Post MD Education
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Best Practices in Evaluation and Assessment (BPEA)

Role of Technology in Assessment and Data Management

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1. Executive Summary

Through a review of relevant articles and discussion among group members, the role of technology in assessment and data management in Competency-Based Medical Education (CBME) was explored. It is anticipated that CBME will radically increase the number of direct observations and assessments conducted during residency training, and that the requirement for data collection and analysis will increase as well. Given the current context of medical education, with the various stages of training and organizational levels of governance, the discussion has been broken down in terms of the University's responsibility for leadership and support (the macro level), the needs and responsibilities of individual residency-training programs (the micro level), and opportunities in the current landscape of educational technology that may meet these needs.

At the macro level, the University has an opportunity and responsibility to provide leadership for programs through the development of a coherent institutional policy, institutional standards, and fostering an environment of support and community innovation. At the micro level, residency-training programs will need a method for gathering and collating the data on individual trainees to use in promotion discussions and decisions. Because of the variety of needs across postgraduate programs, the needs of individual programs will be specific to their specialty and their training environments. There will need to be customizable elements in any technological system that supports a variety of assessment types, data flow systems, and interfaces that are user-friendly and context-specific. There is an opportunity within current educational technology to build a central data management system that allows a flow of data, importing from, and exporting to, multiple secured systems and tools. Adaptability, communication between systems, and data analytics would be essential foundations of a functioning data management system.

The key implications derived from our work are listed below.

1. The PGME Office has the responsibility to provide structure, leadership, and guidance to programs in the area of technology-assisted assessment of learners.
2. Technology should be set up in a collaborative way, to enable management of data through the entire life-cycle of assessment, allowing data to flow not only between learners, faculty, programs, clinical learning environments, and PGME, but also as needed between undergraduate medical education (UME), postgraduate medical education (PGME), and continuing professional development (CPD).

3. A central PGME office data management and analytics system needs to be able to gather data from a modular suite of assessment tools and formats, customizable to the needs of the individual programs.

2. Background

Technology is essential for supporting the assessment of learners throughout their professional lives, starting in training and extending into practice, and in managing increasingly larger and larger amounts of data pertaining to residency assessment in a competency-based training environment. Assessment of trainees using technology ranges from online examinations and simulation training to workplace assessments, both formative and summative. The focus of this working group was largely on the latter, assessment of trainee performance in the context of the clinical learning environment.

Learners must receive feedback and be assessed frequently throughout their training in order to continue to improve and meet the desired objectives of their training programs. For decades, learners have described not receiving enough feedback directly, and Program Directors have described not having enough useful feedback to understand where a trainee is on the continuum, as well as not being able to target gaps in knowledge/skills/attitudes and identify, in a timely fashion, the learners who need more formal remediation.

With the implementation of technology in modern-day medical education, we are in the unique position of having the tools to develop an integrated system that serves our learners and our teachers/evaluators well. This system must be flexible in providing options for a variety of types of formative and summative assessments, as well as for developing a system of “handover” between rotations/sites, in order to design experiences that will address the learner’s needs/gaps in both the Medical Expert and Intrinsic CanMEDS roles.

3. Methodology

The authors initially met via teleconference to discuss the broader topic assigned and to determine what aspects required further review. Each author identified two to three relevant articles on the topic through an abbreviated literature search (PubMed, Google) that included a review of article references to identify additional relevant articles.

All relevant articles were reviewed and then discussed at a subsequent teleconference, with the appropriate themes and principles documented.

4. Results and Discussion

Our search led us to separate the discussion into three areas:

- The macro level, concerned with the overall approach of the University or Institution

- The micro level, outlining the needs at a program level for software and implementation
- Opportunities for technology to support assessment and data management in assessment

4.1. The macro level

At the macro level, the following important issues were identified for the University to consider:

- Following general principles of quality assessment when using technology
- Developing a coherent institutional policy
- Analyzing aggregate data, i.e.: patient outcomes linked to performance
- Setting up technology in a collaborative way to enable management of the entire life-cycle of assessment, e.g. a user should be able to select achievements to export and share between UME, PGME, and CPD systems, as needed
- Providing security and controlled access to assessment information e.g. portfolios containing sensitive information
- Providing a leadership role around making sure individuals with technology expertise are included on relevant committees
- Ensuring appropriate faculty and student development around the use of technology
- Supporting programs as they develop and apply technologies for assessment
- Fostering a community of practice to gather information on new program developments, with the aim of sharing information and best practices between programs

4.2. The micro level

In PGME, each program and educational context will have different needs for their assessments. An assessment system to meet the individual needs of each of more than 70 programs must be customizable. The system must be adaptable enough to support an array of tools, interfaces, and data flow pathways.

- Types of assessment tools will vary between programs
    - *E.g. multi-source feedback (MSF), Mini–Clinical Evaluation Exercise (mini-CEX), portfolios, case logs, simulations, facilitator-completed feedback vs. learner-completed test*
- Delivery of assessments will vary and the interfaces by which learners and assessors enter data must be tailored to the context as needed
    - *E.g. mobile, at the bedside, in clinic, in classroom, learner-driven and/or faculty-driven, multiple formats*
- The flow of assessment data will vary between assessment tools, as some tools will have learners entering data directly, others will be completed by faculty and will then need to be reviewed by learners for comments prior to finalizing, and still other tools will be completed by many and then only visible to learners in aggregate form

- The number of assessments is increasing with a competency-based program, and tracking of assessments and aggregation of data for determination of competence by a committee will be increasingly important for individual programs

4.3. Opportunities: Suites of assessment

Educational technology is moving away from learning management systems (LMS) that attempt to provide a single solution for many programs across a single institution. New systems that emphasize the key features of interoperability, customization, analytics, and collaboration are needed to support higher education.[1] A shift towards adaptable systems, built on the premise of communication between customized individual pieces, is needed in order to meet the varied and changing needs of complex and diverse educational programs.

In the context of PGME, this means considering opportunities to centrally store and manage assessment data, without limiting the inputs and outputs of that data to a rigid set of defined tools and interfaces. An effective assessment system would be customizable for individual programs. A suite of optional assessment tools (e.g. Multi-Source Feedback, Encounter forms, Entrustable Professional Activity [EPA] tracking) would be available that programs could select from in order to meet the needs of their specific teachers, learners, content, and context. In addition, an opportunity for programs to build their own tools that could then exchange information back and forth with the central system (perhaps through an Application Programming Interface [API]) is needed. See Figure 3 in Appendix 2.

Features of this assessment system should include:

- Data collection and analysis at the PGME level
- A suite of pre-made optional modifiable assessment tools to select from
- A build-your-own assessment tool option
- The opportunity to adapt from a colleague's or program's tool
- Bi-directional communication with the management system
- Customized outputs for user groups
- A uniform look and feel for the end user

5. Summary

Following review and discussion, the following key implications were identified.

- The PGME Office has the responsibility to provide structure, leadership, and guidance to programs in the area of technology-assisted assessment of learners.
- Technology should be set up in a collaborative way so as to enable management of data through the entire life-cycle of assessment, allowing data to flow not only between learners, faculty, programs, clinical learning environments, and PGME, but also as needed between UME, PGME, and CPD.

- A central PGME office data management and analytics system needs to be able to gather data from a modular suite of assessment tools and formats, customizable to the needs of the individual programs.

6. References

1. Brown M, Dehoney J, Millichap N. The next generation digital learning environment: A report on research. 2015. https://library.educause.edu/~/media/files/library/2015/4/eli3035-pdf.pdf. Accessed December 24, 2016.

7. Additional References

Amin Z, Boulet JR, Cook DA, et al. Technology-enabled assessment of health professions education: Consensus statement and recommendations from the Ottawa 2010 conference. *Medical Teacher.* 2011;33(5):364-369.

Clark R. *E-learning and the science of instruction: proven guidelines for consumers and designers of multimedia learning.* 2nd ed. San Francisco, CA: Pfeiffer; 2008.

Coulby C, Hennessey S, Davies N, Fuller R. The use of mobile technology for work-based assessment: the student experience. *British Journal of Educational Technology.* 2011;42(2):251-265.

Ellaway R, Masters K. AMEE Guide 32: e-Learning in medical education Part 1: Learning, teaching and assessment. *Medical Teacher.* 2008;30:455-473.

Ferenchick GS, Solomon D. Using cloud-based mobile technology for assessment of competencies among medical students. *Peer J.* 2013;1:e164:DOI 10.7717/peerj.7164.

Nicol D, Milligan C. Rethinking technology-supported assessment in terms of the seven principles of good feedback practice. In: Bryan C, Clegg K, eds. *Innovative Assessment in Higher Education*. London: Taylor and Francis Group Ltd; 2006.

8. Appendices

Appendix 1: Annotated Bibliography

Brown, M., J. Dehoney and N. Millichap. (2015). "The next generation digital learning environment: A report on research." Retrieved May 23, 2017, from https://library.educause.edu/~/media/files/library/2015/4/eli3035-pdf.pdf.

Educational technology is moving away from learning management systems (LMS) that attempt to provide a single solution for many programs across a single institution. The rigidity of LMS has been found to facilitate the administration of education rather than learning itself. No single application can provide all of the key elements: interoperability; personalization; analytics, advising, and learning assessment; collaboration; and accessibility and universal design. These are all needed to support higher education. Rather than looking for one single application, the Next Generation Digital Learning Environment results in a toolbox of applications, content, and platforms that can be assembled in custom ways for program customization and learner personalization. Standards must be set from the outset to ensure interoperability between elements in order to create this adaptive type of system.

Ellaway, R. and K. Masters (2008). " AMEE Guide No. 32: e-Learning in medical education Part 1: Learning, teaching and assessment." Medical Teacher 30(5): 455-473.

This Association for Medical Education in Europe (AMEE) guide is an excellent resource and reference paper as an introduction to technology in medical education. e-Learning has become mainstream in modern day medical education. The authors describe the concepts of e-Learning, e-Teaching, and e-Assessment, emphasizing the fact that the introduction of technology should be purposeful and thoughtful around improving both educational and patient outcomes, but that we can't yet know every eventual outcome. The only guaranteed prediction is that things will continue to change and we have to be ready for this.

e-Learning is discussed from the point of view of the learner, the teacher, and the content. In addition, different systems are described, with detail given around their functionality and where they are best employed. E-assessment is discussed with respect to the broad array of assessment points that can be evaluated and the projected use of assessments to help "loop back" and create other types of testing and examinations.

The potential for e-Learning, e-Teaching, and e-Assessment is likely only constrained by our imaginations. Technology supports medical education in a way we have never seen before, and is an integral and essential part of modern day training. As such, it is our responsibility to learn about it, support it, and be mindful of determining best practices based on best available evidence.

Appendix 2: Figures

Figure 1 Handover between sites

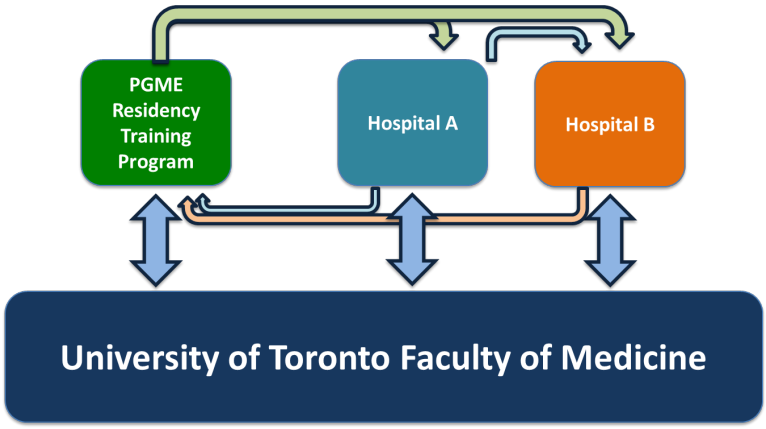

Figure 2 Handover along the continuum of professional development

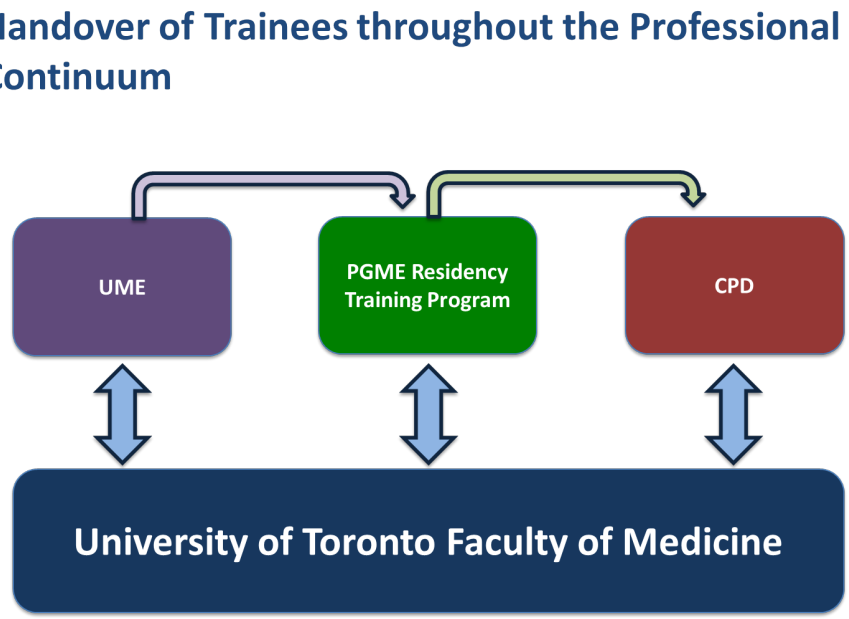

Figure 3 Data management opportunities