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Pilot evaluation of an electronic game developed to teach medication history taking to pharmacy students

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Abstract

Objectives: This pilot study aimed to evaluate a novel electronic medication reconciliation game for teaching medication history taking.

Method: Sixty-six final year Master of Pharmacy students used the eMedRec game during nine weekly tutorials throughout semester two in addition to problem-based learning cases. The authors compared the change in self-perceived confidence and competence surveys in semester two to usual teaching in semester one. Game usability was evaluated using survey the System Usability Scale (SUS) after game exposure.

Results: Difference in student self-perceived confidence after game exposure were comparable to those observed in semester one (difference in mean change -0.31 (-0.72 – 0.08)) while there was a significant increase in self-perceived competence following game exposure compared to usual teaching (difference in mean change 1.2 (0.66 – 1.80)). The game had a SUS score of 48.5/100.

Conclusions: The eMedRec scored moderately on the SUS and increased student self-perceived competence greater than that observed during usual teaching alone.

Keywords: *Computer Game, Gamification, Medication History, Medication Reconciliation, Pharmacy Education*

Introduction

Discrepancies in patient medication history have the potential to result in inappropriate treatment choice, suboptimal quality of care, and medical and prescription errors. It has been suggested that up to 27% of all prescribing errors in hospitals result from incomplete medication documentation during admission (Steurbaut *et al*., 2010) and 20% of adverse drug events (ADEs) can be attributed to information loss or misinterpretation between health providers, particularly at transitions in patient care (Roberts, 2010; Almanasreh, Moles & Chen, 2016). Some studies have shown that up to two-thirds of medication histories contain errors (Beers, Munekata & Storrie, 1990; Lau *et al.,* 2000; Nester & Hale, 2002; Kaboli *et al*., 2004; Miller, 2008; Henneman *et al*., 2014) and it has been suggest that up to 85% of medication treatment discrepancies result from poor medication history taking (Australian Commission on Safety and Quality In Healthcare, 2016).

Medication reconciliation is "a systematic validation and verification process to ensure accuracy and continuity in the patient's medication regimen from pre-hospital care through to admission, transfer and discharge to the next setting". (Lindquist *et al*., 2008: p.998) It is considered an effective method for improving communication during transitions of care and decreasing potentially avoidable ADEs and medication errors (Duguid, 2012). To be successful, medication reconciliation requires taking a best possible medication history (BPMH) including concurrent or recent use of both prescription and non-prescription medicines and their indications (Roberts, 2010; Basey *et al*., 2014; Almanasreh *et al*., 2016), reconciliation against another source and accurate documentation (Henneman *et al*., 2014).

Medication reconciliation can be taught at any stage of a health professional's training. A systematic review of medical trainee medication reconciliation education suggested that the best methods involve a combination of didactic, role-play and experiential learning (Ramjaun *et al*., 2015). Role-playing provides students with an opportunity to practice skills in a safe environment; however, creation of sufficient practice cases for students can be time consuming and difficult. To overcome this, Sando *et al*. developed the Medication Mysteries Infinite Case Tool (MMICT). The MMICT is a three-player card-game (patient, pharmacist and observer) that randomly

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generates medication histories that can be used by students role-playing medication history taking (Sando *et al*., 2013). In the MMICT game, the student playing the patient generates a random patient medication history by rolling a dice and adding five to determine the number of drug and 'confusion' cards that need to be selected. They also develop their own patient demographic card and a personality card. The drug, confusion, demographic and personality cards are used as the basis of the role-play. The student playing the pharmacists then initiates the interview, while the observer peer-assesses the pharmacist using a marking rubric. The MMICT was shown by Sando *et al*. to increase pharmacy student skill and confidence in performing medication history interviews (Sando *et al*., 2013).

The authors describe the design and evaluation of an electronic adaptation of the MMICT to generate random medication histories for history taking role-play. The authors aimed to evaluate the game's feasibility to function as an educational tool, specifically through analysing changes in student accuracy, self-perceived competency and confidence in medication history taking, as well as its usability.

Description of innovation

The authors' electronic adaptation of the MMICT, eMedRec, required the same player roles (patient, health professional and observer) as the MMICT. Each student logged into the game on their own computer and selected their role. The student that selected to play the patient could only see the patient screen, observer the observer screen, and health professional the health professional screen. Rather than students rolling a dice and selecting cards, the patient characteristics (drugs the patient was taking and associated confusions, personality traits and demographics) were randomly selected from the game database, different cases were provided for each game played and shown on the patient screen. The observer's screen was used to record the interaction using an assessment rubric in order to provide the student playing the health professional with feedback on their performance. The authors adapted the assessment criteria to capture Australian medication history taking competencies (Competency Standards Review Steering Committee, 2010; Australian Commission on Safety and Quality In Healthcare, 2016) and concepts such as acknowledgement of potential difficulties the patient may have in accessing, administering or storing medicines. The health professional screen required the student to record the history they had taken by filling out pre-determined fields (drug, dose, frequency, *etc*.). To better simulate real-life, an additional screen and 'on-file' medication history was also included on the health professional screen. Much like in clinical practice, the on-file medication history was not always accurate, requiring the student playing the health professional to identify the discrepancy.

Unlike the tactile version of the MMICT, the electronic version did not require printing or item replacement (such as cards or dice), and cards could be updated electronically and used by students immediately. Students were able to access the game from any computer at any time, including off-campus, and play face-to-face or virtually. Feedback on accuracy of the recorded history was automatic and immediate, and students were able to view the observer and patient screens to receive additional feedback on their performance. In addition, educators were able to access game data, including the number of times each student had accessed the game, game duration, the roles each student played and data input.

Methods

Participants

The authors invited all final-year Master of Pharmacy (M.Pharm.) students at The University of Sydney to participate in the evaluation of the eMedRec game. The authors compared student changes in self-perceived confidence and competence during the intervention phase (semester two) with a historical control (changes observed in semester one) using survey data. Usability was also measured using survey data. The authors also planned to use data stored in the game database to measure educational and usability outcomes. This included measuring change in recorded medication history accuracy, and correlation between end-of-year simulated home medication review exam scores with number of times the game was played and the role played. They also planned to use number of times students accessed the game outside of tutorial time as an additional measure of usability. However, server issues were experienced throughout the study which prevented detailed game-play data collection. Therefore the authors only describe survey methods and results in this manuscript.

Historical Control

During semester one 2016, all final-year M.Pharm. students received standard teaching. This consisted of one lecture on medication history taking, weekly problem-based learning (PBL) cases, and four weeks of clinical placement during the mid-year break. During weekly cases, students worked in groups and were required to interview a simulated patient played by a tutor. Only one student from the group would conduct the interview each week.

Intervention

In semester two 2016, students were then given unlimited access to the eMedRec game over 12 weeks. Each student was required to play the game during the beginning of nine weekly tutorials in addition to usual PBL cases. Three ten-minute rounds were played during each tutorial to allow every student to experience playing the health professional, patient, and observer. Students provided verbal feedback at each tutorial and were observed for engagement level. Students were also able to access the game outside of tutorial time. Students who did not wish to participate in the evaluation of the teaching intervention were still required to use the game as part of their coursework.

Measures

Students were surveyed anonymously using self-perceived confidence (Appendix A) and competency (Appendix B) scales at three time points. Surveys were administered prior to game exposure at the beginning of semester one (time A), at the beginning of semester two (time B) and after game exposure at the end of semester two (time C). Surveys were matched by creating a unique identifier using student-provided last four digits of student ID, gender and month of birth.

Self-perceived confidence was measured using nine survey items and a six-point Likert-type response scale ('very unconfident' to 'very confident'). Self-perceived competency was measured using eleven survey items. The score measured the student's self- perceived level of competence using Miller's stages of clinical competency ('Know' to 'Does' with an additional response option of 'Unsure') in promoting and contributing to the optimal use of medicines. Each survey response: 'Unsure', 'Know', 'Know How', 'Show How' and 'Does' was given a value of 1-5 respectively. The self-perceived competency survey questions were based on the National Competency Standards for Pharmacists in Australia (Competency Standards Review Steering Committee, 2010). Both the self-perceived confidence and competence surveys Scales 1 and 2 have face and content validity, and have been used to measure changes in self-perceived confidence and competence in Australian pharmacy students (Schneider & Moles, 2016).

After game exposure (time C) also contained System Usability Scale (SUS) items and space for written comments to game usability (Appendix C). The SUS is a validated ten-item survey which uses a five-point Likert-type response scale to measure the subjective usability of software (Sauro, 2011; Peres, Pham & Phillips, 2013). It is considered robust and reliable even in small sample sizes (Brooke, 1996; Sauro & Lewis, 2012). SUS has been shown to have superior validity and sensitivity over other usability surveys including the Questionnaire for User Interaction Satisfaction and the Computer System Usability Questionnaire (Bangor, Kortum & Miller, 2008; Sauro & Lewis, 2012; Orfanou, Tselios & Katsanos, 2015). The authors added an additional item "the eMedRec game enhanced my learning during the course" to provide additional insight into the game's use in an educational context.

Analysis

All survey data were stored in MS Access, and analysed in MS Access 2016, SPSS 23 and STATA.(IBM SPSS Inc, 2015; StataCorp, 2015; Microsoft Access, 2016). The authors used the generalised estimating equations method to compare mean changes during semester one with changes during semester two and considered results statistically significant if p-value <0.05. A single number representative of the overall system usability was then calculated for each student for SUS, based on the standard SUS scoring protocol (Brooke, 1996). Content analysis of the SUS written comments was also performed using NVivo (QSR International Pty Ltd., 2015).

Ethical Approval

This project was granted approval from The Sydney University Human Research Ethics Committee (protocol number: 2015/747).

Results

Of the 66 students enrolled in the final-year M.Pharm. cohort, 64 (97%) students completed Survey 1; 64 (97%) students completed Survey 2; and 57 (86%) students completed Survey 3. Respondents to surveys were predominately female (1: 64%, 2: 66% and 3: 67%) reflecting cohort demographics (Table I). Thirty students were matched across all three surveys using the unique identifier; the results of matched surveys are presented below.

Table I: Survey demographic data

Time point	A	B	C	Matched
Female	41	42	38	20
Male	20	21	17	10
Prefer to not say	3	1	2	0
Total	64	64	57	30

The authors found statistically significant increase in matched overall student self-perceived confidence scores during semester one ($p<0.001$) but not semester two ($p=0.293$) (Table II). Mean changes observed in semester one (historical control) compared to semester two (intervention period) were not statistically different from each another ($p=0.122$). Conversely, the authors found statistically significant increase in self-perceived overall competency scores was detected during semester two ($p<0.001$), but not in semester one ($p=0.801$) (Table II).

Mean changes observed in semester one compared to semester two were statistically different (p<0.001).

The mean overall SUS score for the eMedRec games was 48.5/100 (min 2.5, max 82.5). The final item "the eMedRec game enhanced my learning during the course" scored a mean of 2.7/ 5. Content analysis of 27 student comments in the SUS identified three major themes: unmet expectations with patient information sub-theme, server issues, and interface usability (Table III).

Table II: Mean Scores in self-perceived confidence and competence and changes in matched mean scores before and after game use

Self-perception scale	Mean survey score (SD)			Change in mean (95% CI)		
	A	B	C	A v B	B v C	Difference in mean changes
Confidence	3.8 (0.69)	4.3 (0.71)	4.4 (0.62)	0.45 (0.23-0.66)	0.13 (-0.11-0.37)	-0.31 (-0.72-0.08)
Competence	2.5 (0.92)	2.4 (0.85)	3.6 (1.1)	0.06 (-0.41-0.53)	1.2 (0.85-1.5)	1.2 (0.66-1.8)

Table III: Content analysis of SUS comments section

Theme	Number	Sample quote
Unmet expectations	10	*"Game was unnecessary…*[I] *thought it was a waste of time and didn't help with my OSCE."*
Need for more patient information	10	*"This is quite a new and interesting game for a starter but still needs some points to be improved, like it can make a real case more complex one."*
Server issues	6	*"Glitches in med Rec game made it somewhat frustrating to stay on track with class."*

Discussion

The use of gamification in pharmacy education is becoming more prevalent as educators look to create novel ways to incorporate active-learning strategies to increase learning motivation, interactivity and problem solving ability in pharmacy graduates (Aburahma & Mohamed, 2015). The authors developed an electronic adaption of MMICT (Sando *et al.*, 2013) that allows students to practice their medication history taking skills using a computer-based game.

Student self-perceived confidence in medication history improved during usual teaching (semester one/ historical control) and continued to increase at a comparable rate during playing the game in semester two (intervention period). On the other hand, there was no observed increase in self-perceived competence in semester one, despite four weeks of clinical placement. Encouragingly there was a significant increase in self-perceived confidence after game exposure in semester two. This may be because the game allowed students to practice their skills repeatedly in a safe environment with automated feedback as part of their curriculum (Munshi, Lababidi & Alyousef, 2015). Evaluation of the original MMICT game also found an improvement in self-perceived confidence and 97% were considered to be competent or excellent in taking a medication a medication history. Unlike the MMICT study, the authors did not use a retrospective pre-post design, nor were they able to collect sufficient data regarding medication history accuracy.

The usability of eMedRec was also examined and received an 'OK' score of 48.5.(Bangor, Kortum & Miller, 2009) While a SUS score under 68 is considered below average, widely used software often receives low scores, including Microsoft Excel which has received an SUS score of 56 (Sauro, 2011; Kortum & Bangor, 2013). Server issues caused considerable frustration amongst students and was mentioned numerous times in student SUS feedback. Kortum and Bangor (2013) suggested that issues including server and programming problems can reduce the interactivity of any application as it is unable to perform its primary function flawlessly. Some students appear to have expected the game to provide an Objective Structured Clinical Exam (OSCE) or medication review style case to solve, rather than an opportunity to practice medication history taking; when the game did not meet these expectations, students appear to have found the game not worth-while or lacking patient information. Perhaps using the game during sand-alone BPMH taking tutorials, rather than at the beginning of each tutorial, may set clearer expectations of game purpose. In addition, scenarios could be built into the game drawn as an additional 'card' to add context and potential for problem solving.

This study has several strengths. The self-perceived confidence and competence survey instruments used in this study have face and content validity (Competency Standards Review Steering Committee, 2010; Australian Commission on Safety and Quality In Healthcare, 2016) and have been used previously in a similar educational setting (Schneider & Moles, 2016). Selection bias was likely to be minimal as game use was integrated into the curriculum and almost all students provided survey feedback. Use of a historical control further strengthens the findings and indicates that there is potential educational value-add in using an electronic game format for teaching medication history taking over traditional methods alone. However, as self-perceived surveys are subject to recall and social desirability bias, (Holbrook, 2008) students may have overestimated their competency level. As the authors were unable to collect sufficient data to compare self-perceived competency scores with actual medication history taking accuracy scores, it cannot be confirmed that changes in survey scores translated to actual increases in medication history taking competency.

Future studies should compare the relative benefits of using digital versus analogue versions of the game and effect of game use on medication history accuracy and ability to perform a best possible medication history in simulated or real-life scenarios.

Conclusion

The eMedRec game is a novel electronic adaptation of a role-playing card game that allows users to practice medication history taking. Following game exposure, the authors found the increase student self-perceived confidence to be equal to usual teaching methods and the increase in self-perceived competence to be greater than usual teaching. Further evaluation is required to confirm effect on actual competency results.

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Appendices

Appendix A

Self-Perceived Confidence Scale

Students were asked to rate their **self-perceived confidence** in communicating with a patient in order to take a medication history. They were asked to indicate how much confidence they have in doing each of the behaviours (listed below) on a 6-point Likert scale: Very unconfident (1), unconfident (2); somewhat unconfident (3); somewhat confident (4); confident (5); very confident (6).

Behaviour statements:

1. Obtain accurate information from the patient using interview techniques.
2. Assess the patient's compliance with prescribed medication regimen.
3. Identify and reconcile discrepancies between sources of information.
4. Identify potential drug related and non-drug related patient problems.
5. Distinguish between potential drug related and non-drug related patient problems.
6. Provide recommendations to the patient based on identified issues.
7. Provide recommendations to the prescriber based on identified issues.
8. Assess the effectiveness of drug therapy.
9. Identify potential adverse drug effects.

Appendix B

Self-Perceived Competence Scale

Students were provided with statements are based on the National Competency Standards Framework for Pharmacists in Australia relevant to taking a medication history taking competencies. For each statement, they were asked choose the option that best describes their level of competence using the following scale: Know: having knowledge on the topic e.g. able to answer a multiple-choice question (2), Know How: able to apply knowledge to a scenario e.g. able to answer case-based short answer question (3), Shows How: demonstrating performance in a simulated environment e.g. able to perform the skill in an oral assessment (Objective Structured Clinical Exam/ OSCE) (4), Does: work independently and consistently in real life situations e.g. able to consistency perform the skill in a work environment (5), Unsure (1).

Competency statements:

Standard 7.1 Contribute to therapeutic decision-making

1. Obtain accurate medication history
2. Assess current medication management
3. Recommend change in medication management
4. Support and assist consumer self-management

Standard 7.2 Provide ongoing medication management

5. Seek consumer support
6. Review clinical progress
7. Initiate monitoring and intervention
8. Manage medication management records

Standard 7.3 Influence patterns of medicine use

9. Understand the basis for investigating patterns of medicine use
10. Review patterns of medicine use
11. Promote improvement in patterns of medicine use

Appendix C

System Usability Scale

Students were asked to rate the eMedRec game using a 5 point Likert from strongly disagree (1) to strongly agree (5) or N/A. Students were also given space to provide written feedback.

SUS Statements:

1. I think that I would like to use the eMedRec game frequently.
2. I found the eMedRec game unnecessarily complex.
3. I thought the eMedRec application was easy to use.
4. I think that I would need the support of a technical person to be able to use the eMedRec game.
5. I found the various functions in the eMedRec game were well integrated.
6. I thought there was too much inconsistency in the eMedRec game.
7. I would imagine that most people would learn to use the eMedRec game very quickly.
8. I found the eMedRec game very cumbersome to use.
9. I felt very confident using the eMedRec game.
10. I needed to learn a lot of things before I could get going with the eMedRec game.
11. The eMedRec game enhanced my learning during the course.