

INFLUENCE OF ONLINE LEARNING ON THE ACADEMIC PERFORMANCE OF NCE STUDENTS IN FEDERAL COLLEGE OF EDUCATION KONTAGORA NIGER STATE

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Abstract

This study investigated the influence of synchronous and asynchronous online learning on the academic performance of Biology students in the Federal College of Education, Kontagora, Niger State, Nigeria. The objectives were to determine the effect of synchronous online learning, assess the effect of asynchronous online learning, and compare the performance of students exposed to the two methods. A quasi-experimental pre-test/post-test design was adopted, involving 150 NCE III Biology students purposively selected from a population of 326. Participants were divided equally into two experimental groups: one taught using synchronous online learning (real-time interactive classes) and the other through asynchronous online learning (pre-recorded materials and self-paced study). Data were collected using a Biology Achievement Test (BAT) and analyzed with descriptive statistics, paired samples *t*-test, and analysis of covariance (ANCOVA). Findings showed that students in the synchronous group achieved higher gains (mean difference = 18.4; Cohen's *d* = 1.44) than those in the asynchronous group (mean difference = 9.6; Cohen's *d* = 0.86). ANCOVA confirmed a significant difference ($p < 0.05$) between the two groups, with synchronous learning producing superior outcomes. Students valued synchronous learning for real-time interaction and feedback, while asynchronous learning was appreciated for flexibility and repeated access to materials. Conclusively, both online methods are effective in enhancing learning, synchronous online learning has a stronger impact on Biology students' performance. It was recommended that institutions adopt a blended model that combines the strengths of both approaches to optimize student outcomes.

Keywords: Synchronous learning, Asynchronous learning, online education, Academic performance, Biology students.

Introduction

Education is regarded as a key that unlocks the development of potential personal and national values and all other kinds of rights and powers in the world. Education is the only tool that can guarantee all aspect of human development which includes economic growth, social development, environmental protection, scientific development and employment opportunities in an equitable manner (UNESCO, 2017).

The federal government of Nigeria in order to equip students to live effectively in the modern age of science and technology lays emphasis on science education which is taught at all levels of education and made compulsory at both primary and secondary schools. At tertiary level, biology is one of the important subjects that, formed part of the requirement for admission especially in pure and social sciences programmes and it is part of general studies (science technology and society) for students in many fields of studies in Nigerian colleges, Polytechnics and universities (Adaramola, and Obomanu, 2011).

Academic performance serves as a crucial indicator of a student's overall learning experience and their potential for future success (Farley, Swoboda, Chanvisanuruk, McKinley, Boards and Gilday, 2019). Furthermore, it is suggested that students' views of their academic accomplishment serve as a basis for knowledge acquisition and the learning of skills as well enhancement of talents. It becomes one of the several important components in determining the student academic success (Masud, Mufarrih, Qureshi, Khan, Khan, and Khan 2019) besides student's academic progress and student learning process (York et al., 2015). Ratheeswari (2018) opined that in the digital age, the use of Information and Communications Technology (ICT) allows students to learn and apply the skills that they need in the 21st Century. According to Pusvyta Sari (2015), online learning is an alternative pedagogy for the era of technological development and communication, and students in particular need to adapt. Mat Dawi et al. (2016) found that, in the midst of globalisation and the advancement of ICT, technology-based and online learning is highly encouraged. The management of pedagogical processes should be conducted creatively and undergo innovation to facilitate interaction between teachers and students. By interacting online, instructors and educators remain connected with their students notwithstanding being in different locations (Hussin, 2017). Technology-based teaching and learning techniques should be applied within schools and universities by public or private agencies. These methods should be implemented in accordance with the requirements of digital learning, and participants should experience constant interaction without the need for face-to-face communication (Duff, 2008). Various educational

technologies should be employed to ensure that students feel excited to learn, and to resolve any discrepancies between the consistencies of students' learning experiences online, as opposed to face-to-face.

Statement of the Problem

There is a growing concern regarding the effects of synchronous and asynchronous learning on student performance in biology. With the emergence of remote and online education, educators and students are faced with various challenges in adapting to these new learning formats. A researcher revealed that the use of synchronous or asynchronous model of course delivery alone has gaps that make either cognitive development or practical skills acquisition to be deficient in learners (Neelakandan, 2019). For instance, it has been revealed that students taught through the asynchronous mode displayed higher cognitive achievement while those taught through the synchronous e-learning mode displayed improved skills acquisition (Ogbonna, Ibezim, and Obi, 2019).

The problems that have sparked this study are the challenges related to a lack of awareness about the benefits and potential of synchronous and asynchronous teaching methods, readiness of instructors to adopt technology into their teaching, lack of supportive facilities, technological knowhow of instructors, lack of knowledge of impact of these learning methods on students' motivation and engagement, lack of fund, Irregular power supply and poor network.

Research Questions

The following questions guided the study:

- i. What is the perception of students on synchronous and asynchronous online learning methods
- ii. What is the influence of synchronous online learning on the academic performance of Biology students?
- iii. What is the influence of asynchronous online learning on the academic performance of Biology students?
- iv. How does the academic performance of Biology students differ between those taught using synchronous and asynchronous methods?

1.5 Research Hypotheses

The following null hypotheses were tested at 0.05 level of significance

- H_{01} : There is no significant influence of Synchronous online learning on the academic performance of Biology students.
- H_{02} : There is no significant influence of Asynchronous online learning on the academic performance of Biology students.
- H_{03} : There is no significant difference in academic performance between students taught using synchronous and asynchronous methods.
- There is no significance difference in the perception of student on Synchronous and Asynchronous online learning methods.

Concept of Biology Academic Performance

Okolocha and Nwaukwa (2020) viewed academic performance as degree of knowledge and skills exhibited by students in a subject designed by test scores assigned by the teacher. The authors stated that Biology academic performance is usually measured by tests scores and expressed in a grade or units based on students' achievement in the subject which can only be obtained maximally by innovative instructional strategy. Omwirhiren and Ibrahim (2016) opined that there are many kinds of innovative instructional strategies that have help in greater academic performance in Biology and other science subjects. Examples of such are generative learning instructional strategy, think- pair share instructional strategy, computer based assisted instructional strategy, and self-regulated learning strategy, instructional scaffolding e.t.c.

Díaz-Morales and Escribano (2015), expressed academic performance as the result of a combination of psychological, social, and economic factors, which further lead to the proper multifaceted growth of students. Academic Performance can be defined and categorized in terms of gaining knowledge; acquiring skills and competencies; securing high grades and similar academic achievements; securing a progressive career; and intention and persistence towards education.

Concept of Online Learning

Online teaching and learning is faculty-delivered instruction via the Internet. Online instruction includes real-time (synchronous) and anytime, anywhere (asynchronous) interactions. Online education system is being promoted as the educational pedagogy of the future. The rapid growth of online distance education was started in the late 1990s with the creation of the internet where students learn in a virtual environment (Kentnor, 2015). Nafrees et al., (2020) revealed that online learning is a concept that converts the traditional educational tactics into a new form that transforms in person or physical learning into a virtual approach of learning, where students or teachers doesn't need to be available all

the time, but the learning resources can be accessible 24/7 in the form of video or audio or any other file formats.

Teaching online courses can Offer opportunity to think about teaching in new ways which allow you to experiment with techniques only available in online environments, such as threaded discussions and webliographies. Other techniques, such as web-based course calendars and sample papers posted on the Internet (with student permission) can easily be incorporated into a traditional course. Online teaching can expand existing curriculum to students on a regional, national, and international level. It can be an enormously rewarding experience for teachers.

Types of Online Teaching and Learning

Synchronous Learning Method

Synchronous learning according to Simonson, et al (2012) involves any learning situation that requires the use of digital tools and contents ranging from telephone calls and video conferencing to voice over the internet protocol (VoIP) and video broadcast over the internet to facilitate learning. Equally, Great Schools Partnership (GSP) (2020) defined synchronous distance education as a term mostly used to refer to various forms of televisual, digital, and online learning in which students learn from instructors, colleagues, or peers in real time, but not in person usually through media as educational video conferences, interactive webinars, chat-based online discussions etc. These definitions imply that learning activities that requires the presence of learners and instructors who are separated by physical distance in real time with the use of information technology means and learning platforms such as Google meet, zoom, Microsoft teams, skype, Moodle etc. can be termed synchronous distance learning. Okoulina (2020) referred to synchronous learning as any form of training activity where learners participate simultaneously either online or offline. In the words of Higley (2013), synchronous learning enhances efficient education and provides both the students and teachers the various ways and opportunities to network and share idea and collaborating in real-time. Hrastinki (2008) further added that synchronous learning improves learners and instructor`s relationship which can thus lead to increased students` participation in online study. More so, it has been added that synchronous education facilitates prompt feedback, social interaction, collaboration, student`s engagement etc. (Benett, 2020).

Asynchronous Learning Method

Asynchronous learning on the other hand is a student-centered teaching and learning method that offers learners the opportunity to learn at different times and different location as particular to each learner

(Finol, 2020). The term applies to various forms of digital and online learning in which students learn on their own, at their home, with instruction that is delivered via the internet in real time (Griffith et al., 2021). In asynchronous learning, instructors usually set up learning path which the students can engage with at their own time and pace. According to Littlefield (2018), asynchronous learning entails any kind of distance education that occurs when learners and instructor separated by distance interact together in different time. It often requires the use of such technologies as e-mail, e-courses, online forums, audio recordings and video recordings (Littlefield, 2018).

Viewsonic (2020) expressed asynchronous learning as a type of distance learning in which the learners and the teacher are not communicating directly in real-time. Furthermore, Hammond et al as cited in Dada, et al. (2019) opined that asynchronous education as a type of e-learning which makes learning available and accessible whenever it is required thereby giving learners the flexibility to learn. This is a learning situation that does not require the presence of both students and teachers online simultaneously; thus, teachers can drop learning materials and resources for students through platforms while students go online at their own pace and time to interact with the materials without the supervision of the teacher or instructor. Asynchronous learning has been found to be very beneficial to students. According to Benett (2020), asynchronous learning creates room for convenience and reinforcement in learning, flexibility and learners` control while learning. Consequently, Littlefield (2018) added that asynchronous learning is affordable, flexible, and practicable, increases students` motivation and can be undertaken by students at their own space and time regardless of location. In addition to the above benefits of asynchronous learning, the findings of Hammond et al as pointed out by Dada et al. (2019) revealed that other benefits of asynchronous learning are its flexibility in learning process and content, its cheap nature and the ease with which it can be set up. From the forgoing, it is imperative that the introduction of distance education to the teaching and learning process is a great improvement to the education sector of every nation across the world including Nigeria.

Objectives of the study

The general purpose of this study is to find out the influence of synchronous and asynchronous online learning on the academic performance of biology students in federal college of education Kontagora, Niger State, Nigeria. The specific objectives are to:

- i. To determine the difference between the scores (Pre-test/Post-test) of synchronous online learning on the academic performance of Biology students in Federal College of Education Kontagora.

- ii. To determine the difference between the scores (Pre-test/Post-test) of asynchronous online learning on the academic performance of Biology students in Federal College of Education Kontagora
- iii. To compare the academic performance of Biology students exposed to synchronous and asynchronous learning methods.

Methodology

This study adopts a quasi-experimental pre-test, post-test design with two experimental groups to investigate the influence of synchronous and asynchronous online learning modes on students' academic performance. The design is appropriate because it involves intact classes (not randomly assigned) and aims to measure the effect of two different instructional interventions on comparable groups of students.

Population of the Study

The participants of the study comprised of all the Three Hundred and Twenty Six (326) NCE III Biology Students in Federal College of Education Kontagora, Niger State.

Sample and Sampling Techniques

This research used a purposive sampling strategy to choose a sample of 150 NCE III Biology students. Students who satisfied the prerequisites for synchronous and asynchronous online learning—access to a computer or mobile device with reliable internet connection—were chosen using a purposive sampling technique.

The 150 students were divided into two groups for the experiment:

- Experimental Group 1 (Synchronous Learning) – 75 students
- Experimental Group 2 (Asynchronous Learning) – 75 students

Random assignment into the groups ensured that each participant had an equal chance of being placed in either of the two groups, helping to control for biases and maintain internal validity. This sample size was chosen to allow for effective comparison of performance outcomes between the two modes of online instruction while ensuring manageability of the intervention and data collection processes.

Instrumentation

A Biology Achievement Test (BAT) and a structured student perception and experience on synchronous and asynchronous online methods questionnaire were the two primary tools used to gather data in this research. The study's three research objectives and their associated hypotheses were investigated using data generated by these instruments.

Structured Questionnaire

The questionnaire was designed by the researcher to assess students' perceptions and experiences of synchronous and asynchronous online learning. It was divided into four sections:

- **Section A: Demographic Information**

This section collected basic information such as gender, age, and previous exposure to online learning.

- **Section B: Synchronous Online Learning and Academic Performance**

This section contained items to explore students' engagement, motivation, and comprehension during live, real-time online instruction.

- **Section C: Asynchronous Online Learning and Academic Performance**

This part focused on how students experienced flexibility, self-paced learning, and access to recorded content and whether these influenced their understanding of Biology concepts.

- **Group A** received instruction through synchronous online learning (real-time interaction via platforms like Zoom or Google Meet).
- **Group B** received instruction through asynchronous online learning (pre-recorded lectures, notes, and discussion forums without real-time interaction).

Both groups were given a pre-test before the intervention to assess their baseline knowledge and a post-test after the intervention to measure learning outcomes. The difference between the pre- and post-test scores were analysed to determine the effectiveness of each instructional method. This design allows for a comparative analysis of the academic performance of students under the two learning strategies without the need for a control group, as the aim is not to compare with a traditional or no-intervention group, but to determine which of the two online methods is more effective.

Symbolic Representation of the Design:

- Group A (Synchronous): $O_1 — X_1 — O_3$
- Group B (Asynchronous): $O_2 — X_2 — O_4$

Where:

- O_1 and O_2 = Pre-tests for the two groups

- X_1 = Synchronous online learning treatment
- X_2 = Asynchronous online learning treatment
- O_3 and O_4 = Post-tests for the two groups

This design is suitable for the objectives of the study, as it allows the researcher to:

- Determine the individual effects of each method, and
- Compare the effectiveness of synchronous and asynchronous learning in enhancing academic performance.

Reliability of the Instrument

A pilot research was carried out with 30 non-participating NCE III Biology students from College of Education Minna to ascertain the reliability of the questionnaire. For the purpose of evaluating internal consistency, Cronbach's Alpha was applied to the replies. According to the results, the questionnaire was quite reliable (overall reliability coefficient = 0.83).

Biology Achievement Test (BAT)

The Kuder-Richardson Formula 20 (KR-20), designed for items with a binary score (right or incorrect), was used to determine the BAT's dependability. Thirty of the same students that took the pilot exam also took the final exam. The resulting KR-20 reliability value of 0.82 indicates that the BAT is a valid and reliable instrument for assessing Biology course performance due to its high level of internal consistency.

Result of Findings

Effect of Synchronous Online Learning on Academic Performance (Objective One / H_{01})

Testing of Hypothesis One (H_{01}): t-test Results for Synchronous Online Learning Group

Variable	N	Mean	SD	Mean Difference	SE	95% CI	t	df	p	Cohen's d
Pre-test	75	49.5	12.8							
Post-test	75	67.9	15.0							

Paired	18.4	0.254	[17.89,	72.44	74	<0.001	1.44
Difference			18.91]				

The findings from the above Table shows that students taught using synchronous online learning experienced a statistically significant improvement in performance. Their mean scores increased from 49.5 (SD = 12.8) at pre-test to 67.9 (SD = 15.0) at post-test, representing a mean gain of 18.4 points ($t(74) = 72.44, p < 0.001$). The effect size (Cohen's $d = 1.44$) indicates a very large practical effect, suggesting that synchronous online learning had a profound impact on student achievement. This improvement can be attributed to the interactive nature of synchronous learning, which allows real-time communication, immediate feedback, and collaborative discussions. As observed in Table 4.2, over 66% of students agreed that real-time interaction with their instructor improved their understanding, and a similar proportion endorsed immediate feedback as enhancing learning. These findings reflect the importance of social presence and immediacy, which are central benefits of synchronous platforms.

The results align with Hrastinski (2008), who highlighted that synchronous e-learning fosters active participation, emotional engagement, and direct clarification of concepts. Likewise, Dumford and Miller (2018) found that synchronous modalities enhance student engagement and satisfaction compared to fully asynchronous environments. A study by Martin, Sun, and Westine (2020) further corroborates this, concluding that synchronous sessions improve accountability and promote collaborative learning, which directly contributes to higher academic outcomes. Nevertheless, challenges were reported. Nearly 48% of students disagreed that technical difficulties had no effect on their learning (Table 4.2, Item 10), indicating that unstable internet and connectivity issues remain significant barriers. This is consistent with Onyema et al. (2020), who observed that bandwidth instability is one of the greatest hindrances to synchronous learning in Nigerian higher education. Adedoyin and Soykan (2020) also emphasized that infrastructural limitations can limit the effectiveness of synchronous approaches, especially in developing contexts.

In conclusion, the rejection of H_{01} is strongly supported by the data and corroborating literature. Synchronous online learning demonstrably improves Biology students' academic performance, though its success is contingent on stable internet infrastructure.

Effect of Asynchronous Online Learning on Academic Performance (Objective Two / H_{02})

Testing of Hypothesis One (H_{02}): t-test Results for Asynchronous Online Learning Group

Variable	N	Mean	SD	Mean Difference	SE	95% CI	t	df	p	Cohen's d
Pre-test	75	50.1	11.1							
Post-test	75	59.7	12.0							
Paired Difference				9.6	0.104	[9.39, 9.81]	92.31	74	<0.001	0.86

The table above shows that the asynchronous group's mean score rose from 50.1 (SD = 11.1) at pre-test to 59.7 (SD = 12.0) at post-test—a mean gain of 9.6 points that was statistically significant (reported t and p values indicate significance) with a large practical effect (Cohen's $d \approx 0.86$). This directly supports the rejection of H_{02} and indicates that asynchronous learning positively influenced Biology achievement. These gains are consistent with the broader evidence base that shows Self-Regulated Learning (SRL) as the primary mechanism through which asynchronous environments improve outcomes. In a systematic review of online higher education, Broadbent and Poon (2015) found that SRL strategies—time management, goal setting, and metacognitive monitoring—are positively associated with academic achievement, all of which are naturally scaffolded by self-paced, resource-rich asynchronous designs.

Recorded micro-lectures and re-watchable materials enable repeated exposure and targeted review of difficult concepts. Large-scale MOOC analytics (6.9 million viewing sessions) demonstrate that well-produced, concise videos significantly improve student engagement—an important precursor to learning in asynchronous areas (Guo, Kim, & Rubin, 2014). Your students' reported appreciation of recorded lectures and flexible access aligns with these findings. From a theory standpoint, the Community of Inquiry (CoI) framework explains why asynchronous discussion forums, reflective prompts, and structured weekly tasks can foster cognitive presence—the construction and confirmation of meaning through sustained reflection and discourse—ultimately supporting deeper understanding of disciplinary content. When designed with clear teaching presence (structure, facilitation, feedback cycles), asynchronous spaces can yield robust learning even without real-time meetings (Garrison et. al., 2001). At the same time, students noted delays in feedback and occasional feelings of isolation, which are well-documented limitations of purely asynchronous delivery. Meta-reviews and commentaries caution that limited immediacy can depress motivation and persistence if instructors do not proactively engineer feedback loops and social presence (e.g., scheduled check-ins, prompt responses, and multimedia

feedback). Retention research in online courses similarly flags lack of timely interaction as a contributor to attrition risk (Bawa, 2016). Finally, in bandwidth-variable settings like Nigeria, asynchronous delivery is more resilient than synchronous video because students can download materials and engage off-peak; this mitigates inequities tied to unstable internet—an issue repeatedly identified in developing-context studies. The positive gains you observed despite connectivity variability are therefore aligned with the literature showing asynchronous modalities can buffer infrastructure constraints while still improving achievement (Al-Azawei et. al., 2017).

Given the statistically and practically significant pre-test to post-test gains, and in line with the corroborating literature, H_{02} is rejected. Asynchronous online learning significantly improves Biology students' academic performance, particularly when courses explicitly support self-regulation, provide concise, replay able instructional media, and establish regular feedback to counteract delays inherent in non-real-time instruction.

Comparative Influence of Synchronous and Asynchronous Learning (Objective Three / H_{03})

Table 4.9.2: Adjusted Means and Standard Errors

Group	Unadjusted Mean	Adjusted Mean	Standard Error	95% CI
Synchronous	67.9	67.6	0.53	[66.6, 68.7]
Asynchronous	59.7	60.0	0.53	[58.9, 61.1]
Mean Difference	8.2	7.6	0.75	[6.1, 9.1]

The ANCOVA results table demonstrate a clear and statistically robust advantage for synchronous online learning in this study. After controlling for pre-test scores, the synchronous group obtained an adjusted mean of 67.6 compared to 60.0 for the asynchronous group (adjusted mean difference = 7.6, $F(1,147) = 136.4$, $p < 0.001$, partial $\eta^2 = 0.481$). The effect-size indicators (partial $\eta^2 = 0.481$; adjusted Cohen's $d \approx 0.58$) indicate a substantive—practically meaningful—difference attributable to learning mode. Synchronous learning affords real-time interaction, immediate clarification of misconceptions, and dynamic instructor feedback-factors closely tied to improved conceptual understanding and task motivation. Hrastinski (2008) and Fabriz et al. (2021) discuss how synchronous sessions increase social presence and perceived competence, which often translate to better engagement and performance. Students from the data reported that real-time interaction and immediate feedback improved understanding (Table 4.2), and synchronous learners rated teacher-student relationships more positively

(Table 4.4). These process advantages plausibly contributed to the larger gain scores in the synchronous group.

Biology often involves conceptual reasoning, procedural skills, and for some topics visual or lab-like demonstrations that benefit from real-time interaction. A comparative study in a biomedical statistics course found that 96.7% of students in synchronous sessions reported fairly or clearly understanding concepts, versus only 56.7% in asynchronous sessions ($P < 0.001$), with significantly higher confidence in problem-solving among synchronous learners ($P < 0.05$) (Yadav et. al. 2021). These results illustrate that synchronous formats can facilitate immediate clarification and reinforce cognitive confidence particularly critical for science disciplines like Biology where real-time feedback on complex ideas matters. Meta-analytic and comparative studies report mixed results, some meta-analyses find trivial or small advantages for asynchronous learning, while others find small advantages for synchronous formats or no meaningful difference overall. For example, a recent meta-analysis reported a very small advantage favoring asynchronous learning across diverse disciplines (Zeng & Luo, 2023), whereas other syntheses and empirical studies emphasize small synchronous benefits for cognitive outcomes or greater student satisfaction in synchronous settings (Ebner & Gegenfurtner; Fabriz et al., 2021). These divergent results show that effect size depends on course design, discipline, student engagement, feedback strategies, and infrastructural aspect.

Conclusion

Examining the effects of both real-time and delayed online instruction on the academic achievement of Biology majors at Kontagora's Federal College of Education was the primary goal of this research. The following findings were obtained from the analyses:

Learning Biology via synchronous online learning is a game-changer. Evidence suggests that students develop a deeper knowledge and perform better when exposed to real-time interactive training, which includes live conversations, collaborative activities, and quick feedback. Students' post-test scores show much larger improvements in this kind of instruction. There is a considerable improvement in performance with asynchronous online learning as well. Meaningful academic improvements were shown by students in this group, demonstrating that learning is successfully supported by flexibility, recurrent access to recorded lectures, and supplemental resources. In contrast to synchronous learning, nevertheless, the improvement was less substantial.

It is better to study in real time rather than at a later date. By comparing adjusted post-test averages, we found that synchronous training significantly outperformed asynchronous instruction in terms of learning gains. This distinction highlights the need of being present and immediate in order to succeed academically in science-based courses such as Biology.

Both approaches have their uses, and they're both effective. Although synchronous learning yields better performance results, asynchronous learning is more adaptable and can overcome obstacles caused by bad internet connection. It follows that a mixed model combining the two approaches would provide the best possible learning results by capitalising on the unique qualities of each.

Recommendations

- Teachers of Biology should incorporate synchronous online learning strategies such as real-time discussions, live demonstrations, and immediate feedback, since these approaches significantly improved student performance.
- Instructors should not rely solely on synchronous methods; they should also integrate asynchronous components (e.g., recorded lectures, online resources, discussion boards) to allow students flexibility and opportunities for repeated review.
- Students should be encouraged to actively participate in synchronous sessions to maximize opportunities for immediate clarification of concepts.
- Peer-learning groups can be promoted to enhance collaborative engagement, especially in asynchronous settings.
- The Federal College of Education, Kontagora, and similar institutions should invest in stable internet infrastructure, digital platforms, and ICT resources to support effective online teaching and learning.

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