

A New Disease and a New Experience: Knowledge, Attitude and Perception of Online Learning Among Medical Students During the COVID-19 Pandemic

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Abstract: The rapid transition to exclusive online teaching and learning during the COVID-19 pandemic has uncovered significant challenges to the delivery of undergraduate medical curricula. We aim to evaluate the knowledge, attitude, and experiences of medical students regarding online learning during the pandemic, and to determine whether seniority, prior exposure to online learning, conceptual understanding of e-learning, motivation, perceived support, ability to self-reflect and the presence of anxiety has any significant predictive impact on their responses. A single centre, self-administered online survey was conducted in June 2020. Descriptive statistics were used to summarise the survey findings, while inferential statistics were used to compare the responses by year of study and to determine the response predictors. A total of 192 medical students participated in the study. Two-thirds of students reported pandemic-induced anxiety. Compared to the others, Year 3 students were the most severely affected by the pandemic, and perceived to be least supported, felt least motivated, and reported poorer self-reflection and higher rates of anxiety. An appreciation of the factors that impact on online learning amid the pandemic will help inform curriculum design and educational policies to ensure the continuous delivery of high-quality medical education during this time.

Keywords: COVID-19 pandemic, medical education, online learning, medical student

Suggested citation: Bhargava, P., Khine P. P., Lim Y. S., Shanmuganathan, P., Samraj, B., Earnest P., ...Lim S-Y. (2022). Impact of IR 4.0 on assessment at higher education institutes. *Asia-Pacific Journal of Futures in Education and Society*, 1(1), 97–113.

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Introduction

The coronavirus disease (COVID-19) pandemic declared in March 2020 has posed significant challenges to medical education. In many parts of the world, students were removed from hospitals and other healthcare facilities due to enforced lockdown measures and to allow for more judicious use of medical resources. Additionally, campus activities were largely suspended during this time and medical schools worldwide rapidly transferred to an exclusively online-based e-learning curriculum, including the implementation of online assessments.

A variety of adaptations to online teaching, learning and assessments have been rapidly implemented by medical schools worldwide during the pandemic, ensuring borderless, affordable and efficient access to continued education (Agarwal & Kaushik, 2020; Chandra et al., 2020; Hofmann et al., 2020; Moszkowicz et al., 2020; Ross, 2020; Wilcha, 2020). However, there have been significant limitations, including challenges in delivering clinical skills teaching effectively (Dost et al., 2020; Shahrivini et al., 2021), poor access to the internet especially in rural regions (Dube, 2020), and difficulties in assuring the academic integrity of online assessments (Mukhtar et al., 2020). Online learning during the pandemic poses further unprecedented challenges as students face long periods of social isolation and higher rates of mental health issues (Alsoufi et al., 2020; Kecojevic et al., 2020).

With many parts of the world still under enforced lockdown at the time of writing, the true impact of this disruption and almost-exclusive reliance on online teaching on medical students remains unknown. Despite the promise of effective vaccines and a better understanding of the disease, it is likely that significant modifications to teaching and learning will remain necessary for the foreseeable future, leading to a 'new normal' in medical education. In this study, we describe how our students perceive various aspects of online learning during the pandemic and aim to identify rectifiable factors that impact on their learning during this time. As the students adjust to this novel approach of remote learning via newer and extended online modalities, it is imperative to gauge their readiness, mindset, and views. These findings could have implications for future research and improvements in educational practices.

Study Context

The medical undergraduate degree programme at our institution consists of pre-clinical studies for the first two years (Years 1 and 2), followed by three years of clinical studies (Years 3 to 5). During the clinical phase, students undertake placements in healthcare facilities where they interact with patients, undergo bedside teaching, and shadow medical staff. During their clinical training, the students become proficient in various procedural and clinical examination skills. At the start of the enforced

lockdown in March 2020, in compliance with the government's Movement Control Order (MCO) and the Ministry of Higher Education's directives on continuing education, we transitioned to a fully-online curriculum where all teaching and learning activities were undertaken remotely with students based at home. We used our pre-existing Moodle-based learning management system as our main teaching platform. Synchronous teaching comprising of lectures, case-based discussions, clerking of real and simulated patients, and student-led seminars were conducted via video-conferencing applications such as Zoom (Zoom Video Communications, Inc; San Jose, California, USA), and Microsoft Teams (Microsoft Corporation; Redmond, Washington, USA). All students were already familiar with e-learning and had access to a variety of online resources such as electronic textbooks, medical journals, and video recordings of clinical cases and procedures to supplement their learning.

Study Aims and Hypothesis

The first aim of the study is to describe the knowledge, attitude, and experiences of medical students relating to online learning during the COVID-19 pandemic using our self-developed survey questionnaire. The second aim is to identify factors that have a significant impact on their responses. We hypothesised that the students' knowledge, attitude, and experiences are affected by the following factors: seniority (represented by year of study), length of exposure to online learning prior to the pandemic, their conceptual understanding of e-learning (represented by their responses in the Knowledge domain), feelings of motivation, perceived support, ability to self-reflect on one's learning, perceived effectiveness of online learning, availability and quality of learning resources, and the presence of pandemic-induced anxiety.

Methods

Questionnaire Design and Validation

A self-administered online questionnaire comprising of 14 items was developed. The items assessed the students' knowledge, attitude, and experience of online learning during the COVID-19 pandemic. 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 choices: 'Agree', 'Disagree' and 'Not sure'. Responses for the Attitude and Experience domains comprised of a 5-point Likert scale ranging from 'Strongly disagree' to 'Strongly agree'.

For content validation, an expert panel comprising of all the authors in this study (selected for their expertise in medical education and differing medical disciplines) contributed questionnaire items, provided feedback on the interpretability of the items, and independently rated the relevance of each item from which the item-content validity index (I-CVI) was calculated. Items with a low level of agreement were discarded until an overall content validity index of at least 0.91 for each domain was achieved.

The survey was administered via Google Forms. A pilot study was carried out on a separate group of 21 medical students to determine the internal consistency of the questionnaire and to help further refine the questions. The revised questionnaire is shown in Table 1. Internal consistency reliability was measured using Cronbach's alpha, giving a coefficient of 0.83 and 0.74 for the domains of Attitude and Experience respectively. We felt that it was inappropriate to measure internal consistency reliability for the Knowledge domain as each item contributed to largely different aspects of this domain in a formative rather than reflective manner and would not necessarily correlate highly with one another (Stadler et al., 2021). Hence, the knowledge-specific items retained in the revised questionnaire were based on their relevance to our study aims and the intended breadth of coverage of this construct following consensus agreement by the panel.

Table 1. Survey questionnaire

Domain	Questions
<i>Knowledge</i>	<p>K1 e-Learning is a comprehensive concept that involves the use of all forms of electronic media, information and communication technology in education.</p> <p>K2 For a successful online session, both e-teachers and e-learners need special information and communication technology skills.</p> <p>K3 e-Learners' performance can be adequately and fairly assessed via online assessment.</p> <p>K4 The e-learner is more independent than the traditional face-to-face student.</p> <p>K5 e-Learners' feedback is important to create a more effective and engaging online learning experience.</p>
<i>Attitude</i>	<p>A1 I am able to sustain my motivation for learning online.</p> <p>A2 I feel adequately supported by the school in adapting to this medium of learning.</p> <p>A3 I am confident that I will be able to apply what I learned online to the workplace (to real patients).</p> <p>A4 I feel that online activities and online feedback help me to reflect in depth on the subject learned.</p> <p>A5 I feel that discussion using an online learning platform is as effective as face-to-face.</p>

Table 1 (con't)

Domain	Questions
<i>Experience</i>	E1 I feel that internet connectivity was a major concern.
	E2 I feel that I have access to appropriate devices/ hardware.
	E3 I feel that I have access to appropriate e-resources.
	E4 I feel that pandemic-induced anxiety hampered my online teaching/ learning.

Participants and Data Collection

Sample size was determined using a web-based sample size calculator (Raosoft.com, 2004). The minimum number of participants required for the study to produce a 95% confidence interval and 7.5% margin of error based on the estimated population size of medical students in Malaysia (Wong & Abdul Kadir, 2017) is 170.

Ethics approval was obtained from the university’s Human Ethics Committee. Sampling was performed by way of convenience sampling. All current medical students (from Year 1 to 5) in the medical undergraduate degree program at our institution were invited to participate in the study through email and phone messaging. Participation was voluntary. To help improve response rates and to reduce volunteer bias, a student representative from each intake was recruited to personally approach all students in their intake, and reminders were sent every four days until the survey closed. Written consent was obtained from each participant. All responses were submitted anonymously over a two-week period in June 2020.

Statistical Analysis

For the descriptive component of the study, data were summarised as frequencies and percentages for the Knowledge domain, and as median and interquartile range for the Attitude and Experience domains. To test our study hypothesis, inferential statistics was applied. Fisher’s exact test was used to determine the relationship between year of study and the students’ responses in the Knowledge domain. Kruskal-Wallis H test with Bonferroni post-hoc testing for multiple comparisons was used to identify any significant difference between the year of study in the Attitude and Experience domains. Binary logistic regression was used to determine the demographic and domain predictors for the response outcomes in Knowledge, Attitude and Experience domains. Response outcomes were dichotomised with a single cut-off to reflect agreement vs disagreement/uncertainty. The use of binary logistic regression instead of ordinal regression was justified in this case as the assumption of proportional odds was violated (Bender & Grouven, 1998). Demographic predictors were year of study, gender, nationality and duration of exposure to e-learning. Domain predictors included all statements in the domains of Knowledge, Attitude and Experience, examining both intra- and inter-domain effects of each response. A p-value of < 0.05

was considered statistically significant (alpha value of 0.05). All statistical analyses were performed using SPSS v26 (SPSS Inc., Chicago, Illinois, USA).

Results

From a total of 274 medical students invited for the study, there were 192 participants, giving an overall response rate of 70%. Participant characteristics given as frequencies and percentages are summarised in Table 2. International students from various countries including Australia, Bangladesh, Maldives, Mauritius, Oman, and South America make up a proportion of our international student population (17.7%).

Table 2. Participant demographics

Year of study	No. of students, n (%)	Gender, n (%)		Age group, n (%)				Nationality, n (%)		Duration of exposure to e-learning, n (%)	
		M	F	< 20 yrs	21 – 22 yrs	23 – 24 yrs	> 25 yrs	M'sian	Non-M'sian	< 6 mths	> 6 mths
1	27 (14.1)	13 (48.1)	14 (51.9)	25 (92.6)	2 (7.4)	0	0	21 (77.8)	6 (22.2)	22 (81.5)	5 (18.5)
2	32 (16.7)	12 (37.5)	20 (62.5)	8 (25)	22 (68.8)	2 (6.3)	0	28 (87.5)	4 (12.5)	22 (68.8)	10 (31.3)
3	48 (25.0)	22 (45.8)	26 (54.2)	5 (10.4)	32 (66.7)	10 (20.8)	1 (2.1)	37 (77.1)	11 (22.9)	31 (64.6)	17 (35.4)
4	42 (21.9)	16 (38.1)	26 (61.9)	1 (2.4)	16 (38.1)	23 (54.8)	2 (4.8)	33 (78.6)	9 (21.4)	31 (73.8)	11 (26.2)
5	43 (22.4)	20 (46.5)	23 (53.5)	0	2 (4.7)	27 (62.8)	14 (32.6)	39 (90.7)	4 (9.3)	27 (62.8)	16 (37.2)
Total	192	83 (43.2)	109 (56.8)	39 (20.3)	74 (38.5)	62 (32.3)	17 (8.9)	158 (82.3)	34 (17.7)	133 (69.3)	59 (30.7)

Students' Knowledge about Online Learning

Frequencies and percentages of the responses in the Knowledge domain are presented in Table 3. Overall, there was a high awareness of the basic concepts of e-learning across all years of study (78.6 – 100%) with the majority in agreement that information and communication technology skills are important prerequisites, and that student feedback is essential to ensure its effectiveness. Over 70% (more specifically, 71.9%) of students were uncertain or disagreed that online assessments could adequately

assess their academic performance. Participants' responses also reflected a degree of ambivalence about whether online learning involved more independent learning than the traditional face-to-face setting, with 57.3% of students agreeing that it does. There was no significant difference in the overall responses by year of study.

Table 3. Participants' responses in the Knowledge domain according to year of study

Question	Response	Year 1, n (%)	Year 2, n (%)	Year 3, n (%)	Year 4, n (%)	Year 5, n (%)	p value
K1	Agree	22 (81.5)	2 (100)	43 (89.6)	33 (78.6)	38 (88.4)	NS
	Disagree	2 (7.4)	0 (0)	1 (2.1)	4 (9.5)	0 (0)	
	Not sure	3 (11.1)	0 (0)	4 (8.3)	5 (11.9)	5 (11.6)	
K2	Agree	24 (88.9)	30 (93.8)	44 (91.7)	34 (81.0)	33 (76.7)	NS
	Disagree	2 (7.4)	0 (0)	2 (4.2)	4 (9.5)	4 (9.3)	
	Not sure	1 (3.7)	2 (6.3)	2 (4.2)	4 (9.5)	6 (14.0)	
K3	Agree	6 (22.2)	11 (34.4)	9 (18.8)	13 (31.0)	15 (34.9)	NS
	Disagree	15 (55.6)	15 (46.9)	17 (35.4)	17 (40.5)	14 (32.6)	
	Not sure	6 (22.2)	6 (18.8)	22 (45.8)	12 (28.6)	14 (32.6)	
K4	Agree	13 (48.1)	22 (68.8)	24 (50.0)	27 (64.3)	24 (55.8)	NS
	Disagree	11 (40.7)	6 (18.8)	13 (27.1)	9 (21.4)	11 (25.6)	
	Not sure	3 (11.1)	4 (12.5)	11 (22.9)	6 (14.3)	8 (18.6)	
K5	Agree	24 (88.9)	30 (93.8)	44 (91.7)	39 (92.9)	36 (83.7)	NS
	Disagree	2 (7.4)	0 (0)	1 (2.1)	2 (4.8)	0 (0)	
	Not sure	1 (3.7)	2 (6.3)	3 (6.3)	1 (2.4)	7 (16.3)	

NS = not significant

Students' Attitude towards Online Learning

Responses for the Attitude domain are presented in Table 4. Among all the participants, those in Year 5 were most able to sustain their motivation for online learning, with 65.1% agreeing or strongly agreeing with this statement. This was statistically significant in comparison to Year 1 (33.3%), Year 2 (37.5%) and Year 3 participants (12.5%) ($p = 0.022, 0.001$ and < 0.0005 respectively). Correspondingly, those in Year 5 felt most supported in adapting to online learning (68.8% agreed/strongly agreed) compared to the others. This was statistically significant when compared to those in Year 3 (33.4%) ($p = 0.048$).

Relating to work-readiness, only 29.7% of participants overall agreed or strongly agreed that they felt confident about being able to apply what they have learnt online to the workplace (to real patients). This was highest among Year 5 participants (34.9%) and lowest among those in Year 3 (22.9%), however this difference was not statistically significant.

Year 3 participants felt least able to reflect on the subjects learned online, with only 25% agreeing or strongly agreeing to this statement. This was statistically significant in comparison to Year 2 (62.5%) and Year 5 participants (65.1%) ($p = 0.005$ and 0.001 respectively).

Compared to pre-clinical students (Years 1 and 2), a higher proportion of clinical students (Years 4 and 5) perceived discussions conducted online to be as effective as those conducted face-to-face. The proportions of those who agreed/strongly agreed with this ranged from 46.5% in Year 5, 40.5% in Year 4, 27.1% in Year 3, 25% in Year 2, to only 22.2% in Year 1. This difference was statistically significant when comparing responses in Year 5 participants with those in Years 2 and 3 ($p = 0.006$ and 0.001 respectively).

Table 4. Participant responses in the Attitude domain

Question	Year 1, Median (IQR)	Year 2, Median (IQR)	Year 3, Median (IQR)	Year 4, Median (IQR)	Year 5, Median (IQR)	p value
A1	3 (2)*	2.5 (3)*	3 (1)*	3 (2)	4 (1)	<0.0005
A2	3 (2)	4 (1)	3 (1)*	3 (1)	4 (1)	0.012
A3	3 (2)	3 (2)	2 (1)	3 (2)	3 (2)	NS
A4	3 (2)	4 (1)†	3 (2)	4 (2)	4 (1)†	<0.0005
A5	2 (2)	2 (3)*	2 (3)*	3 (2)	3 (2)	0.001

IQR = Interquartile range; 1- Strongly disagree; 2 – Disagree; 3 – Not sure; 4 – Agree; 5 – Strongly agree

*Significant compared to Year 5; †Significant compared to Year 3

Students' Experience of Online Learning

Responses for the Experience domain are presented in Table 5. Internet connectivity was a concern in 75.6% of students overall, the difference of which was significant between Year 1 (96.3% whom agreed/strongly agreed with this statement) and Year 5 (62.8%). Despite these concerns, the majority of students (80.2%) had access to the appropriate hardware such as computers and other electronic devices required for online learning, with no significant differences between the year groups. Most participants in the study (73.5%) agreed/strongly agreed that they had access to appropriate e-learning resources during lockdown, such as the university's e-learning platform and online library resources.

Among the study participants, those in Year 3 most frequently reported that pandemic-induced anxiety had affected their learning, with 66.7% agreeing/strongly agreeing with this. This was followed by Year 2 participants (62.5%). In contrast, only 33.4% of Year 4 and 34.9% of Year 5 participants reported the same. This

difference was statistically significant for Years 2 and 3 in comparison with Year 4 ($p = 0.003$ and 0.014 respectively).

Table 5. Participant responses in the Experience domain

Question	Year 1, Median (IQR)	Year 2, Median (IQR)	Year 3, Median (IQR)	Year 4, Median (IQR)	Year 5, Median (IQR)	p value
E1	5 (0)*	5 (1)	5 (2)	4.5 (1)	4 (2)	0.007
E2	4 (2)	4 (1)	4 (1)	4 (1)	4 (0)	NS
E3	4 (1)	4 (2)	4 (2)	4 (1)	4 (0)	NS
E4	3 (2)	4 (2) [†]	4 (3) [†]	2 (3)	3 (1)	0.002

Key: 1- Strongly disagree; 2 – Disagree; 3 – Not sure; 4 – Agree; 5 – Strongly agree

*Significant compared to Year 5; †Significant compared to Year 4

Demographic and Domain Predictors of Knowledge, Attitude and Experience Responses

Students were more likely to demonstrate an understanding of the basic concept of e-learning (agree/strongly agree with K1 statement) if they were exposed to online learning for more than 6 months compared to those who were exposed for less than 6 months (OR 5.9, 95% CI 1.24 – 27.9, $p = 0.025$). However, the duration of e-learning exposure did not have any significant impact on any of the other domain outcomes.

Participants who showed awareness of the importance of independent learning in the online environment (agreed/strongly agreed with K4 statement) were significantly more likely to report being motivated (OR 2.3, 95% CI 1.07-5.08, $p = 0.03$), were more likely to report that they were able to reflect in-depth on the subjects they learnt online (OR 3.28, 95% CI 1.59-6.77, $p = 0.001$), more likely to perceive discussions conducted online as being as effective as face-to-face learning (OR 14.16, 95% CI 5.08-39.4, $p < 0.0005$) and less likely to report pandemic-induced anxiety (OR 0.16, 95% CI 0.056-0.459, $p = 0.001$). On the other hand, those who reported that pandemic-induced anxiety had affected their learning were less likely to report feeling motivated (OR 0.35, 95% CI 0.15-0.81, $p = 0.014$).

Students who agreed that their performance can be adequately and fairly assessed via online assessment were significantly more likely to find online learning as effective as face-to-face learning (OR 7.24, 95% CI 2.98-17.6, $p < 0.0005$). Students were more likely to report feeling supported by the school if they felt that they had adequate access to e-resources (OR 11.9, 95% CI 4.3-33.3, $p < 0.0005$).

Discussion

Online Assessments

A significant proportion of students felt uncertain or did not feel that online assessments could adequately evaluate their academic performance. Both formative and summative assessments in medical education typically comprise of theory and clinical (practical) assessments, with the implementation of the latter proving a bigger challenge during the pandemic. Medical educators worldwide have adopted various measures including open-book assessments and online/remote objective structured clinical examinations (OSCE) during this time (Major et al., 2020; Monaghan, 2020). With appropriate design and proctoring, open-book medical examinations have shown comparable validity and reliability to that of closed-book examinations (Sam et al., 2020). However, OSCEs conducted online tend to be restricted mostly to the evaluation of history-taking and communication skills, with limited means for testing hands-on practical and clinical examination skills. A recent trial of online OSCE at a UK medical school produced comparable scores to that of prior face-to-face examinations, although the feedback obtained from students were mixed and mirrored our own students' reservations about whether their skills could be properly demonstrated online (Ryan et al., 2020).

The transition to an effective, fully online assessment system in medicine requires further study of how to adapt existing assessment frameworks for a fair and comprehensive evaluation, while ensuring that relevant knowledge and skills are not left out. Several long-term solutions have been proposed, including converting to a competency-based medical curriculum, use of multimodal assessments, and the use of virtual patients for clinical examinations, though each are not without their own limitations (Sabzwari, 2020). A thorough needs analysis that considers the learners' expectations and other facilitating conditions relevant to the individual programme should ideally precede any effort to implement new modes of online learning and assessments (Samat et al., 2020).

Online Learning Effectiveness

The perceived lack of work-readiness evident in the students surveyed reflect the loss of direct clinical exposure, patient contact, and hands-on practical skills training. Our findings are largely corroborated by a recently-published survey of over 3,000 medical students across various medical schools which highlighted the inadequacy of online learning modes, particularly for bedside and practical training during the pandemic (Stoehr et al., 2021). Medical education combines the delivery of theoretical knowledge with clinical skills teaching in both simulated and real clinical environments; the latter taking an increasingly important role as the students progress through the years. While more medical programmes have begun to adopt e-learning through blended learning approaches (Vallée et al., 2020), hospital-based

and practical training have steadfastly remained the backbone of undergraduate medical education, with little alternative. Despite various innovations to help deliver clinical and hospital-based teaching during the pandemic, this has remained a major challenge (Wilcha, 2020). Given the nature of medical education, it would seem more practicable in the long term to develop a safe, blended-learning environment particularly for students engaged in clinical training. This should involve robust mitigation strategies including the implementation of standard operating procedures, risk stratification, and access to vaccines and personal protective equipment in the clinical setting, while incorporating the use of technology such as telemedicine wherever possible.

Students in our survey generally found online discussions less effective than those conducted face-to-face, especially Year 3 and pre-clinical students. Peer-assisted, problem-based learning (PBL) is widely implemented in our pre-clinical teaching and relies heavily on group interactions, which is often difficult to achieve online despite the use of modern videoconferencing platforms. While student performance in web-based PBLs have been shown to be comparable to that of face-to-face sessions, students report lower levels of satisfaction with the former (Raupach et al., 2009). Meaningful social interactions with their peers not only help students learn better and produce better academic results (Tinto, 1997), but also reduces the risk of burnout and mental health issues amongst students in healthcare (Ray et al., 2019). In direct response to the disruption of clinical training and enforced social isolation during the pandemic, medical educators have devised innovative approaches to help improve social connectivity amongst trainees, for example by creating national-level educational social networks (Duggan et al., 2020) and even a student-led volunteering network for community and clinical services (Soled et al., 2020).

Student Factors

Independent learning is an important determinant of online learning effectiveness (Kintu et al., 2017). While this study does not directly assess the students' independent learning ability, our findings suggest that awareness of this fact is important as it is likely to encourage self-regulating behaviours, which is particularly important as there is higher tendency for multi-tasking online than in face-to-face teaching (Lepp et al., 2019). In our study, students who were aware of the importance of independent learning in the online environment were more motivated, more reflective, less anxious, and more likely to find online learning effective. Part of this could also be attributed to self-efficacy, defined as an individual's belief in their ability to succeed in a specific situation or accomplish a specific task (Bandura, 2012). Students with high self-efficacy have higher motivation to learn, resulting in higher academic achievement, because they believe that they have an ability to achieve their goal. Efforts to promote self-efficacy beliefs and self-regulatory behaviours relating to online learning should encompass time-management skills and technological competencies (Heo et al.,

2021). Having a dedicated learning space for online learning is also significantly associated with higher self-regulation during the pandemic (Roslan & Halim, 2021).

Medical students are more likely to report feelings of anxiety compared to the general population (Tian-Ci Quek et al., 2019). Our findings highlight how anxiety related to the current pandemic may impact on the students' motivation and learning. In a related study (Win et al., 2020), we found that the high levels of anxiety felt by students during the pandemic were largely related to their perceived deterioration of practical skills and unpreparedness for future clinical examinations, fear of contagion, and uncertainty of returning to normal. The findings reiterate the importance of identifying psychological distress and addressing the mental well-being of students during this time.

Unsurprisingly, technology constraints have a major impact on online learning effectiveness during the pandemic, particularly in resource-limited regions (Gismalla et al., 2021). Concerns regarding internet connectivity appear not only to affect our students, but are also experienced by learners nationwide, impacting on their online learning readiness (Chung et al., 2020). During the lockdown, many remained at home including areas where telecommunications infrastructures are less well-developed. This highlights the urgent need for expanding and optimising internet connectivity and access to the appropriate technological equipment in all parts of the country.

Experience of Year 3 Students

Our results show that final year (Year 5) students felt most motivated and most supported by the school during their online learning experience. In contrast, Year 3 students felt the least supported and showed considerable concerns regarding poor motivation, poor self-reflection, and high rates of pandemic-induced anxiety. This could be, in part, attributed to the transition from the pre-clinical to clinical phase of the medical undergraduate programme. While the main emphasis in the pre-clinical phase (Years 1 and 2) is on the foundational knowledge of anatomy, physiology and medical sciences, the clinical phase (Years 3 to 5) focuses on their application of knowledge to clinical problem-solving, where clinical reasoning, communication skills and practical skills are essential. Learning in the pre-clinical phase consists mostly of didactic lectures and small-group teaching, whereas in the clinical phase, a stronger emphasis is placed on self-directed learning in the real clinical environment. Students often find this transitory period particularly stressful (Radcliffe & Lester, 2003) and we expect this to be further compounded by the cessation of hospital-based bedside teaching and clinical exposure during the pandemic, which are normally crucial for helping students adjust to clinical practice, for contextualisation and consolidation of their theoretical knowledge, and to prepare them for the workplace. Although our medical curriculum follows a vertically integrated structure in which clinical teaching is integrated into both the pre-clinical and clinical phases, this may be a call for further strengthening of students' clinical exposure in the first

two years of study. Special measures during this period such as online real-patient encounters (also known as ‘telemedicine’), can help the pre-clinical students gain clinical exposure in a safe and pragmatic manner where access to physical patients is limited (Waseh & Dicker, 2019).

The abrupt change in physical environment may also adversely impact on the perceptions and experiences of online learning in Year 3 students. Upon completing their pre-clinical studies, our students are transferred to a clinical campus located in the vicinity of our main teaching hospital for the remaining duration of their course. For the current group of Year 3 students, this transition occurred under the enforced lockdown and their first encounter with the clinical faculty and program was online. Unfamiliarity and the complete lack of face-to-face interactions are likely to have contributed to the abovementioned findings. Year 5 students, who have spent considerable time with faculty and facilities, felt better supported and engaged correspondingly. Strengthening the existing Mentor-Mentee system and an extended reinforcement during the “Orientation Programme” for the new Year 3 students could allay some of their fears and apprehensions. Further support by designating a “Senior Buddy” and incorporating additional tools that augment collaborative online learning may also be useful.

Study Limitations

A self-developed questionnaire was used in this study due to the lack of an appropriate pre-existing survey instrument given the novelty of the study context at the time, thus our instrument lacked the benefits of repeated testing and further validation in different student populations. As participation was voluntary, the study was prone to volunteer bias whereby students who were more interested in the study were more likely to participate. Nonetheless, the use of student volunteers to assist in recruitment helped to widen the selection of respondents. To improve completion rates and further reduce volunteer bias, the total number of items in the survey questionnaire was restricted to those which we considered most essential for the purpose of our study while providing a permissible measure of reliability. Although this ensured that the survey length was acceptable to respondents, it limited our ability to obtain more precise inferences from each domain. The use of convenience sampling and voluntary participation in our study limits our ability to apply the findings from inferential statistics beyond our own student population. Nonetheless, the findings presented here provide useful exploratory data for planning of future studies with more robust hypothesis testing ideally by random sampling from a wider student population.

The cross-sectional design of the study limits it to a single snapshot of a constantly-evolving situation. Moreover, the feedback obtained from our students reflect a period of early, abrupt changes to the curriculum. With the passage of time and with the benefit of hindsight since, subsequent improvements made to our online curriculum delivery may yield differences in student perceptions and experiences.

Conclusion

The negative impact of the pandemic on online learning in medicine are largely related to the loss of clinical exposure and patient contact, reduced quality of social interactions, and the lack of confidence in the reliability of online assessments perceived by the students. Student factors that impact on their learning include self-motivation and awareness of the need for independent learning, anxiety resulting from the pandemic, and internet connectivity. It is worth highlighting that Year 3 medical students, who are already in a challenging phase of their studies, are particularly vulnerable to the adverse effects of the pandemic, prompting a call for improved academic and psychological support. Finally, the implementation of an effective, exclusively online curriculum requires extensive planning and a phased approach, which were not possible due to the abrupt onset of the pandemic. A deeper appreciation of the factors that significantly impact on medical students' online learning during the pandemic will help inform the design of medical curricula and planning of educational policies to ensure the continuous delivery of high-quality medical education and to better prepare ourselves for similar disruptions in the future.

Suggestions for Future Research

Our findings provide a basis for a longitudinal study examining the longer-term impact of the pandemic on medical teaching and learning. Moreover, our findings also warrant a further study on the implications on work readiness among medical students who have spent a significant part of their clinical training years online.

Co-author Contributions

The authors confirm that there are no conflicts of interest in this article. All authors named in the study were involved in the questionnaire design and data collection. P. Bhargava, P.P. Khine, S.Y. Lim, Y.S. Lim, and S. Punitha were involved in drafting the article. S.Y. Lim carried out the statistical analysis, wrote up the results and oversaw the write-up of the whole article.

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