JMIR Medical Education

Contents

Original Papers

Original Paper

Global Outreach of a Locally-Developed Mobile Phone App for Undergraduate Psychiatry Education

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Abstract

Background: Over the past decade, there have been massive developments in both Web-based and mobile phone technologies. Mobile phones are well accepted by students, trainees, and doctors. A review of the current literature has identified the following specialties that have used mobile phones in education: pediatrics, ophthalmology, nephrology, plastic surgery, orthopedics, pharmacology, and urology. However, to date, there are no published papers examining the application of the latest mobile phone technologies for psychiatry education internationally.

Objectives: The main objectives of this study are (1) to determine the feasibility and receptiveness of a locally-developed psychiatry mobile phone app and user perspectives (both quantitative and qualitative) towards it, and (2) to determine the receptiveness of a locally-developed app for psychiatry education internationally.

Methods: A Web-based app that contained textbook contents, videos, and quizzes was developed using HTML5 technologies in 2012. Native apps were subsequently developed in 2013. Information about the apps was disseminated locally to Singaporean medical students, but the respective native apps were made available on the app stores. A user perspective survey was conducted locally to determine student's perception of the app.

Results: From the inception of the app until the time of preparation of this manuscript, there have been a cumulative total of 28,500 unique visits of the responsive HTML5 Web-based mobile phone app. There have been a cumulative total of 2200 downloads of the Mastering Psychiatry app from the Apple app store and 7000 downloads of the same app from the Android app store. The initial user perspective survey conducted locally highlighted that approximately a total of 95.2% (177/186) of students felt that having a psychiatry mobile phone app was deemed to be useful. Further chi-squared analysis demonstrated that there was a significant difference between males and females in their perception of having textbook contents in the mobile phone app (χ^2_4=12.9, P=.0012).

Conclusions: To the best of our knowledge, this is the first study to demonstrate the feasibility and global acceptance of a local, self-designed educational app for psychiatry education. Whilst the current research has managed to demonstrate the feasibility and acceptance of such an app, future studies would be warranted to look, in-depth, into whether there are cultural differences in terms of perceptions towards having such an app in psychiatry and what contents different cultures and cohorts of students might want within an app.

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Introduction

Over the past decade, there have been massive developments in both Web-based and mobile phone technologies. It was perhaps the release of Apple's iPhone in 2007 and the launch of the Apple App store in July, 2008 that was pivotal in causing a huge change in the way the world uses mobile phone devices. Mobile phones with app capabilities are considered to be a new generation of mobile technology, that are equipped with immense computing capabilities allowing individuals to have constant access to the internet and make use of various apps [1].

Previous studies have looked into medical students and trainee's ownership and perspectives towards mobile phone usage. In 2012, a questionnaire-based survey was distributed amongst the interns in the Republic of Ireland [2]. The survey demonstrated that mobile phones were widely adopted and accepted and that they were being used by interns to aid them in performing their daily duties. The survey highlighted that the most popular app that was commonly used was that of the British National Formulary app [2]. Other studies have highlighted similar results, in that there was a high usage rate of mobile phones and the associated apps amongst medical students and junior doctors, and other studies have also found that iPhone users tend to own more apps [3]. Previous studies indicate that students and junior doctors make use of the app for an estimated 30 minutes each day [3]. Given the results of the previous questionnaire surveys, it is apparent that mobile phone technologies are well accepted by students, trainees, and doctors. It would be of interest to determine how several specialties have made use of a hybrid of online and mobile device technology in educational settings.

A review of the current published literature on several databases has identified the following specialties to be using mobile phone technologies in education: pediatrics, ophthalmology, nephrology, plastic surgery, orthopedics, pharmacology, and urology. For example, in pediatrics, a mobile phone neonatal intubation app was deployed to enhance overall intubation skills [4]. In ophthalmology, a cumulative total of 342 apps have been identified to be of value in terms of enhancing clinical skills [5]. In nephrology, several online Web-based resources were identified to be of value for medical students and residents to augment their knowledge with regards to the complications of chronic kidney disorders [6]. In plastic surgery, 16 apps that are of educational value to the plastic surgeon have been identified [7]. It is thus of interest to us to determine to what extent psychiatry, as a discipline, has embraced online, Web-based, and mobile phone technologies for educational

needs of psychiatry medical students and residents. A literature search revealed that the most recent apps of Web-based technology was that of the usage of virtual worlds for role-play simulation in child and adolescent psychiatry [8], the usage of telemedicine for peer-to-peer psychiatry learning between medical students in the United Kingdom and Somaliland [9], the usage of stimulation for performance evaluation in psychiatry [10], and the usage of virtual patients as training tools to teach clinical interviewing skills [11,12]. A search through the existing published literature using the keywords "psychiatry, smartphone, education" did not yield any published papers to date that examined the app of the latest Web-based and mobile phone technologies for psychiatry education.

We hope to make use of the latest Web-based and mobile phone technologies in implementing both a Web- as well as a native mobile phone-based psychiatry textbook companion for undergraduate students in psychiatry, as a means of overcoming the limitations in the current literature. In addition, we hope to be able to determine local and international users' receptiveness towards such an innovative methodology of acquiring psychiatry knowledge.

The main objectives of this study are (1) to determine the feasibility and receptiveness of a locally-developed psychiatry mobile phone app and user perspectives (both quantitative and qualitative) towards it, and (2) to determine the receptiveness of a locally-developed app for psychiatry education internationally.

Methods

A newly written textbook (jointly written by the authors MWBZ and RCMH of this study) that integrated both local (Singapore) and United Kingdom clinical guideline was initially crafted in 2011. The core textbook contents are comprised of chapters, which include subjects in the areas of psychopathology, clinical interview, formulation and management, schizophrenia and psychotic disorders, mood disorders, anxiety disorders, personality disorders, substance misuse and dependence disorders, eating disorders, psychiatric emergencies, psychotherapies, sleep disorders, psychosexual disorders, somatoform and dissociative disorders, consultation liaison psychiatry, old age psychiatry, child and adolescent psychiatry, and forensic psychiatry and psychiatry ethics. As the book was self-published by the authors of this study, the copyrights of the chapters belonged to the authors and hence no permissions were required to reproduce the materials in the mobile phone app. In addition, the authors filmed videos demonstrating assessment methodologies for the various psychiatric disorders locally in Singapore (Textbox 1).

Textbox 1. Filmed videos demonstrating assessment methodologies for various psychiatric disorders

Videos

1. Psychosis: history taking

2. Depression: history taking

3. Anxiety: history taking

4. Explanation of antidepressants

5. Explanation of cognitive behavioral therapy

6. Assessment of borderline personality disorder

7. Suicide risk assessment

8. Explanation of electro-convulsive therapy treatment

9. Frontal lobe examination

10. Mini mental state examination

11. Explanation of lithium therapy

12. Explanation of neuroleptic malignant syndrome

13. Violence risk assessment

14. Explanation of dementia medications

15. Sleep disorder assessment

The core textbook materials, as well as the videos, were then integrated into a Web-based mobile phone app. The Web-based mobile phone app was programmed using an online app builder and a blogging website using both HTML5 and Java-script coding. Videos were stored online on a video-hosting website (Vimeo) [13], and embedded within the Web-based mobile phone app. In addition, a questionnaire-based quiz that contains both multiple choice questions and short answered questions was crafted using an online questionnaire builder and integrated into the Web-based app. Prior to the launch, the usability of the app was evaluated across several different computing platforms to ensure that the system was robust.

In 2013, the authors MWBZ and RCMH were offered an educational grant for the development of a native Apple- and Android-based mobile phone app. The English language version of the Apple IOS and Android Play apps were made available for free on the app stores in late 2013. Given that the apps were made available for free downloads, no proceeds arose from their downloads.

Information about the app was disseminated via printed materials locally in Singapore, as well as by means of a short demonstration to undergraduate students at the National University of Singapore, Yong Loo Lin School of Medicine on the first day of their clinical psychiatry posting. With ethics approval from the National University of Singapore, a user perspective survey was administered to students immediately after the end of their posting test to determine user's perspectives towards the usefulness of such an app.

Results

Download Statistics

The Web-based mobile phone app, Mastering Psychiatry [14], was launched on July 15, 2012 and from the inception of the app until the time of preparation of the manuscript, there have been a cumulative total of 28,500 unique visits of the responsive HTML5 Web-based app. The majority of the users were from Singapore (68.01%, 19,383/28,500), followed by the United States (5.22%, 1487/28,500) and Malaysia (3.31%, 942/28,500). The geographical utilization of the portal since inception until the time of preparation of this manuscript is shown in Figure 1.

With regards to the utilization of the native apps, there have been a cumulative total of 2200 and 7000 downloads of the Mastering Psychiatry app from the Apple and Android app store, respectively (Figure 2). To our knowledge, the native app has been granted a score of 4+ out of 5 on the Apple app store, whilst on the Android app store, it has been granted a score of 4.5 out of 5. A total of 161 users have rated our app on the Android store and a cumulative total of 88.8% (143/161) of the users have given the app a score of ≥3. Some of the qualitative feedback made available on the Android store was that the app was deemed to be a great book for beginners and that it was an excellent app. Some users communicated technical issues pertaining to the usage of the app on some devices to the authors and the app developers.

Figure 1. Geographical map of the utilization of the web-based app since its inception.
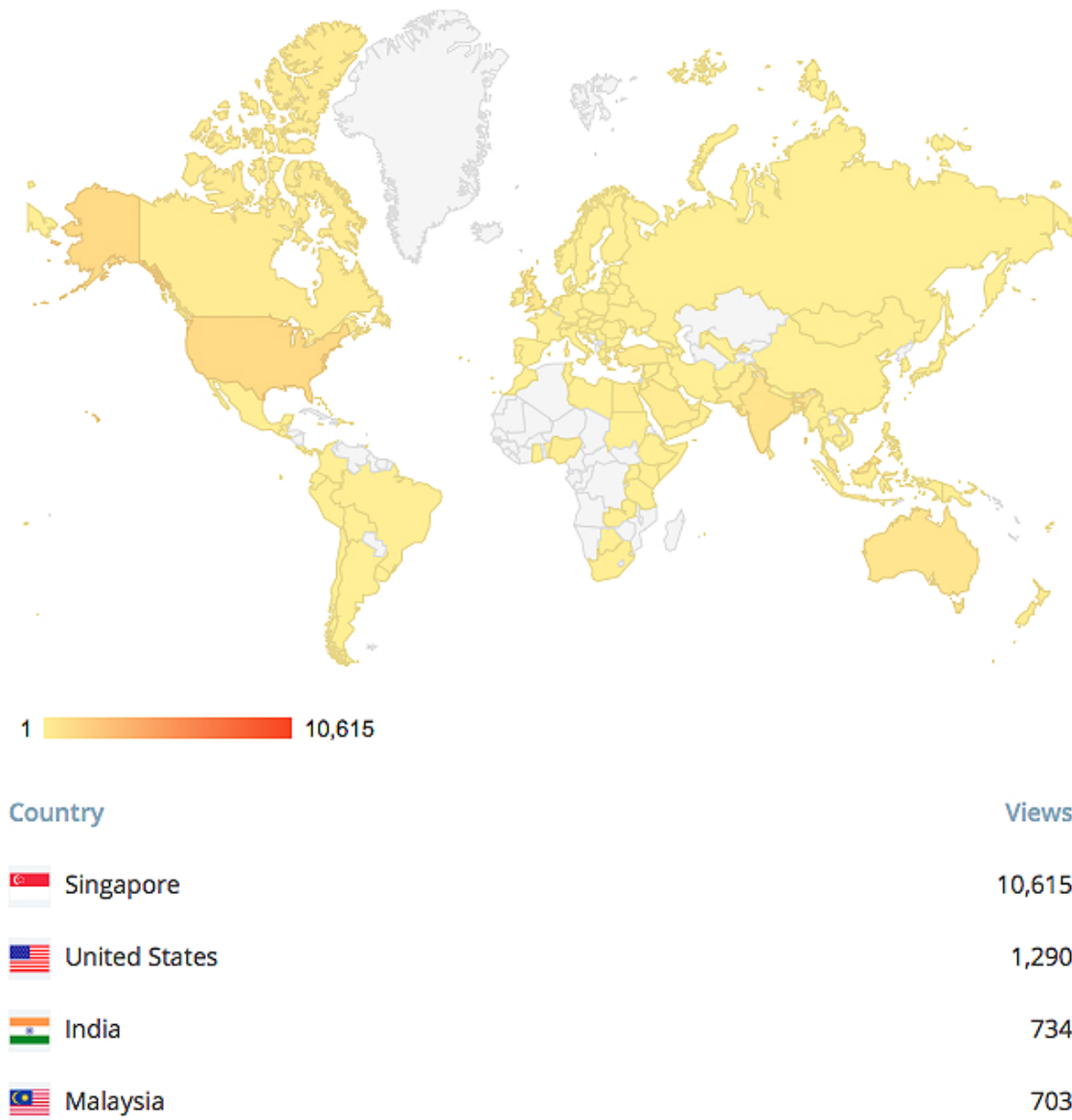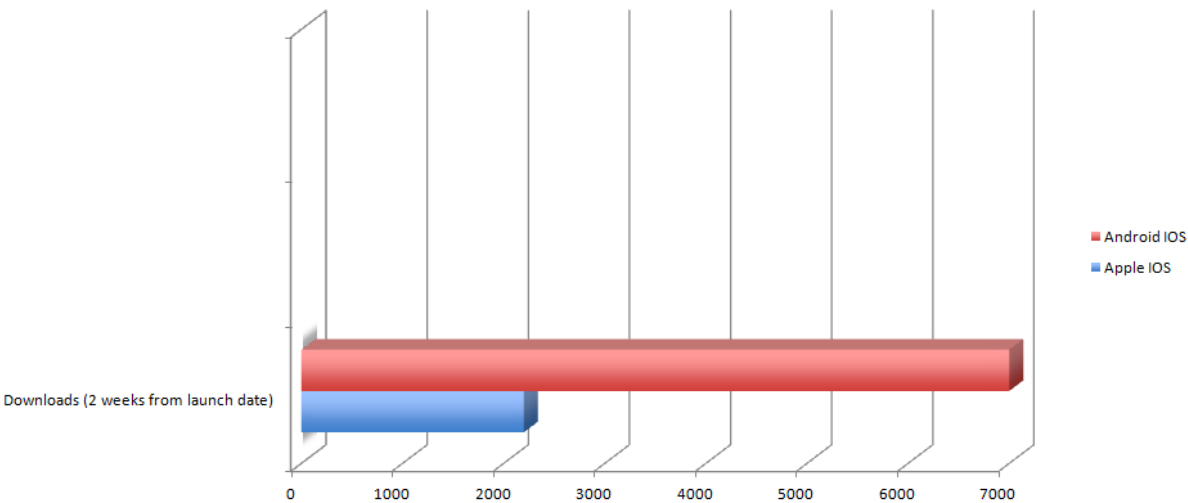

Country	Views
Singapore	10,615
United States	1,290
India	734
Malaysia	703

Figure 2. Cumulative total number of downloads from each of the respective app stores.

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User Perception Survey and Focus Group Analysis

A cumulative total of 185 students voluntarily participated in the user perspective survey. The mean age for males was 22.3 years (SD 0.8) and that for females was 22.0 years (SD 0.4). The majority of the students (53.3%, 121/227) used an Apple IOS device, whereas 21.6% (49/227) of the students used an Android device. The majority of the students (66.7%, 124/168) had between 1-5 medical apps in their mobile phones. The medical apps they had previously downloaded were mainly used for educational purposes as well as for use in the clinics and wards. Table 1 shows the baseline demographic information and the statistical analysis that have been conducted to evaluate the differences between the genders.

In terms of student's perception about the utility of the app, a total of 95.2% (177/186) of the students indicated that having a psychiatry mobile phone app would be useful. The majority of the students wanted the app to contain textbook content and clinical videos and found these features particularly useful. Students perceived that an event management system within the app would be helpful for coordinating the tutorials. A total of 57.1% (105/184) of the students agreed that the app for psychiatry was helpful, and 71.4% (132/185) of the students agreed that a mobile phone app would be a good companion to a traditional textbook.

Further chi-squared analysis demonstrated that there was a significant difference between males and females in their perception of having textbook contents in the app (χ^2_4=12.857, P=.0012). There were no demonstrated significant differences between the genders in terms of their perception of having an app in mastering psychiatry, having clinical videos in the apps, having revision lecture videos in the apps, having text messaging notification services in the app, and in terms of the usefulness of the app, and whether the app was a good companion to a book. Table 2 shows the statistical analysis of the gender comparisons with respect to their perceptions to the individual app features.

A focus group was conducted with a cumulative total of 5 students (n=5). Thematic analysis was conducted and qualitative feedbacks are summarized in Multimedia Appendix 1.

Table 1. Baseline demographic information and statistical analysis conducted to evaluate the differences between the genders (N=185).

Demographic variables		Male	Female	Statistical data	P value
Age, years (SD)		22.3 (0.8)	22.0 (0.4)	[a]t_{176} =2.7	.008
Average monthly income, dollars (SD)		4214.36 (2778.33)	4583.33 (2800.30)	t_{18} =-0.3	.789
Mobile phone ownership, %				[b]χ^2_5=6.0	.307
	None	1.3%	0.0%		
	iPhone	27.9%	25.2%		
	Google Android	10.6%	11.1%		
	iPad	6.2%	4.4%		
	Android Tablet	2.7%	0.9%		
	Laptop/notebook computer	5.3%	4.4%		
Medical-related apps, %				χ^2_4=3.3	.508
	None	13.5%	8.1%		
	1-5 apps	33.5%	33.0%		
	6-10 apps	4.9%	3.2%		
	11-15 apps	0.5%	1.1%		
	≥15 Apps	1.6%	0.5%		
Purpose of medical-related app, %				χ^2_4=5.7	.220
	Education- revision	9.7%	5.2%		
	Education- learning	12.3%	14.9%		
	Clinical (wards)	14.9%	16.0%		
	Clinical (clinics)	10.1%	10.4%		
	Others	4.1%	2.2%		
Frequency of medical app usage, %				χ^2_3=2.1	.560
	Rarely	30.7%	25.6%		
	2-3 times per week	13.1%	12.5%		
	1-2 times per day	5.7%	6.3%		
	≥3 times a day	4.5%	1.7%		
Time spent on medical app per day, %				χ^2_6= 5.0	0.549
	None	19.0%	15.6%		
	1-10 mins	22.9%	17.9%		
	11-20 mins	6.1%	5.6%		
	21-30 mins	3.9%	3.9%		
	31-60 mins	2.2%	1.1%		
	1-24 h	0.0%	1.1%		
	≥24 h	0.6%	0.0%		

[a]t test

[b]Chi-square test

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Table 2. Comparison between the genders in terms of their perceptions to the individual app features.

Perspectives	Males, %					Females, %					Chi-square[a]
	Absolutely useless	Useless	Of Some use	Useful	Very Useful	Absolutely useless	Useless	Of Some use	Useful	Very Useful	
Mobile phone app to learn psychiatry	1.1	2.7	28.1	16.8	5.4	0.0	1.1	22.2	15.1	7.6	5.0
Textbook content in app	2.2	3.8	17.4	22.3	8.2	0.0	0.5	11.4	22.8	11.4	12.9
Clinical OSCE videos in app	0.5	4.3	13.4	24.2	11.8	0.5	2.2	12.9	18.8	11.3	1.3
Revision lecture videos in app	1.6	4.8	15.1	22.0	10.8	0.5	2.7	11.3	18.8	12.4	2.5
SMS notification/event management services in app	1.6	2.7	17.3	18.4	14.6	0.5	2.2	9.7	20.0	13.0	3.9
Usefulness of app for psychiatry	4.9	23.9	22.8	2.2	0.5	5.4	22.8	16.8	0.5	0.0	3.7
Good companion to book	9.8	29.3	9.2	4.3	1.6	10.9	21.2	11.4	1.6	0.5	5.0
Recommended app for other medical fields	14.7	32.1	6.0	0.5	1.1	10.9	26.6	7.6	0.5	0.0	3.7

[a]Chi-square values reported as χ^2_4

Discussion

Principal Findings

To the best of our knowledge, this study is one of the first to demonstrate the success of the implementation of mobile phone technologies for educational needs in psychiatry. The initial findings demonstrate the feasibility and acceptance of mobile phone apps for psychiatry in Singapore, as well as the feasibility and acceptance of psychiatry-focused apps globally. Our initial findings show that Asian students are amenable to using an online portal for their educational needs in psychiatry. In addition, a significant group of Asian students are amenable to trying newer modalities of technology, such as mobile phone technologies, to help them fulfill their mobile educational needs. The user perspective survey results show that a high proportion of students would like an educational psychiatry app to contain textbook-based content, clinical OSCE videos, and an event notification service. A high proportion of students concurred with the perception that a mobile phone app would be helpful in psychiatric education and that a mobile device could be a viable alternative to a traditional textbook. We postulate that the gender differences identified with regards to having textbook content in apps might be due to differences in learning methods between the genders. Of importance, no significance differences were found between the genders in the other domains, highlighting that the other materials included appealed to both genders and did help them with mastering a specialized topic matter.

The usefulness of mobile phone apps for education has been supported by prior research. Tripathi et al [15] conducted a review of relevant apps for neurosurgery on the respective app stores and highlighted that students and medical doctors preferred apps that have links to scoring systems, operative illustrations, as well as textbook-based contents. In consideration of the previous findings, we postulate that the current success of our app internationally might be due to the fact that the app offers students not only access to textbook-based materials, but also access to other materials such as videos and questionnaire quizzes. These might be relevant and deemed useful with regards to helping students to acquire the necessary knowledge in psychiatry.

Another recent study published in 2014 by Heeyoung Han et al [16] examined medical students' online learning technology needs. In that study, the authors developed a 120-item survey in collaboration with the New Technology in Medical Education Committee at Southern Illinois University to investigate students' perceptions of their online learning technology needs. The results of their study concurred with our findings with regard to students' perceptions of their online learning technology needs. In their study and the current study, both samples perceived multimedia tools, scheduling tools, and communication tools to be useful educational technologies for their learning. Similar to our findings, their study showed that students in their clinical clerkship years perceived mobile devices to be useful for their learning.

Perhaps the closest correlation with our current study is by Waldmann and Weckbecker [17]. They designed a Web-based app to help teach their medical students about primary care guidelines and found that amongst their group of 14 student testers, the majority made use of the app more frequently, and also made use of their free time to study the guidelines. They

concluded that their self-designed mobile phone app has helped to create interest amongst student and has helped them to acquire valuable knowledge. Similarly, our self-created Web-based and native app has enabled students to learn on the go, as well as help to augment their learning needs in psychiatry.

The main strength of the current study is the demonstration of the feasibility of implementation of a mobile phone app for psychiatry both locally and internationally. The current study has also managed to demonstrate that local Singaporean students perceive mobile phone apps in psychiatry positively. This study also consistent with some of the findings of other studies with regards to the usage of apps for education.

Limitations

There are several limitations to the current study. We acknowledge that while there is a good number of viewership of our Web-based app, we do not have the absolute number of individual users who have downloaded the app, as we are limited by the database being able to only track individual unique access. This information, in conjunction with the platform that users view the app, is crucial in terms of designing future educational apps, as well as planning future studies. In addition, our perspective survey has only been administered to a local cohort of students and might not be entirely representative of the views of the global audience. To mitigate this limitation, we would need to find liked-minded individuals from organizations overseas to collaborate and perform a comparative study with regards to user perception of our educational app.

Conclusions

This study is one of the first to demonstrate the feasibility and the global acceptance of a local, self-designed educational app for psychiatry education. Whilst the current research has managed to demonstrate the feasibility and acceptance of such an app, future studies are warranted to look in-depth into whether there are cultural differences in terms of perceptions towards having such an app in psychiatry and what contents different cultures and cohorts of students might want within an app.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Thematic analysis of how the app has helped learning in psychiatry.

[PDF File (Adobe PDF File), 178KB - mededu_v1i1e3_app1.pdf]

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Original Paper

Information-Seeking Behaviors of Medical Students: A Cross-Sectional Web-Based Survey

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Abstract

Background: Medical students face an information-rich environment in which retrieval and appraisal strategies are increasingly important.

Objective: To describe medical students' current pattern of health information resource use and characterize their experience of instruction on information search and appraisal.

Methods: We conducted a cross-sectional web-based survey of students registered in the four-year MD Program at Dalhousie University (Halifax, Nova Scotia, and Saint John, New Brunswick, sites), Canada. We collected self-reported data on information-seeking behavior, instruction, and evaluation of resources in the context of their medical education. Data were analyzed using descriptive statistics.

Results: Surveys were returned by 213 of 462 eligible students (46.1%). Most respondents (165/204, 80.9%) recalled receiving formal instruction regarding information searches, but this seldom included nontraditional tools such as Google (23/107, 11.1%), Wikipedia, or social media. In their daily practice, however, they reported heavy use of these tools, as well as EBM summaries. Accessibility, understandability, and overall usefulness were common features of highly used resources. Students identified challenges managing information and/or resource overload and source accessibility.

Conclusions: Medical students receive instruction primarily on searching and assessing primary medical literature. In their daily practice, however, they rely heavily on nontraditional tools as well as EBM summaries. Attention to appropriate use and appraisal of nontraditional sources might enhance the current EBM curriculum.

KEYWORDS

information-seeking behavior; information retrieval; Internet; medical education; medical students

Introduction

The information landscape is expanding rapidly, in large part due to the advent and evolution of the Internet. In the developed world, widespread access to the Internet along with intuitive and user-friendly search tools have made information on a vast range of topics available within moments. Some tools have gained such ubiquity as to become part of common parlance: "Google" is now a dictionary-approved verb [1].

Medicine has seen a similar trend, and the volume of information is not unequivocally helpful to practice. Authors have previously cited the challenges of staying up to date on a multitude of articles [2] and guidelines [3]; today, even the tools to access evidence proliferate. Whereas evidence-based medicine (EBM)

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developed as an approach to manage the challenge of translating primary evidence into clinical practice, the field has evolved to define increasingly sophisticated approaches to the body of literature as a whole. Indeed, some authors suggest that information management training may be as important as instruction on searching the primary literature [4,5].

Instruction in EBM is variable, however, and whether it affects long-term behaviors is uncertain [6-8]. The realities of daily work can present barriers to evidence-based practice, which is often perceived as a time- and effort-intensive pursuit [8-10]. Moreover, access to primary medical literature, summaries, and clinical support tools often comes with costly subscription fees.

These challenges make the user-friendly, freely accessible tools that are useful for general purpose inquiries appealing. Indeed, studies of medical trainees and practicing physicians support the popularity of general purpose tools for clinical or academic queries [9,11,12]. Notwithstanding concerns regarding reliability, some evidence suggests that general resources such as Google can be effective in answering clinical questions [13-15].

If these issues are important for the future of medicine, we need to understand how information-seeking behaviors develop. Medical school lays foundations of knowledge and behavior patterns. Students' active engagement in participatory knowledge building is critical to this process, and thus information acquisition and use have central importance. Students turn to information sources to build background knowledge and will subsequently develop increasingly patient-specific questions and searches. As clinical encounters lead them to continually integrate this knowledge, they gradually build mental maps that enable automatic processing for quick clinical decision making [16]. Meanwhile, however, they must recognize the ongoing need to engage with information sources: to update their mental maps and to supplement when prior knowledge is absent or insufficient [16]. Their medical education must therefore prepare them as managers of information as well as experts in human health.

Previous studies that focused on medical students in the developed world have considered the use of specific resources [17-19] or technology [20-22]. Others have reported on experimental educational interventions [23-25]. With the current study, we sought a holistic characterization of the information-seeking behaviors of a medical student cohort in the context of an existing formal EBM curriculum.

We surveyed students enrolled in a medical doctorate training program regarding their use of Internet resources for medical information and the instruction they have received in EBM and information management. We hypothesized that this group would report high use of general purpose resources with minimal instruction in the use or interpretation of such resources.

The primary objective of this study was to define students' current patterns of resource use. We also sought to characterize student experiences of current informatics instruction. Lastly, we began an inquiry into student valuations of various resources for medical information.

Methods

Survey Instrument

We developed a web-based survey to assess student information-seeking behavior, formal instruction on information searches, and evaluation of sources of health information. The survey was developed based on a review of relevant published literature and pretested with a convenience sample of ten medical students. The final survey contained 20 questions, predominantly requiring yes/no or rating scale responses; one question required a numeric estimate, one asked students to list their five most-used resources, and two were open-ended. Questions regarding resource use were based on recall of the previous seven days. The list of survey questions is included in Multimedia Appendix 1.

Participant Recruitment

All students registered in the Dalhousie University 4-year medical doctorate program, at either the Halifax or the Saint John site, were considered eligible for participation in the survey. At the time of the survey, there were 462 registered students. We considered students in years 1 and 2 preclinical and those in years 3 and 4 clinical because the first two years are classroom-based while the third and fourth years take place predominantly within clinical settings.

The survey was published online using the Opinio 6 survey platform (ObjectPlanet, Inc) and remained open for two weeks. Two of the study authors (AO and EW) made in-class announcements to each student cohort, and invitation and reminder emails were sent to eligible students.

Data Analysis

The survey responses were exported from the survey platform into Excel (Microsoft Corp). Data were analyzed using descriptive statistics, computed by hand. Frequencies were reported as percentages. Where appropriate, 95% confidence intervals were calculated using the .cii command with exact binomial confidence intervals using STATA version 12.1 (StataCorp LP). No correction was made for multiple statistical testing.

One question asked respondents to list their five most-used resources from the previous seven days. We assessed response frequency, and used Wordle [26] to generate a graphical representation of this data in which type size reflects frequency of occurrence.

Selected data were subsequently graphed using R (The R Foundation). In keeping with a paper presented at the 2011 Joint Statistical Meeting [27], these Likert data were presented graphically, using diverging stacked bar charts across information sources.

Open-ended questions were analyzed qualitatively for themes by AO. Responses were read and common themes identified; on second reading, responses were categorized into thematic groups. Responses that reflected more than one theme were included in each relevant thematic group.

Ethics

The study was formally reviewed and approved by the IWK Health Centre Research Ethics Board. We also received approval from the Dalhousie Undergraduate Medical Education Curriculum Committee.

Results

Participant Recruitment

Of 462 students invited to respond, 213 (46.1%) provided evaluable responses. Two-thirds of closed-ended questions received response rates of 42.0% or above (193 or more students), and all but one question had responses from at least 39.0% (180 students). Ten students accessed the survey but did not provide any responses; these were considered to be nonrespondents and were not included in the response rate figures.

Study Participants

Of the respondents, 56.6% (120/212) were female and 42.0% (89/212) were male; 3 preferred not to answer this question. Preclinical and clinical training levels received comparable representation (110/212, 51.9%, and 102/212, 48.1%, respectively). Roughly half (109/207, 52.7%) had prior experience as contributors to peer-reviewed literature, while relatively few (35/207, 16.9%) had posted information online for the public.

Instruction on Information Searching

While 80.9% (165/204; 95% CI 74.8%-86%) of respondents recalled receiving formal instruction on searching for health information, 67.1% (139/207; 95% CI 60.3%-73.5%) also recalled being discouraged from using certain resources.

Education regarding bibliographic databases (eg, PubMed) was common (162/206, 78.6%; 95% CI 72.4%-84.0%), whereas respondents seldom had instruction regarding general purpose Internet sources. Only 11.1% (23/207; 95% CI 7.2%-16.2%) reported teaching regarding the general search engine Google, and fewer had education on Wikipedia (a free, online, open-content encyclopedia) or social media. Although self-rated competence in finding information showed some variability, a strong majority (184/207, 88.9%; 95% CI 83.8%-92.8%) felt their skills were good or better.

Pattern of Resource Use

We considered a resource to be heavily used if a student reported use 4 or more times in the previous 7 days (Figure 1, Table 1). Most respondents use Google on a daily basis (154/202, 76.2%; 95% CI 69.8%-81.9%), and very few reported using the search engine on fewer than 4 of the prior 7 days (13/202, 6.4%; 95% CI 3.5%-10.8%). Wikipedia, UpToDate (a subscription-only, evidence-based summary source), and personal/provided notes were also heavily used. In contrast, few respondents (28/199, 14.1%; 95% CI, 9.6%-19.7%) had used bibliographic databases on at least 4 days, and just over one-third (68/199, 34.2%; 95% CI, 27.6%-41.2%) had not used such sources at all in the previous week.

Comparison of preclinical- and clinical-level respondents revealed two prominent differences: clinical-level respondents reported less frequent use of bibliographic databases (*P*<.001) and more frequent use of UpToDate (*P*<.001) (Table 1).

Of note, these results were somewhat different from respondents' self-generated lists of most used resources. Here, UpToDate was the most-listed single reference, while Google and Wikipedia were the next most commonly cited resources (Figure 2).

Table 1. Preclinical and clinical student use of resources during the previous 7 days.

| Source		Responses	Never n (%)	Once n (%)	2-3 times n (%)	4-6 times n (%)	Daily n (%)
Google		202	0 (0)	1 (0.5)	12 (5.9)	35 (17.3)	154 (76.2)
	Preclinical	102	0 (0)	0 (0)	8 (7.8)	19 (18.6)	75 (73.5)
	Clinical	99	0 (0)	1 (1.0)	4 (4.0)	16 (16.2)	78 (78.8)
Wikipedia		201	6 (3.0)	19 (9.4)	48 (23.9)	45 (22.4)	83 (41.3)
	Preclinical	101	4 (4.0)	8 (7.9)	25 (24.8)	25 (24.8)	39 (38.6)
	Clinical	99	2 (2.0)	11 (11.1)	23 (23.2)	20 (20.2)	43 (43.4)
Notes		197	19 (9.6)	20 (10.2)	54 (27.4)	39 (19.8)	65 (33.0)
	Preclinical	100	9 (9.0)	7 (7.0)	34 (34.0)	18 (18.0)	32 (32.0)
	Clinical	96	10 (10.4)	12 (12.5)	20 (20.8)	21 (21.9)	33 (34.4)
UpToDate		201	35 (17.4)	13 (6.5)	31 (15.4)	65 (32.3)	57 (28.4)
	Preclinical	101	30 (29.7)	7 (6.9)	18 (17.8)	37 (36.6)	9 (8.9)
	Clinical	99	5 (5.0)	6 (6.1)	13 (13.1)	27 (27.3)	48 (48.5)
Bibliographic databases		199	68 (34.2)	44 (22.1)	59 (29.6)	20 (10.0)	8 (4.0)
	Preclinical	100	19 (19.0)	18 (18.0)	40 (40.0)	16 (16.0)	7 (7.0)
	Clinical	98	49 (50.0)	26 (26.5)	18 (18.4)	4 (4.1)	1 (1.0)

Figure 1. Student self-reported use of resources in the previous 7 days.
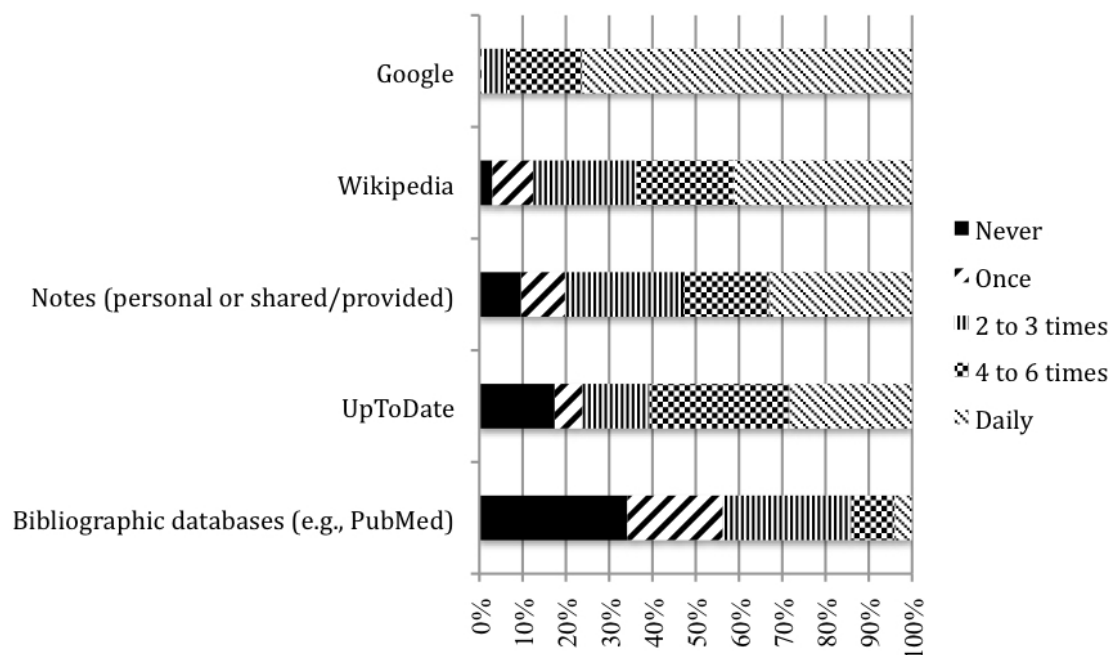
Figure 2. Student-identified top resources from the previous 7 days.
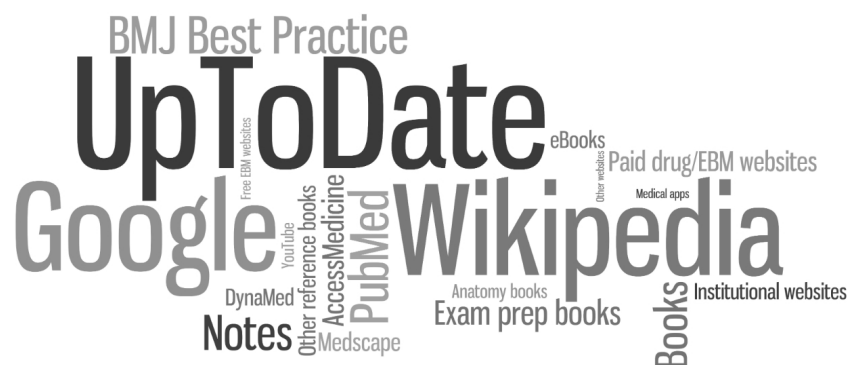
Values and Reasons for Using Sources

Whereas students valued the general purpose resources Google and Wikipedia highly for their accessibility, understandability, and usefulness, they gave PubMed and other bibliographic databases stronger ratings for accuracy and trustworthiness. As a representative EBM summary, UpToDate appeared to bridge this gap: it received high ratings across values although many students noted elsewhere that access to this resource was limited by cost and lack of an institutional subscription (Figure 3).

Students identified key factors in their impressions of a source's trustworthiness: recognition of factual errors in a reference and reputation among mentors and peers, as well as being specifically counseled to use or avoid a reference.

Figure 3. Student evaluations of specified resources.
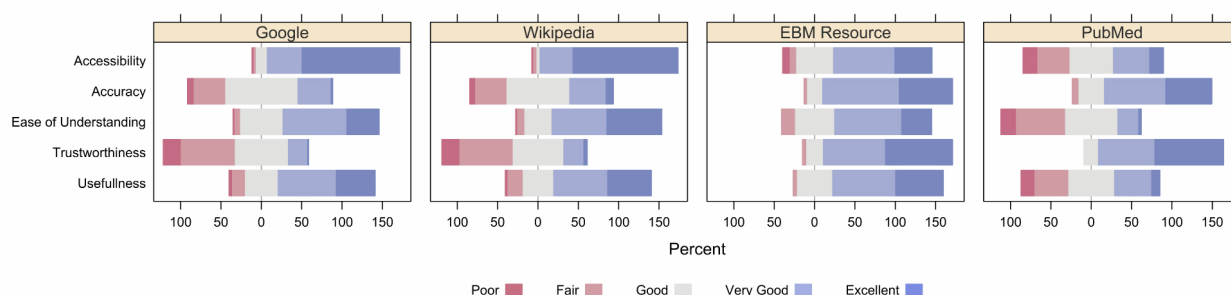
Self-Identified Needs and Abilities

Students offered valuable insights in their responses to open-ended questions, and several themes emerged. Many spoke of being overwhelmed by the number of available and/or suggested resources as well as by the density of information in these sources; respondents repeatedly reported a need for more basic information and for managing information/source overload. They requested faculty- and/or peer-generated resource recommendations, although some noted that current lists added to a sense of overload. Perhaps in response to this challenge, several requested increased and longitudinally integrated instruction on searching for information and often highlighted a desire to learn how to approach nontraditional, or general purpose, Internet sources. Finally, resource accessibility presented an additional, practical barrier to finding useful information. Respondents commonly identified a need for freer access, including at the point of care; they cited lack of universal Internet access, inconvenience of multiple sign-ins, and subscription-based access as barriers.

Discussion

Dalhousie University Medical School Curriculum

Our survey assessed patterns of information resource use among students in the undergraduate MD program at Dalhousie University. Students in the program must have an undergraduate degree; some have additional study or work experience. The school has two campuses (Halifax, Nova Scotia, and Saint John, New Brunswick); the sites share a uniform curriculum, and many lectures are videoconferenced. All students have remote access to Dalhousie University library electronic resources throughout their training.

The medical school follows a 4-year curriculum. Two classroom-based preclerkship years aim to provide a foundation of knowledge and basic skills. A two-year clerkship follows, spent mostly in clinical settings.

A concentrated series of lectures on EBM are delivered at the beginning of year one. On a recent syllabus, seven hours during that unit were devoted to aspects of EBM, including five hours on question formulation and searching for evidence. Lecture notes refer to a standard hierarchy of preappraised evidence and discuss how and when to use various resources [Robin Parker, Sources of evidence, 10 September 2012, Dalhousie University, Canada].

Information management and EBM continue to receive attention at various points after this introductory unit. Weekly sessions during the first two years address evidence search and appraisal and other topics (ethics, law, population health, and professionalism). The formal curriculum is more limited during the clinical years, and much of the planned teaching time addresses clinical skills; training objectives continue to refer to critical use and appraisal of evidence.

Students have access to an array of resources and resource guides. They receive reference recommendations for each unit, and notes and links are posted on general and course-specific websites. The library website houses subject guides for each course and clinical rotation, including guides to search strategies

for PubMed and Cochrane Library, a subscription-based set of medical and healthcare databases.

Principal Findings

Behavior Diverges From Formal Instruction

In this survey, most students recalled having received formal instruction on health information searches during their training, most of which concerned traditional information sources such as PubMed or other bibliographic databases. Although students commonly reported being discouraged from using certain resources and seldom recalled instruction in the use of general purpose search resources (such as Google), they reported Google as the most frequently used in their actual practice. The contrast between self-reported formal instruction and practice may have several explanations. Medical education takes place on multiple levels: while the formal curriculum transmits intentional and explicit instruction, informal and hidden curricula operate through experience, interactions, and role modeling [28]. A substantial body of literature avers the importance of these latter curricula on the emerging professional and ethical identities of the students. Our respondents likewise rated reputation among peers and mentors as an important factor in their valuation of information sources. Informal curricula may well influence learning behaviors as much as they do ethical ones. If so, given the high rates of general purpose and preappraised resource use among medical residents and qualified physicians [9,11,12]—students' chief mentors during training—it is not surprising that these students should so frequently use such resources. Moreover, increased informal, experiential interaction with these mentors during the clinical training years would be expected to result in increased use of role-modeled resources.

Changing Patterns of Resource Use

Students in their clinical years used Google heavily but reported increased use of UpToDate and less reference to bibliographic databases compared to their preclinical peers. With the shift to a clinical setting, students' information needs change: they require more patient-oriented information, whereas preclinical students must accumulate basic knowledge of physiology and disease. As well, the real-world, clinical setting demands increased search efficiency, often making review of individual studies impractical [4]. Such needs may have influenced the students in this study and have spurred an industry of preappraised, summarized information sources (including UpToDate). Although criticized for variable design and timeliness [29,30], preappraised summaries have proven superior to primary literature searches in some cases [31,32] and are commonly considered an important part of evidence-based practice [33].

Access to EBM summaries may have been a contributing factor to the seniority-related variation in resource use. Anecdotally, several students told us that they purchase or share subscriptions to resources, including UpToDate, upon entering clerkship. While our university does not hold a license for UpToDate—the EBM summary most frequently named by students—some clinical settings do.

Meanwhile, the fact that students less commonly named evidence summaries to which our university *does* offer access

is significant. It may reflect the strength of peer and mentor influences. It could also speak to the problem of information resource overload. Excess information may lead to errors of omission in the clinical context [34,35]: with such a large variety and volume of resources, information may be lost. One medical librarian's observation that "students may not have an accurate picture of the access they're entitled to" [personal communication by Kathleen Gadd, 9 March 2015] lends support to this possibility.

Resource Selection: A Balance of Needs

The values respondents attributed to various information sources identify ease of understanding and accessibility as common features among the more heavily used resources. Meanwhile, their comments highlight challenges navigating a surplus of information and managing source accessibility. Their practice appears to reflect a trade-off between accessibility/digestibility and accuracy: students appear to believe the balance of benefit lies with summary sources, whether medical or general purpose.

Such calculations constitute a satisficing approach to searching and source selection. Faced with practical limits on obtaining and analyzing a large volume of relevant data, individuals select what they perceive to be a good enough option [36-38]—for example, selecting Google or UpToDate to locate a piece of needed information instead of conducting a thorough literature review. The concern, of course, is whether students are equipped to know and choose what is actually good enough. Can they appraise the source and the information,adequately to determine whether it meets minimum standards? An optimistic view would hold that this is the case. On the other hand, given the lack of instruction on use and appraisal of their most-used sources, we might question the bases for their strategies and consider the risks of uncritical information seeking.

Student Self-Assessment

A strong majority of respondents rated their information seeking skills as good or better—this despite reporting information search practices that diverged from the formal instruction they had received. Perhaps this is because they achieve good results with their current search practices. It is worth noting, however, the limits inherent to self-assessment. Individual self-rating bears little relation to actual competence, and most students overestimate their performance; this is demonstrable among medical students, among others [39-41]. Individuals who believe they have adequate skills are unlikely to seek remediation, whether or not they are truly competent. Furthermore, the students in this survey reported feeling overwhelmed by the information landscape; we know medical professionals consistently choose CME activities that address interests and skills rather than weaknesses and can surmise that medical student behavior is likely similar. It seems unlikely that these students will independently seek out ways to improve their skills, now or possibly even into their careers. If there is a better approach to seeking information, medical educators must offer active guidance.

Study Limitations

Our study has limitations. We conducted the survey at a single medical school. The response rate was lower than desired. Our response rate appears comparable, however, to that achieved by previous online surveys addressing technology and information management in medicine [20-22,42].

Our survey relied on self-reported behaviors, which are known to be subject to social desirability bias. External observation of behavior, however, is not feasible for the current inquiry. A daily diary approach might have offered greater accuracy but at a further cost to the response rate. We asked respondents to report practices from the preceding 7 days as a strategy to obtain more accurate self-reported data than a more general inquiry. Despite this, the difference seen between the frequencies of use reported for different resources and respondents' self-generated lists of most-used resources suggested the possibility of bias in some questions. We would, however, have expected social desirability bias to skew results away from non-traditional, general-purpose sources—instead we saw quite a dramatic favoring of such resources over bibliographic databases.

Our survey obtained a cross-sectional assessment, with reference to behavior during the preceding seven days. It is possible that student behavior differed from usual practice during the week prior to the survey, rendering nonrepresentative results. In an effort to limit this possibility, we discussed survey timing with the Dalhousie Undergraduate Medical Education Curriculum Committee and student leaders and selected survey dates that fell during the routine session, avoiding examination or recess periods.

Conclusions

No tool is optimal for every purpose. Students need to gain skills and familiarity assessing primary literature, but they also must learn to find useful, practical information efficiently. They need to recognize what tool will best serve a given purpose—whether this is getting an overview of a common condition or physiologic process or assessing effectiveness of alternate medical therapies—and to appreciate the limitations inherent to that tool. Thus, whereas current formal instruction on information searching neither reflects nor appears to alter,student behavior, consideration should be given to instruction on information management and appraisal in general. Medical education that includes use and appraisal of primary literature, summary sources, and even general purpose resources might more effectively equip students in their pursuit of lifelong learning.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Survey instrument.

[PDF File (Adobe PDF File), 123KB - mededu_v1i1e4_app1.pdf]

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Abbreviations

EBM: evidence-based medicine

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Original Paper

Learning Clinical Procedures Through Internet Digital Objects: Experience of Undergraduate Students Across Clinical Faculties

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Abstract

Background: Various digital learning objects (DLOs) are available via the World Wide Web, showing the flow of clinical procedures. It is unclear to what extent these freely accessible Internet DLOs facilitate or hamper students' acquisition of clinical competence.

Objective: This study aimed to understand the experience of undergraduate students across clinical disciplines—medicine, dentistry, and nursing—in using openly accessible Internet DLOs, and to investigate the role of Internet DLOs in facilitating their clinical learning.

Methods: Mid-year and final-year groups were selected from each undergraduate clinical degree program of the University of Hong Kong—Bachelor of Medicine and Bachelor of Surgery (MBBS), Bachelor of Dental Surgery (BDS), and Bachelor of Nursing (BNurs). All students were invited to complete a questionnaire on their personal and educational backgrounds, and their experiences and views on using Internet DLOs in learning clinical procedures. The questionnaire design was informed by the findings of six focus groups.

Results: Among 439 respondents, 97.5% (428/439) learned a variety of clinical procedures through Internet DLOs. Most nursing students (107/122, 87.7%) learned preventive measures through Internet DLOs, with a lower percentage of medical students (99/215, 46.0%) and dental students (43/96, 45%) having learned them this way (both $P<.001$). Three-quarters (341/439, 77.7%) of students accessed DLOs through public search engines, whereas 93.2% (409/439) accessed them by watching YouTube videos. Students often shared DLOs with classmates (277/435, 63.7%), but rarely discussed them with teachers (54/436, 12.4%). The accuracy, usefulness, and importance of Internet DLOs were rated as 6.85 (SD 1.48), 7.27 (SD 1.53), and 7.13 (SD 1.72), respectively, out of a high score of 10.

Conclusions: Self-exploration of DLOs in the unrestricted Internet environment is extremely common among current e-generation learners and was regarded by students across clinical faculties as an important supplement to their formal learning in the planned curriculum. This trend calls for a transformation of the educator's role from dispensing knowledge to guidance and support.

Introduction

The growing popularity of the Internet in the past two decades has entirely changed people's lifestyles and the learning patterns of students around the world. As a new form of knowledge acquisition, Web-based learning has been advocated and incorporated widely as a supportive measure to the traditional ways of learning in classrooms [1,2]. It has also become an

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important part of health sciences education [3]. Although cumulative evidence does not support its higher effectiveness over traditional learning, Web-based learning has often been associated with several advantages, such as accessibility and convenience, cost-saving features, better acceptance, and higher student satisfaction, especially when combined with traditional teaching activities in a blended-learning setting [1,4,5]. Students' modes of Web-learning are not limited to e-learning resources provided by their faculties or prescribed by the teaching staff, but also include spontaneous information seeking through the Internet—a learning pattern that is highly encouraged under the concept of self-directed learning [1,2,6].

For students who are pursuing careers as health care providers, acquiring competence in performing respective clinical procedures is a fundamental part of their professional training. The general public and students' future employers would expect a high standard of clinical performance and patient management when they graduate. Traditionally, clinical procedures are explained, demonstrated, and practiced in the preclinical and clinical sessions through face-to-face, instructor-led learning. Student clinicians learn and refine their skills through observing and practicing on mannequins, virtual simulation, and clinical placements. Knowledge can also be obtained through many digital learning objects (DLOs), be it videos, animations, illustrations, or photos showing the flow of the procedures. It is believed that "multimedia instructional messages that are designed in light of how the human mind works are more likely to lead to meaningful learning than those that are not" [7]. Studies have shown better learning outcomes when audiovisual materials were used as compared with mere text materials [8]. Traditional teaching methods are comparatively passive in nature in bringing about understanding, retention, and application of information delivered, as active processing of materials is hindered [7]. A more dynamic approach is advocated, and together with the blooming usage of electronic appliances in the new generation, it is perhaps not too difficult to recognize the trend of dissemination of information in more innovative approaches utilizing information technologies.

Many DLOs for medical education purposes are available via the World Wide Web and are increasingly used by clinical leaners [2,9,10]. It is, however, largely unknown what students experience during this process and how these materials shape their clinical learning [1,11]. Understanding these factors will be useful for educators, students, and practitioners to improve their teaching systems or learning patterns. Previous studies are mainly directed at e-learning through materials provided by faculties [2-4]. Little is known about how students explore freely accessible materials on the Internet and use them for their clinical learning. Our previous qualitative study, using six focus groups consisting of undergraduate students, has captured a wide spectrum of students' opinions toward Internet DLOs [12]. While there were many approving views supporting the unique roles of Internet DLOs, some concerns were raised regarding the use of these materials for their clinical learning [12].

Based on the findings of our qualitative study, this larger-scale quantitative study was carried out to understand the experience of undergraduate students across clinical disciplines—medicine, dentistry, and nursing—in using openly accessible Internet DLOs, and to investigate the impact of Internet DLOs on their clinical learning.

Methods

Digital Learning Objects

Internet DLOs were defined as digital learning materials (eg, videos, animations, graphic illustrations, and photos) that were openly accessible on public websites. Pure text materials were not included. The e-learning materials provided by students' own faculties were not included in the scope of this study.

Target Groups

This study targeted current undergraduate students in clinical faculties of the University of Hong Kong, which is the sole institution in Hong Kong dedicated to training dentists, and one of the two institutes providing degree programs in medicine and nursing. Following the education reform in 2012, undergraduate programs in Hong Kong's universities have been extended by a year. Current students recruited before 2012 are still under the original 5-year Bachelor of Medicine and Bachelor of Surgery (MBBS) program, the 5-year Bachelor of Dental Surgery (BDS) program, and the 4-year Bachelor of Nursing (BNurs) program. There are two semesters in each academic year. Holding a first degree is not a requirement for admission to these clinical programs. The curricula in these three clinical programs are integrated, student centered, and inquiry based to promote students' critical thinking skills and application of acquired knowledge. Early clinical contact is arranged in the first or second year. Clinical sessions gradually take up an increased proportion of their teaching hours until their final year of studies, when attachments to different departments in various hospitals are organized.

From each clinical degree program, mid-year students—MBBS III, BDS III, and BNurs II—and final-year students—MBBS V, BDS V, and BNurs IV—were selected for this study. All students enrolled in the selected years were eligible to join this study, regardless of their gender, age, secondary educational background (ie, local schools, international schools in Hong Kong, or overseas), and prior degree attainment (ie, first-degree holder or not). The protocol of this study was reviewed by the Institutional Review Board of the University of Hong Kong/Health Authority Hong Kong West Cluster. Ethical approval was obtained (reference number: UW13-020). The details of this study were explained to students through a participant information sheet. Written consent was obtained from each participating student.

Questionnaire Design

A self-administered structured questionnaire was developed to collect the following participant information: (1) demographic profile (ie, age and gender), (2) secondary educational background, (3) prior degree attainment, (4) usage of, and access to, Internet DLOs, (5) procedures learned through Internet DLOs, (6) frequency and scenarios of using Internet DLOs, (7) sharing with peers and clarification with tutors/teachers, and (8) ratings on the accuracy, usefulness, and importance of Internet DLOs.

The formulation of questions was informed by the findings of our previous qualitative study (ie, focus groups with students) [12]. All questions were in English, which is the medium of instruction at this university, and were pretested among 4 students to ensure clarity. Out of a total of 13 questions, 12 were closed-ended, multiple-choice questions (MCQs) (see Multimedia Appendix 1). For one MCQ on learning preventive measures, the possible answers were tailor-made for each degree program so that the question was relevant to individual programs. Since clinical procedures were many, an open question was asked allowing students to fill in the procedures they learned through Internet DLOs.

Participant Recruitment and Completion of Questionnaires

All students in the selected years of three degree programs were approached by several means: (1) MBBS III students during full class lectures, (2) MBBS V students during small group lectures, (3) BDS III students during Simulation Laboratory class, (4) BDS V students through their clinical group representatives, and (5) BNurs II students during full class lectures. Since BNurs IV students had clinical practice in groups of two and were scattered throughout different hospitals in Hong Kong, direct access to them was difficult. Hence, an invitation was posted in their class Facebook group through their class representative. A total of four reminders were posted. To further improve the response, the departmental office of the School of Nursing was approached and an invitation was sent to the university email accounts of all BNurs IV students through departmental circulars.

Participants in BNurs IV completed an electronic questionnaire posted online, whereas other participants completed a printed questionnaire at the venue where they were recruited. All questionnaires were completed anonymously. The completion of a questionnaire took approximately 5 minutes.

Data Analysis

Data were analyzed using IBM Statistical Package for the Social Sciences (SPSS) version 20. Descriptive analysis was done on participants' demographic profile, their educational background, and their experiences and views on using Internet DLOs to learn clinical procedures. Inferential analysis was conducted for identifying factors (ie, age, gender, secondary educational background, prior degree attainment, current degree program, and year of study) associated with students' usage of, and opinions on, Internet DLOs. Parametric or nonparametric tests were used, as appropriate, for comparing means. The chi-square test was used for comparing proportions. Multivariate analysis was conducted for identifying factors affecting students' ratings on Internet DLOs (linear regressions) and the use of Internet

DLOs for learning preventive measures (logistic regressions) after controlling for other factors.

Results

Response Rate and Profiles of Participants

In total, 439 students participated in the questionnaire survey, including 218 (49.7%) MBBS students, 97 (22.1%) BDS students, and 124 (28.2%) BNurs students. The response rates for MBBS III, MBBS V, BDS III, BDS V, BNurs II, and BNurs IV students were 65.0% (104/160), 72.6% (114/157), 93% (52/56), 90% (45/50), 56.1% (101/180), and 12.8% (23/180), respectively.

The majority (371/439, 84.5%) of the participants were 20 to 23 years old. Males and females made up 41.7% (183/439) and 58.3% (256/439) of the participants, respectively. Out of the 439 participants, 351 (80.0%) completed their secondary education in local schools, while 4.8% (21/439) and 15.3% (67/439) of students graduated from international schools in Hong Kong and overseas schools, respectively. Out of 439 participants, 42 (9.6%) had obtained a first degree before joining the current clinical program.

Usage of, and Access to, Internet Digital Learning Objects

Only 2.5% (11/439) of the participants had never used Internet DLOs, while the overwhelming majority (428/439, 97.5%) had experience in learning clinical procedures through Internet DLOs (see Table 1). The majority of the participants (409/439, 93.2%) accessed Internet DLOs from YouTube, and almost half of them (180/439, 41.0%) accessed Internet DLOs from other universities' websites. Other sources included blogs (55/439, 12.5%), manufacturers' guidelines (131/439, 29.8%), and other websites (118/439, 26.9%). Three-quarters of participants (341/439, 77.7%) found Internet DLOs through public search engines, while one-third (152/439, 34.6%) and one-quarter (126/439, 28.7%) received recommendations from classmates or teaching staff.

Students often used Internet DLOs before their first time performing a procedure (267/439, 60.8%), while one-quarter (113/439, 25.7%) accessed Internet DLOs after that time. Around half (241/439, 54.9%) used Internet DLOs to reinforce their clinical skills and 28.9% (127/439) used Internet DLOs to learn procedures that they rarely have the chance to practice. Over half (241/439, 54.9%) of the students used Internet DLOs to learn "some procedures." One-third (159/439, 36.2%) used it for "few procedures," while only 7.5% (33/439) of students used it for "most or all procedures."

Table 1. Uses of, and access to, Internet digital learning objects.

Information about Internet DLOs[a]	Participants (n=439), n (%)[b]
Usage	
Always	428 (97.5)
Never	11 (2.5)
Source(s)	
YouTube	409 (93.2)
Blogs	55 (12.5)
Manufacturers' guidelines	131 (29.8)
Other universities' websites	180 (41.0)
Other websites	118 (26.9)
How students found Internet DLOs	
Recommendations from classmates	152 (34.6)
Recommendations from teaching staff	126 (28.7)
Public search engine	341 (77.7)
Others	8 (1.8)
Scenarios for use	
Before first time performing a procedure	267 (60.8)
After first time performing a procedure	113 (25.7)
To reinforce skills	241 (54.9)
For some procedures I have rare chances to practice	127 (28.9)
Frequency of use	
Few procedures	159 (36.2)
Some procedures	241 (54.9)
Most procedures	26 (5.9)
All procedures	7 (1.6)

[a]Digital learning objects (DLOs).

[b]Percentages may add up to more than 100% since multiple choices were allowed.

Procedures Learned

Clinical procedures learned by BDS students through Internet DLOs were mainly restoration (49/97, 51%), tooth preparation for crown or denture (46/97, 47%), oral surgery (36/97, 37%), preoperative preparation (31/97, 32%), and impression or facebow record (29/97, 30%) (see Table 2). Medical students mainly learned clinical examination (86/218, 39.4%), surgery (71/218, 32.6%), and catheter handling (62/218, 28.4%), whereas nursing students mainly learned catheter handling (63/124, 50.8%) and wound dressing (54/124, 43.5%) through Internet DLOs.

As for preventive procedures, about a quarter (26/96, 27%) of the dental students learned fluoride application, while some students learned fissure sealant placement (17/96, 18%), oral hygiene instructions (10/96, 10%), and prophylaxis (6/96, 6%). No dental student reported learning dietary counseling through Internet DLOs. Preventive measures learned by medical students included hygienic instructions (64/215, 29.8%), counseling on lifestyle (37/215, 17.2%), vaccination (28/215, 13.0%), and prenatal counseling (22/215, 10.2%). Nursing students often learned hygienic instructions (87/122, 71.3%), counseling on lifestyle (30/122, 24.6%), vaccination (21/122, 17.2%), and elderly care (25/122, 20.5%). Over half of the dental students (53/96, 55%) and medical students (116/215, 54.0%) never used Internet DLOs to learn preventive measures, whereas the percentage was 12.3% (15/122) among nursing students.

Table 2. Procedures and measures learned through Internet digital learning objects.

Type of procedure or measure	Participants, n (%)[a]
Clinical procedures	
MBBS [b] (n=218)	
Clinical examination	86 (39.4)
Surgery	71 (32.6)
Catheter handling	62 (28.4)
Personal protective equipment	9 (4.1)
Others (eg, endoscopy)	74 (33.9)
BDS [b] (n=97)	
Simple restorative work	49 (51)
Crown/denture tooth preparation	46 (47)
Oral surgery	36 (37)
Preoperative preparation (eg, rubber dam)	31 (32)
Impression/facebow record	29 (30)
Others (eg, root debridement)	37 (38)
BNurs [b] (n=124)	
Catheter handling	63 (50.8)
Wound dressing	54 (43.5)
Personal protective equipment	24 (19.4)
Clinical examination	16 (12.9)
Surgery	13 (10.5)
Others (eg, oral care)	45 (36.3)
Preventive measures	
MBBS (n=215)	
Hygienic instructions	64 (29.8)
Counseling on lifestyle	37 (17.2)
Vaccination	28 (13.0)
Prenatal counseling	22 (10.2)
Elderly care	7 (3.3)
Others (eg, anti-drug abuse)	1 (0.5)
None of the above	116 (54.0)
BDS (n=96)	
Fluoride application	26 (27)
Fissure sealant	17 (18)
Oral hygiene instruction	10 (10)
Prophylaxis	6 (6)
Dietary counseling	0 (0)
None of the above	53 (55)
BNurs (n=122)	
Hygienic instructions	87 (71.3)
Counseling on lifestyle	30 (24.6)
Elderly care	25 (20.5)

Type of procedure or measure	Participants, n (%)[a]
Vaccination	21 (17.2)
Prenatal counseling	9 (7.4)
Others (eg, psychiatric predischarge counseling)	2 (1.6)
None of the above	15 (12.3)

[a]Percentages may add up to more than 100% since multiple choices were allowed.

[b]Bachelor of Medicine and Bachelor of Surgery (MBBS), Bachelor of Dental Surgery (BDS), Bachelor of Nursing (BNurs).

Multivariate analysis showed that, compared with nursing students, medical students (odds ratio [OR] 0.121, 95% CI 0.065-0.227) and dental students (OR 0.116, 95% CI 0.058-0.231) were less likely to learn preventive measures through Internet DLOs (*P*<.001) (see Table 3).

Table 3. Effect of program on learning of preventive measures.

Program	Learning preventive measures through Internet DLOs[a], odds ratio (95% CI)[b]	*P*
BNurs[c]	1 (reference)	<.001
MBBS[c]	0.121 (0.065-0.227)	
BDS[c]	0.116 (0.058-0.231)	

[a]Digital learning objects (DLOs).

[b]Results were obtained through stepwise logistic regression. The dependent variables were "learning any preventive measure through Internet DLOs or not." Independent variables entered were age, gender, degree program, year of study, secondary educational background, and prior degree attainment.

[c]Bachelor of Nursing (BNurs), Bachelor of Medicine and Bachelor of Surgery (MBBS), Bachelor of Dental Surgery (BDS).

Sharing Internet Digital Learning Objects for Discussion and Clarification

Two-thirds (277/435, 63.7%) of students shared content of Internet DLOs with classmates, but only 12.4% (54/436) discussed DLOs with their teachers or clinical tutors (see Table 4). When the content of an Internet DLO contradicted with formal teaching, students mainly clarified with classmates (242/438, 55.3%) or tutors/teachers (245/438, 55.9%), or kept searching for other sources (198/438, 45.2%). A small proportion chose to trust (31/438, 7.1%) or ignore (65/438, 14.8%) the content in Internet DLOs without clarification.

Table 4. Sharing and clarification of Internet digital learning objects.

Sharing or clarification activities	Participants, n (%)[a]
Share/discuss with classmates (n=435)	
Yes	277 (63.7)
No	158 (36.3)
Share/discuss with teachers (n=436)	
Yes	54 (12.4)
No	382 (87.6)
Action when Internet DLOs [b] contradict formal teaching (n=438)	
Trust Internet DLOs	31 (7.1)
Ignore Internet DLOs	65 (14.8)
Discuss with classmates	242 (55.3)
Clarify with tutors/teachers	245 (55.9)
Keep searching for other sources	198 (45.2)

[a]Percentages may add up to more than 100% since multiple choices were allowed.

[b]Digital learning objects (DLOs).

Rating of Internet Digital Learning Objects

Students' mean ratings on the *accuracy*, *usefulness* and *importance* of Internet DLOs were 6.85 (SD 1.48), 7.27 (SD 1.53), and 7.13 (SD 1.72), respectively, out of a high score of 10 (see Table 5). MBBS and BDS students gave higher ratings on the *accuracy* of Internet DLOs as compared with nursing students (*P*=.034 and .044, respectively). No significant

difference was found among three degree programs in students' mean ratings on the *usefulness* and *importance* of Internet DLOs (P=.213 and .908, respectively).

Table 5. Rating of Internet digital learning objects.

DLO[a] characteristic	Rating, mean (SD)			
	MBBS[b] (n=218)	BDS[b] (n=97)	BNurs[b] (n=124)	Total (n=439)
Accuracy[c]	6.96 (1.40)	7.02 (1.23)	6.54 (1.74)	6.85 (1.48)
Usefulness	7.39 (1.53)	7.27 (1.30)	7.05 (1.66)	7.27 (1.53)
Importance	7.17 (1.82)	7.11 (1.55)	7.07 (1.69)	7.13 (1.72)

[a]Digital learning object (DLO).

[b]Bachelor of Medicine and Bachelor of Surgery (MBBS), Bachelor of Dental Surgery (BDS), Bachelor of Nursing (BNurs).

[c]Rating on *accuracy* of Internet DLOs was significantly higher among MBBS and BDS students than among BNurs students (P=.034 and .044, respectively).

Multivariate analysis showed that, compared with their counterparts, nursing students and female students rated the *accuracy* and *usefulness* of Internet DLOs more unfavorably (P=.010 and .018, respectively) (see Table 6).

Table 6. Factors affecting rating of Internet digital learning objects.

Factor affecting DLO[a] rating		B[b] (95% CI)	P
Rating on *accuracy* of Internet DLOs			
	Constant	6.986 (6.820-7.153)	<.001
	Nursing students	-0.419 (-0.737 to -0.100)	.010
Rating on *usefulness* of Internet DLOs			
	Constant	7.863 (7.362-8.364)	<.001
	Female students	-0.366 (-0.668 to -0.064)	.018
Rating on *importance* of Internet DLOs		N/A[c]	

[a]Digital learning object (DLO).

[b]Regression coefficient (B): results were obtained through stepwise multiple linear regression. The dependent variables were students' ratings on Internet DLO characteristics. Independent variables entered were age, gender, degree program, year of study, secondary educational background, and prior degree attainment.

[c]Not applicable (N/A): no associated factor identified.

Discussion

Principal Findings

The World Wide Web has opened up new horizons for learners at all levels. As in many other fields of education, clinical students' self-exploration of learning resources in the unrestricted Internet environment is very common. This is supported by our finding that almost all (428/439, 97.5%) students used Internet DLOs to facilitate their clinical learning. In addition to the "see one, do one, teach one" apprenticeship model for medical education [13,14], students often "Google many" to consolidate their clinical skills. This may prepare students to perform procedures safely and reduce the chance of preventable harm to patients [15].

Students reported learning a wide range of clinical procedures through Internet DLOs. Learning preventive measures through Internet DLOs was more common among nursing students than with medical and dental students. This may be due to the fact that medical doctors and dentists are increasingly delegating preventive work to auxiliary staff, whereas nurses tend to take up the role of educating patients. Dental students learned fluoride application, dental sealants placement, and oral hygiene instructions from Internet DLOs. Nevertheless, no dental student reported learning dietary counseling through Internet DLOs, although it is regarded as a main component for patient counseling in order to prevent oral diseases [16,17]. This might reflect the lower priority that students give to dietary counseling, or their underestimation of the skills required for effective dietary counseling. To the best of our knowledge, comparisons of Internet learning experiences of clinical students across various disciplines have not been reported previously. The differences among medical, dental, and nursing students can be further investigated in other populations.

Our findings suggested that Internet DLOs have become an important channel for students to connect to the international learning community. The Internet breaks the isolation of learners and enables learning interactions that were not possible before, such as the coupling of novices with experts from around the world, the opportunity to communicate with a world audience, and the ability to coconstruct knowledge and negotiate meaning

[4,7]. Learning clinical procedures through Internet DLOs is not only relevant at the undergraduate education stage. It can be anticipated that this mode of learning will stay with students throughout their professional lives as an alternative method to gain procedural experience and to update their clinical skills.

Despite several advantages of technology-enhanced learning, such as its economic benefit, high efficiency, and easy and timely access, there has been a long-standing debate regarding whether media can influence learning [18,19]. Some believe that both the medium and instructional methods influence the ways that learners process information and construct knowledge [18,20]. However, many accept the assertion that media are mere vehicles that deliver instruction, and what influences learning is the instructional method underlying the medium employed [19,21]. From either side of the argument, the content and the instructional method are considered important for learning to occur. Given the wide use of Internet DLOs and their often uncensored nature, the question is raised regarding how to actively engage faculties in developing and selecting high-quality DLOs and in providing needed guidance to students [9]. Providing teachers with a framework, appropriate tools, and concrete assistance may help them use DLOs to exchange ideas at the international level.

Although the younger generation possesses a certain level of computer literacy, our survey showed that students' searches for learning resources were predominately through public search engines, implying their limited ability to locate information [22,23]. Support from teaching, library, and information technology (IT) staff may be needed in order for students to take advantage of the possibilities that the Internet offers and be able to retrieve, evaluate, and synthesize information critically and effectively [24]. Although there is a myriad of videos and other DLOs on the Web, the majority are not developed by an accredited body or endorsed by an institution. Clearly stated learning objectives and outcomes are often lacking. Our findings showed that students' ratings on the accuracy of Internet DLOs was only 6.85 out of 10. This highlighted students' awareness and concerns of the low quality of a considerable amount of online material, which was observed in a previous study examining the quality of YouTube videos on the topic of medical science [9].

Educators, therefore, carry the role of guiding students in selecting quality and up-to-date materials to assist their learning. Collective efforts have been made to develop peer-reviewed learning resource banks [25-27]. Linking them to popular public search sites, for example, by creating a YouTube channel or iTunes app, might help increase the searchability of these websites and steer students to these reliable sources [28].

Limitations

Various means were attempted in this study to approach all students in the three degree programs. This contributed to a high response from dental students and a reasonable response from medical students and nursing mid-year students. However, the response from nursing final-year students to the online questionnaire was low, despite various efforts. This might have introduced some bias into some of our findings concerning final-year nursing students. Although this study involved students in three clinical programs, data were collected from only one university that adopts a student-centered and inquiry-based learning system. In universities using a traditional didactic teaching method, students may hold different views, which are yet to be explored in future studies. In addition, learning through Internet DLOs may not be equally relevant for students in developing and underdeveloped countries, where easy and free access to Internet resources is not possible.

Conclusions

Our study showed that Internet DLOs are a commonly used channel for learning clinical procedures among undergraduate students in dentistry, medicine, and nursing. They are regarded by undergraduate students across clinical faculties as useful and important supplements to their formal learning in the planned curriculum. Self-exploration of learning resources in the unrestricted Internet environment has a profound impact on the clinical training of e-generation learners. This trend calls for a transformation of the educator's role from dispensing knowledge to guidance and support.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Study questionnaire.

[PDF File (Adobe PDF File), 82KB - mededu_v1i1e1_app1.pdf]

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Abbreviations

BDS: Bachelor of Dental Surgery
BNurs: Bachelor of Nursing
DLO: digital learning object
IT: information technology
MBBS: Bachelor of Medicine and Bachelor of Surgery
MCQ: multiple-choice question
OR: odds ratio
SPSS: Statistical Package for the Social Sciences

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Original Paper

Student Preferences on Gaming Aspects for a Serious Game in Pharmacy Practice Education: A Cross-Sectional Study

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Abstract

Background: Serious games are motivating and provide a safe environment for students to learn from their mistakes without experiencing any negative consequences from their actions. However, little is known about students' gaming preferences and the types of serious games they like to play for education.

Objective: This study aims to determine the types of gaming aspects that students would like to play in a pharmacy-related serious game.

Methods: A cross-sectional study was conducted using a self-administered survey, which obtained students' responses on their preferences regarding various gaming aspects (reward systems, game settings, storylines, viewing perspectives, and gaming styles) and for a hypothetical gaming scenario (authentic simulation or post-apocalyptic fantasy). Descriptive statistics, chi-square, and Fisher's exact tests were used for statistical analyses.

Results: Response rate was 72.7% (497/684 undergraduates). The most popular game reward systems were unlocking mechanisms (112/497, 22.5%) and experience points (90/497, 18.1%). Most students preferred fantasy/medieval/mythic (253/497, 50.9%) and modern (117/497, 23.5%) settings, but lower year undergraduates preferred modern settings less than upper year seniors (47/236, 19.9% vs 70/242, 28.9%, P=.022). Almost one-third (147/497, 29.6%) preferred an adventurer storyline or an authentic pharmacy-related plot (119/497, 23.9%), and a collaborative game style was most preferred by the students (182/497, 36.6%). Three-dimensional game perspectives (270/497, 54.3%) were more popular than two-dimensional perspectives (221/497, 44.5%), especially among males than females (126/185, 68.1% vs 142/303, 46.9%, P<.001). In terms of choice for a pharmacy-related serious game, a post-apocalyptic fantasy game (scenario B, 287/497, 57.7%) was more popular than an authentic simulation game (scenario A, 209/497, 42.1%). More males preferred the post-apocalyptic fantasy scenario than females (129/187, 69.0% vs 155/306, 50.7%, P<.001).

Conclusions: In general, students want a three-dimensional, fantasy/medieval/mythic post-apocalyptic game, based on an adventurer storyline with an unlocking mechanism reward system. A balance between real-life and fantasy elements needs to be struck in order for the game to cater students towards health care practices.

KEYWORDS

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Introduction

As we embrace the digital age, the use of serious games has become increasingly popular in many domains, including education, health care, defense, art and culture, religion, corporate training, and advertising [1,2]. Serious games are digital games that have a purpose beyond entertaining the player [1] such as teaching, training, promoting health and well-being, promoting change, and persuading [3]. Serious games can potentially serve as powerful tools in education because they are motivating and can provide a safe environment for students to learn from their mistakes without having to experience any negative consequences from their actions [4]. Serious games can also be adapted to different learning styles of learners. By matching the learning environment to the ways in which students process and engage with educational material, serious games can provide a learner-centered approach that can supplement didactic teaching methods [5-7].

There are many examples of how serious games have been used for health care education. By creating different clinical reasoning pathways using virtual environments, serious games have potential to train clinical reasoning skills [8]. For example, serious games have been used to train medical students in pediatric medicine [9], insulin management [10], and surgical skills such as coronary artery bypasses and knee arthroplasties [11,12]. Nursing students have used simulation games for training on life support procedures [13] and emergency medical services [14]. Both medical and nursing students have shown to be supportive of the use of serious games in their education [14-16]. In pharmacy education, physical quiz-based games, card games, and board games have been used to teach metabolic pathways, pharmacotherapeutics, and pharmacokinetics [17-19]. However, to our knowledge, evidence on the use of serious games for pharmacy education is scarce even though pharmacy students have indicated their desire for serious games to be incorporated in their curriculum [20,21]. Although medicine, nursing, and pharmacy are all health care disciplines, existing serious games for medical and nursing students cannot be adopted by pharmacy students because the intricacies of drug compounding and preparation of extemporanous (non-commercially available) products, drug dispensing, medications management, medication labeling and review, and other crucial elements of pharmacy education are not present in serious games for medical and nursing students.

Pharmacy education is still largely instructor-centered and based on didactic, knowledge-based teaching [22-24]. At the National University of Singapore, the only provider of pharmacy education in the country [25], pharmacy undergraduates undergo a 4-year program where content and skills are taught through lectures, tutorials, and practical laboratory sessions. As part of a new theme-based curriculum which includes experiential learning [25], the Department of Pharmacy intends to develop and incorporate a serious game into the pharmacy practice modules for the incoming batch of undergraduates. From our reviews of published literature, there have been no studies that characterized the gaming preferences of pharmacy students on a pharmacy-related serious game. In order for us to develop such a game for pharmacy education, we needed to determine what aspects of gameplay (eg, settings, storylines, perspectives, and styles) would be interesting and motivating for our students to play as part of their modules. This study aimed to determine the preferences of students on the gaming aspects and type of pharmacy-related serious game they would like to play as part of their pharmacy practice education. The data collected would then serve as guidance for the development of a pharmacy-related serious game catering to the preferences of pharmacy undergraduates at our institution.

Methods

Questionnaire Design

The questionnaire consisted of 13 questions split into two main sections. The first obtained demographic information about the participants and whether they had paid for any in-game items before. If they had, they were asked to indicate for which games and how they paid for them (eg, parents' money, own allowance, own income). Their interest in playing a pharmacy-related serious game was also obtained using a 5-point Likert scale indicating their interest (1 being not interested at all and 5 being extremely interested).

The second section obtained the preferences of participants regarding various aspects of gameplay for a pharmacy-related serious game, such as their preferred game reward systems, settings, storylines, perspectives, and styles (Textbox 1). These aspects were adapted from classifications defined in the literature [26,27] and modified based on input from the game design team. In addition, participants were asked to choose between two hypothetical scenarios conceived for the serious game: scenario A (authentic simulation) and scenario B (post-apocalyptic fantasy). Scenario A was designed in accordance with the principles of the authentic learning environment theory [28-30], whereas scenario B was a fantasy scenario designed for students who prefer a nonauthentic learning environment. The themes for scenario B were inspired based on the popularity of post-apocalypse and vampirism tropes in the media at the time of the study [31-33]. The survey questions were designed by the study team, and the survey was pre-tested on a small group of science students who were not majoring in the pharmacy course.

Textbox 1. Descriptions of the gameplay aspects obtained from survey respondents.

Reward system—how the game provides positive experiences to the player

- Score: number used to mark quality of player performance

- Experience points: points accumulated during gameplay that reflect effort and time invested into the game. Usually used to mark the growth and development of the player.

- Item granting: the acquirement of virtual items that can be used by players. These items can possess useful in-game properties and abilities, collectability value, and/or social comparison value.

- Resources: valuables that are collected primarily for practical game use

- Achievement system: titles that are given to players upon completing certain stated conditions

- Feedback messages: fleeting pictures, sounds, or animations during gameplay that evoke positive emotions

- Plot animations and pictures: visually attractive animations and pictures that serve as milestones for player achievement. These usually follow important events in the game.

- Unlocking mechanism: access to new game content such as new levels and minigames awarded when certain conditions are fulfilled. The content motivates the player by evoking and maintaining curiosity towards the game.

Game setting—environment and background in which the player is immersed

- Science fiction: based on futuristic technology, space and time travel, extraterrestrial life, etc.

- Historical: based on real historical persons or events

- Fantasy/medieval/mythic: based on magic and other supernatural phenomena. Includes magical/mythical creatures such as giants, elves, and dragons.

- Modern: setting similar to an authentic, present-day pharmacy

Game storyline—plot and overarching theme in the game

- War: player is a warrior in a violent, organized conflict involving two or more factions.

- Heroic/saving humanity: player must defeat a great evil to save the world.

- Spy/secret agent: player must complete missions while remaining covert and discreet.

- Adventurer: player explores a largely unknown world.

- Authentic pharmacy-related plot: player carries out a role in a workplace that is closely related to an actual pharmacy.

Game perspective—planes along which gameplay action occurs

- 2D game perspectives: gameplay action occurs along a 2D plane only.

  - 2D top-down: camera angle displays the player's avatar and the surrounding area from above.

  - 2D side-scrolling: camera angle is from the side of the player's avatar.

- 3D game perspectives: gameplay action occurs in a 3D axis.

  - 3D first-person: camera angle shows the perspective from the viewpoint of the player's avatar.

  - 3D third-person: camera angle depicts a view that is slightly behind and above the player's avatar.

Game style—interactivity of how the game is played

- Competitive: players form strategies and directly oppose other players in the game.

- Cooperative: players work together but the benefits from collective efforts are not necessarily shared equally.

- Collaborative: players work together while sharing all payoffs and outcomes.

Game scenario—hypothetical scenarios for a pharmacy-related serious game

- Scenario A (authentic simulation): set in an authentic, modern day pharmacy workplace with a dramatic plot. The goal of the game is to experience the day-to-day operations of a pharmacy. Students will manage contemporary, realistic social issues such as drug addiction, haze, and epidemics. In-game tasks will include activities involving compounding, communication, and pharmaceutical care management.

- Scenario B (post-apocalyptic fantasy): set in a post-apocalyptic 3050, where a pandemic has turned the majority of humans into bloodthirsty vampires. To survive, the remaining humans have learned to use herbs to produce synthetic blood to satisfy the vampires' craving for human blood. The goal of the game is to find a remedy to reverse the vampiric mutation and to save mankind. In-game tasks will include activities involving compounding, communication, and pharmaceutical care management.

Study Design

This was a cross-sectional census study using a self-administered survey. Pharmacy students from each of the 4 years of undergraduate study were recruited for the study. Emails were sent to the lecturers-in-charge to seek support and permission to conduct the survey post-lecture. A short briefing would be given regarding the background and aims of the study before distributing the questionnaires. Participation was voluntary and submission of the questionnaire would be considered as consent to the survey. Ethics approval was obtained from the university's Institutional Review Board.

Data Analysis

Students were divided into groups based on their demographic information and responses to the survey questions. Their year of study was categorized into lower (years 1 and 2) and upper batches (years 3 and 4). Their interest levels in playing a pharmacy-related serious game were categorized as those who were not interested (not interested) or interested (slightly interested, moderately interested, very interested, and extremely interested). Among those who were interested, interest levels were further split into 2 categories: weak interest (slightly interested and moderately interested) and strong interest (very interested and extremely interested). Students were also classified into two groups by their preferred game perspectives: two-dimensional (2D) top-down or side-scrolling and three-dimensional (3D) first-person or third-person perspectives. Students who chose scenarios A and B were known as scenario A students and scenario B students, respectively.

Results were analyzed using descriptive statistics. Chi-squared tests were used to determine the associations between preferred gameplay aspects and gender (males and females), year of study (lower and upper batches), and preferred game scenarios (scenario A and scenario B students). Statistical significance was defined as $P < .05$. As the questions on gaming preferences were single-choice questions, multiple responses were excluded from analyses. Similarly, missing responses were also excluded from analyses. All analyses were conducted using the Statistical Product and Service Solutions Version 21 (IBM) software.

Results

Demographics and Preferred Gaming Aspects of Respondents

Response rate was 72.7% (497/684 students). More than half were females (307/497, 61.8%) (Table 1). There were almost equivalent proportions of lower batch (249/497, 50.1%) and upper batch (248/497, 49.9%) students. The majority (450/490, 90.5%) was interested in playing a pharmacy-related serious game, among which 65.1% indicated weak interest and 34.9% indicated strong interest. Over one-fifth (118/497, 23.7%) of students had paid for in-game items before, among which most had used their own allowance (101/118, 85.6%) to pay for the items.

The top 2 most popular reward systems were unlocking mechanisms (112/497, 22.5%) and experience points (90/497, 18.1%). Fantasy/medieval/mythic game settings were the most popular (253/497, 50.9%), followed by modern settings (117/497, 23.5%). Almost one-third (147/497, 29.6%) of respondents preferred an adventurer storyline over an authentic pharmacy-related plot (119/497, 23.9%). Three-dimensional game perspectives were more popular than 2D game perspectives (270/497, 54.3% vs 221/497, 44.5%), within which 3D first-person (147/270, 54.4%) and 2D top-down (158/221, 71.5%) views were the more popular ones. A collaborative game style was the most popular (182/497, 36.6%), and scenario B (post-apocalyptic fantasy) was preferred over scenario A (authentic simulation) (287/497, 57.7% vs 209/497, 42.1%).

Table 1. Demographics and preferred gaming aspects of respondents.

Parameters			Total[a], N=497, n (%)
Gender			
	Male		187 (37.6)
	Female		307 (61.8)
Year of study			
	Year 1		134 (27.0)
	Year 2		115 (23.1)
	Year 3		126 (25.4)
	Year 4		122 (24.5)
Interest in playing			
	Not interested		40 (8.0)
	Interested		450 (90.5)
		Weak interest (n=450)	293 (65.1)
		Strong interest (n=450)	157 (34.9)
Paid for in-game items			
	No		379 (76.3)
	Yes		118 (23.7)
		Own allowance (n=118)	101 (85.6)
		Own income (n=118)	20 (16.9)
		Parents' money (n=118)	13 (11.0)
Reward system			
	Score		65 (13.1)
	Experience points		90 (18.1)
	Item granting		42 (8.5)
	Resources		23 (4.6)
	Achievement system		60 (12.1)
	Feedback messages		5 (1.0)
	Plot animations & pictures		38 (7.6)
	Unlocking mechanism		112 (22.5)
Game setting			
	Science fiction		67 (13.5)
	Historical		39 (7.8)
	Fantasy/medieval/mythic		253 (50.9)
	Modern		117 (23.5)
	Others		2 (0.4)
Game storyline			
	War		50 (10.1)
	Heroic/saving humanity		61 (12.3)
	Spy/secret agent		99 (19.9)
	Adventurer		147 (29.6)
	Authentic pharmacy-related plot		119 (23.9)
	Others		5 (1.0)
Game perspective			

Parameters			Total[a], N=497, n (%)
	2D		221 (44.5)
		2D top-down, (n=221)	158 (71.5)
		2D side-scrolling (n=221)	63 (28.5)
	3D		270 (54.3)
		3D first-person (n=270)	147 (54.4)
		3D third-person (n=270)	123 (45.6)
Game style			
	Competitive		147 (29.6)
	Cooperative		160 (32.2)
	Collaborative		182 (36.6)
Game scenario			
	A (authentic simulation)		209 (42.1)
	B (post-apocalyptic fantasy)		287 (57.7)

[a] Percentages may not add to 100% due to missing data or multiple responses.

Analysis by Gender

Among respondents who were interested in playing a pharmacy-related game, males had a stronger interest than females (77/169, 45.6% vs 79/278, 28.4%, $P<.001$) (Table 2). Males were also more likely to have paid for in-game items compared to females (59/187, 31.6% vs 59/307, 19.2%, $P=.002$), and they were more likely to have used their own income to pay for these items (14/58, 24.1% vs 6/59, 10.2%, $P=.045$).

There was a trend in preference for reward systems. Males preferred experience points (31/157, 19.7%) to unlocking mechanisms (29/157, 18.5%); the opposite was true for females, who preferred unlocking mechanisms (83/275, 30.2% vs 59/275, 21.5%). While males were less likely to want unlocking mechanisms for the game (29/159, 18.5% vs 83/275, 30.2%, $P=.008$), they were more likely to want rewards of item granting (22/157, 14.0% vs 20/275, 7.3%, $P=.023$) and plot animations and pictures (19/157, 12.1% vs 18/275, 6.5%, $P=.047$).

A fantasy/medieval/mythic game setting with an adventurer storyline was the most popular in both genders, followed by a modern setting with an authentic pharmacy-related plot (Table 2). In addition, males preferred storylines with a war component more (38/183, 20.8% vs 11/295, 3.7%, $P<.001$) and spy/secret agent settings less (23/183, 12.6% vs 76/295, 25.8%, $P<.001$).

The perspectives and game styles were similar for both genders, with 2D top-down and 3D first-person views and a collaborative style being the most popular. However, in terms of game perspectives, 3D views were more popular among males than females (126/185, 68.1% vs 142/303, 46.9%, $P<.001$). Similarly, while both genders preferred scenario B (post-apocalyptic fantasy) for the pharmacy-related game, males were more likely choose this scenario than females (129/187, 69.0% vs 155/306, 50.7%, $P<.001$).

Table 2. Comparison of gaming aspects by gender.

Gaming aspects		Male (N=187), n (%)	Female (N=307), n (%)	P values
Interest in playing				
	Not interested	17/186 (9.1)	23/301 (7.6)	.558
	Interested	169/186 (90.9)	278/301 (92.4)	
Interest level of interested students				
	Weak interest	92/169 (54.4)	199/278 (71.6)	
	Strong interest	77/169 (45.6)	79/278 (28.4)	<.001[b]
Paid for in-game items				
	Yes	59/187 (31.6)	59/307 (19.2)	
	No	128/187 (68.4)	248/307 (80.8)	.002[b]
Payment method for in-game items [a]				
	Own allowance	50/58 (86.2)	51/59 (86.4)	.971
	Own income	14/58 (24.1)	6/59 (10.2)	.045[b]
	Parents' money	6/58 (10.3)	7/59 (11.9)	.794
Reward system				
	Score	26/157 (16.6)	39/275 (14.2)	.506
	Experience points	31/157 (19.7)	59/275 (21.5)	.674
	Item granting	22/157 (14.0)	20/275 (7.3)	.023[b]
	Resources	7/157 (4.5)	15/275 (5.5)	.651
	Achievement system	23/157 (14.6)	37/275 (13.5)	.730
	Feedback messages	0 (0.0)	4/275 (1.5)	.302
	Plot animations & pictures	19/157 (12.1)	18/275 (6.5)	.047[b]
	Unlocking mechanism	29/157 (18.5)	83/275 (30.2)	.008[b]
Game setting				
	Science fiction	30/182 (16.5)	36/293 (12.3)	.199
	Historical	18/182 (9.9)	21/293 (7.2)	.293
	Fantasy/medieval/mythic	98/182 (53.8)	153/293 (52.2)	.730
	Modern	36/182 (19.8)	81/293 (27.6)	.053
	Others	0 (0.0)	2/293 (0.7)	-
Game storyline				
	War	38/183 (20.8)	11/295 (3.7)	<.001[b]
	Heroic/saving humanity	25/183 (13.7)	35/295 (11.9)	.564
	Spy/secret agent	23/183 (12.6)	76/295 (25.8)	<.001[b]
	Adventurer	54/183 (29.5)	93/295 (31.5)	.642
	Authentic pharmacy-related plot	41/183 (22.4)	77/295 (26.1)	.362
	Others	2/183 (1.1)	3/295 (1.0)	-
Game perspective				
	2D	59/185 (31.9)	161/303 (53.1)	
	3D	126/185 (68.1)	142/303 (46.9)	<.001[b]
2D game perspectives				

Gaming aspects		Male (N=187), n (%)	Female (N=307), n (%)	P values
	2D top-down	48/59 (81.4)	110/161 (68.3)	.057
	2D side-scrolling	11/59 (18.6)	51/161 (31.7)	
3D game perspectives				
	3D first-person	67/126 (53.2)	79/142 (55.6)	.687
	3D third-person	59/126 (46.8)	63/142 (44.4)	
Game style				
	Competitive	54/182 (29.7)	93/304 (30.6)	.830
	Cooperative	56/182 (30.8)	101/304 (33.2)	.575
	Collaborative	72/182 (39.6)	110/304 (36.2)	.457
Game scenario				
	A (authentic simulation)	58/187 (31.0)	151/306 (49.3)	
	B (post-apocalyptic fantasy)	129/187 (69.0)	155/306 (50.7)	<.001[b]

[a]Percentages may not add to 100% due to multiple responses.

[b]Statistical significance was defined as $P<.05$.

Analysis by Year of Study (Lower and Upper Batches)

Lower batch students were more likely to have paid for in-game items compared to upper batch students (70/245, 28.1% vs 48/245, 19.4%, $P=.022$) (Table 3). However, among those who paid for in-game items, the lower batch was less likely to have used their own income (8/70, 11.4% vs 12/47, 25.5%, $P=.047$).

An experience points reward system (54/214, 25.2%) was more popular for lower batch students compared to unlocking mechanisms (45/214, 21.0%). In contrast, the experience points system was less popular among upper batch students (36/221, 16.3% vs 67/221, 30.3%). Lower batch students were more likely to want an experience points-based reward (54/214, 25.2% vs 36/221, 16.3%, $P=.021$) than an unlocking mechanism reward (45/214, 21.0% vs 67/221, 30.3%, $P=.027$).

Fantasy/medieval/mythic and modern game settings were the most popular among both lower and upper batch students (Table

3). However, lower batch students preferred modern settings less than their upper batch counterparts (47/236, 19.9% vs 70/242, 28.9%, $P=.022$). The adventurer game storyline was the most popular among lower batch students (75/237, 31.6%), but an authentic pharmacy-related plot was more popular than the adventurer storyline among the upper batch students (77/244, 31.6% vs 72/244, 29.5%). In fact, upper batch students were more likely to prefer the authentic pharmacy-related plot (77/244, 31.6% vs 42/237, 17.7%, $P<.001$). On the other hand, lower batch students preferred a spy/secret agent storyline more than their seniors (58/237, 24.5% vs 41/244, 16.8%, $P=.038$). In terms of game scenario preferences, while scenario B (post-apocalyptic fantasy) was generally more popular for both batches, lower batch students were more open to playing the post-apocalyptic fantasy scenario in the pharmacy-related game (161/248, 64.9% vs 126/248, 50.8%, $P=.001$).

Table 3. Comparison of gaming aspects by year of study.

Gaming aspects		Lower batch (N=249), n (%)	Upper batch (N=248), n (%)	*P* values
Interest in playing				
	Not interested	22/245 (9.0)	18/245 (7.3)	.509
	Interested	223/245 (91.0)	227/245 (92.7)	
Interest level of interested students				
	Weak interest	139/223 (62.3)	154/227 (67.8)	.220
	Strong interest	84/223 (37.7)	73/227 (32.2)	
Paid for in-game items				
	Yes	70/245 (28.1)	48/245 (19.4)	
	No	179/245 (71.9)	200/245 (80.6)	.022[b]
Payment method for in-game items [a]				
	Own allowance	59/70 (84.3)	42/47 (89.4)	.433
	Own income	8/70 (11.4)	12/47 (25.5)	.047[b]
	Parents' money	9/70 (12.9)	4/47 (8.5)	.463
Reward system				
	Score	31/214 (14.5)	34/221 (15.4)	.793
	Experience points	54/214 (25.2)	36/221 (16.3)	.021[b]
	Item granting	24/214 (11.2)	18/221 (8.1)	.278
	Resources	10/214 (4.7)	13/221 (5.9)	.573
	Achievement system	28/214 (13.1)	32/221 (14.5)	.673
	Feedback messages	0 (0.0)	5/221 (2.3)	.061
	Plot animations & pictures	22/214 (10.3)	16/221 (7.2)	.262
	Unlocking mechanism	45/214 (21.0)	67/221 (30.3)	.027[b]
Game setting				
	Science fiction	35/236 (14.8)	32/242 (13.2)	.613
	Historical	18/236 (7.6)	21/242 (8.7)	.675
	Fantasy/medieval/mythic	135/236 (57.2)	118/242 (48.8)	.064
	Modern	47/236 (19.9)	70/242 (28.9)	.022[b]
	Others	1/236 (0.4)	1/242 (0.4)	-
Game storyline				
	War	24/237 (10.1)	26/244 (10.7)	.849
	Heroic/saving humanity	35/237 (14.8)	26/244 (10.7)	.175
	Spy/secret agent	58/237 (24.5)	41/244 (16.8)	.038[b]
	Adventurer	75/237 (31.6)	72/244 (29.5)	.611
	Authentic pharmacy-related plot	42/237 (17.7)	77/244 (31.6)	<.001[b]
	Others	3/237 (1.3)	2/244 (0.8)	-
Game perspective				
	2D	109/245 (44.5)	112/246 (45.5)	.817
	3D	136/245 (55.5)	134/246 (54.5)	
2D game perspectives				

Gaming aspects		Lower batch (N=249), n (%)	Upper batch (N=248), n (%)	P values
	2D top-down	75/109 (68.8)	83/112 (74.1)	.383
	2D side-scrolling	34/109 (31.2)	29/112 (25.9)	
3D game perspectives				
	3D first-person	73/136 (53.7)	74/134 (55.2)	.799
	3D third-person	63/136 (46.3)	60/134 (44.8)	
Game style				
	Competitive	71/243 (29.2)	76/246 (30.9)	.686
	Cooperative	84/243 (34.6)	76/246 (30.9)	.387
	Collaborative	88/243 (36.2)	94/246 (38.2)	.648
Game scenario				
	A (authentic simulation)	87/248 (35.1)	122/248 (49.2)	
	B (post-apocalyptic fantasy)	161/248 (64.9)	126/248 (50.8)	.001[b]

[a]Percentages may not add to 100% due to multiple responses.

[b]Statistical significance was defined as $P<.05$.

Analysis by Choice of Game Scenario

In general, as the students grew in the number of study years, their choices shifted from scenario B (post-apocalyptic fantasy) to scenario A (authentic simulation) (Table 4). Students in year 1 of the pharmacy course were more likely to want to play a post-apocalyptic fantasy game (90/287, 31.4% vs 43/209, 20.6%, $P=.007$), while those who were near graduation preferred to play the authentic simulation game (61/209, 29.2% vs 61/287, 21.3%, $P=.043$).

In terms of rewards, unlocking mechanisms was the most popular choice among scenario A students (57/184, 31.0%), while experience points was the most popular among scenario B students (57/250, 22.8%). Students who chose the authentic simulation scenario (scenario A) were more likely to want an unlocking mechanism reward system for the game compared to those who chose the post-apocalyptic scenario (scenario B) (57/184, 31.0% vs 55/250, 22.0%, $P=.035$). A modern game setting was preferred by scenario A students (90/201, 44.8% vs 27/276, 9.8%, $P<.001$), in contrast to a fantasy/medieval/mythic setting, which was the more preferable choice among scenario B students (187/276, 67.8% vs 66/201, 32.8%, $P<.001$).

An authentic pharmacy-related plot was the most popular among scenario A students (86/201, 42.8%) but the least popular among scenario B students (33/279, 11.8%). Scenario A students were more likely to want an authentic pharmacy-related plot for the game (86/201, 42.8% vs 33/279, 11.8%, $P<.001$), while scenario B students were more likely to want war (38/279, 13.6% vs 12/201, 6.0%, $P=.007$), heroic/saving humanity (44/279, 15.8% vs 17/201, 8.5%, $P=.018$), or spy/secret agent (67/279, 24.0% vs 31/201, 15.4%, $P=.021$) storylines. Those who chose authentic simulations (scenario A) preferred the game to be in a 2D perspective (119/207, 57.5%), compared to those who chose the post-apocalyptic fantasy (scenario B), who preferred it in a 3D perspective (182/283, 64.3%, $P<.001$). The latter group (scenario B students) were also more likely to want a competitive style (95/281, 33.8% vs 52/207, 25.1%, $P=.039$) for the game.

Table 4. Comparison of gaming aspects by game scenario choice in the pharmacy-related serious game.

Gaming aspects		Scenario A (N=209), n (%)	Scenario B (N=287), n (%)	P values
Year of study				
	Year 1	43/209 (20.6)	90/287 (31.4)	.007[a]
	Year 2	44/209 (21.1)	71/287 (24.7)	.337
	Year 3	61/209 (29.2)	65/287 (22.6)	.099
	Year 4	61/209 (29.2)	61/287 (21.3)	.043[a]
Interest in playing				
	Not interested	20/206 (9.7)	19/283 (6.7)	.227
	Interested	186/206 (90.3)	264/283 (93.3)	
Interest level of interested students				
	Weak interest	126/186 (67.7)	167/264 (63.3)	.326
	Strong interest	60/186 (32.3)	97/264 (36.7)	
Paid for in-game items				
	Yes	41/209 (19.6)	77/287 (26.8)	.063
	No	168/209 (80.4)	210/287 (73.2)	
Payment method for in-game items				
	Own allowance	39/40 (97.5)	62/77 (80.5)	.010[a]
	Own income	6/40 (15.0)	14/77 (18.2)	.665
	Parents' money	1/40 (2.5)	12/77 (15.6)	.034[a]
Reward system				
	Score	31/184 (16.8)	34/250 (13.6)	.349
	Experience points	33/184 (17.9)	57/250 (22.8)	.217
	Item granting	13/184 (7.1)	28/250 (11.2)	.146
	Resources	11/184 (6.0)	12/250 (4.8)	.588
	Achievement system	24/184 (13.0)	36/250 (14.4)	.686
	Feedback messages	3/184 (1.6)	2/250 (0.8)	.654
	Plot animations & pics	12/184 (6.5)	26/250 (10.4)	.158
	Unlocking mechanism	57/184 (31.0)	55/250 (22.0)	.035[a]
Game setting				
	Science fiction	23/201 (11.4)	43/276 (15.6)	.196
	Historical	22/201 (10.9)	17/276 (6.2)	.060
	Fantasy/medieval mythic	66/201 (32.8)	187/276 (67.8)	<.001[a]
	Modern	90/201 (44.8)	27/276 (9.8)	<.001[a]
	Others	0 (0.0)	2/276 (0.7)	-
Game storyline				
	War	12/201 (6.0)	38/279 (13.6)	.007[a]
	Heroic/saving humanity	17/201 (8.5)	44/279 (15.8)	.018[a]
	Spy/secret agent	31/201 (15.4)	67/279 (24.0)	.021[a]
	Adventurer	55/201 (27.4)	92/279 (33.0)	.188
	Authentic pharmacy-related plot	86/201 (42.8)	33/279 (11.8)	<.001[a]

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Gaming aspects		Scenario A (N=209), n (%)	Scenario B (N=287), n (%)	*P* values
	Others	0 (0.0)	5/279 (1.8)	-
Game perspective				
	2D	119/207 (57.5)	101/283 (35.7)	
	3D	88/207 (42.5)	182/283 (64.3)	<.001[a]
2D game perspectives				
	2D top-down	87/119 (73.1)	71/101 (70.3)	.644
	2D side-scrolling	32/119 (26.9)	30/101 (29.7)	
3D game perspectives				
	3D first-person	54/88 (61.4)	93/182 (51.1)	.112
	3D third-person	34/88 (38.6)	89/182 (48.9)	
Game style				
	Competitive	52/207 (25.1)	95/281 (33.8)	.039[a]
	Cooperative	68/207 (32.9)	91/281 (32.4)	.914
	Collaborative	87/207 (42.0)	95/281 (33.8)	.063

[a]Statistical significance was defined as *P*<.05.

Analysis by Past Payment for In-Game Items

Out of the 497 respondents, 118 (23.7%) had previously paid for in-game items. Males were more likely than females to have paid for in-game items (59/187, 31.6% vs 59/307, 19.2%, *P*=.002) (Table 2). Lower batch students were also more likely to have paid for in-game items compared to upper batch students (70/245, 28.1% vs 48/245, 19.4%, *P*=.022) (Table 3). Among the 110 students who indicated the games in which they had made in-game purchases, the most popular game by 57 respondents (51.8%) was MapleStory.

A fantasy/medieval/mythic game setting was preferred by students who had paid for in-game items (80/118, 67.8% vs 186/377, 49.3%, *P*<.001), in contrast to a modern setting, which was the preferred choice among students who had never paid for in-game items (108/377, 28.6% vs 16/118, 13.6%, *P*=.001). For game storyline, students with past payment for in-game items preferred war (20/118, 16.9% vs 35/377, 9.3%, *P*=.021) and adventurer (48/118, 40.7% vs 112/377, 29.7%, *P*=.026) storylines; authentic storylines were preferred by students who had never paid for in-game items (105/377, 27.9% vs 18/118, 15.3%, *P*=.006).

Discussion

Developing a Pharmacy-Related Serious Game Based on Gaming Preferences of Students

The gaming behaviors and preferences of students have been extensively documented in the literature [15,34-40]. However, these studies have predominantly focused on recreational, not serious, gaming. The focus of serious games is on a purpose other than entertainment, in this case pharmacy education. Although certain recreational gaming preferences can also help explain students' gaming preferences for a serious game, different categorizations of gaming aspects can render direct comparisons between the two types of gameplay difficult. For example, role-playing recreational games can be further split into fantasy/medieval/mythic (eg, World of Warcraft) or science fiction (eg, Eve Online) settings [15,41,42]. In order for us to develop a serious game for pharmacy education, we needed to find out more about the types of gameplay aspects (eg, settings, storylines, perspectives, and styles) that would be relevant. Based on our literature reviews, we could not find any study results that could be directly translated for us to develop such a game. Studies on gaming in medical and nursing education were generally focused on simulations and not role-playing. Furthermore, the gaming preferences of students in different health care fields might differ. To our knowledge, this is the first study that has identified the preferences of students in relation to gaming aspects and the associations between gaming aspects and gender, year of study, and choice of hypothetical game scenarios. In addition, this is the first survey conducted on an Asian population with regards to serious games, and it may help lay the foundation for more studies. In general, the most popular game reward systems and game settings were unlocking mechanisms and fantasy/medieval/mythic settings. Students generally preferred to play an adventurer game in a collaborative mode and from a 3D viewing perspective.

Our results suggested that recreational gaming behavior might also explain serious gaming preferences. The most popular game among students who had paid for in-game items was MapleStory, which has a fantasy/medieval/mythic setting and an adventurer storyline [43,44]. For the pharmacy-related serious game, these gaming aspects were also preferred by these students compared to their counterparts who had not previously paid for in-game items.

Generally, both genders shared the same gaming preferences. The difference in gaming perspectives between males and females, who preferred 3D and 2D perspectives respectively, could be due to the types of gaming platforms used by both genders for recreational gaming. Studies have shown that males

were more likely to play games on advanced gaming equipment, such as the Microsoft Xbox and PlayStation gaming consoles [15,34,35]. The recreational gaming preferences of the students could also have played a role in their perceptions of secondary gaming aspects. For example, the higher preference for war storylines by males could be linked to the fact that they played violent video games for recreation more frequently [36]. The preference of males towards choosing a post-apocalyptic fantasy (scenario B) could also be related to their preference for games that involved fantasy genres [40]. On the other hand, the preference of females for an authentic simulation (scenario A) game in pharmacy could mimic the fact that they liked games which involved close simulation of real-life activities [45].

While both the lower and upper batches of students showed similarities in preferences for the gaming aspects, their preferences for the game storyline and setting were quite different. The lower and upper batch students chose the adventurer storyline and authentic pharmacy-related plot respectively, and the upper batch also preferred the intended game to portray a modern setting similar to a present-day pharmacy. Their preferences could be related to the fact that younger players tended to be more motivated by fantasy elements and required more stimulation than older players when playing video games [37,46]. However, the shift in choice of scenario B (post-apocalyptic fantasy) to scenario A (authentic simulation) for the pharmacy game among the student batches showed their maturity in attitude as they neared graduation. Their preferences for fantasy elements decreased, and they were more attracted to realistic and authentic elements as they neared the transit from undergraduate study to working life.

The differences in preferences among the genders and batches make it a challenge to design a serious game that caters to all pharmacy students. Our results show diversity in gaming preferences, but there are several aspects that can be generalized across the groups. The popularity of realistic and authentic gaming aspects suggests that the final version of the serious game should incorporate elements that mirror that of real-life pharmacy practices. The differences in preferences on reward systems may imply that it is necessary to incorporate an array of reward systems in the final game. In fact, the use of multiple reward systems already exists for current recreational games in the market. For example, Diablo 3 (Blizzard Entertainment) primarily uses an item-granting reward system, where players obtain rare and gameplay-enhancing items by defeating enemies. At the same time, the players can level up their characters by gaining experience points, compete against other players in a leaderboard scoring system, and collect game rewards through achievement and completion of game events. Nevertheless, it will still be a challenge to design a game that caters towards the variety of preferences. While some gaming aspects can be tailored to the player (ie, 3D and 2D perspectives for males and females), other aspects will need to change as the game evolves and caters to a more mature audience (ie, from a fantasy to a more authentic storyline and setting). For our pharmacy game,

it will be important to incorporate a variety of reward systems and a mixture of fantasy and authentic elements in order to encourage students to achieve the learning objectives of the module.

Limitations

A major limitation in this study is that our results are mainly focused on the gaming aspects that students prefer for a serious game. Taking into consideration that the serious game is intended for educational purposes, other characteristics such as the learning styles of students can affect their gaming preferences. For example, in the Keirsey temperament sorter personality test [6], students who are Artisans value freedom and spontaneity and therefore may prefer gaming aspects that offer such qualities, such as adventurer storylines. On the other hand, students who are Guardians are traditional and conservative and may prefer gaming aspects that are more grounded in real-life environments, such as having modern settings. However, obtaining such information on our students' learning styles was not feasible in this study due to the limited time in lectures allocated for the survey. Background information such as duration of gaming experience, recreational gaming habits, and technology aversion was not collected, as we were mindful that the increase in the number of questions might predispose the students to survey fatigue and affect the response rate. Obtaining this information is necessary, however, and will be a next step for us in order to cater the game successfully towards its educational purpose.

Another limitation is that our results may have limited generalizability to pharmacy students in other countries. However, our university houses the only pharmacy school in the country, and our department produces majority of the country's pharmacy workforce. Therefore, the results of this study are still applicable to the cohorts of students entering pharmacy school in Singapore. Our survey is also valuable as a basic framework that can be used to obtain the perceptions of serious games of other populations of pharmacy students. Future work can obtain quantitative information regarding students' recreational gaming experiences and habits so that more detailed analyses, such as regression models, can be performed to obtain further insights.

Conclusion

This is the first study that has attempted to characterize the preferences of pharmacy students on various gaming aspects for a serious game in their education. In general, students want a game with the following combination of gaming aspects: an unlocking mechanism reward system, a fantasy/medieval/mythic setting, an adventurer storyline, a 3D viewing perspective, and a collaborative game style. Students prefer a post-apocalyptic fantasy scenario over an authentic simulation scenario, although this preference shifts as the students mature over the course of their undergraduate years. A balance between real-life environments and fantasy aspects will need to be struck.

Acknowledgments

Conflicts of Interest

None declared.

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Abbreviations

2D: two-dimensional
3D: three-dimensional

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