ORIGINAL ARTICLE

Changing Undergraduate Medical Students' Perception of Online Learning and Assessment During the Covid-19 Pandemic: a One Year Follow-up Study

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ABSTRACT

Introduction: Like most educational institutions, our medical school transitioned to online learning during the COVID-19 pandemic in March 2020. An initial survey of 192 undergraduate medical students conducted in June 2020 revealed a low acceptance of online assessments, lack of work-readiness, perception of online discussions as being inferior to face-to-face, and prevalent anxiety. Following this, we implemented pedagogic changes to encourage independent learning, improve patient contact, and increase social interactions between students. Methods: A follow-up study was conducted 12 months later in the same student population, excluding those who had graduated. The same 14-item anonymized survey questionnaire was administered, and comparisons were made between the follow-up and initial responses. Results: At follow-up, 45.6% of participants felt that online assessments can adequately and fairly assess students' performance compared to the initial study (26.2%, p = 0.002). Participants at follow-up were generally more agreeable that discussion using an online learning platform was as effective as face-to-face learning compared to before (p = 0.017). Subgroup analysis showed that this was only true for Year 2 – 4 students. Year 5 students perceived online learning as less effective then face-to-face, reported lower confidence in their ability to apply their knowledge, and an increased in anxiety compared to before. Conclusion: While perception of online learning and assessment had improved at follow-up, the ramifications from restrictions to medical education over the past two years are now being felt most severely by the current final year students, emphasizing the importance of anticipating and addressing these concerns much earlier.
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INTRODUCTION

The most significant paradigm shift in medical education has been over the past two years, brought upon by the coronavirus disease 2019 (COVID-19) pandemic. During the height of the pandemic in Malaysia and elsewhere, online learning and assessments replaced physical classrooms and traditional pen-and-paper tests in all educational institutions. Medical students faced significant disruption to their education as access to healthcare facilities became restricted and their clinical rotations were halted. Implemented in haste and regarded as the only option for teaching medical students at the time, technology-based teaching has quickly evolved into a diverse range of effective and efficient methods of delivering synchronous and asynchronous educational content (1). Nonetheless there are major disadvantages to online learning in medical education, which have seen limited resolution so far. We previously reported that medical students generally found online learning time-saving and convenient because of its flexibility, although there were also challenges with inattention and disengagement (2). Moreover, it is widely acknowledged that online or virtual clinical teaching cannot possibly replicate the crucial experiential learning of 'hands-on' clinical medicine and all its nuances from being taught at the patients' bedside (3, 4).

We previously identified several actionable factors that impacted on our medical students' online learning of during the early stages of the pandemic (5). During this time, we had relied mainly on our Moodle-based learning management system (LMS) and teleconferencing platforms such as Zoom (Zoom Video Communications, Inc; San Jose, California, USA), and Microsoft Teams (Microsoft Corporation; Redmond, Washington, USA) to conduct all our teaching and learning activities remotely. Problem-Based Learning (PBL), Case-Based Learning (CBL), student-led seminars, clinical case

discussions, and didactic lectures were conducted via teleconferencing. Lecture notes, supplementary reading materials, recordings and formative and summative assessments were accessed via our LMS platform. Our study reported a low acceptance of online assessments, lack of work-readiness, a general perception of online discussions as being less effective than face-to-face discussions, and high rates of anxiety among undergraduate medical students. We also found that students who appreciated the role of independent learning in the online environment were less anxious, and more motivated, more self-reflective, and were likely to perceive online learning as being effective. Moreover, we believed that students' social isolation and a lack of direct interaction with their peers were important underlying factors for their poor mental health during the pandemic (2). Based on our findings at the time, we implemented several changes to our curriculum delivery, on top of our regular online teaching and learning activities. Although our students were already somewhat familiar with independent learning through student-led seminar, PBL, and CBL, to further encourage independent learning online, we prioritized a flipped classroom approach for core disciplines which require delivery of dense, complex information such as Neurology. Flipped learning, a form of blended learning approach with an asynchronous component, improves student satisfaction and produces comparable assessment scores to that of didactic teaching (6, 7). As bedside teaching in healthcare facilities and face-to-face clinical skills teaching were inaccessible during this period, we introduced regular teleconferencing sessions between our students and real patients sourced from the community and local clinical facilities, as a form of 'virtual' patient clerking. In this manner, the students were regularly exposed to real patients with authentic clinical histories, with clinical signs and symptoms as well as genuine concerns. Students not only find this form of learning highly engaging, but it is also effective in improving their patient-centered communication skills (8). To encourage more social interaction between students and with their lecturers, we incorporated the use of Padlet, a free online platform based on the concept of a shared virtual space that serves as a bulletin board and discussion forum, into our learning management system. While online discussions generally lack the same back-and-forth conversational interactions that face-to-face discussions offer, the use of online platforms can have a 'democratizing' effect on the class and facilitates participation in those who are otherwise unlikely to engage directly in larger, face-to-face classrooms (9).

Given the developments in our online teaching approach and the ongoing impact of the pandemic on medical education, we decided to conduct a follow-up study to re-explore the perception of medical students towards online learning and assessment 12 months from our initial study. We aim to describe their current knowledge, attitudes, and experiences in various aspects of online teaching and learning, and to compare the findings with our initial study. Thus, the alternate hypothesis for this study states that we expect to observe a change in the perceptions and experiences of online learning and online assessments following various pedagogical interventions. With this, we hope to identify further unmet needs of our medical students in a rapidly evolving situation, and to help guide future development of technology-based medical education frameworks.

MATERIALS AND METHODS

Participants

Ethics approval for this study was obtained from the institution's human ethics committee (reference HEC 2021/161). Participants in this study comprised of medical students from our 5-year undergraduate medical programme, who had started medical school between 2015 and 2019. An initial survey-based study involving 192 medical students was performed in mid-2020 to explore their knowledge, attitude, and experience of online learning during the COVID-19 pandemic and to identify factors that have a significant impact on their teaching and learning (5). This is a follow-up study on the same medical students conducted exactly 12 months after the initial study, following the implementation of various measures to improve their online learning experience during the ongoing pandemic, as described in the previous section. Students were excluded from this follow-up study if they had not participated in the initial study. All participants were informed of this exclusion criteria in the instructions given. Forty-three participants who had graduated in the interim period were also excluded from the follow-up study and statistical comparisons, leaving 149 eligible participants. Students who had failed to progress in the previous year were included in the study, as we felt that their responses were still relevant, unlikely to produce significant bias, and provided a realistic representation of a typical cohort of medical students at any given time.

Survey questionnaire and data collection

Questionnaire design and validation were described in the initial study (5). The questionnaire comprised of 14 items grouped into the domains of Knowledge, Attitude, and Experience. Knowledge-based items assessed the students' awareness and conceptual understanding of various aspects of e-learning; Attitude-based items assessed the students' affective traits or states which were likely to directly influence their behaviour towards online learning, and Experience-based items assessed the students' subjective encounter with online learning. Responses for the Knowledge domain comprised of the following categories: 'Agree', 'Disagree' and 'Not sure'. Responses for the Attitude and Experience domains comprised of a 5-point Likert scale ranging from 'Strongly disagree'(1) to 'Strongly agree'(5).

Google Forms was used to administer the survey. All participants who had been involved in the initial study were invited to participate in the follow-up study via email and phone messaging. To improve response rates, participants were sent reminders every three to four days for a two-week period until the survey closed. We utilized student batch leaders to disseminate the study invitation and reminders to their peers, thus avoiding direct communication between lecturers and respondents to reduce response bias. All participants provided written consent. All responses were submitted anonymously and were identifiable only by their student intake year.

Statistical analysis

As this was a follow-up study based on the initial survey cohort (5), our sample size was restricted by the size of this cohort. Moreover, as there were no similar studies on which to base our parameter estimates for the intended comparisons, precise sample size calculations could not be performed, therefore a sensitivity analysis was done instead. An effect-size sensitivity analysis using G*Power v3.1.9.7 (http://www.gpower.hhu.de/) indicated that, given a minimum sample size of 100 to compare against the initial cohort of 149, we will be able to detect a small effect size (d) of 0.37 or more for a Mann-Whitney U test, and a difference in proportions of at least 18% for the chi-square test, with a desired power of 0.80 based on an alpha of 0.05.

Descriptive statistics were used to describe the survey findings. Responses for the Knowledge domain were binarized into 'Agree' and 'Disagree/Not sure' and presented as frequencies and percentages, while responses for the Attitude and Experience domains were presented as ordinal data using median and interquartile range. The responses were further stratified by student intake year.

Because individual responses were anonymized, we could not perform pairwise analysis to compare findings between the initial and follow-up survey. Therefore, Mann-Whitney U test was used to compare overall responses between the initial and follow-up survey in the Attitude and Experience domains. Effect sizes for this test were reported as the rank-biserial correlation coefficient (r), where r values of 0.10, 0.24 and 0.37 correspond to d values of 0.20 (small effect size), 0.50 (medium effect size), and 0.80 (large effect size), respectively (10). Chi-square test of homogeneity was used to explore the differences in proportions of overall responses between the initial and follow-up survey in the Knowledge domain, except for instances when expected counts were less than 5, Fisher's exact test was used instead. All statistical analyses were conducted using R version 4.0.4 (R Foundation for Statistical Computing, Vienna, Austria). All tests were 2-tailed and a p value of less than 0.05 was considered significant.

RESULTS

From a total of 149 medical students invited to participate in the follow-up study, there were 103 participants, giving a response rate of 69%. Participant demographics are summarized in Table I. Majority of participants were female (56.3%), aged over 20 years (86.4%) and were Malaysians (83.5%).

Table I: Sociodemographic characteristics of participants in the follow-up study

Characteristic	Total, n (%)
Current year of study and intake year	
Year 2 (intake year 2019)	13 (12.6)
Year 3 (intake year 2018)	35 (34)
Year 4 (intake year 2017)	35 (34)
Year 5 (intake year 2016)	20 (19.4)
Gender	
Male	45 (43.7)
Female	58 (56.3)
Age	
≤ 20 years	14 (13.6)
21 – 22 years	34 (33)
23 – 24 years	43 (41.7)
≥ 25 years	12 (11.7)
Nationality	
Malaysian	86 (83.5)
Non-Malaysian	17 (16.5)

Knowledge domain

Comparisons of Knowledge-based responses between the initial and follow-up study are summarized in Table II. A significantly higher proportion of participants in the follow-up study (45.6%) agreed that online assessments can adequately and fairly assess students' performance (K3), compared to the initial study (26.2%), with a difference in proportions of 19.4% (p = 0.002). There was no significant difference in the proportion of agreeable responses for all the other Knowledge items. The detailed responses grouped by student intake year are demonstrated in Fig. 1. The proportion of responses for each Knowledge item were largely comparable between student intake years.

Attitude and Experience domains

Comparisons of overall responses in the Attitude and Experience domains between the initial and follow-up study are summarized in Table III. The detailed responses grouped by student intake year are demonstrated in Fig. 2 (Attitude domain) and Fig. 3 (Experience domain).

In the Attitude domain, there was no significant change in the participants' self-reported ability to sustain their motivation for online learning (A1) and their perception of support received from the school (A2). They were generally less confident that they would be able to

Table II: Comparison of Knowledge responses between the initial and follow-up study

	Knowledge items	% Agreed		
		Initial n = 149	**Follow-up n = 103**	**P value**
K1	E-Learning is a comprehensive concept that involves the use of all forms of electronic media, information, and communication technology in education.	87.2	84.5	ns
K2	For a successful online session, both e-teachers and e-learners need special information and communication technology skills.	88.6	82.5	ns
K3	E-learners' performance can be adequately and fairly assessed via online assessment.	26.2	45.6	0.002
K4	The e-learner is more independent than the traditional face-to-face student.	57.7	56.3	ns
K5	E-learners' feedback is important to create a more effective and engaging online learning experience.	91.9	87.4	ns

ns: Not significant

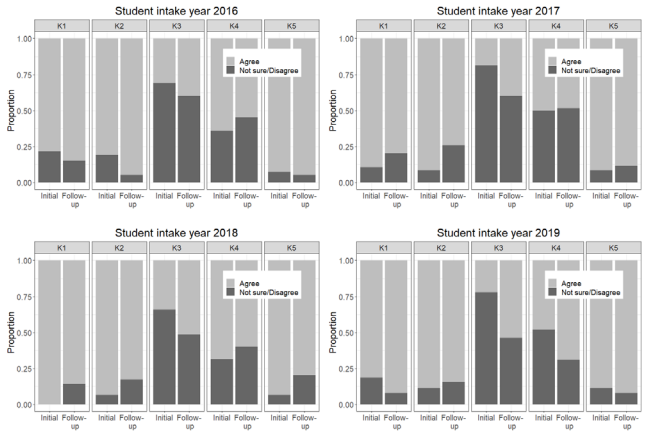

Figure 1: Knowledge responses grouped by student intake year

apply what they had learnt online to the workplace (A3), particularly in the Year 5 students, although this was not significantly different from the initial study. Participants in the follow-up study were generally more agreeable that online activities and online feedback helped them reflect in depth on the subject learned (A4), however this was not a significant change. Participants in the follow-up study were significantly more agreeable that discussion using an online learning platform is as effective as face-to-face learning (A5), in comparison to the initial study (median Likert score of 2 vs 3, p = 0.017, r = -0.17, 95% CI -0.13 to -0.03). From the detailed responses, we noted that this was true for the pre-clinical students (intake year 2019) and early clinical years students (intake year 2017 and 2018), whereas the opposite was true for the Year 5 students (intake year 2016).

In the Experience domain, internet connectivity (E1) was less of a concern than previously reported (median Likert score of 5 vs 4, p < 0.001, r = 0.24, 95% CI

Table III: Comparison of Attitude and Experience responses between the initial and follow-up study

	Items	Median Likert score (IQR)		
		Initial n = 149	**Follow-up n = 103**	**P value**
Attitude				
A1	I am able to sustain my motivation for learning online.	3 (2 - 4)	3 (2 - 4)	ns
A2	I feel adequately supported by the school in adapting to this medium of learning.	3 (3 - 4)	3 (2 - 4)	ns
A3	I am confident I will be able to apply what I learned online to the workplace (to real patients).	3 (2 - 4)	2 (1.5 - 3)	ns
A4	I feel that online activities and online feedback help me to reflect in depth on the subject learned.	3 (2 - 4)	4 (2 - 4)	ns
A5	I feel that discussion using an online learning platform is as effective as face-to-face learning.	2 (1 - 4)	3 (2 - 4)	0.017
Experience				
E1	I feel that internet connectivity was a major concern.	5 (4 - 5)	4 (3 - 5)	<0.001
E2	I feel that I have access to appropriate devices/ hardware.	4 (4 - 5)	4 (4 - 5)	ns
E3	I feel that I have access to appropriate e-resources.	4 (3 - 5)	4 (3 - 4)	ns
E4	I feel that pandemic-induced anxiety hampered my online teaching/learning.	4 (2 - 5)	4 (3 - 5)	ns

ns: Not significant, IQR: Interquartile range, 1: Strongly disagree, 2: Disagree, 3: Not sure, 4: Agree, 5: Strongly agree

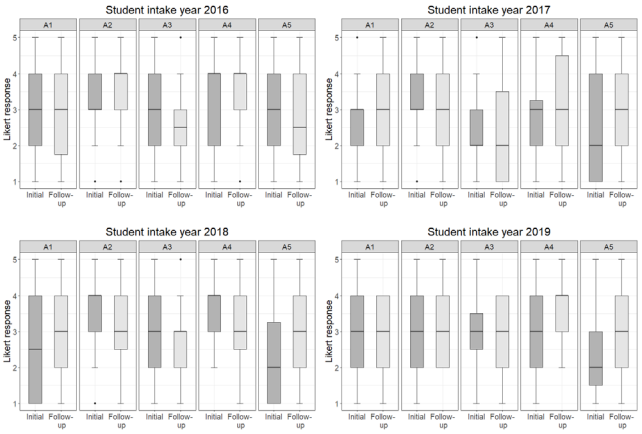

Figure 2: Attitude responses grouped by student intake year

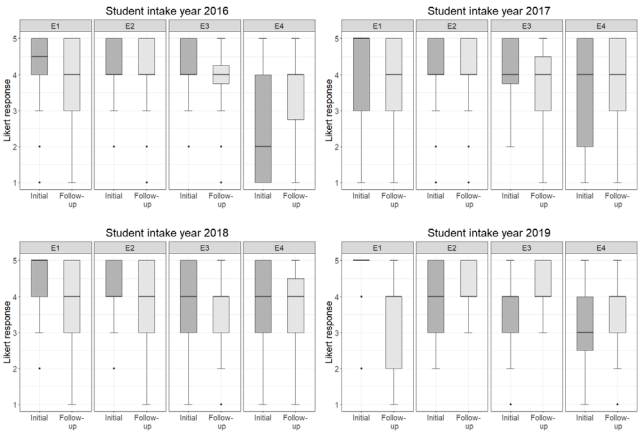

Figure 3: Experience responses grouped by student intake year.

0.10 to 0.37). Access to appropriate hardware (E2) and e-resources (E3) remained largely unchanged. While there was no significant change in the overall distribution of responses from participants reporting that pandemic-induced anxiety had hampered their online learning (E4), the final year students (intake year 2016) demonstrated a notable increase in this aspect at follow-up.

DISCUSSION

We believe that this is the first study exploring the changing perceptions of undergraduate medical students towards online learning and assessment during the COVID-19 pandemic in a longitudinal manner. Cross-sectional studies on this subject have repeatedly highlighted the adverse effects of the pandemic on medical students' mental health and their clinical training, and the challenges of sustaining an online learning environment (11-17). However, it is less clear how these issues might evolve with time. Internet access and low computer literacy adversely affected online learning quality in many developing countries, especially early in the pandemic (11, 18). Expedited by the pandemic, innovations and improvements in online learning will likely see more comparable benefits to that of physical or face-to-face learning and a likely increase in student satisfaction (19). However, while the ramifications of the pandemic are still being felt on students' social lives and education, mental health concerns are likely to persist, and may even worsen after the pandemic (20).

While our medical students have a relatively low acceptance of online assessments as a fair and adequate measure of their performance, this had improved at follow-up. Possible explanations for this change are that the students have become more accustomed to online assessments during the pandemic and were more familiar with the Moodle-based system used for our assessments. We had also introduced dual-camera video proctoring for all remote online assessments to discourage collusion and other forms of cheating, which likely improved their perceived reliability. The findings from this study largely mirror that of a recent study showing that around 48% of medical students perceived online assessments conducted during the COVID-19 pandemic as reliable (21).

It has been shown that medical students highly favour multiple choice questions (MCQ) as an online assessment and consider it an objective measure of knowledge (22). Another study which explored medical student performance and the quality of online assessments during the COVID-19 pandemic showed that online MCQs had relatively high reliability and discrimination indices compared to paper-based and face-to-face tests (23). It is worth noting that throughout the study period, our theory assessments comprised of single best answer MCQs and modified essay questions (MEQ), whereas clinical skills were assessed by online patient clerking sessions (of real or simulated patients via Zoom) and virtual objective structured practical examinations (OSPE) using clinical photographs and videos conducted through our online learning management system, which does not allow for assessment of physical examination or procedural skills. While it was not within the scope of this study to compare the quality and reliability of each our online assessments with paper-based or face-to-face assessments, it remains an important consideration for all medical institutions which plan to maintain online assessments beyond the pandemic period. There are obvious benefits to online assessments such as greater ease of marking and provision of feedback and the opportunity to incorporate various multimedia into assessments (24), however there are significant unresolved challenges in its implementation such as proctoring difficulties, internet connectivity concerns, and the ability to test psycho-motor clinical skills.

This study showed a statistically significant improvement in the perception of online learning compared to face-to-face learning. Although the effect size was small, this nonetheless suggests a greater acceptance of online learning as an effective method of curriculum delivery during the pandemic. This most likely reflects the increased familiarity with online learning platforms among our students and academic staff, increased use of self-directed learning applications and diverse online teaching tools, and the incorporation of regular contact with real and simulated patients, and virtual clinical skills sessions in our curriculum delivery. Ibrahim et al. (25) reported that medical students generally perceive online learning as a good substitute of face-to-face learning during the pandemic (with the exception of clinical teaching), citing the educator's e-learning proficiency, the taught subject, instructional design, level of interaction, student motivation, and the learning management system itself as important enabling factor. A large European study revealed significant levels of medical student satisfaction with online learning during the pandemic along with improved attendance rates, however, the unsuitability of online teaching methods in delivering bedside clinical teaching remained a significant issue (17).

This study revealed that the self-reported motivation and perceived support received by students remained relatively low despite the online learning interventions. Motivation and engagement in online learning are highly related to self-determination and other environmental and psychological factors which underpin various motivational theories (26). However, there remains a lack of research and incorporation of the relevant motivational theories into the design and delivery of effective and sustainable digital pedagogies, especially in medical education. In their review, Chiu et al highlighted the role of socialization and self-directness as important determinants of motivation, and recommend improving

the preparation of students for online learning by fostering digital skills, better collaborative environments for peer support, giving priority to student autonomy, and enhancing instructors' efficacy in applying the motivational theories (26), which one should consider incorporating into the core framework of future medical curricula. Additionally, the variation of responses within the subgroups in this study reflects how a 'one-size-fits-all' approach to online learning needs to be reconsidered. Incorporation of adaptive learning into digital technology appears to be a promising framework that could address the varying needs of our medical students and could extend beyond the course content to include personalized learning repositories and discussion forums (27). The provision of academic, emotional, and social support to students was particularly challenging during the pandemic because of reduced inter-personal contact and the lack of an effective system to identify those in need. Along with the relatively high prevalence of self-reported anxiety among the study cohort, we have been prompted to reconsider our current measures. While several approaches for providing effective support to undergraduate medical students have been described (28), these need to be individualized to the student population and the appropriate cultural context. For instance, online communication-based forms of support may work less well than non-virtual face-to-face consultations in students who are affected by social isolation and in whom language barriers could make open communication more difficult. A more comprehensive support system is needed to address the often intertwined academic and mental health needs of our medical students who are not only facing the psychological burdens of a highly demanding course, but also the extra stresses brought upon by the pandemic. The current Year 5 students (intake year 2016) had an overall more negative perception of the effectiveness of online learning at follow-up compared to the initial study. This is unsurprising, given that direct clinical exposure remained severely limited due to restrictions imposed by our training healthcare facilities during the study period. Correspondingly, they reported lower confidence in their ability to apply their knowledge to the workplace (clinical) setting and an increased in anxiety compared to previously. Their feelings of inadequacy would likely be compounded by the expectations that they should have by now achieved satisfactory competencies in various psychomotor clinical skills through repeated practice and observation in the clinical setting during the past two years, which they were not able to do. While the use of online patient clerking and virtual clinical skills sessions are appropriate for pre-clinical (Years 1 and 2) and early to mid-clinical students (Years 3 and 4), these sessions alone are insufficient for final year students to achieve the desired psychomotor competencies. While healthcare facilities remain inaccessible to medical students, the reopening of teaching facilities should be prioritized and the use of medical simulation expanded to include a wider range of clinical skills training incorporating the appropriate technology. It is also possible that, with advanced planning, clear standard operating procedures, and careful coordination between medical schools and their teaching hospitals, medical students can be provided with continuous clinical and bedside teaching during the pandemic (29). Another viable option would be to recruit suitably qualified and willing final year medical students into the healthcare workforce during the pandemic, to help accelerate their skills training while providing critical medical assistance to the public (30).

This study has several limitations. Despite actively engaging students to participate, high attrition resulted in fewer participants in the follow-up study, reducing its statistical power. Moreover, as a single centre study, it will be difficult to generalize our findings to other medical institutions. Our results shown here are nonetheless valid for our own student population which is largely representative of most private medical institutions in Malaysia. The use of unpaired analysis would make this more prone to Type II errors compared to a paired analysis, therefore a true difference may go undetected. However, this was necessary due to the anonymization of each respondent which aimed to encourage more accurate and unbiased responses. Lastly, our follow-up survey did not enquire directly about the effects of the interventional measures implemented following the initial survey, and therefore it is difficult to gauge the extent of their impact. This study could be improved by conducting several follow-up surveys at different timepoints following the implementation of specific online learning interventions to analyze the impact of each one. As students differ in their learning and support needs, further information about the characteristics of students whose perception and experience of the various aspects of online learning had improved, and those who had not, could help us identify the type of support and interventions beyond the instructional program that can be adopted for a more personalized approach. To address the limitations of unmatched analysis, the use of random identifiers assigned by an elected study custodian to facilitate tracking of individual responders while preserving their anonymity to the study investigators would have enabled us to perform matched analysis without increasing the risk of response bias, provided this was explained clearly to the respondents. Involving a larger cohort of students from multiple centres will improve the external validity of the study and enable the identification of distinct populations of students in whom additional learning, emotional and social support are warranted.

CONCLUSION

The perception of medical students towards online teaching and learning is one that is rapidly changing, as the delivery of medical education continues to evolve. With familiarity and the use of innovative technology,

online teaching and learning platforms are increasingly being perceived as an effective mode of delivering quality medical education, although there are still issues regarding overall student motivation, confidence in applying their knowledge, and anxiety. The inadequacy of delivering clinical teaching online is more evident in the final year of the medical undergraduate programme, While online assessments have gained more acceptance since the start of the pandemic, its relatively low acceptance overall highlights the many unaddressed limitations especially regarding the assessments of clinical skills. The longer-term impact of these changes on students' ongoing medical education and their future clinical practice are yet unknown. It is therefore important to regularly identify the ongoing needs and expectations of our medical students and to redress these promptly, given that online learning and assessment are likely to persist in the form of blended learning beyond the pandemic period.

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