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The Efficacy of Digital Case Scenario Versus Paper Case Scenario On Clinical Reasoning in Problem-Based Learning: A Systematic Review and Meta-Analysis

Vahideh Zarea Gavvani¹, Hakimeh Hazrati^{2*}, Morteza Ghojzadeh³

¹ Health Services Management Research Center, National Public Health Management Center (NPMC), Tabriz University of Medical Sciences, Tabriz, Iran

² Medical Education Research Center, Education Development Center (EDC), Tabriz University of Medical Sciences, Tabriz, Iran

³ Liver and Gastrointestinal Diseases Research Center, Tabriz University of Medical Sciences, Tabriz, Iran

Article info

Article Type:

Systematic Review

Article History:

Received: 26 Jan 2015

Accepted: 31 May 2015

ePublished: 4 July 2015

Keywords:

Digital Case Scenario,
Paper Case Scenario,
Problem-Based Learning

Abstract

Introduction: In medical and clinical education, creating critical thinking and promoting clinical reasoning abilities are the highest aims and results of education. The main aim of this study was to assess the efficacy of digital case scenarios versus print/paper case scenarios on clinical reasoning in problem-based learning (PBL). If a study used the multimedia scenario case interventions, video case scenarios and online-guided scenarios as digital case PBL, we would consider it eligible.

Methods: The study was a systematic review and meta-analysis. A comprehensive search for all randomized controlled trials, systematic reviews and meta-analyses for digital case scenarios versus paper case scenarios in PBL were conducted using Medline (Ovid), Scopus, ISI Web of Science and CINAHL. Google Scholar was used to follow the bibliographies of the related papers to create an exhaustive data set. Search results were limited to the years 2003-2013.

Results: Our searches yielded 65 hits. After initial screenings of the titles and abstracts, we assessed the full texts of studies. Five eligible studies with 222 students were included in the meta-analysis. The meta-analysis showed that both of the digital and paper-based scenarios have similar impacts on clinical reasoning. But the review of papers showed that 73% of students are more satisfied with digital scenarios in comparison with paper-based scenarios and found that digital scenarios are 90% more time saving than paper-based scenarios.

Conclusion: According to the results of meta-analysis, efficacy of digital-based scenarios is similar to the efficacy of paper-based scenarios while simultaneously creating more satisfaction and saving the time of students and teachers; therefore, it is suggested that electronic PBL be used rather than paper-based in all levels of medical education.

Introduction

The inclination to use digital media based on communicative and informative technology in education is growing. In medical and clinical education, creating critical thinking and promoting clinical reasoning abilities are the highest aims and results of education. Rogers et al. argue this environment can appear "overwhelming" and threatening to juniors because of the serious nature of many patients' clinical condition and the perceived ease by which they could be compromised.¹ Therefore, a moulage scenario allows students to apply their knowledge to the management of critical events and, although it is simulated, it provides training for an episode that students

may be hesitant to experience for the first time with real patients. Critical care environments offer a unique learning environment for healthcare practitioners because they allow them to apply cognitive skills gained during pre-clinical courses, such as physiology and pharmacology, directly toward taking care of patients.² The medium of presenting information, educational tools and educational methods all have an effect on critical thinking. A problem-based method is one of the effective ways to promote clinical reasoning ability.³ Joe described the outcomes of PBL as a teaching method for 24 nursing students, finding that PBL encouraged students to think critically and take large

*Corresponding authors: Hakimeh Hazrati, Email: hakimeh.hazrati@gmail.com

amounts of information and synthesize that information for presentation back to their group.⁴ Twenty-six novice nurses were assessed after an 18-week PBL program, and the best features of PBL included group participation, self-directed learning, interacting with various individuals and recognizing how to apply critical thinking skills.⁵ In mainland China, PBL was used in clinical nursing education classrooms. Students indicated that PBL assisted them in gaining a deeper understanding and memorizing the knowledge and enhanced their abilities of self-directed learning, critical thinking and group cooperation.⁶ There is no evidence on the efficacy or efficiency of one of the methods of presenting paper-based or electronic-based or multi-media scenarios. Furthermore, the type of medium in presenting scenarios can have an influence on the time of presenting, education, costs and attractiveness of lessons. The objective of this systematic review of all available randomized controlled trials was to determine if digital case scenarios have a larger impact than the paper-based scenarios on clinical reasoning abilities when the lesson is performed with PBL. It was assumed that digital case scenarios may be more effective in promoting clinical reasoning, saving time and creating satisfaction among learners and lecturers.

Primary outcome measure: The efficacy of digital case scenarios versus print/paper-based case scenarios on clinical reasoning in problem-based learning

Secondary outcomes: Time and satisfaction

The primary aim of this study is to assess the efficacy of digital case scenarios versus print/paper case scenarios on clinical reasoning in problem-based learning (PBL).

Materials and Methods

Study Design: A systematic review and meta-analysis of randomized controlled trial studies

Inclusion Criteria

We included randomized controlled trial studies concerning digital case scenario intervention versus paper-based scenarios in medical education using PBL. All the studies with non-randomized control design and non-digital scenario intervention were excluded. If the study used multimedia scenario case interventions, video case scenarios and online-guided scenarios for digital case PBL, it was considered eligible and was included in the study. We limited the study to English language studies within the 10-year period from 2003 to 2013.

Search strategy

Appropriate search strategies were applied through each selected database to perform a comprehensive and accurate search. *Medline (Ovid)*, *Scopus*, *CINAHL* and *ISI Web of Science* were searched for RCT studies from 2003 to 2013. We also ran a manual search through Google Scholar to cover the related studies from the bibliographies of the selected articles.

The following textual terms and MeSH headings were used according to PICO. "Problem solving" was excluded from the results.

Patient/Problem: problem based learning, medical education

Intervention: digital case, multi media case, electronic case, online case

Comparison: paper based case

Outcomes: critical thinking, clinical reasoning, think, satisfaction, time saving

Review method: Two reviewers systematically reviewed the eligible papers through three phases: 1) reading the title and abstract to assess the tentative eligibility, 2) reading the full text to interpret and select the eligible papers, 3) assessing the interpretation despite the inclusion of studies with vague objectives, methods or reporting.

Selecting the studies

All identified articles were entered in article management software and the duplicates were eliminated. Then, two reviewers (medical information specialists) independently screened the citations from the literature search for eligibility, or titles that appeared potentially relevant to the study area. Two reviewers independently reviewed and assessed abstracts against three criteria to determine if 1) the study was a randomized controlled trial; 2) it was performed in medical education; 3) it was not a problem-solving method. If reviewers faced disagreement about the eligibility of a study, they would discuss it together. Full papers were retrieved if both investigators considered the abstract suitable. Our searches yielded 65 hits. After initial screenings of the titles and abstracts, we assessed the full-texts of studies; 5 eligible studies were included in the meta-analysis (Figure 1).

Quality appraisal

We used CASP to appraise the quality of papers when it was applicable. And the PRISMA flow was followed in selection and inclusion of data.

Data extraction

The authors extracted the quantitative results of students' critical thinking, including 3 stages of searching information, theorizing and analyzing.

Data Analysis

This study focused on the effects of digital case scenarios versus print/paper-based case scenarios on clinical reasoning in problem-based learning and was done in a two qualitative equation format: effects of digital case scenarios on clinical reasoning in problem-based learning and effects of print/paper case scenarios on clinical reasoning in problem-based learning. We compared the effectiveness of two methods then we entered data to CAM 2.1 software. Comparing the effectiveness of two methods had a comparison ratio and calculated odds ratio with a 95% confidence interval.

Analysis

The primary analysis was done with random effects models. A funnel plot of all included trials was used to check for publication bias. The log odds ratio and 95%

confidence interval was computed and the chi-square test for heterogeneity was used to test for the assumption of a fixed effects model. All the statistical reports were changed to percentages to create consistency in analysis of different data.

Ethical Considerations

According to the type of study i.e. Meta-Analysis, there was no need to state the ethical statement, however ethical issues related to the use of retrieval documents have been considered in this study.

Results

Five RCT studies met our criteria to be included in the review. In the data analysis, 222 students from health (80 students) and medical sciences (142 students) fields (5 systematic reviews) were included in the meta-analysis. The geographic locations of 4 studies was Europe and the US and one study was done in Asia (China). The range of date for included studies was from the years 2005 to 2011 (Table 1).

There was no publication bias in the selection based on the funnel plot and log odds ratio (Figure 2) and all of the five RCTs were hetrogen of studies $Q=1.25, df=4, p=0.08$ Despite the differences in the effects of paper case scenarios

and digital case scenarios on the meta-reasoning of learners (students) that was reported in the different studies, our meta-analysis showed no significant difference between these two tools. The result of meta-analysis indicated the effect of both digital-based scenarios and paper-based scenarios are similar and no difference was found by the random test [OR=1.24 95% cI (0.57-2.68) $P=0.58 z=0.54$] (Figure 3). In other words, PBL is effective in clinical reasoning independent of whether the scenario is in paper or digital form.

Secondary outcomes: Time and satisfaction of learners

Level of satisfaction as the secondary outcome of study

In all 5 studies, the level of satisfaction in using digital and non-paper environments for supporting problem-based learning was greater.

It seems that the designed scenarios in digital environments are more attractive, stimulate learning and lead to active learning in students. Also, they give visual information about scenarios to students and facilitate information searching. Elio declared that there is a limitation of communicative skills about real patients and it may not be ethically true for some individuals to work on one patient. The simulated environments reduce the communicative limitations of a real environment. Rebecca Maldonado

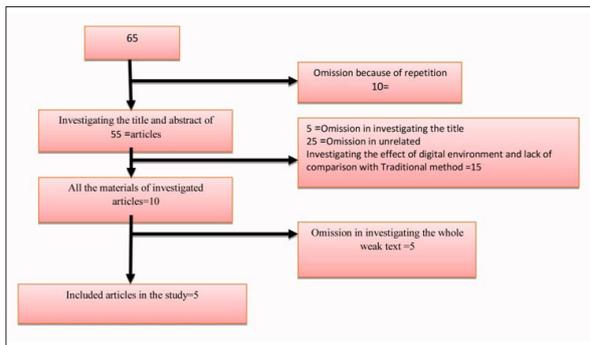


Figure 1. Flow diagram of study selection, assessment and inclusion in analysis

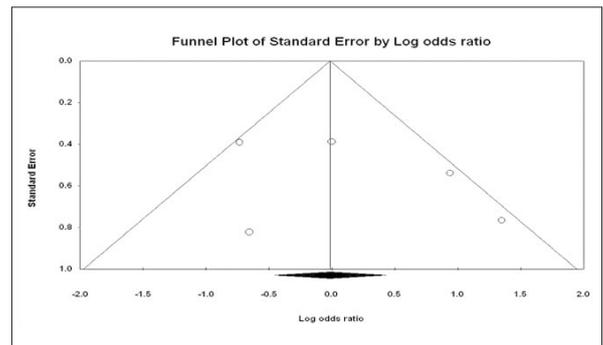
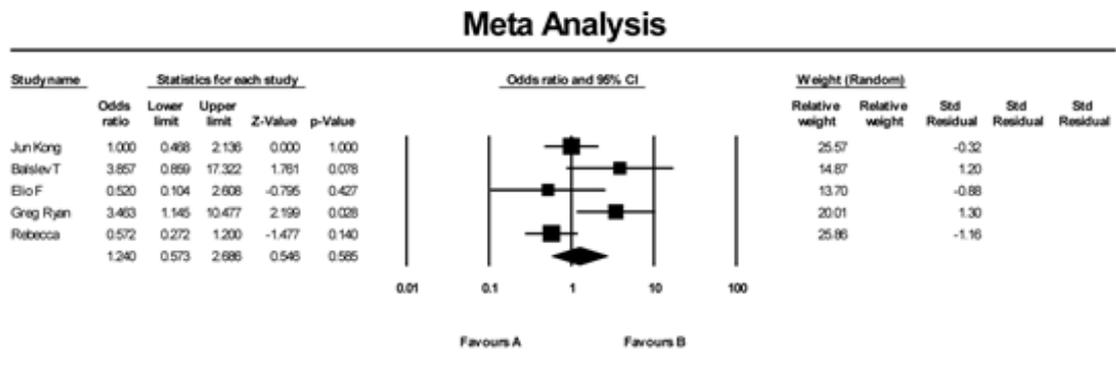


Figure 2. Standard error in the selected studies by log odds ratio



Meta Analysis

Figure 3. Effect of intervention in clinical reasoning

Table 1. Key Features of Included Studies

Author (year)	Sample	Setting	Outcome 1: reasoning	Outcome 2: satisfaction	Outcome 3: saving time
Jun Kong ⁷	N=60	Department of Ophthalmology, China Medical University	The 2 PBL classes had significantly higher mean results of theoretical and case analysis examinations ($P<.001$),but there was no significant difference ($P = .86$) between the 2 PBL classes.	Their teaching model was greater in the PBL group using either digital (93%, 28 of 30) or paper-based scenarios (90%, 27 of 30) oup stated that the cases stimulated their interest, a percentage that was much higher than that of the paper case group (73%, 22 of 30).	Learned the ophthalmic examination in a shorter amount of time.
Balslev T ⁸	N=12	Denmark- Aarhus University	Meta-reasoning was lower after the video case intervention compared with the text case intervention. ($X^2=13.6$;DF=1; $P=<0/001$)	The video recording showed posture and/or movements better than a text would be able to do	Residents spending more time analyzing the video case than the text case suggest that different cognitive processes may be involved
Elio F ⁹	18	California State University, Northridge, CA	Students participating in the traditional project reported a higher adjusted mean cognitive learning score of 7.9 compared with students who participated in the simulation project, who had a lower adjusted mean score of 6.9 ($p=0.03$). Although the study showed using this approach, students participating in the traditional project produced a lower unadjusted mean score of 73.1% compared with 85.5% for students participating in the simulation project ($p=0.03$).	Indicated that students found the simulation to be interesting and potentially motivating. Student feedback included recommendations that collaborative work tools be included, as well as a greater degree of interaction between students and simulation characters	The ability to facilitate collaborative group work around a virtual, yet realistic, problem may provide an important means to offer constructivist public health training opportunities in a global environment by transcending constraints related to time and space.
Greg Ryan ¹⁰	52	University of Sydney, Sydney, Australia	The mean rating by students of the extent to which the online guide reflected the diagnostic reasoning of hospital clinicians was 7.75 (range 6.0–9.5).The mean rating by clinical tutors was 7.16 (range 6.0–8.0).	End-of-year questionnaire evaluation data have consistently shown that the majority of students have been satisfied with the overall process	
Rebecca Maldonado ¹¹	39+41	University of Colorado	The clinical reasoning score between cohorts increased 12% with the increased use of multimedia clinical case scenario software. The PBL course had statistically higher clinical reasoning scores than the students who completed primarily text-based PBL cases ($P < 0.0001$)	Facilitation was exclusively by student request, indicates a statistically significant ($P < 0.0001$) reduction in faculty time over traditional text-based PBL	A quantitative analysis of faculty time commitment was performed comparing the cohorts using a paired t-test. The savings in faculty facilitator time was 41% using the blended curriculum of text-based cases and multimedia cases. This time savings could potentially rise to 92% using multimedia cases exclusively

stated that applying facilitators to digital environments is better and students can have access to facilitators in digital environments any time that they want.

Time saving: Applying digital environments can overcome the place and time limitations and allow students and teachers to save time. The study by Rebecca Maldonado showed that when digital environments are used in conjunction with paper-based scenarios, teachers save 40% more time, but when just digital environments are used, teachers save 90% more time.¹² Balslev has compared groups' scenario analysis considering time and concluded that the time spent by the students on digital scenarios was more than the time spent by students on paper scenarios. Perhaps the reason was because of the change in students' cognition.

Discussion

The primary outcome of this systematic review was to determine if digital case scenarios have a larger impact than paper-based scenarios on clinical reasoning abilities when the lesson is performed with PBL. According to the results of the meta-analysis, there is no significant difference between using digital clinical scenarios and paper-based scenarios in promoting students' clinical reasoning, although the studies showed some differences in some stages of critical thinking with paper-based scenarios. There is no agreement about this in previous studies, as some media concluded that digital environments cause primary promotion in critical thinking and help students in searching sources and theorizing. However, it was found that they do not promote students' critical thinking. That is, digital environments help in primary stages of investigating scenarios. In fact, it was found in those studies that they facilitate primary stages of PBL, but students' clinical reasoning after applying digital media was lower than in the traditional format.^{7,8,9} Another study, which was carried out in Australia, showed that electronic media promote students' critical thinking,^{10,11} while Ghanch declared that paper-based methods promote students' critical thinking and 90% of students prefer the traditional method. Paper-based scenarios are interesting and help group discussions and also increase students' communicative skills in comparison with digital scenarios.¹³

The secondary outcome of this systematic review was the learners' satisfaction of electronic media and its effect in saving time. This study showed that, altogether, most learners were satisfied with digital environments and considered it more time-saving than the traditional method.^{10,11} This study also showed that the digital method promotes students' interaction in small groups and makes clinical cases more attractive. The digital method provides students with active and interesting environments, provides easy access to informational sources and helps adults with independent learning. Also, it was found that students can have informational exchanges with their peers,^{9,14,15} while in the study by Vahidi, the teachers' inclination and time were the obstacles of performing PBL in Iran.¹⁶

Conclusion

Based on the systematic review and meta-analysis in this study, it is concluded that both digital and paper-based scenarios are equally effective in promoting clinical reasoning and critical thinking of medical science students and there is no statistically significant difference between their outcomes. But when the other factors like time and satisfaction are considered in the selection of scenarios, the digital case scenario is suggested when performing PBL. This study also suggests using the digital form scenario in performing PBL in Iran to eliminate barriers such as lack of satisfaction in tutors and being time consuming.¹⁶

Limitations

We focused on medical databases like Medline (Ovid), Scopus, CINAHL and ISI Web of Science, but not the database ERIC. This may be considered as limitation for this paper.

Competing interests

The authors declare that there is no conflict of interest.

Acknowledgement

This study was funded by the Education Development Center (EDC) of Tabriz University of Medical Sciences, Iran.

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