OTL and to employ OTL as teachers. However, participants in Ardiyansah (2021) "...had proper technical equipment, and they were equipped with good quality of technical skills for teaching online" (p.97) indicating preparedness prior to the participation in OTL, while participants in this study had challenges with equipment and technical skills to fully engage in OTL as there was no preparation for this mode of teaching. A comparison depicted in Figure 1 show some positive relationship between experience and perceptions of PSTs. These summarises DeCoito & Estaiteyeh (2022) point that the kind of experience pre-service teachers have during training has a bearing on how they formulate their perceptions. Despite their scepticism towards OTL in science, PSTs acknowledge that they had acquired skills on how to search for information from the internet, appreciate research (Farrah & Al-Bakry, 2020) as well as some basic knowledge about affordances and constraints of OTL.

Conclusions

The anchoring problem under investigation in this study was about PSTs who had no to little experience of OTL but who had to, without other alternatives, access learning through online modes during Covid 19 pandemic. The findings from this study provide some indication that the status of OTL in relation to infrastructure and how it is implemented can promote positive or negative perceptions in pre-service teachers about OTL. This was demonstrated by PSTs perceptions that there were more teaching and learning challenges than affordances. As a result, PSTs to a large extent made strong arguments that OTL may not satisfactorily meet demands of science teaching and learning. Nonetheless, there are more opportunities tied to OTL when well-planned, provided with resources and strategically implemented. As suggested by some PSTs, these opportunities include promotion of self-regulated learning, promotion of research and provision of an alternative mode of access to education. Overall, it could be argued that if the experience during OTL does not prove to be effective in learning and in line with pre-service teachers' expectations, they are more likely to perceive it negatively and rate it low on PU and PEU and eventually show scepticism to implement it in their future practice.

Limitations

Even though important insights could be derived from the study findings, some limitations should also be stated, viz, the study only focused on a small purposive and convenient sample which made it challenging to engage robust statistical analysis of data. Consequently, the data collected may not be simply generalised to a wider population of science pre-service teachers. Nonetheless, it could still provide some useful insights to contexts similar to that of the study and beyond. Furthermore, the study findings could have also been influenced by other factors associated with the way OTL was introduced as an emergency remote teaching and learning intervention, rather than a planned initiative.

Recommendations

The study recommends that pre-service teachers should be given adequate experience and support with OTL so that, in case of emergencies, and even under normal circumstances, they have some required experience to employ OTL. As alluded to by Modise (2020), findings of this study further lead to a recommendation that institutions should exploit the space of OTL by investing in infrastructure as well as technical repertoire for both instructors and their students' clientele. Teachers' possession of digital skills and how to facilitate teaching and

learning across online platforms is an essential skill for the 21st century when the world is rapidly embracing affordances of information and communication technology in most sectors for betterment of societies and schools are not an exemption. However, challenges associated with OTL should not be overlooked in the process (Herkulaas & Oosthuizen, 2020). Lessons learned from OTL during the covid-19 pandemic could provide insights into how students and instructors could be equipped with technological skills as well as collaboration skills in remote environments (Samortin et al., 2022).

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References

Önal, A., & Özdemir, A. (2021). An investigation into pre-service teachers' online learning climate perceptions. *Journal of Educational Technology and Online Learning*, *4*(2), 310-333. https://doi.org/10.31681/jetol.927998

Alexander, M. W., Truell, A. D., & Zhao, J. J. (2012). Expected advantages and disadvantages of online learning: Perceptions from college students who have not taken online courses. *Issues in Information Systems*, *13*(2), 193-200.

Al-Salman, S. & Haider, A. S. (2021). Jordanian University students' views on emergency online Learning during COVID-19. *Online Learning*, *25*(1), 286-302. https://doi.org/10.24059/olj.v25i1.2470

Alvarez, A. J., & Corcuera, L. (2021). The webinar experiences of higher education instructors in the time of emergency remote education. *International Journal of Scholars in Education*, *4*(2), 134-145. https://doi.org/10.52134/ueader.983093

Arbaugh, J.B. (2005). A structural equation model of predictors for effective online learning. *Journal of Management Education*, *29*(4), 531-563. https://doi.org/10.1177/1052562904271199

Ardiyansah, T. Y. (2021). Pre-service teachers' perceived readiness in teaching online in international internship program. *Celtic: A Journal of Culture, English Language Teaching, Literature and Linguistics*, *8*(1), 90-102. https://doi.org/10.22219/celtic.v8i1.16456

Bordens, K. S., & Abbott, B. B. (2011). *Research design and methods, a process approach* (8th ed.). The McGraw-Hill Companies, Inc.

Chuttur, M. (2009). Overview of the technology acceptance model: Origins, developments and future directions. *Sprouts: Working Papers on Information Systems*, *9*(37), 1-21. http://sprouts.aisnet.org/9-37

Cobanoglu, A. A. & Cobanoglu, I. (2021). Do Turkish student teachers feel ready for online learning in post-covid times? A study of online learning readiness. *Turkish Online Journal of Distance Education*, *22*(3), 270-280. https://doi.org/10.17718/tojde.961847

Cohen, L., Manion, L. & Morrison, K. (2005). *Research methods in education* (5th ed.). RoutledgeFalmer.

Corcuera, L.C., & Alvarez, A.V. (2021). Teacher's roadblocks in the time of quarantine teaching. *International Journal of Social Sciences and Education Research*, 7(4), 427-434. https://doi.org/10.24289/ijsser.1003162

Creswell, J. W. (2014). *Research design: qualitative, quantitative, and mixed methods approaches* (4th ed.). *SAGE Publications, Inc*.

Darling-Hammond, L., Chung, R., & Frelow, F. (2002). Variation in teacher preparation: How well do different pathways prepare teachers to teach? *Journal of Teacher Education, 53*(4), 286-302. https://doi.org/10.1177/0022487102053004002

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340. https://doi.org/10.2307/249008

DeCoito, I. & Estaiteyeh, M. (2022). Transitioning to online teaching during the Covid-19 pandemic: An exploration of STEM teachers' views, successes, and challenges. *Journal of Science Education and Technology*, *31*(3), 340-356. https://doi.org/10.1007/s10956-022-09958-z

Dolenc, K., Šorgo, A., & Ploj Virtič, M. (2021). The difference in views of educators and students on forced online distance education can lead to unintentional side effects. *Education and Information Technologies*, *26*(6), 7079-7105. https://doi.org/10.1007/s10639-021-10558-4

Farrah, M., & Al-Bakry, G. H. (2020). Online learning for EFL students in Palestinian universities during corona pandemic: Advantages, challenges and solutions. *Indonesian Journal of Learning and Instruction, 3*(2), 65-78. https://doi.org/10.25134/ijli.v3i2.3677

Feldman, J. (2020). An ethics of care: PGCE students' experiences of online learning during Covid-19. *Critical Studies in Teaching and Learning (CriSTaL), 8*(2), 1-17. https://doi.org/10.14426/cristal.v8i2.326

Hassan, M. (2021). Online teaching challenges during covid-19 pandemic. *International Journal of Information and Education Technology*, *11*(1), 41-46. https://doi.org/10.18178/ijiet.2021.11.1.1487

Herkulaas, M., & Oosthuizen, L. L. (2020). First-year student transition at the University of the Free State during COVID-19: Challenges and insights. *Journal of Student Affairs in Africa*. *8*(2), 31-44. https://doi.org/10.24085/jsaa.v8i2.4446

Kalaycıoğlu, D. B., ömer Toprak, A., Eyerci, C., Zeynep, U. G. U. R., Ayşe, G. Ü. Ç., Yildiz, S. & Çelikkaya, R. (2022). Academics' perception and practices of online education during the Covid-19 pandemic: The case of Turkey. *Journal of Educational Technology and Online Learning*, *5*(1), 32-46. https://doi.org/10.31681/jetol.975896

Khan, M.A., Vivek, Nabi, M.K., Khojah, M., & Tahir, M. (2021). Students' perception towards e-learning during covid-19 pandemic in India: An empirical study. *Sustainability*, *13*(57), 1-14. https://doi.org/10.3390/su13010057

Makafane, T., & Chere-Masopha, J. (2021). Covid-19 crisis: Challenges of online learning in one university in Lesotho. *African Perspectives of Research in Teaching & Learning 5*(1), 126-138. http://hdl.handle.net/10386/3299

Mayring, P. (2014). *Qualitative content analysis: theoretical foundation, basic procedures and software solution.* Klagenfurt. https://nbn-resolving.org/urn:nbn:de:0168-ssoar-395173.

Modise, M. P. (2020). Continuous professional development and student support in an open and distance e-learning institution: A case study. *International Journal of African Higher Education*, *7*(1), 49-68. https://doi.org/10.6017/ijahe.v7i1.10902

Mojtaba, V. & Sherrill, S. (2019). Theme in qualitative content analysis and thematic analysis. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, 20*(3). https://doi.org/10.17169/fqs-20.3.3376

Mpungose, C. B., & Khoza, S. B. (2021). Students' reflections on the use of the zoom video conferencing technology for online learning at a South African University. *International Journal of African Higher Education, 8*(1), 159-178. https://doi.org/10.6017/ijahe.v8i1.13371

Mukhtar, K., Javed, K., Arooj, M., & Sethi, A. (2020). Advantages, limitations and recommendations for online learning during covıd-19 pandemic era. *Pakistan journal of medical sciences*, *36*(COVID19-S4). https://doi.org/10.12669/pjms.36.COVID19-S4.2785

Nsibande, R. (2020). From Use to Influence: Student evaluation of teaching and the professional development of academics in higher education. *Critical Studies in Teaching and Learning*, *8*(1), 133-152. https://doi.org/10.14426/cristal.v8i1.208

Pal, D., & Patra S. (2021). University students' perception of video-based learning in times of covid-19: A TAM/TTF perspective, *International Journal of Human–Computer Interaction*, *37*(10), 903-921. https://doi.org/10.1080/10447318.2020.1848164

Samortin, M. B., Corcuera, L. C., Alvarez, A. V. Jr., & Palmero, H. R. (2022). Education and the pandemic: Examining students' remote learning experiences in the Philippines. *International Journal of Scholars in Education*, *5*(1), 1-13. https://doi.org/10.52134/ueader.1064312

Schreier. (2014). Qualitative content analysis. In Flick W. (Ed), *The Sage Handbook of Qualitative Data Analysis* (pp. 170-183). SAGE Publications Ltd.

Teo, T. (2010). Development and validation of the e-learning acceptance measure (ElAM). *The Internet and Higher Education*, *13*(3), 148-152. https://doi.org/10.1016/j.iheduc.2010.02.001

Twesige, D., Gasheja, F., Misago, K. I., & Muvunyi, E. (2021). COVID-19's impact on the student learning process in Rwandan higher education institutions. *International Journal of African Higher Education*, *8*(3), 144-160.

Umit, I. O., & Sezginsoy, B. (2021). Distance education in the covid-19 pandemic period: opinions of primary pre-service teachers about teaching practice course. *Journal of Educational Technology and Online Learning*, *4*(4), 726-744. https://doi.org/10.31681/jetol.1016098

Yildirim, Ö. K. (2022) A Research about the opinions of pre-service Turkish teachers on the online education process. *Journal of Educational Technology and Online Learning*, *5*(4), 1122-1139. https://doi.org/10.31681/jetol.1160476

Yuhanna I., Alexander A. & Kachik A. (2020). Advantages and disadvantages of online learning. *Journal Educational Verkenning*. *1*(2), 13-19. https://hdpublication.com/index.php/jev

Zylfiu, D., Gerbeshi, B. & Rasimi, D. (2020). Challenges and advantages of online learning: The case of Kosovo. *International Journal of Management*, *11*(10), 1873-1880. https://doi.org/10.34218/IJM.11.10.2020.175