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Original Article

Dentistry Section

Dental Students' Perceptions of the Current Educational Environment and Readiness for the Simulation-based Teaching Model: A Questionnaire-based Cross-sectional Study from Malaysia

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ABSTRACT

Introduction: To facilitate the advancement of dental education in Malaysia, it is imperative to get insight into the perceptions held by dental students towards the current situation of the Educational Environment (EE). Moreover, in the current evolution of the educational framework, a shift is occurring from the conventional pedagogical approach to the implementation of simulation-based experiences. For a better understanding of virtual learning, it is crucial to determine students' level of technology readiness.

Aim: To identify the students' perceptions regarding the present dental EE in Malaysia and their technology readiness for a simulation-based teaching and learning model and to verify whether technology readiness influences students' perceptions of the present EE.

Materials and Methods: The study utilised a cross-sectional survey design. A total of 146 dental students enrolled in year 4 and year 5 of three dental faculties in Malaysia were invited to this study from May to June 2023. The survey used the Dundee Ready Educational Environment Scale (DREEM) and the modified Technology Readiness Index (TRI) to measure students' perceptions of EE and readiness for the new educational model. Mann-Whitney U tests were conducted to explore the differences among different demographic information for both DREEM and modified TRI. Multivariable linear regression analysis was conducted to determine associated factors with the TRI score. Pearson's correlation coefficient was used to measure the correlation between DREEM and modified TRI. All tests for statistical significance were carried out using Statistical Package for Social Sciences (SPSS) software version 26.0.

Results: The overall global score of DREEM was 127.74/200. Comparing the subscale and global DREEM scores between public and private universities, significant differences were found in all dimensions and global DREEM scores except for students' Social Self-Perception (SSP). Year four Undergraduate (UG) students showed more positivity in Students' Perception of Learning (SPL) (p=0.020) and Students' Perception of Teachers (SPT) (p=0.031) than year five students. While the overall mean score of the modified TRI was 3.08/5. The level of technology readiness would not affect the overall global DREEM score.

Conclusion: Dental UGs' perception of the EE is considered to be "more positive than negative." However, improvements are needed in SPL and SPT. Generally, dental UGs in Malaysia have reached an adequate technology readiness level toward simulation-based teaching and learning.

Keywords: Augmented reality, Computer simulation, Dental education, Distance education, Educational technology, Online learning, Virtual reality

INTRODUCTION

Dental education includes didactic and clinical training for future specialists in oral healthcare [1]. Dental education has been characterised as an exceptionally challenging, stressful, and demanding academic field [2]. Undergraduates (UG) are expected to acquire the necessary academic, clinical, and inter-personal skills within a 4-6-year program [3]. Numerous studies have reported the high level of stress experienced by dental students in many countries [4-7]. Telang LA et al., conducted research focusing on the factors contributing to stress among Malaysian dental students, as well as the relationship between financial responsibilities and stress levels [8]. Additionally, Mohd Nayan NA et al., have highlighted that the key factor influencing the depression levels of dentistry UG is the students' Educational Environment (EE) [9].

In addition to some inherent stresses that cannot be eliminated, one source of stress comes from the discrepancy between the theory taught in the classroom and the practice in the real clinical world [10]. It was found that students experienced difficulty understanding concepts as they received knowledge passively through lecture notes [11]. Telang LA et al., also found that a student-friendly EE can reduce the harmful consequences of stress [8]. Simulation approaches can serve as a means to improve the efficacy of clinical training, allowing learners to engage in both real and simulated environments [12].

Changes to didactic instruction post-pandemic compelled dental educators to shift to virtual modes of teaching and learning [13,14]. To accommodate this transition, several virtual teaching and learning techniques were applied [15,16]. Among them, Augmented Reality (AR) and Virtual Reality (VR) were found to be applicable in educational settings [17]. However, these require further enhancements specific to dental education [18,19].

Furthermore, to understand the impact of these technologies on dental EE in Malaysia, students' views can provide important information on the development of UG dental curriculum. Hence,

the main objective of this study was to assess the current state of dental EE in Malaysia through students' perceptions and to identify areas for improvement. It is worth mentioning that the modified Technology Readiness Index (TRI) is simultaneously issued to assess the readiness of UG students for virtual teaching and learning and to determine whether the technology readiness level affects students' perceptions of the EE.

MATERIALS AND METHODS

A cross-sectional study design was employed, and students from three dental schools in Malaysia-Universiti Sains Malaysia (USM), Penang International Dental College (PIDC), and Asian Institute of Medicine, Science and Technology (AIMST) University-participated in this study. Two questionnaires, namely DREEM and modified TRI, were distributed simultaneously in the three institutions from May to June 2023. Ethical approval was received from the Human Research Ethics Committee (HREC) at Universiti Sains Malaysia (USM/JEPeM/21110756).

Inclusion Criteria: Year 4 and year 5 Under Graduate (UG) dental students enrolled in the three institutions who have finished theoretical courses and the pre-clinical phase and are undergoing the clinical phase.

Exclusion Criteria: Students who have not been exposed to the clinical phase and those who are not willing to provide consent forms.

Sample Size: A purposive sampling method was employed to identify further participants from the initial sample. The sample size was calculated by the following formula:

n={z2*p(1-p)}/e2/1+{z2*p(1-p)}/e2*N

where,

z=1.96 at a 5% level of significance; p=proportion of 50%=0.50; N=population size=282; e=margin of error=0.05; n=sample size=138.15

Hence, the minimum sample size needed was 138. Out of 282 students, 146 provided their informed consent by signing a consent form. Consequently, the DREEM and modified TRI questionnaires were distributed to these 146 students as two separate Google Forms. The entire process was voluntary and confidential.

Procedure

The DREEM instrument: A DREEM survey was developed by the University of Dundee in the UK to assess the instructional settings of medical schools and other places for health training [20]. The DREEM was selected in this study due to its wide adoption in health professions education across several nations and its proven reliability as an assessment tool [21]. The DREEM is a 50-item validated inventory with five sub-scales to measure students' perceptions of their institute: (a) SPL: 12 items; (b) SPT: 11 items; (c) Students' academic self-perception (ASP): 8 items; (d) Students' perception of the atmosphere (SPA): 12 items; (e) Students' SSP: 7 items. Nine items are negative (items 4, 8, 9, 17, 25, 35, 39, 48, and 50) and will be scored in reverse order, such that a higher score indicates a more positive reading. The DREEM questionnaire contains three demographic information and 50 items on a 5-point Likert scale (0=Strongly disagree; 1=Disagree; 2=Neutral; 3=Agree; 4=Strongly agree).

A those with mean scores of 3.5 and above are considered strong areas, those with mean scores between 2 and 3 are considered areas where the EE might be enhanced, and those with mean scores of 2.0 and below belong to the problematic areas [21]. The internal reliability for the DREEM scale is between 0.757 and 0.941. Each domain had a scale reliability above 0.7, so this instrument is acceptable based on Nunnally JC's study [22].

Modified TRI instrument: Technology readiness is a well-recognised concept that pertains to people's capacity to accept new technology [23]. The initial TRI was developed from marketing research to assess consumers' willingness to embrace new technology-based products or services [23]. A modified TRI questionnaire was adapted from the original questionnaire [23-25]. In this modified TRI questionnaire, some economics terms have been modified to adapt to the healthcare environment.

In the present study, the modified TRI developed by Caison was adopted, which consists of four dimensions: 1) Optimism: 10 items; 2) Innovation: 9 items; 3) Discomfort: 10 items; 4) Insecurity: 6 items. In addition, this questionnaire substitutes the term "technology" with "educational technology," which specifically encompasses digital devices capable of accessing educational curricula. This questionnaire contains eight demographic information and 35 TRI items on a 5-point Likert scale (1=Strongly disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly agree).

Following the proper reverse coding, mean scores for optimism, innovation, discomfort, and insecurity are computed [23]. Since the number of questions varies across the four domains, a weighted calculation was performed to obtain the overall TRI mean score [25]. The final TRI score is the mean of the four components, assessed on a scale of 5, where higher scores indicate greater technological readiness [26]. Each domain of modified TRI has a scale reliability above 0.7, from 0.788 to 0.895, which indicates this instrument has an acceptable high level of reliability [22].

STATISTICAL ANALYSIS

Cronbach's Alpha coefficient was employed to show the degree of reliability for each scale and overall instrument for both DREEM and modified TRI. Descriptive statistical analysis, including mean, Standard Deviation (SD), and percentages, was computed to indicate the characteristics of participants in this study.

Regarding the DREEM, total and subscale scores were compared using a Mann-Whitney U test. For the modified TRI, a Mann-Whitney U test was conducted as appropriate to explore the differences among different genders, school types, academic years, and whether the participants received the scholarship. The Kruskal-Wallis H test was used to analyse differences regarding household income and Wi-Fi signal. Multivariable linear regression analysis was conducted to determine which factors are associated with the overall TRI score.

The Pearson correlation coefficient was used to measure the correlation between EE and technology readiness. All tests for statistical significance were carried out at a 5 percent significance level using SPSS software version 26.0.

RESULTS

Out of the 146 questionnaires disseminated, 104 individuals responded (response rate 71.2%). The distribution of respondent demographics is described in [Table/Fig-1]. There were 81 (77.9%) female respondents, while only 23 (22.1%) were male respondents. Of the total, 83 (79.8 percent) were in the fourth year, while 21 students (20.2 percent) were in the fifth year. Private and public institutions were almost equally distributed [Table/Fig-1].

[Table/Fig-2] shows the overall global DREEM score was 127.74 out of 200, in the "more positive than negative" category. The mean scores in the five subscales were SPL=31.85 (a more positive approach), SPT=29.37 (moving in the right direction), ASP=20.64 (feeling more on the positive side), SPA=31.55 (a more positive atmosphere) and SSP=14.34 (not a nice place) [27].

The overall global DREEM score of male students was 128.74, while female students obtained 127.46. However, there was no significant gender difference. Public institutions outperformed private ones in each dimension and global DREEM scores and exhibited significant differences except for SSP [Table/Fig-3]. Regarding different academic years, year 4 students obtained higher scores in each domain and showed significant differences in SPT and SPL [Table/Fig-3]. For the individual items, eight scored

over 3, with the highest scoring question, "The teachers are knowledgeable," received 3.47 points. Four individual items scored below two are shown in [Table/Fig-4].

Variable	Frequency (N=104)	Percentage (%)
Gender		
Male	23	22.1
Female	81	77.9
Institution		
Public	49	47.1
Private	55	52.9
Academic year		
Year 4	83	79.8
Year 5	21	20.2

[Table/Fig-1]: Demographics of participants of DREEM.

Latitude	Full marks	Mean±SD	Percentage of the maximum score	Interpretation [27]
SPL	48	31.85±5.29	66.35%	A more positive approach
SPT	44	29.37±4.65	66.75%	Moving in the right direction
ASP	32	20.64±3.57	64.50%	Feeling more on the positive side
SPA	48	31.55±7.12	65.73%	A more positive atmosphere
SSP	28	14.34±2.57	51.21%	Not very bad
Overall global DREEM score	200	127.74±18.06	63.87%	More positive than negative

[Table/Fig-2]: Subscale and overall global score of DREEM.

Item	Mean±SD
The teaching over emphasise factual learning.	1.06±0.75
The teachers are authoritarian.	1.51±0.98
The teaching is too teacher centered.	1.67±0.99
I'm too tired to enjoy this course.	1.78±1.12

[Table/Fig-4]: Problematic individual items of DREEM instrument.

A total of 108 out of 146 responses were received (response rate: 73.9%). The distribution of response characteristics is described in [Table/Fig-5]. Of the 108 responses, 82 (75.9%) were females, while 26 (24.1%) were males. As for the academic year, 88 (81.5%) were in the fourth year, and 20 (18.5%) were in the fifth. Based on monthly household income, 28 (25.9%) were more than RM10970; 46 (42.6%) were from RM4851 to RM10970; 34(31.5%) were less than RM4850. The response rates based on Wi-fi signal were 38(35.2%), 50(46.3%), and 20(18.5%) for fast, average, and basic. The types of institutions were almost equally distributed [Table/Fig-5]. A total of 54 (50%) for each scholarship recipients and non-recipients.

The subscale and overall TRI scores are presented in [Table/Fig-6]. Optimism, innovation, discomfort, and insecurity obtained scores of 3.92±0.50, 3.30±0.58, 2.89±0.60, and 2.21±0.67, respectively.

Variable	Frequency (N=108)	Percentage (%)
Gender		
Male	26	24.1
Female	82	75.9
Institution		
Public	50	46.3
Private	58	53.7
Academic year		
Year 4	88	81.5
Year 5	20	18.5
Monthly household income		
More than RM10,970	28	25.9
RM4,851- RM10,970	46	42.6
Less than RM4,850	34	31.5
Wi-fi signal		
Fast >200 Mbps	38	35.2
Average >100 Mbps	50	46.3
Basic >25 Mbps	20	18.5
Scholarship		
Yes	54	50.0
No	54	50.0

[Table/Fig-5]: Distribution of response characteristics of modified TRI.

Variables		SPL Mean±SD	SPT Mean±SD	ASP Mean±SD	SPA Mean±SD	SSP Mean±SD	Overall global DREEM score
Gender	Male (n=23)	32.30±5.85	28.96±5.08	20.74±3.97	31.96±7.26)	14.78±2.73	128.74±20.49
	Female (n=81)	31.72±5.15	29.48±4.55	20.62±3.48	31.43±7.12	14.21±2.52	127.46±17.44
	p	0.419	0.721	0.918	0.925	0.463	0.881
Institution	Public (n=49)	33.51±4.70	30.86±4.21	21.45±3.80	33.10± 6.94	14.71±2.87	133.63±17.05
	Private (n=55)	30.36±5.38	28.04±4.65	19.93±3.22	30.16± 7.05	14.00±2.24	122.49±17.44
	p	**0.004 ****	**0.009 ****	**0.025 ***	**0.030 ***	0.201	**0.005 ****
Academic year	Fourth (n=83)	32.53±4.83	29.92±4.44	20.83±3.67	31.81±6.85	14.36±2.63	129.45±17.29
	Fifth (n=21)	29.14±6.23	27.19±4.91	19.90±3.15	30.52±8.20	14.24±2.39	121.00±19.88
	p	**0.020 ***	**0.031 ***	0.316	0.429	0.961	0.090

[Table/Fig-3]: DREEM scores by demographic characteristic.
*p <0.05; **p <0.01

The overall TRI score obtained was 3.08±0.31. Different levels of household income affect an individual's optimism about new technology, but none of the other independent variables make a significant difference to the TRI score.

Linear regression analyses showed that all demographic information had no effect on TRI scores, as shown in [Table/Fig-7]. Besides, no significant correlation was found between dental EE and students' technology readiness level [Table/Fig-8].

DISCUSSION

In this study, the overall global DREEM score was 128.74±20.49, which belongs to the "more positive than negative" category. This finding is consistent with research conducted in recent years in India, Australia, Korea, Saudi Arabia, the Netherlands, Turkey, and Syria, with scores ranging from 100.61 to 127 [21,28-33]. Students' perceptions of their DREEM subscale values demonstrated that students' perceptions of learning, teachers, atmosphere, academics, and SSP were more positive and

Variables		Optimism Mean±SD	Innovation Mean±SD	Discomfort# Mean±SD	Insecurity# Mean±SD	TRI score Mean±SD
All participants		3.92±0.50	3.30±0.58	2.89±0.60	2.21±0.67	3.08±0.31
Gender	Male (n=26)	3.91±0.53	3.41±0.61	3.01±0.57	2.26±0.57	3.15±0.32
	Female (n=82)	3.92±0.49	3.27±0.57	2.85±0.61	2.21±0.70	3.06±0.30
	p	0.857	0.313	0.225	0.759	0.190
Institution	Public (n=50)	4.01±0.53	3.34±0.60	2.85± 0.72	2.20±0.66	3.10±0.35
	Private (n=58)	3.84±0.47	3.27±0.56	2.93±0.49	2.24±0.68	3.07±0.27
	p	0.162	0.793	0.765	0.941	0.603
Academic year	Year 4 (n=88)	3.93±0.49	3.32±0.59	2.89±0.62	2.21±0.65	3.09±0.32
	Year 5 (n=20)	3.88±0.53	3.26±0.53	2.90±0.55	2.27±0.74	3.07±0.27
	p	0.827	0.978	1.000	0.949	0.849
Scholarship	Yes (n=54)	3.99±0.55	3.32±0.57	2.93±0.50	2.19±0.69	3.09±0.34
	No (n=54)	3.84±0.44	3.29±0.59	2.86±0.70	2.25±0.64	3.08±0.27
	p	0.264	0.951	0.858	0.841	0.978
Household income	More than RM10970 (n=28)	4.01±0.45	3.22±0.58	2.97±0.66	2.22±0.57	3.11±0.35
	RM4851- RM10970 (n=46)	3.78±0.46	3.34±0.60	2.91±0.52	2.23±0.61	3.07±0.27
	Less than RM4850 (n=34)	4.03±0.56	3.33±0.55	2.80±0.67	2.20±0.82	3.09±0.33
	p	**0.029 ***	0.957	0.658	0.789	0.738
Wi-fi	Fast (n=38)	3.94±0.51	3.34±0.67	2.86±0.59	2.13±0.65	3.07±0.33
	Average (n=50)	3.86±0.54	3.33±0.51	2.84±0.63	2.24±0.70	3.07±0.30
	Basic (n=20)	4.00±0.37	3.18±0.55	3.08±0.53	2.34±0.63	3.15±0.31
	p	0.597	0.598	0.264	0.688	0.378

[Table/Fig-6]: Modified TRI scores by demographic characteristic.
*p<0.05 #scores are reverse coded

	Adjusted b	t	Sig.
Institution			
Public	Reference		
Private	-0.034	-0.563	0.574
Gender			
Male	Reference		
Female	-0.084	-1.218	0.226
Grade			
Year 4	Reference		
Year 5	-0.012	-0.159	0.874
Scholarship			
Yes	Reference		
No	-0.012	-0.194	0.846
Income			
T20	Reference		
M40	-0.040	-0.536	0.593
B40	-0.017	-0.211	0.834
Wifi			
Fast	Reference		
Average	0.002	0.033	0.974
Basic	0.083	0.976	0.331

[Table/Fig-7]: Results of multivariable linear regression analysis of TRI.
Dependent variable: TRI score; R-square=0.028

	SPL	SPT	ASP	SPA	SSP	Overall DREEM
r[a]	0.058	0.159	-0.105	-0.007	-0.007	0.032
p	0.557	0.106	0.289	0.940	0.940	0.748

[Table/Fig-8]: Correlations between TRI scores and DREEM subscales.
a: Pearson's correlation coefficient

consistent with previous studies [21,27-29,32]. However, the scores were inconsistent with those reported in Turkey and Syria, which revealed a negative perceptions were noted in SPL and SSP [31], and a negative SPL and SPA [33]. When considering the percentage scores for each domain, SPT received the highest percentage score, in line with studies conducted in Australia, Saudi Arabia, and Turkey [28,29,33]. The SSP domain received the lowest percentage score, which is partly consistent with the previous study [27,31].

However, the EE still needs improvement due to the problematic outcomes of the individual item results. "The teaching over-emphasises factual learning," "The teaching is too teacher-centered," and "The teachers are authoritarian" were poorly rated in this study, consistent with other studies involving dental academies in different countries [21,29,31-33]. This suggests that the traditional teacher-centered education model continues to dominate Malaysian dental education. Some elements of the current apprenticeship-based education system are less than ideal, and several areas still need revision and improvement [34-36]. A previous study pointed out that many doctor-teachers lack formal qualifications, and their worth is frequently based on their clinical experience [35]. Moreover, the study proposed some solutions, including Simulation-Based Medical Education (SBME), a method that complements the traditional apprenticeship-based education model [35].

No significant differences were found between males and females in all subscales and overall global DREEM scores, consistent with previous studies [21,29,33]. Year 4 dental students obtained significantly higher scores in SPT and SPL than year 5 students ($p<0.05$). The overall global DREEM score of year 4 was also higher than year 5, but not statistically significant ($p>0.05$). However, another study found higher overall global DREEM scores among year 5 students [33]. The Korean and Australian studies compared overall global DREEM scores and sub-scale scores for students from year 1 to year 4 and found that the overall global DREEM scores decreased progressively as the grade level increased, with significant differences observed in all subscales and overall global DREEM scores [21,28].

The findings from the current study highlight that senior students were able to identify problems with the current teaching model during clinical training and expressed concerns about the teacher-

centered and factual learning model of teaching. Increased clinical work pressure may also lead to lower confidence among senior students in the current EE. Malaysian public universities obtained a significantly higher overall global DREEM score (133.63/200) than private institutions (122.49/200). Sub-scale scores in public universities showed significant differences, high except for SSP. The differences in the score may be attributed to differences in the teaching model. This finding does not correspond to the study in Korea, which found no significant differences between public and private institutions in each subscale and overall global DREEM scores [22].

With the analysis of the results of the DREEM instrument, it is necessary to ensure that students are comfortable with technology to benefit dental students as they transition from students to clinicians [37]. TRI is one of the most well-established tools for assessing comfort with technology and propensity to adopt new technologies, although its use in healthcare settings is limited [37]. Most research on the use of TRI in healthcare has focused on nursing staff and attending physicians, with little literature on TRI in medical students [25,26,37-40], and almost no research in the dental setting.

The study found the overall TRI score (3.08/5) to be at the same level as in previous studies but slightly lower than in the United States (3.27/5), Australia (3.24/5), South Africa (3.2/5), and Columbia (3.1/5) [26,39,41,42]. The score in optimism was the highest, while Insecurity obtained the lowest, which is consistent with previous studies [26,41-43]. This result indicates that although students hold an optimistic attitude towards educational technology, there is also a significant amount of insecurity over its function, supporting the finding reported by Parasuraman [23]. Furthermore, the result of the present study showed a lower score in discomfort than in other studies [26,42,43]. There was no statistical significance for gender, academic year, type of school, household income, Wi-Fi signal, and scholarship in TRI scores ($p>0.05$), indicating that demographic variables play little role in the TRI score of dental students. The overall TRI score indicates that Malaysian dental UGs have reached an adequate level toward virtual teaching and learning [26,39]. The level of technology readiness had no effect on their perceptions of the EE.

In light of the above results, although students have achieved a satisfactory level of educational technology readiness, they may not have the same level of proficiency when it comes to using technology for educational purposes [44]. The lack of ability to utilise technology for educational purposes stems from a lower level of interest and motivation to utilise technology for learning compared to its use for social activities [45].

Therefore, course designers must strategically design learning experiences that offer increased assistance to students during their transition into clinical practice [10]. This may be achieved by giving students with timely knowledge, fostering confidence, and enhancing clinical performance [10]. These measures aim to effectively equip students with the necessary skills and readiness to enter the clinical setting successfully. Dutã M et al., noted that VR and AR technologies have revolutionised dental clinical teaching by overcoming the inherent limitations of the conventional phantom head system [46]. The author emphasised that VR continues to be the next step in dental education. The worldwide emergence of the Coronavirus Disease-2019 (COVID-19) pandemic has expedited the adoption of e-learning techniques within the field [15,16,47,48]. These techniques encompass many forms of technology-mediated instruction, such as mobile learning, computer-assisted teaching, simulation-based learning, and virtual learning. Khalaf ME et al., conducted research to evaluate students' online and blended learning EE during COVID-19 [49]. They used the DREEM with a supplementary questionnaire and obtained a total score of 149.08, which is much higher than in the previously stated studies [21,28-33] and has highlighted the importance of adopting blended learning in future dental curricula.

Limitation(s)

Since the data gathered is cross-sectional, it is impossible to track changes in the subject over time, making it challenging to assess genuine causality. In addition, only one public university was included in this study, and therefore, the findings cannot be generalised to all public universities in Malaysia. The DREEM instrument has limitations as it did not include questions on the dental educational program, such as the clinical requirements for students. As for modified TRI, the lack of modified TRI-related research, especially in dentistry, may lead to bias in results.

CONCLUSION(S)

Based on the findings of the study, the authors conclude that dental UGs considered the EE in Malaysia to be "more positive than negative." However, the traditional teacher-centered model of education still needs enhancement. Students have reached an adequate level of simulation-based teaching and learning. Thus, simulation-based teaching and learning are viable options for future dental education in Malaysia. Virtual teaching and learning are trends that, at the same time, bridge the gap in current dental education in Malaysia.

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