

Student's perspectives, satisfaction and experiences with online and classroom learning during the COVID-19 pandemic: Findings and implications on blended learning

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Abstract

Objectives: The coronavirus disease 2019 (COVID-19) pandemic disrupted classroom-based learning, necessitating the adoption of online learning in most universities. However, there has been a lack of information on university students' perspectives regarding online learning during the COVID-19 pandemic. This study assessed the perspectives, satisfaction and experiences with online and classroom learning among human health students at the University of Zambia.

Methods: This cross-sectional study was conducted among 737 students at the University of Zambia from October 2022 to April 2023. Data were analysed using Stata version 16.1.

Results: Of the 737 participants, 51.6% were female and 56.5% agreed that blended learning should continue even after the COVID-19 pandemic. However, 78.4% of the students believed that group discussions were more suitable in the classroom than online learning. Most students (67.1%) disagreed that they preferred online learning to classroom learning. Furthermore, 77.6% of the students disagreed that online learning gave more satisfaction than classroom learning.

Conclusions: This study found that most students recommended the continuation of blended learning after the pandemic. However, they believed that follow-up tutorials and assessments were better undertaken in physical classrooms than online learning. These findings are important in sensitising stakeholders in the education sector and governments to consider

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blended learning as a teaching strategy in the future. There is a need to develop and implement curricula that offer blended learning to students as well as ensure the students have the necessary facilities and equipment to support such learning.

Keywords

Blended learning, classroom learning, e-learning, online learning, satisfaction, university students, Zambia

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Introduction

The coronavirus disease 2019 (COVID-19) and its consequences appreciably impacted many facets of life globally, including the education sector.^{1–4} Due to the high transmissibility and rapid spread of COVID-19, lockdown measures were rapidly instigated across countries as key mitigation measures to curb the pandemic in the absence of effective treatments and vaccines certainly initially.^{5–9} The consequent closure of universities and other educational establishments appreciably impacted learning programmes.^{1,3,10–13} Both students and academic staff were left to grapple with adjusting to online learning as well as grappling with concerns about the affordability of the necessary information and communication technology (ICT) equipment, internet bundles and approaches to effectively instigate online learning, especially among low- and middle-income countries (LMICs).^{1,14–20} In the case of healthcare students, this included the added problems of conducting practical sessions as well as teaching patient care, which resulted in a rapid move towards simulations.^{1,21,22}

Online learning, also referred to as e-learning, involves providing education services to students using electronic media including computers, smartphones and tablets.^{23–29} Various platforms are currently being used to deliver e-learning lectures and other educational approaches, including Moodle, Zoom, Microsoft Teams, Blackboard and Google Meet.^{30–32} However, this mode of learning has suffered setbacks, especially in resource-limited settings where universities were initially inadequately equipped to teach online effectively and lecturers were unfamiliar with these techniques.^{1,33,34} In addition, and, as mentioned, there were challenges for students in terms of the necessary ICT equipment in addition to mobile phones, the prohibitive cost of internet bundles without financial support, having a quiet room available to listen and take part in lectures, workshops and simulations as well as adapting to e-learning approaches.^{1,3,35,36} Students, and lecturers alike, have reported different experiences regarding online learning.^{37–44}

Most students from LMICs expressed challenges to online learning initially at the start of lockdown measures. Challenges included a lack of resources to purchase the necessary equipment required for online learning.^{1,3,45–48} In addition, typically poor internet connectivity,^{49–51} power cuts⁵² as well as living in remote areas with often a lack of a learning environment^{35,50,53} and poor infrastructure for online learning.^{51,54,55} These circumstances have all been cited to

impact negatively on this mode of learning. Moreover, many students certainly initially found difficulties in learning certain subjects associated with their inherent complexities, using online platforms and the lack of extended and more personalised faculty support.^{1,56} The lack of technical support was also cited as a main barrier to online learning as computer literacy was quite low among students in some countries.^{1,57} Alongside this, many students experienced mental health challenges as they could not handle the physical school closures and initiation of online learning.^{53,54} Anxiety, depression and stress have all been reported among learners during the establishment of online learning.^{4,54,58–64}

However, after lockdown measures were lifted, learning institutions typically continued providing online learning alongside physical classes.^{65–69} The incorporation of online and classroom (face-to-face) learning, commonly referred to as blended learning,^{70,71} offers many benefits over physical learning alone.⁷² Blended learning approaches ensure that learning continues even during the closure of educational establishments,^{73,74} as well as promoting distance learning, which has a wider reach beyond the limits of the physical infrastructure of an institution.^{71,73} Additionally, students can download lectures and material at a time convenient to them.⁷⁵

In Zambia, the first case of COVID-19 was reported on 18 March 2020^{1,8,76,77} followed shortly afterwards by the instigation of comprehensive lockdown measures to contain the spread of the disease, which included the closure of educational establishments.^{1,8} Consequently, most universities in Zambia introduced online learning using Moodle, Google Meet and Zoom to ensure that students continued with their academic activities synchronously and asynchronously.^{35–78} When the COVID-19 threat subsided, and strict social-distancing restrictions including lockdowns were lifted, most institutions of higher learning continued offering online learning in addition to the traditional physical classes, in line with approaches in higher-income countries.⁷⁴ Some of the activities that were being, and still offered, through online learning include lectures, tutorials, assignments, tests and theoretical examinations. Skills-based learning, such as clinical rotations, laboratory sessions, dispensing sessions and community-based education, are now typically undertaken in face-to-face sessions.

Despite these developments, and given today's uncertainty, gaining a differentiated understanding of Zambian students concerning online and classroom learning during

the COVID-19 pandemic is critical for current and future considerations. This builds on a re-assessment of the measures taken to address the challenges among LMICs with the introduction of lockdown measures.³ Consequently, this study sought to answer the following questions: Do students prefer online learning to classroom learning? Alternatively, do students prefer blended learning compared to online learning alone or traditional classroom learning alone? Given this background, this study aimed to address this evidence gap by assessing students' perspectives, satisfaction and experiences with online and classroom learning in Zambia. The results can be used to guide future learning approaches among students in Zambia including future hybrid learning approaches ready for future pandemics.

Materials and methods

Study design, settings and population

This cross-sectional study was conducted from October 2022 to April 2023 among human health students at the University of Zambia (UNZA) in line with the STROBE guidelines. This institution was chosen because it is the largest public university in Zambia that offers training in various health and non-health programmes. To be eligible, a student needed to be registered with UNZA, Ridgeway Campus, in human health programmes including medicine, pharmacy, biomedical sciences, nursing sciences, public health, physiotherapy and radiography and should have provided informed and written consent. Additionally, the study included students from first year up to the final year of study, which included those who had been through the pandemic. The students were informed about the purpose of this study before the request for their voluntary participation. We excluded all students who refused to participate in the study and those who were not from the Ridgeway Campus.

Sample size estimation and sampling criteria

The sample size was estimated using Taro Yamane's formula as described by Charan and Biswas.⁷⁹ Using a margin of error of 5%, a conservative proportion estimate of 50%, and a finite population of 1895, the minimum sample size was estimated to be $n=331$. A 10% non-response rate was anticipated and this gave a sample size of 364. Finally, using a design effect of 1.5, we obtained a sample size of 546. We used a convenient sampling technique, and a total of 750 questionnaires were distributed among University of Zambia human health students.

Ethical approval

This study was approved by the University of Zambia Health Sciences Research Ethics Committee (UNZAHSREC) with an approval number of 202211231184. Participation in the study was voluntary after students were informed of the

purpose of the study. All participants provided verbal and written consent before filling in the questionnaire. Confidentiality was assured and no identifiable personal information was obtained from the participants.

Data collection

A structured questionnaire from a previous study was adopted for the present study.¹⁶ The questionnaire was reviewed for content and face validation by experts from the University of Zambia. Additionally, a pilot study was conducted among 20 students at the University of Zambia to check for the simplicity and feasibility of the questionnaire. Subsequently, no changes were made to the adopted questionnaire. A Cronbach's alpha of 0.880, indicating acceptable internal consistency, was used to determine the reliability of the questionnaire.¹⁶

The questionnaire had four sections. These included Section A (socio-demographic characteristics of participants: gender, age, marital status, employment status and the year of study); Section B (three questions on the perceptions of participants on online and classroom learning during the COVID-19 pandemic); Section C (seven questions on the effectiveness of online learning); and Section D (seven questions on students' satisfaction with online and classroom learning). All the questions from Sections B to D had five responses and were scored using a 5-point Likert scale as follows: strongly disagree (1), disagree (2), neutral (3), agree (4) and strongly agree (5).⁸⁰⁻⁸² The minimum and maximum score for satisfaction was 5 and 25, respectively. Participants who scored less than the mean score were considered dissatisfied towards online learning. Those who scored equal to, or above, the mean score was regarded as satisfied. To report the results, agreed and strongly agreed were reported as agreed or satisfied, whereas neutral, disagreed and strongly disagreed were reported as disagreed or dissatisfied. We also reported the mean score out of five (5) scores for each of the responses under students' perspectives on online learning in order to ascertain the most preferred learning mode and effectiveness of online learning. Scores above the overall mean (2.8 ± 0.8) were considered as preference for online learning. Two focal data collectors were responsible for data collection at the institution. Data were collected from October 2022 to April 2023 using a self-administered structured paper-based questionnaire. Information about the demographics, and the experiences of students regarding accessibility, engagement and preference for online learning were obtained.

Statistical analysis

Data were first entered into Excel for cleaning and logic checks. Data analysis was done using Stata version 16.1 (Stata Corp, College Station, TX, USA). Descriptive statistics computed on sample characteristics include frequencies,

Table 1. Socio-demographic characteristics of participants' comparisons of satisfaction levels with online learning ($n = 737$).

Variable	Category	Total population	Unsatisfied	Satisfied	p-Value
		n (%)	n (%)	n (%)	
Gender	Female	380 (51.6)	191 (50.3)	189 (49.7)	0.787
	Male	357 (48.4)	183 (51.3)	174 (48.7)	
Age (years)	18–23	378 (51.3)	210 (55.7)	168 (44.4)	0.0001
	24–29	236 (32.0)	122 (51.7)	114 (48.3)	
	30–35	68 (9.2)	25 (36.8)	43 (63.2)	
	>35	55 (7.5)	15 (37.5)	25 (62.5)	
Marital status	Married	90 (12.2)	35 (38.9)	55 (61.1)	0.016
	Unmarried	647 (87.8)	339 (52.4)	308 (47.6)	
Employment status	Employed	195 (26.5)	68 (34.9)	127 (65.1)	0.0001
	Unemployed	542 (73.5)	306 (56.5)	236 (43.5)	
Year of Study	First-year	5 (0.7)	3 (60)	2 (40)	0.065
	Second-year	139 (18.9)	75 (54.0)	64 (46.0)	
	Third-year	245 (33.2)	135 (55.1)	110 (44.9)	
	Fourth-year	146 (19.8)	77 (52.7)	69 (47.3)	
	Fifth-year	152 (10.6)	63 (41.5)	89 (58.6)	
	Sixth-year	10 (1.4)	5 (50.0)	5 (50.0)	
	Seventh-year	7 (0.9)	5 (71.4)	2 (28.6)	
	Postgraduate	33 (4.5)	11 (33.3)	22 (66.7)	

percentage and the results were presented in tables and figures. To identify factors associated with satisfaction with online learning, unadjusted logistic regression was performed initially. Variables with a p -value < 0.2 were considered in the adjusted regression analysis. The variables with a $p < 0.05$ in adjusted logistic regression were considered as the factors that affected university students' satisfaction with online learning during the COVID-19 pandemic. The level of statistical significance was set at 0.05.

Results

Socio-demographic characteristics of study participants

Of the 737 students that participated in this study, 380 (51.6%) students were females and 51.3% of them were aged between 18 and 23 years. The majority of the participating students (87.8%) were unmarried with 73.5% currently unemployed (Table 1).

Students' preferred mode and effectiveness of learning

Most students (56.5%) agreed that blended learning should continue after the COVID-19 pandemic. The overall mean score for the preferred learning mode among students was 2.8 (SD \pm 0.8) (Table 2). Furthermore, 78.4% of participating students agreed that group discussions were more suitable when delivered in a classroom learning environment (Table 2).

Student's satisfaction with online learning

Most students (54.1%) felt that online learning gives them opportunities to cheat during assessments. However, most students, (56.7%) and (67.1%) respectively, disagreed that they studied more efficiently with online learning and liked it more than classroom learning. The majority (77.6%) of participating students disagreed with the statement that 'online learning gives more learning satisfaction than classroom learning' (Figure 1).

Factors associated with satisfaction with online learning

In the unadjusted model, students in the 30–35 years age range crude odds ratio (COR = 2.2, 95% CI: 1.26–3.67, $p = 0.005$) and those aged > 36 years (COR = 8.1, 95% CI: 1.81–36.5, $p = 0.006$) were more likely to be satisfied with online learning. Employed (COR = 0.4, 95% CI: 0.29–0.58, $p = 0.0001$) and unmarried students (COR = 0.6, 95% CI: 0.37–0.91, $p = 0.017$) were less likely to be satisfied with online over classroom learning. Variables that were significant at a level of $p < 0.2$ were fitted in the adjusted logistic regression model to determine key factors associated with satisfaction with online learning. Students aged > 36 years adjusted odds ratio (AOR = 5.1, 95% CI: 1.06–24.7, $p = 0.042$) were more likely to be satisfied with online learning while those who were employed (AOR = 0.5, 95% CI: 0.31–0.67, $p = 0.002$) were less likely to be satisfied with online learning (Table 3).

Table 2. Students' perspectives on online learning ($n=737$).

Attributes	A (%)	D (%)	N (%)	SA (%)	SD (%)	Mean (\pm SD)
Student's learning mode preferences						
Blended learning should continue even after the pandemic	36.8	14.9	12.7	19.7	15.9	3.3 \pm 1.4
Clarification sessions are more suitable for online learning	19.0	39.9	11.8	9.5	19.8	2.6 \pm 1.3
Assessments are more suitable for online learning	12.6	33.9	24.3	8.3	20.9	2.5 \pm 1.2
Effectiveness of online learning						
Group discussions are more suitable delivered in classroom learning	41.6	7.7	11.7	36.8	2.2	4.0 \pm 1.0
I do not experience stress during online learning	21.8	31.8	17.2	6.8	22.4	2.6 \pm 1.2
I do not experience any problems during online learning	7.6	45.6	9.9	3.8	33.1	2.0 \pm 1.0
I have more time to prepare learning materials before group discussions with online learning	32.4	26.3	22.3	10.9	8.1	3.1 \pm 1.2
I have more time to review all of the learning materials after class with online learning	26.5	28.2	25.8	6.6	12.9	2.9 \pm 1.1
I recommend blended learning at our university	36.0	15.4	15.6	19.4	13.6	3.3 \pm 1.3
I recommend online examinations in future at our university provided online platforms are effective and secure	25.6	23.3	17.6	12.5	20.9	2.9 \pm 1.3

SD: strongly disagree; DA: disagree; N: neutral; A: agree; SA: strongly agree.

Discussion

We believe this is the first study in Zambia to assess students' perspectives of and satisfaction with online and classroom learning to provide future guidance to all key stakeholder groups. Our study found that most students felt that blended learning should continue during and after the pandemic. Additionally, most students felt that lecture clarifications and group discussions were more suitable when delivered in classroom learning. Students who were aged above 36 years of age were more likely to be satisfied with online learning.

Most students in our study were in favour of the continuation of blended learning post-COVID-19 pandemic, similar to the findings from the UK.^{65,74} In addition, similar findings were reported from studies that were conducted across developed and developing countries including Sweden,⁸³ Bahrain,⁶⁷ Kazakhstan,⁸⁴ Saudi Arabia,⁸⁵ Kenya,⁸⁶ India,⁸⁷ Malaysia⁸⁸ and Bangladesh.³ This is because blended learning offers many benefits to teachers and students including continued learning even with the closure of physical classes.⁸⁹ Furthermore, it improves the efficient use of time by avoiding challenges with double-booked venues as well as the lateness of the lecturer or unavoidable delays among students.^{86,88,90} Furthermore, blended learning also promotes social interaction among students as opposed to purely online learning, which tends to motivate their learning.^{83,91} On top of this, blended learning also encourages students to learn at their own pace, subsequently motivating many students who may struggle in purely classroom learning situations.⁷⁴ However, the limitations posed by the available teaching technology infrastructure within lecture halls in LMICs can make it a challenge to demonstrate complex processes or concepts that require the use of a projector, screen, appropriate accessories including complex lighting and other technological issues.^{92,93} Consequently, being able to engage

students through their ICT equipment during online learning can be an effective way to bridge this infrastructure gap, and we will be exploring this further in the future.

The majority of students in our current study disagreed with the view that lecture clarifications were better when undertaken online as opposed to physical classroom lessons. This is similar to findings from studies conducted in the Czech Republic⁹⁴ and Australia⁹⁵ where most students reported that lecture clarifications were better when undertaken in face-to-face learning than online. Another study in India also confirmed this by revealing that most students did not favour online learning alone because they were not satisfied with the clarifications as well as the relevance of the study materials that were given to them.⁹⁶ These findings are also similar to those reported in a study conducted in Bahrain where students and faculty members were more satisfied with face-to-face learning and preferred this mode of learning and teaching over e-learning in this situation.⁹⁷ Similar findings have been seen in Kenya,⁹⁸ Jordan,¹⁷ Tukey⁹⁹ and India.¹⁰⁰ However, other studies have reported that students experienced more satisfaction with online learning during the COVID-19 pandemic.^{16,101–103} The differences in these findings could partially be due to the different challenges faced by students when accessing online learning and some topics that require physical skills-based learning. In addition, difference in funding for pertinent ICT equipment and training between countries at the start of the pandemic.

There were also concerns with online learning in our study in terms of the potential level of interaction with lecturers and fellow students during the lecture or workshops. Alongside this, most students in our study felt that online learning did not give similar or more satisfaction compared to face-to-face learning. However, our findings are in contrast to those reported in Indonesia where students felt that clarifications were better when performed online.¹⁶ These

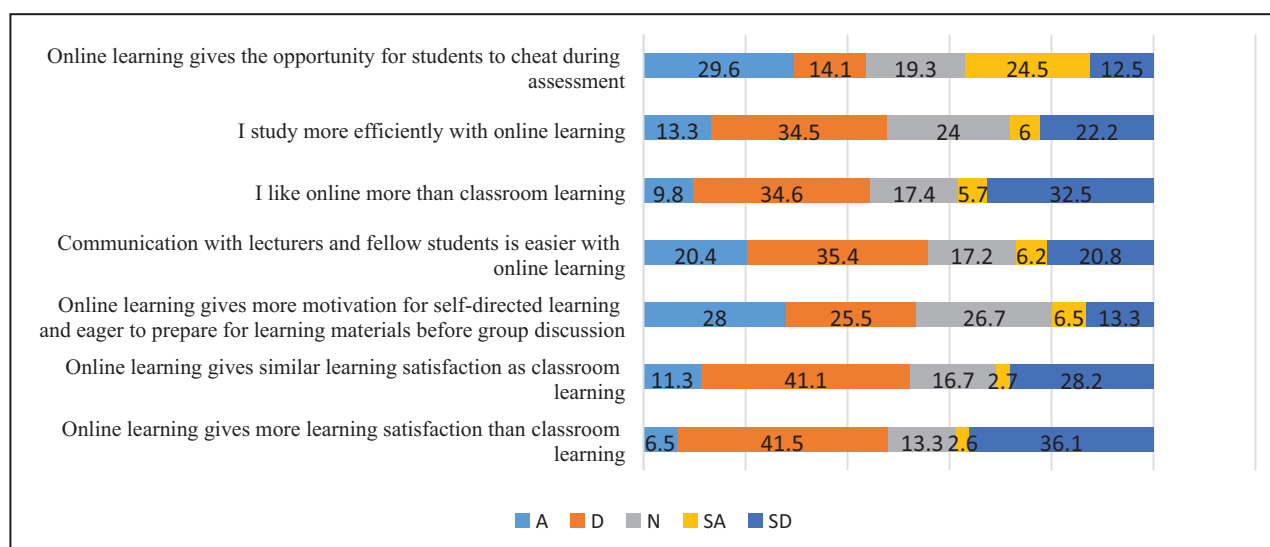


Figure 1. Student satisfaction with online learning ($n=737$).
A: agree; D: disagree; N: neutral; SA: strongly agree; SD: strongly disagree.

Table 3. Bivariate and multivariate logistic regression analysis of factors associated with satisfaction with online learning.

Variable	Category	Unadjusted			Adjusted		
		COR	95% CI	p-Value	AOR	95% CI	p-Value
Gender	Female	1					
	Male	1	0.72–1.28	0.787	–	–	–
Age (years)	18–23	1					
	24–29	1.2	0.84–1.62	0.351	1.1	0.76–1.49	0.705
	30–35	2.2	1.26–3.67	0.005**	1.5	0.72–3.02	0.277
	>36	8.1	1.81–36.5	0.006**	5.1	1.06–24.7	0.042*
Employment	Unemployed	1					
	Employed	0.4	0.29–0.58	0.0001**	0.5	0.31–0.67	0.002*
Marital status	Married	1					
	Unmarried	0.6	0.37–0.91	0.017**	0.93	0.70–2.74	0.357
Year of study	First-year	1					
	Second-year	1.3	0.21–7.90	0.79	–	–	–
	Third-year	1.2	0.20–7.44	0.828	–	–	–
	Fourth-year	1.3	0.22–8.28	0.75	–	–	–
	Fifth-year	2.1	0.34–13.1	0.418	–	–	–
	Six-year	1.5	0.17–13.2	0.715	–	–	–
	Seventh-year	0.6	0.52–6.79	0.68	–	–	–
	Postgraduate	3	0.43–20.7	0.265	–	–	–

COR: crude odds ratio; AOR: adjusted odds ratio; CI: confidence interval.

**p-value < 0.2 in the unadjusted model, *p-value < 0.05 in the adjusted model.

differences could be due to challenges that students from LMICs usually experience, including poor internet connectivity, electricity cuts, expensive internet bundles and a lack of internet gadgets.³⁵ However, further research is necessary before we can say anything with certainty. Poor internet connectivity demotivates students from attending online classes,^{96,104–106} and negatively affected their satisfaction and perception of e-learning.^{104,105,107} This needs to be addressed

especially among LMICs if both students and faculty members are to take full advantage of the potential for blended learning. Additionally, there have been concerns that teachers did not offer online learning properly, which can be demotivating for students.⁹⁴ This though has now been addressed in many LMICs by offering courses and training to lecturers on optimal ways to deliver online lectures and tutorials.³

Similarly, in our study, students found that group discussions conducted within classroom settings were more favoured by them compared to online discussions, similar to studies conducted in Kenya,⁸⁶ Egypt,¹⁰⁸ Jordan¹⁷ and India.⁹⁶ This is because it can be challenging to maintain discussions virtually due to several deterrents. Deterrents include distractions in the home environment, especially if there is no designated quiet room, challenges with internet connectivity, incompatible software, online platforms that are not user-friendly as well as power outages.^{51,109,110}

Most students in our study also preferred writing assessments (theoretical tests and examinations) physically than online. This is because of concerns with the integrity of online assessments, similar to the findings from Australia¹¹¹ Norway¹¹² and Jordan.¹¹³ However, some studies reported that students preferred online assessments to physical assessments because of their convenience.^{16,114} These differences could be due to variations in the effectiveness and implementation of online learning across countries coupled with measures put into place to ensure the integrity of any work submitted.¹ However, our current study revealed that most students did not prefer online-based examinations even if the credibility of the assessments was assured. Given these concerns, there is a conscious need to strengthen the infrastructure that can support an online learning environment for examinations. This is because our study findings align with those reported in Jordan, where students did not prefer online examinations as there was time to prepare for exams and potential dishonesty among candidates.¹¹³ Additionally, most students in our study did not study efficiently using online platforms and thus preferred face-to-face learning to e-learning. These findings though contrast with reports from Norway where most of the students preferred online examinations online than the physical ones on campus.¹⁰³ Similarly, a study in Spain also found that veterinary students preferred online examinations written from home.¹¹⁵ These differences could again be due to the many challenges that still exist within LMICs to take full advantage of the potential for blended learning.¹¹⁰ However, this is beginning to change.³

More efforts are needed among universities in LMICs regarding blended learning as the majority of the students in our study experienced stress and other problems due to online learning during the COVID-19 pandemic. These findings corroborate reports from other studies.^{116–119} This could be due to most students being exposed to online learning for the first time, which is now changing.³ Additionally, the challenges experienced by the students during online learning, which could have contributed to stress and other mental health problems.^{2,10,11,14}

Encouragingly, the majority of the students in the current study agreed they had enough time to prepare learning materials before having group discussions online. However, they stated that they did not have enough time to review all their learning materials after having online classes. Our findings are in agreement with reports from an Egyptian study where

most students did not have enough time to review their learning materials after online classes causing them to spend a lot more time on learning compared to the pre-pandemic period.¹⁰⁸ Time management limitations contributed to students failing to complete some requirements for certain courses.⁵³ These factors must be taken into consideration by lecturers in Zambia and other LMICs going forward. Having said this, in a study conducted in Indonesia, the authors found that most students had enough time to review their learning materials after attending online classes.¹⁶

In our study, older students were significantly associated with satisfaction with online learning compared to young students. This finding is supported by a study conducted among students in Southern Italy in which older students were likely to be involved in and satisfied with online learning.¹²⁰ However, an earlier study reported that age did not have an influence on the satisfaction of students with online learning.¹²¹ We are not sure of the reasons behind these differences; however, we will be exploring this further in future studies given the concerns that this could raise for younger students with hybrid approaches.

Overall, it is important to establish a variety of ways to help both lecturers and students adapt and grow with online learning, building on the situation within countries, because blended learning approaches are here to stay. In view of this, institutions must develop a variety of strategic plans to help improve the effectiveness and efficiency of online learning for healthcare students combined with face-to-face learning. The use of tools and techniques that will improve interaction and communication with students during the online learning process, combined with those to improve the robustness of formative assessments and evaluation activities, can be included in professional development training sessions for university lecturers going forward. We will continue to monitor and investigate this.

We were aware that there are some limitations to this study. Firstly, we only included one university; consequently, generalisation of the findings must be done with caution. Secondly, the questionnaire was adapted from another study. However, this was piloted to enhance its robustness. In addition, utilising self-reported measures for the study may be subjected to exaggeration and lead to bias. Additionally, the use of a cross-sectional research design could not effectively indicate causal inferences. Despite these limitations, we believe our findings are robust providing direction for the future. Additional research should clarify psychological responses including emotional stress and quality of life, and institutions should work to improve students' learning during and post-COVID-19 era. We will be following this up in future studies.

Conclusion

This study found that most students felt that blended learning should continue even after the pandemic. However, the surveyed students preferred physical classroom clarifications

and assessments compared to online learning. This underlines the importance of addressing the needs of students for face-to-face clarification and evaluation within a blended learning framework. There is also an identified need to develop and implement curricula that offer blended learning to the students. In addition, the implementation of blended learning curricula should be guided by continuous assessment and feedback from students. This will enable educational institutions to refine and improve their approaches over time, ensuring that the blend of online and face-to-face components remains responsive to the evolving needs of learners.

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Author contributions

Conceptualisation of the study: SM; Methodology: SM, VD, WM, MM and GS; Data collection: SM, VD, WM, RLM, MC and GS; Data validation: SM, SKM, BC, PS, MK (Maisa Kasanga), GM, MK (Martin Kampamba), CNH, MM, MHGK, LAZM, RNO, BG and JF; Data curation: SM; Data analysis: SM and MK (Martin Kampamba); Interpretation of the data: SM, VD, SKM, BC, PS, RLM, MK (Maisa Kasanga), OCO, GM, MK (Martin Kampamba), MM, LAZM, RO, BG and JF; Writing of first draft: SM, VD, SKM, MK (Maisa Kasanga), PS and RLM; Reviewing and editing of the manuscript: SM, VD, SKM, BC, PS, RLM, MK (Maisa Kasanga), OCO, GM, MK (Martin Kampamba), CNH, MM, MHGK, LAZM, GS, RO, MC, BG and JF; Writing the final version: SM, VD, SKM, BC, PS, RLM, MK (Maisa Kasanga), OCO, GM, MK (Martin Kampamba), CNH, MM, MHGK, LAZM, GS, RO, MC, BG and JF; Supervision: SM, WM, BG and JF; All authors read and approved the final version of the manuscript for submission and publication.

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Informed consent

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Supplemental material

Supplemental material for this article is available online.

References

1. Etando A, Amu AA, Haque M, et al. Challenges and innovations brought about by the COVID-19 pandemic regarding medical and pharmacy education especially in Africa and implications for the future. *Healthcare* 2021; 9: 1722.
2. Burgess S and Sievertsen HH. The impact of COVID-19 on education | VOX, CEPR policy portal. <https://voxeu.org/article/impact-covid-19-education> (2020, accessed 12 March 2021).
3. Lutfor A, Jahan F, Siddiqui T, et al. The impact of the covid-19 pandemic on the education of medical, dental and non-medical healthcare professionals in Bangladesh: findings and connotation. *Adv Hum Biol* 2023; 13: S85–S95.
4. Sharma P, Chowdhury K, Kumar S, et al. A pilot study regarding the consequences of the COVID-19 pandemic on healthcare education in India and the implications. *Adv Hum Biol* 2022; 12: 180–189.
5. Guzzetta G, Riccardo F, Marziano V, et al. The impact of a nation-wide lockdown on COVID-19 transmissibility in Italy. *Emerg Infect Dis* 2021; 27(1): 267–270.
6. Farooq F, Khan J and Khan MUG. Effect of lockdown on the spread of COVID-19 in Pakistan. *arXiv Prepr arXiv200509422*, <https://arxiv.org/abs/2005.09422v1> (2020, accessed 19 September 2021).
7. Haider N, Osman AY, Gadzekpo A, et al. Lockdown measures in response to COVID-19 in nine sub-Saharan African countries. *BMJ Glob Health* 2020; 5: e003319.
8. Ogunleye OO, Basu D, Mueller D, et al. Response to the novel Corona Virus (COVID-19) pandemic across Africa: successes, challenges, and implications for the future. *Front Pharmacol* 2020; 11: 1205.
9. Talic S, Shah S, Wild H, et al. Effectiveness of public health measures in reducing the incidence of covid-19, SARS-CoV-2 transmission, and covid-19 mortality: systematic review and meta-analysis. *BMJ* 2021; 375: e068302.
10. Harmey S and Moss G. Learning disruption or learning loss: using evidence from unplanned closures to inform returning to school after COVID-19. *Educ Rev* 2021; 75(4): 637–656.
11. Viner RM, Russell SJ, Croker H, et al. School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review. *Lancet Child Adolesc Health* 2020; 4: 397–404.
12. Perets EA, Chabeda D, Gong AZ, et al. Impact of the emergency transition to remote teaching on student engagement in a non-stem undergraduate chemistry course in the time of Covid-19. *J Chem Educ* 2020; 97: 2439–2447.
13. Mudenda S, Zulu A, Phiri MN, et al. Impact of coronavirus disease 2019 (COVID-19) on college and university students: a global health and education problem. *Aquademia* 2020; 4: ep20026.

14. Moonasamy A and Naidoo G. Digital learning: challenges experienced by South African university students during the COVID-19 pandemic. *Indep J Teach Learn* 2022; 17: 76–90.
15. Yeo SC, Lai CKY, Tan J, et al. A targeted e-learning approach for keeping universities open during the COVID-19 pandemic while reducing student physical interactions. *PLoS One* 2021; 16: e0249839.
16. Amir LR, Tanti I, Maharani DA, et al. Student perspective of classroom and distance learning during COVID-19 pandemic in the undergraduate dental study program Universitas Indonesia. *BMC Med Educ* 2020; 20: 392.
17. Al-Balas M, Al-Balas HI, Jaber HM, et al. Distance learning in clinical medical education amid COVID-19 pandemic in Jordan: current situation, challenges, and perspectives. *BMC Med Educ* 2020; 20: 513.
18. Senn S and Wessner DR. Maintaining student engagement during an abrupt instructional transition: lessons learned from COVID-19. *J Microbiol Biol Educ* 2021; 22: 22.1.47.
19. Elsayed M and Shabbat A. Technology acceptance model as a mediator explaining factors affecting online education Mayar Farrag Singab Elsayed. *Arab J Adm* 2025; 45: 227–246.
20. Pérez MA, Tiemann P and Urrejola-Contreras GP. The impact of the learning environment sudden shifts on students' performance in the context of the COVID-19 pandemic. *Educ Medica* 2023; 24: 100801.
21. Nimavat N, Singh S, Fichadiya N, et al. Online medical education in India – different challenges and probable solutions in the age of COVID-19. *Adv Med Educ Pract* 2021; 12: 237–243.
22. Rashid AA, Rashid MRA, Yaman MN, et al. Teaching medicine online during the covid-19 pandemic: a Malaysian perspective. *Bangladesh J Med Sci* 2020; 19: S77–S81.
23. Dolgunsöz E and Yıldırım G. The role of mobile devices on online EFL skill courses during Covid-19 emergency remote education. *Acuity J English Lang Pedagog Lit Cult* 2021; 6: 118–131.
24. Basar ZM, Mansor AN, Jamaludin KA, et al. The effectiveness and challenges of online learning for secondary school students – a case study. *Asian J Univ Educ* 2021; 17: 119–129.
25. Wang JC, Hsieh CY and Kung SH. The impact of smartphone use on learning effectiveness: a case study of primary school students. *Educ Inf Technol* 2022; 28: 6287–6320.
26. Sung YT, Chang KE and Liu TC. The effects of integrating mobile devices with teaching and learning on students' learning performance: a meta-analysis and research synthesis. *Comput Educ* 2016; 94: 252–275.
27. Haleem A, Javaid M, Qadri MA, et al. Understanding the role of digital technologies in education: a review. *Sustain Oper Comput* 2022; 3: 275–285.
28. Sage K, Jackson S, Fox E, et al. The virtual COVID-19 classroom: surveying outcomes, individual differences, and technology use in college students. *Smart Learn Environ* 2021; 8: 27.
29. Rapanta C, Botturi L, Goodyear P, et al. Balancing technology, pedagogy and the new normal: post-pandemic challenges for higher education. *Postdigital Sci Educ* 2021; 3: 715–742.
30. de Vries TJ. The pandemic that has forced teachers to go online. Zooming in on tips for online teaching. *Front Educ* 2021; 6: 647445.
31. Serhan D. Transitioning from face-to-face to remote learning: students' attitudes and perceptions of using zoom during COVID-19 pandemic. *Int J Technol Educ Sci* 2020; 4: 335–342.
32. Gopinathan S, Kaur AH, Veeraya S, et al. The role of digital collaboration in student engagement towards enhancing student participation during COVID-19. *Sustainability* 2022; 14: 6844.
33. Islam MS. Unlearning, relearning, and paradigm shift to online tertiary education during the COVID-19 pandemic in Bangladesh. *Bangladesh J Med Sci* 2021; 20: 65–71.
34. Ossai EN. Impact of COVID-19 on medical education and the challenges: how prepared is Nigeria? *Pan Afr Med J* 2020; 37: 45.
35. Mwila K, Mudenda S, Kampamba M, et al. Factors affecting access to e-learning during the coronavirus disease 2019 pandemic among rural-based pharmacy students in Zambia: a qualitative study original research. *Epidemiol Open J* 2021; 6: 25–34.
36. Lufungulo ES, Mwila K, Mudenda S, et al. Online teaching during COVID-19 pandemic in Zambian Universities: unpacking lecturers' experiences and the implications for incorporating online teaching in the University Pedagogy. *Creat Educ* 2021; 12: 2886–2904.
37. Tashtoush MA, Wardat Y and Elsayed AM. Mathematics distance learning and learning loss during COVID-19 pandemic: teachers' perspectives. *J High Educ Theory Pract* 2023; 23: 1–13.
38. Almahasees Z, Mohsen K and Amin MO. Faculty's and students' perceptions of online learning during COVID-19. *Front Educ* 2021; 6: 638470.
39. Shin M and Hickey K. Needs a little TLC: examining college students' emergency remote teaching and learning experiences during COVID-19. *J Furth High Educ* 2021; 45: 973–986.
40. Almpanis T and Joseph-Richard P. Lecturing from home: exploring academics' experiences of remote teaching during a pandemic. *Int J Educ Res Open* 2022; 3: 100133.
41. Craig TS and Akkaya T. Forced to improve: open book and open internet assessment in vector calculus. *Int J Math Educ Sci Technol* 2022; 53: 639–646.
42. Selvaraj A, Radhin V, Ka N, et al. Effect of pandemic-based online education on teaching and learning system. *Int J Educ Dev* 2021; 85: 102444.
43. Hsieh PL, Yang SY, Lin WY, et al. Facilitated virtual learning for advanced geriatric education among nursing students during the COVID pandemic in Taiwan. *Libr Hi Tech* 2022; 41: 59–70.
44. Saini SK, Kaur S, Sharma N, et al. Satisfaction among the nursing teachers with web-based teaching during COVID-19: a cross-sectional survey. *Int J Community Med Public Health* 2021; 8: 2000–2006.
45. Iwabuchi K, Hodama K, Onishi Y, et al. Covid-19 and education on the front lines in Japan: what caused learning disparities and how did the government and schools take initiative? In: Reimers FM (ed.) *Primary and secondary*

- education during Covid-19. Cham: Springer International Publishing, 2021, pp. 125–151.
46. Maatuk AM, Elberkawi EK, Aljawarneh S, et al. The COVID-19 pandemic and e-learning: challenges and opportunities from the perspective of students and instructors. *J Comput High Educ* 2022; 34: 21–38.
 47. Krishnapillai A, Lugova H, Haque M, et al. The shock of the SARS-CoV-2 pandemic on health professionals' education: a pilot qualitative study in Malaysia. *J Appl Pharm Sci* 2022; 12: 161–171.
 48. Alrasheedy AA, Abdulsalim S, Farooqui M, et al. Knowledge, attitude and practice about coronavirus disease (Covid-19) pandemic and its psychological impact on students and their studies: a cross-sectional study among pharmacy students in Saudi Arabia. *Risk Manag Healthc Policy* 2021; 14: 729–741.
 49. Moustakas L and Robrade D. The challenges and realities of e-learning during COVID-19: the case of university sport and physical education. *Challenges* 2022; 13: 9.
 50. Mahyoob M. Challenges of e-learning during the COVID-19 pandemic experienced by EFL learners. *Arab World English J* 2020; 11: 351–362.
 51. Kabundula PP and Namushi N. Constraints and prospects of online platforms in higher learning institutions: the case of selected private Universities in Lusaka District, Zambia. *Int J Res Innov Soc Sci* 2023; 7: 85–94.
 52. Montiel MDLN, Fonseca-Feris R and Arrúa-Jacquet K. Adaptation and transition in higher education students in the face of the COVID-19 pandemic. *Rev Int Investig en Ciencias Soc* 2022; 18: 343–358.
 53. Barrot JS, Llenares II and del Rosario LS. Students' online learning challenges during the pandemic and how they cope with them: the case of the Philippines. *Educ Inf Technol* 2021; 26: 7321–7338.
 54. Kurniawan AD and Andani YF. Challenges faced by students on the online learning during the COVID-19 pandemic in West Kalimantan Province. In: *Proceedings of the 5th International Conference on Current Issues in Education (ICCIE 2021)*, Surabaya, Indonesia. Amsterdam, The Netherlands: Atlantis Press, pp. 369–372.
 55. Albalushi H, Al Mushaiqri M, Sirasanagandla SR, et al. Students' performance in face-to-face, online, and hybrid methods of teaching and assessment in anatomy. *Int J Environ Res Public Health* 2022; 19: 13318.
 56. Mwila K, Kalolo F, Mudenda S, et al. Impact of COVID-19 on academic activities of final year nursing students: a Zambian reflection. *Int J Basic Clin Pharmacol* 2021; 10: 806.
 57. Wekullo CS, Kabindio B and Juma I. Faculty and students' perspectives of online learning during COVID-19 crisis: constraints and opportunities for Kenyan Universities. *E-Learning Digit Media* 2023; 20427530231156483. DOI: 10.1177/20427530231156483.
 58. Arima M, Takamiya Y, Furuta A, et al. Factors associated with the mental health status of medical students during the COVID-19 pandemic: a cross-sectional study in Japan. *BMJ Open* 2020; 10: e043728.
 59. Mheidly N, Fares MY and Fares J. Coping with stress and burnout associated with telecommunication and online learning. *Front Public Health* 2020; 8: 574969.
 60. Copeland WE, McGinnis E, Bai Y, et al. Impact of COVID-19 pandemic on college student mental health and wellness. *J Am Acad Child Adolesc Psychiatry* 2021; 60: 134–141.e2.
 61. Moghimi E, Stephenson C, Gutierrez G, et al. Mental health challenges, treatment experiences, and care needs of post-secondary students: a cross-sectional mixed-methods study. *BMC Public Health* 2023; 23: 655.
 62. Zhang Y, Tao S, Qu Y, et al. The correlation between lifestyle health behaviors, coping style, and mental health during the COVID-19 pandemic among college students: two rounds of a web-based study. *Front Public Heal* 2023; 10: 1031560.
 63. Yoo HJ and Marshall DT. Examining the relationship between motivation, stress, and satisfaction among graduate students. *J Furth High Educ* 2022; 46: 409–426.
 64. Chinna K, Sundarasan S, Khoshaim HB, et al. Psychological impact of COVID-19 and lockdown measures: an online cross-sectional multicounty study on Asian University students. *PLoS One* 2021; 16: e0253059.
 65. Finlay MJ, Tinnion DJ and Simpson T. A virtual versus blended learning approach to higher education during the COVID-19 pandemic: the experiences of a sport and exercise science student cohort. *J Hosp Leis Sport Tour Educ* 2022; 30: 100363.
 66. Batista-Toledo S and Gavilan D. Implementation of blended learning during COVID-19. *Encyclopedia* 2022; 2: 1763–1772.
 67. Atwa H, Shehata MH, Al-Ansari A, et al. Online, face-to-face, or blended learning? faculty and medical students' perceptions during the COVID-19 pandemic: a mixed-method study. *Front Med* 2022; 9: 791352.
 68. Singh J, Steele K and Singh L. Combining the best of online and face-to-face learning: hybrid and blended learning approach for COVID-19, post vaccine, and post-pandemic world. *J Educ Technol Syst* 2021; 50: 140–171.
 69. Kim KJ. Moving forward: embracing challenges as opportunities to improve medical education in the post-COVID era. *Humanit Soc Sci Commun* 2022; 9: 419.
 70. Dziuban C, Graham CR, Moskal PD, et al. Blended learning: the new normal and emerging technologies. *Int J Educ Technol High Educ* 2018; 15: 3.
 71. Hrastinski S. What do we mean by blended learning? *TechTrends* 2019; 63: 564–569.
 72. Rasmitadila R, Yahya W, Humaira MA, et al. Using blended learning approach (BLA) in inclusive education course: a study investigating teacher students' perception. *Int J Emerg Technol Learn* 2020; 15: 72–85.
 73. Shantakumari N and Sajith P. Blended learning: the student viewpoint. *Ann Med Health Sci Res* 2015; 5: 323–328.
 74. Hassoulas A, de Almeida A, West H, et al. Developing a personalised, evidence-based and inclusive learning (PEBIL) model of blended learning: a cross-sectional survey. *Educ Inf Technol* 2023; 28: 14187–14204.
 75. Moorhouse BL and Wong KM. Blending asynchronous and synchronous digital technologies and instructional approaches to facilitate remote learning. *J Comput Educ* 2022; 9: 51–70.
 76. Simulundu E, Mupeta F, Chanda-Kapata P, et al. First COVID-19 case in Zambia – comparative phylogenomic analyses of SARS-CoV-2 detected in African countries. *Int J Infect Dis* 2021; 102: 455–459.

77. Kasanga M, Mudenda S, Gondwe T, et al. Impact of COVID-19 on blood donation and transfusion services at Lusaka provincial blood transfusion centre, Zambia. *Pan Afr Med J* 2020; 35: 74.
78. Kampamba M, Chiluba K, Hikaambo CN, et al. The paradigm shift towards online learning during Covid-19 pandemic: an assessment of the attitudes on the learning practices among University of Zambia pharmacy students. *BMC Med Educ* 2023; 23: 458.
79. Charan J and Biswas T. How to calculate sample size for different study designs in medical research? *Indian J Psychol Med* 2013; 35: 121–126.
80. Mbonane H, Sibanda M, Godman B, et al. Knowledge, attitudes and practices of healthcare professionals on the use of an electronic stock visibility and management tool in a middle-income country: implications for access to medicines. *Explor Res Clin Soc Pharm* 2023; 9: 100233.
81. Vishwanathan K, Patel G and Patel D. Impact and perception about distant online medical education (tele-education) on the educational environment during the COVID-19 pandemic: experiences of medical undergraduate students from India. *J Fam Med Prim Care* 2021; 10: 2216–2224.
82. Altwaijry N, Ibrahim A, Binsuwaidan R, et al. Distance education during covid-19 pandemic: a college of pharmacy experience. *Risk Manag Healthc Policy* 2021; 14: 2099–2110.
83. Langedgård U, Kiani K, Nielsen SJ, et al. Nursing students' experiences of a pedagogical transition from campus learning to distance learning using digital tools. *BMC Nurs* 2021; 20: 23.
84. Bolatov AK, Gabbasova AM, Baikanova RK, et al. Online or blended learning: the COVID-19 pandemic and first-year medical students' academic motivation. *Med Sci Educ* 2022; 32: 221–228.
85. Al-Kahtani N, Almurayh A, Subbarayalu AV, et al. Sustaining blended and online learning during the normal and new normal conditions in a Saudi higher education institution: health science students' perspectives. *Heliyon* 2022; 8: e10898.
86. Njambi KV and Mayoka GW. Inequality in accessing learning during pandemic crises in developing countries: reflections from covid-19-induced online learning at a Kenyan pharmacy school. *Pharm Educ* 2021; 21: 713–722.
87. Swaminathan N, Ravichandran L, Ramachandran S, et al. A comparison of physiotherapy students' perception about blended learning with online learning during COVID-19 pandemic: a mixed method of study. *J Educ Health Promot* 2022; 11: 335.
88. Sulaiman F. Online learning conveniences from students' perception: a case study in Universiti Malaysia Sabah online learning conveniences from students' perception: a case study in Universiti Malaysia Sabah. *Glob J Human Social Sci G Linguist Educ* 2014; 14: 39–43.
89. Bruggeman B, Tondeur J, Struyven K, et al. Experts speaking: crucial teacher attributes for implementing blended learning in higher education. *Internet High Educ* 2021; 48: 100772.
90. Cai Y. The impact of online education on higher education in the context of education equity. *SHS Web Conf* 2023; 168: 01006.
91. Biber DD and Heidorn J. Tailoring the walking classroom to promote college student engagement. *Coll Teach* 2021; 69: 169–172.
92. Alvarez JA V. Learning from the problems and challenges in blended learning: basis for faculty development and program enhancement. *Asian J Distance Educ* 2020; 15: 112–132.
93. Namyssova G, Tussupbekova G, Helmer J, et al. Challenges and benefits of blended learning in higher education. *Int J Technol Educ* 2019; 2: 22–31.
94. Simonova I, Faltynkova L and Kostolanyova K. New blended learning enriched after the COVID-19 experience? students' opinions. *Sustainability* 2023; 15: 5093.
95. Diong J, Lee H and Reed D. The effect of face-to-face versus online learning on student performance in anatomy: an observational study using a causal inference approach. *Discov Educ* 2023; 2: 3.
96. Kumari S, Gautam H, Nityadarshini N, et al. Online classes versus traditional classes? Comparison during COVID-19. *J Educ Health Promot* 2021; 10: 457.
97. Joji RM, Kumar AP, Almarabheh A, et al. Perception of online and face to face microbiology laboratory sessions among medical students and faculty at Arabian Gulf University: a mixed method study. *BMC Med Educ* 2022; 22: 411.
98. Li X, Odhiambo FA and Ocansey DKW. The effect of students' online learning experience on their satisfaction during the COVID-19 pandemic: the mediating role of preference. *Front Psychol* 2023; 14: 1095073.
99. Yazıcı MM, Ataş İ, Güler E, et al. Comparison of traditional and online education in airway management. *Int J Res Med Sci* 2023; 11: 1509–1513.
100. Pratheebha C and Jayaraman M. Learning and satisfaction levels with online teaching methods among undergraduate dental students-A survey. *J Adv Pharm Technol Res* 2022; 13: 168–172.
101. Elakiya TT and Kalabarathy S. Level of satisfaction on online teaching method among undergraduate students – a descriptive cross-sectional study. *Cardiometry* 2022; 1140–1145.
102. Xu T and Xue L. Satisfaction with online education among students, faculty, and parents before and after the COVID-19 outbreak: evidence from a meta-analysis. *Front Psychol* 2023; 14: 1128034.
103. Almendingen K, Morseth MS, Gjølstad E, et al. Student's experiences with online teaching following COVID-19 lockdown: a mixed methods explorative study. *PLoS One* 2021; 16: e0250378.
104. Hettiarachchi S, Damayanthi BWR, Heenkenda S, et al. Student satisfaction with online learning during the COVID-19 pandemic: a study at state universities in Sri Lanka. *Sustainability* 2021; 13: 11749.
105. Dhingra S, Pasricha N, Sthapak E, et al. Assessing the role of internal motivation and extrinsic factors on online undergraduate medical teaching in a resource-poor setting during covid-19 pandemic in north India: an observational study. *Adv Med Educ Pract* 2021; 12: 817–823.
106. Wei HC and Chou C. Online learning performance and satisfaction: do perceptions and readiness matter? *Distance Educ* 2020; 41: 48–69.

107. Muthuprasad T, Aiswarya S, Aditya KS, et al. Students' perception and preference for online education in India during COVID-19 pandemic. *Soc Sci Humanit Open* 2021; 3: 100101.
108. Mortagy M, Abdelhameed A, Sexton P, et al. Online medical education in Egypt during the COVID-19 pandemic: a nationwide assessment of medical students' usage and perceptions. *BMC Med Educ* 2022; 22: 218.
109. Wut TM and Xu J. Person-to-person interactions in online classroom settings under the impact of COVID-19: a social presence theory perspective. *Asia Pacific Educ Rev* 2021; 22: 371–383.
110. Faria I, Moura CB, Graner M, et al. Online medical education: a student survey. *Clin Teach* 2023; e13582.
111. Sabrina F, Azad S, Sohail S, et al. Ensuring academic integrity in online assessments: a literature review and recommendations. *Int J Inf Educ Technol* 2022; 12: 60–70.
112. Chirumamilla A, Sindre G and Nguyen-Duc A. Cheating in e-exams and paper exams: the perceptions of engineering students and teachers in Norway. *Assess Eval High Educ* 2020; 45: 940–957.
113. Elsalem L, Al-Azzam N, Jum'ah AA, et al. Remote E-exams during Covid-19 pandemic: a cross-sectional study of students' preferences and academic dishonesty in faculties of medical sciences. *Ann Med Surg* 2021; 62: 326–333.
114. Hollister B, Nair P, Hill-Lindsay S, et al. Engagement in online learning: student attitudes and behavior during COVID-19. *Front Educ* 2022; 7: 851019.
115. Marín García PJ, Arnau A and Llobat L. Preferences and scores of different types of exams during COVID-19 pandemic in faculty of veterinary medicine in Spain: a cross-sectional study of paper and E-exams. *Educ Sci* 2021; 11: 386.
116. Dirzyte A, Vijaikis A, Perminas A, et al. Associations between depression, anxiety, fatigue, and learning motivating factors in E-learning-based computer programming education. *Int J Environ Res Public Health* 2021; 18: 9158.
117. Shekhar SK. Investigating the mediating effect of anxiety and fear of a third wave of COVID-19 among students in South India. *Ann Med Psychol (Paris)* 2022; 181: 330–335.
118. Banihashem SK, Noroozi O, den Brok P, et al. Modeling teachers' and students' attitudes, emotions, and perceptions in blended education: towards post-pandemic education. *Int J Manag Educ* 2023; 21: 100803.
119. Tomaszek K and Muchacka-Cymerman A. Student burn-out and PTSD symptoms: the role of existential anxiety and academic fears on students during the COVID-19 pandemic. *Depress Res Treat* 2022; 2022: 6979310.
120. Rega A, Nappo R, Simeoli R, et al. Age-related differences in psychological distress during the COVID-19 pandemic. *Int J Environ Res Public Health* 2022; 19: 5532.
121. Ke F and Kwak D. Online learning across ethnicity and age: a study on learning interaction participation, perception, and learning satisfaction. *Comput Educ* 2013; 61: 43–51.