Digital Learning Tools: Findings from a National Survey of Canadian Medical Learners

Claire Sethuram[1,2], Tess McCutcheon[1], Hui (Harriet) Yan[2], Sathya Karunananthan[1,3], Alex Hajjar[4], Oussama Outbih[2], Kim Rozon[2], Ed Seale[2], Lyn K. Sonnenberg[5,6], Clare Liddy[1,2,7]

[1] C.T. Lamont Primary Health Care Research Centre, Bruyère Research Institute, Ottawa, Ontario, Canada

[2] Department of Family Medicine, University of Ottawa, Ottawa, Ontario, Canada

[3] Interdisciplinary School of Health Sciences, University of Ottawa, Ottawa, Ontario, Canada

[4] Department of Surgery, University of Alberta, Edmonton, Alberta, Canada

[5] Office of Education, University of Alberta, Edmonton, Alberta, Canada

[6] Glenrose Rehabilitation Hospital, Edmonton, Alberta, Canada

[7] Ontario eConsult Centre of Excellence, The Ottawa Hospital, Ottawa, Ontario, Canada

Correspondence:
Clare Liddy; cliddy@uottawa.ca

Date Submitted: April 8, 2025
Date Accepted: June 7, 2025
Date Published: December 9, 2025

DOI: https://doi.org/10.18192/UOJM.V15i2.7448

Keywords: *primary care, digital learning, medical education, equity*

ABSTRACT

Objectives: The need for enhanced adoption of digital learning tools into medical education was highlighted by the COVID-19 pandemic. To inform development and implementation of such tools during training, we designed a survey exploring the current scope of digital learning tool use by medical students and family medicine residents in Canada.

Methods: We conducted a national survey of medical students and family medicine residents at 14 of 17 medical schools across Canada. We used frequency tables and descriptive statistics to summarize the multiple-choice responses and performed a content analysis of the free-text responses to identify recurrent themes.

Results: Survey responses indicated that learners value information quality, user experience, and accessibility. Barriers to accessing digital learning tools included cost and usability.

Conclusions: Medical educators looking to improve the delivery of medical education should focus on learner experience, removing the aforementioned barriers, and using iterative evaluation by learners to maintain relevance, usefulness, and effectiveness.

RÉSUMÉ

Objectifs : La nécessité d'adopter davantage les outils d'apprentissage numériques dans l'enseignement médical a été mis en évidence par la pandémie de COVID-19. Afin d'informer le développement et la mise en œuvre de tels outils pendant la formation, nous avons conçu une enquête pour explorer l'étendue actuelle de l'utilisation des outils d'apprentissage numériques par les étudiants en médecine et les résidents en médecine familiale au Canada.

Méthodes : Nous avons mené une enquête nationale auprès d'étudiants en médecine et de résidents en médecine familiale dans 14 des 17 facultés de médecine en Canada. Nous avons utilisé des tableaux de fréquence et des statistiques descriptives pour résumer les réponses à choix multiples et avons effectué une analyse du contenu des réponses libres afin d'identifier les thèmes récurrents.

Résultats : Les réponses de l'enquête ont indiqué que les apprenants apprécient la qualité de l'information, l'expérience utilisateur et l'accessibilité. Les obstacles à l'accès aux outils d'apprentissage numériques comprenaient le coût et la facilité d'utilisation.

Conclusions : Les éducateurs en médecine qui cherchent à améliorer la livraison de l'enseignement médical devraient se concentrer sur l'expérience des apprenants, supprimer les obstacles susmentionnés et utiliser une évaluation itérative par les apprenants pour maintenir la pertinence, l'utilité et l'efficacité.

INTRODUCTION

Over the past few decades, digital learning has gained prevalence in education, although widespread adoption within medical education has been limited.[1,2] The onset of the COVID-19 pandemic has accelerated the need for medical educators to shift focus to integrating meaningful and interactive digital tools that complement traditional learning. The value of digital learning tools (DLTs) has been well documented in the literature for professional development, enhancing learning outcomes, material retention, study motivation, and accessible learning.[3–10] DLTs are defined as "any online or offline computer-based resource, mobile application, electronic game, or resource that supports, enhances, or contributes to medical education". This definition was collaboratively developed by an interdisciplinary team of faculty members, program administrators, students, and researchers, with expertise in medicine, software development, education, and research methods.

The early phases of an ongoing scoping review regarding DLTs in medical teaching has revealed immense heterogeneity in this field.[11] As medical education programs like ours at the University of Ottawa's Department of Family Medicine strive to improve online curriculum accessibility, it is essential to understand current user experiences.[12,13] As such, our team conducted a national survey to explore the scope of DLT use by medical students and family medicine (FM) residents in Canada. We targeted these groups because they are both considered FM learners, as medical students rotate through FM as part of their training, and therefore both groups will be affected by changes to the FM online curriculum. Our findings may inform the development and implementation of DLTs for medical learners across training programs in Canada and beyond as medical education evolves in response to the digital shift with the COVID-19 pandemic.

METHODS

Survey Design

We designed a 12-question survey which included multiple-choice questions with the option for free-text comments (**Appendix A**). Four additional questions regarding access and Equity, Diversity, and Inclusion (EDI) (**Appendix B**) were added to the surveys sent to two medical schools (University of Ottawa and Université de Montreal), as these questions were developed after the initial ethics approval processes took place at other schools. Recruitment emails and surveys were provided in both English and French to ensure that it was equally accessible to anglophone and francophone populations.

Population and Ethics

Participants were eligible if they were enrolled as an undergraduate medical student or FM resident at a Canadian medical school in January 2022. The survey was open for eight weeks from February to April 2022.

Ethics approval was obtained from the Ottawa Health Science Network and the Bruyère Continuing Care Research Ethics Boards. Ethics approval was also obtained from 16/17 postgraduate FM programs and 10/17 undergraduate programs at their local institutions for inclusion in the study. Only participants from schools with ethics approval in place were contacted.

Recruitment

To reach undergraduate medical students, we contacted program administrators and/or student representatives. FM program directors were asked to distribute the survey to reach FM residents. Reminder emails were sent two weeks after the initial invitation to participating programs.

Quantitative Analysis

Responses to survey questions were exported into Microsoft Excel for analysis. We used frequency tables and descriptive statistics to summarize multiple-choice responses.

Qualitative Analysis

We conducted a content analysis of the free-text responses about terms used to refer to DLTs and comments to developers of DLTs using a latent pattern content analysis strategy to identify recurrent themes.[14] Two members of the research team (CS and TM) independently reviewed all responses and broadly coded the data without preconceived themes. Survey responses were anonymized. The two researchers (CS and TM) met to test codes and develop a codebook, which was used to develop themes that capture the qualitative data.

RESULTS

A total of 150 learners, including medical students (n=62) and FM residents (n=88), completed the survey, with national representation from 14/17 schools across the country. Demographic data was collected from all survey respondents (**Table 1**). Access and EDI data was provided by 27 respondents. Among them, 96% of respondents reported no disability and 48% of respondents reported their racial or ethnic group as White – North American (e.g., Canadian, American).

Table 1. Characteristics of Survey Respondents

Characteristic	Number of respondents (%)
Language (n=150)	
English	128 (85)
French	22 (15)
Age (n=150)	
18-24	19 (13)
25-35	118 (79)
36-50	13 (9)
Gender (n=150)	
Female	95 (63)
Male	49 (33)
Other	6 (4)

Digital Learning Tool Utilization

The majority of survey respondents (98%; n=147) agreed with the aforementioned definition of DLTs. Most respondents considered studying subscription services (97%), clinical aids (97%), online learning modules (96%), and mobile applications (96%) to be DLTs. During medical school and/or residency training, learners had used clinical aids (97%), online learning modules (89%), and mobile applications (77%) to support their learning. Some respondents indicated that DLTs were endorsed by their program, including online learning modules (78%), clinical aids (75%), and mobile applications (27%). Additional information regarding DLT use can be found in **Table 2**. No meaningful differences were observed between different years of medical school and FM residency training.

Of the individuals who responded to the access and EDI questions, the majority (78%; n=21) expressed that they experience barriers to accessing DLTs. The percentage of respondents experiencing each of the specific barriers to access can be found in **Table 3**. Cost was the most commonly reported barrier, with both highest responses relating to the cost of the DLT (70%) and cost of equipment (26%), respectively.

Qualitative Analysis

Three overarching themes emerged from the analysis of over 150 free-text comments: quality, user experience, and accessibility.

Respondents' discussions of the quality of DLTs involved factors such as information quality, simplicity, and usefulness. Several respondents also highlighted that user expe-

Table 2. Digital Learning Tool Use (n=150)

Digital learning tool	Number of respondents that considered it a digital learning tool (%)	Number of respondents that used this tool during their training (%)	Number of respondents that indicated the digital learning tool was endorsed by their program (%)
Online learning module	144 (96)	133 (89)	117 (78)
Studying subscription service	146 (97)	107 (71)	18 (12)
Quizzing software	134 (89)	88 (59)	25 (17)
Social media educational post	50 (33)	37 (25)	5 (3)
Virtual reality simulation	129 (86)	31 (21)	12 (8)
Educational video game	92 (61)	7 (5)	1 (1)
Online escape room	20 (13)	2 (1)	1 (1)
Online card game	20 (13)	2 (1)	0 (0)
Online board game	19 (13)	2 (1)	1 (1)
Clinical aid	145 (97)	146 (97)	113 (75)
Mobile application	144 96)	116 (77)	40 (27)
Online game miscellaneous	2 (1)	3 (2)	1 (1)
Other	12 (8)	19 (13)	31 (21)

rience should be a key consideration in DLT development. The user experience includes the structure of content and the audience (level of learning) for the DLTs, as well as their usability/user-friendliness. Finally, several comments related to the accessibility of DLTs, not only in terms of ease of access, but also cost (i.e., low or no cost), time (i.e., short time to use the tool), portability, and multi-device operability. For example, one survey respondent wrote, "make it accessible (easy to find, easy to use) and affordable."

DISCUSSION

The results of this national survey reveal valuable insights into DLT use among Canadian medical learners. Clinical aids, online learning modules, and mobile applications were the most common types of DLTs used by survey respondents and endorsed by their programs. In the development and implementation of novel tools, this survey revealed that Canadian medical learners value quality, user experience, and accessibility. When incorporating novel tools into medical curricula, educators should consider the quality of information presented to ensure it reflects learning objectives without introducing redundancy. DLT developers should also prioritize user-centered design processes with regular feedback from learners to ensure tools are easy to navigate (i.e., user-friendly). Finally, to enhance traditional learning, DLTs must be low-cost and multi-device compatible to enhance accessibility.

Interestingly, this survey revealed that a large proportion of Canadian medical learners face barriers related to the use of DLTs. This is consistent with studies from other jurisdictions that cite barriers related to poor internet coverage, limited interaction and engagement, user-friendliness, variation across platforms, and lack of suitable devices.[1,12,15,16] However, in our survey, the most common barriers reported were costs associated with equipment and individual tools or subscription services. As digital tools become more commonplace in medical education, it is critical for developers and educators to recognize cost as a significant barrier to access. Undergraduate and postgraduate medical faculties and departments should make efforts to ensure that DLTs are accessible, affordable, and available to learners. This survey revealed that affordability extends beyond the cost of a tool itself. For example, mobile applications that are available only on newer devices may limit their use as the cost of equipment represents a barrier. Further, DLTs that require a high-speed internet connection in the home may also be difficult for some learners to access, which is consistent with perspectives from learners in other countries.[12,15,16]

To our knowledge, our study is the first to conduct a survey of undergraduate medical students and FM residents on DLT at a national scope. Another novel aspect is the qualitative analysis from over 150 free-text responses. We provided our survey in both English and French to increase accessibility and minimize the common sampling bias favouring participants who speak fluent English. This is important because some medical practitioners serve French-speaking communities and benefit from the availability of DLT in multiple languages. Indeed, one respondent identified "Unavailable in preferred language" as a barrier. One significant study limitation is low response rate. Additionally, participation rates differed between medical students and FM residents, as well as between institutions. Those individuals using digital tools may be more likely to respond; perhaps those who have not used them did not answer the survey. As such, the results produced by this survey could be biased and may not be completely representative of all Canadian medical and FM learners. Strategies such as a longer data collection period, additional email reminders, increased promotion on social media, and monetary compensation may have increased survey participation.[17–22]

Table 3. Barriers to access experienced by respondents (n=27)

Barriers to Access	Number of respondents that experienced barriers (%)
Cost of Equipment (laptop, tablet, mobile phone)	7 (26)
Lack of available equipment through university (laptop, tablet, mobile phone)	4 (15)
Usability (functionality, universal design)	7 (26)
Cost of the digital learning tool (licence, subscription)	19 (70)
Reliable high-speed internet at home	1 (4)
Reliable high-speed internet on campus	0 (0)
Unavailable in preferred language	1 (4)
No need / no interest / not useful	1 (4)

CONCLUSION

In conclusion, clinical aids, online learning modules, and mobile applications were the most common types of DLTs reported by survey respondents. When incorporating these tools into medical education, barriers to access, particularly related to cost, should be actively addressed to ensure equity among learners. The free-text responses of this survey highlighted themes of quality, user experience, and accessibility, which should be considered by educators and developers during the design, development, and implementation of DLTs. Moreover, ongoing evaluation is essential to ensure these tools remain relevant, useful, effective, and aligned with learners' needs.

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Conflicts of Interest Disclosure
There are no conflicts of interest to declare.

APPENDICES

Appendix A: Survey

1. In this survey, we are using “digital learning tools” to refer to any online or offline computer-based resource, mobile application, electronic game or resource that supports, enhances, or contributes to medical education.

   Does this definition capture your understanding of digital learning tools? Please select one response.

   ☐ Yes
   ☐ No
   ☐ Uncertain
   ☐ Don't know

2. Are there other terms you would use to refer to what we have defined here as “digital learning tools”?
   Free text

3. Which of the following do you consider a digital learning tools? Please check all that apply.

   ☐ Online learning module
   ☐ Studying Subscription Service (ex: Osmosis, MedSkool, SketchyMedic)
   ☐ Quizzing software (ex: Quizlet, TopHat, Kahoot)
   ☐ Social media educational post (ex: Snapchat stories from surgeons)
   ☐ Virtual reality simulation (ex: Simulated patient encounters)
   ☐ Educational video game (ex: Septris)
   ☐ Online Escape Room
   ☐ Online card game
   ☐ Online board game
   ☐ Clinical aid (ex: UpToDate, Lexicomp)
   ☐ Mobile app (ex: Complete Anatomy, Touch Surgery)
   ☐ Online game miscellaneous
   ☐ Other (please specify)

4. What digital learning tools have you used in your medical and/or residency training? Please check the box that most accurately describes the modality, and write its name in text.

   ☐ Online learning module
   ☐ Studying Subscription Service (ex: Osmosis, MedSkool, SketchyMedic)
   ☐ Quizzing software (ex: Quizlet, TopHat, Kahoot)
   ☐ Social media educational post (ex: Snapchat stories from surgeons)
   ☐ Virtual reality simulation (ex: Simulated patient encounters)
   ☐ Educational video game (ex: Septris)
   ☐ Online Escape Room
   ☐ Online card game
   ☐ Online board game
   ☐ Clinical aid (ex: UpToDate, Lexicomp)
   ☐ Mobile app (ex: Complete Anatomy, Touch Surgery)
   ☐ Online game miscellaneous
   ☐ Other (please specify)

5. Please indicate the name of the corresponding program/application you have used in the text box.

6. What digital learning tools have been endorsed by your program to support your medical education and/or residency training? Please select all options that accurately describe the digital learning tools.

   ☐ Online learning module
   ☐ Studying Subscription Service (ex: Osmosis, MedSkool, SketchyMedic)
   ☐ Quizzing software (ex: Quizlet, TopHat, Kahoot)
   ☐ Social media educational post (ex: Snapchat stories from surgeons)

- ☐ Virtual reality simulation (ex: Simulated patient encounters)
- ☐ Educational video game (ex: Septris)
- ☐ Online Escape Room
- ☐ Online card game
- ☐ Online board game
- ☐ Clinical aid (ex: UpToDate, Lexicomp)
- ☐ Mobile app (ex: Complete Anatomy, Touch Surgery)
- ☐ Online game miscellaneous
- ☐ Other (please specify)

7. Please indicate the name of the corresponding program/application you have used in the text box.

8. In thinking about the current way medical students and family medicine residents are being taught, what is the one thing you would like the people creating digital learning tools to understand. **Free Text**

Demographic Question

9. Indicate which age category you belong to: (please select one)

- ☐ 18-24
- ☐ 25-35
- ☐ 36-50
- ☐ 51-64
- ☐ 65+

10. With which gender do you identify? (please select one)

- ☐ Male
- ☐ Female
- ☐ Other
- ☐ Prefer not to say

11. What university do you currently attend? (Check off the appropriate institution)

- ☐ University of British Columbia
- ☐ University of Alberta
- ☐ University of Calgary
- ☐ University of Saskatchewan
- ☐ University of Manitoba
- ☐ Northern Ontario School of Medicine
- ☐ Western University
- ☐ McMaster University
- ☐ University of Toronto
- ☐ Queen's University
- ☐ University of Ottawa
- ☐ McGill University
- ☐ Université Laval
- ☐ Université de Montréal
- ☐ Université de Sherbrooke
- ☐ Dalhousie University
- ☐ Memorial University of Newfoundland
- ☐ Centre de formation médicale du Nouveau-Brunswick
- ☐ Other

12. What year of training are you currently in? (check off year)

- ☐ Undergraduate medicine year 1

- ☐ Undergraduate medicine year 2
- ☐ Clerkship Year 3 & 4
- ☐ PGY1
- ☐ PGY2
- ☐ PGY3+

OPTIONAL: If you are interested in being contacted by our team for future surveys or interviews related to digital learning tools in medical education, please provide your name and email address below.

Name
School
Email Address

Appendix B: Additional Questions – Access and EDI

9. Do you experience barriers that prevent you from using digital learning tools? **Yes/No**

10. If yes, what are the barriers that prevent you from using digital learning tools (select all that apply):

- ☐ Cost of equipment (laptop, tablet, mobile phone)
- ☐ Lack of available equipment through university (laptop, tablet, mobile phone)
- ☐ Usability (functionality, universal design)
- ☐ Cost of the digital learning tool (license, subscription)
- ☐ Reliable high-speed internet at home
- ☐ Reliable high-speed internet on campus
- ☐ Unavailable in preferred language
- ☐ No need/no interest/not useful
- ☐ Other:

13. Which of the following BEST describes your racial or ethnic group? Check ONE only.

- ☐ Asian - East (e.g., Chinese, Japanese, Korean)
- ☐ Asian - South (e.g., Indian, Pakistani, Sri Lankan)
- ☐ Asian - South East (e.g., Malaysian, Filipino, Vietnamese)
- ☐ Black - African (e.g., Ghanaian, Kenyan, Somali)
- ☐ Black - Caribbean (e.g., Barbadian, Jamaican)
- ☐ Black - North American (e.g., Canadian, American)
- ☐ Black - European (e.g., English, Italian, Portuguese, Russian)
- ☐ Indian - Caribbean (e.g., Guyanese with origins in India)
- ☐ Latin American (e.g., Argentinean, Chilean, Salvadorian)
- ☐ First Nations
- ☐ Inuit
- ☐ Métis
- ☐ Middle Eastern (e.g., Egyptian, Iranian, Lebanese)
- ☐ White - European (e.g., English, Italian, Portuguese, Russian)
- ☐ White - North American (e.g., Canadian, American)
- ☐ Indigenous/Aboriginal not included elsewhere
- ☐ Mixed heritage (e.g., Black - African and White - North American) (Please specify)
  _____
- ☐ Other(s) (Please specify) _____
- ☐ Prefer not to answer
- ☐ Do not know

14. Do you identify as a person with a disability?

- ☐ Yes
- ☐ No
- ☐ Prefer not to answer