Designing a serious game about critical appraisal of medical literature for pregraduate students

Conception d'un jeu sérieux centré sur la lecture critique d'articles médicaux pour des étudiants pré-gradués

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RÉSUMÉ

La lecture critique d'un article médical est une étape cruciale dans la pratique de la médecine basée sur les faits, spécialement pour les étudiants pré-gradués qui se posent beaucoup plus de questions concernant les maladies que concernant la prise en charge des patients. L'utilisation des jeux sérieux semble être attractive afin de joindre un objectif important, qui est celui de la prise en charge des malades, et un jeu. Les auteurs ont décrit leur approche dans le cadre du développement et de la création, sans l'aide d'un informaticien, d'un jeu sérieux dédié aux étudiants en DCEM1 des études médicales. Toutes les étapes de création ont été décrites. De plus, une étude pilote ralliant une analyse de satisfaction, basée sur un questionnaire type-likert et un process de "pensée à voix haute", et une évaluation de l'amélioration des connaissances cognitives des étudiants a été menée

Mots-clés: jeux sérieux, lecture critique d'un article médical, médecine

SUMMARY

Critical appraisal of medical literature is a crucial step in the evidence-based-medicine practice, especially for pregraduate medical students who used to deal more with background questions than with patients' health problems. Using serious games seems to be attractive in order to link between a serious purpose, which is handling a health problem and gaming. The authors aimed to describe the process they adopted in order to develop, without a game developer, a serious game dedicated to third-year-medical students. All the steps of the process design were described. Besides, they performed a pilot study in order to assess the students' satisfaction using a think aloud process and a likert-scale questionnaire and aimed to evaluate the effectiveness of the process by comparing pre and post-tests scores.

Key-words: serious game, critical appraisal of medical literature, medical education

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INTRODUCTION

critical appraisal of medical literature represents a key step in the evidence-based medicine practice. It follows the formulation of the research question and the literature research steps. This step is crucial, time consuming for tutors and hard achieving for medical students. It has been introduced early in the curriculum of many medical universities but it seems to be challenging and not motivating for pregraduate medical students. In order to increase the interest of the students to the critical appraisal practice, we tried to design a patient-centred serious game. Serious games have been introduced in the medical education in the last decade with many games validated according to their effectiveness and to the importance of the students' interest and motivation (1-4). The association of a serious purpose with a gaming environment defines them. The pedagogical approaches mainly used were the behaviourist and cognitivist approaches. Those approaches were integrated into the active pedagogy in which the students play a central role into their learning. According to these approaches, the different links established by the students between the different learning concepts play an important role into their learning process (5). The authors aimed to report an experience about designing a serious game about critical appraisal of medical literature and targeted to assess its effectiveness and the satisfaction of a pool of students included into a pilot study

METHODS

in this section, the authors describe the population of students tutored, the general learning process in which the serious game was included and the study scheme. All study procedures complied with institutional ethical standards for human subject research and with the Helsinki Declaration.

Population

Since 2013, 17 students in the third year of medical training are received in the Department of Pathology. The faculty of medicine board assigned the students randomly. The training period lasts three weeks according to the university's recommendations.

Inclusion criteria

Students who agreed to play the game were included in the present study.

General learning process

As students weren't used to critical appraisal practice, the different steps of the evidence-based-practice (EBP) were planned during the third week of training as mentioned in table 1. Different learning methods were used to implement the principles of EBP including lectures. The last days of training were dedicated to the presentation of the serious game to the student and they were asked to play the game after giving their consent.

Table 1. structure of the evidence-based-medicine learning during the third week of training

Day 1: 3-hour-session	-Pretest -Introduction to evidence-based-medicine, phrasing questions and the different types of publications (Lectures and conferences)
Day 2: 2-hour-session	-Searching the literature
Day 3: 2-hour-session	-Introduction to critical appraisal and study design (lecture)
Day 4: 3-hour session	-Critical appraisal of a meta-analysis about a diagnostic test (lecture).
Day 5: 3-hour-voluntary-session	-Serious game -Think Aloud process
Day 6	-Likert-scale questionnaire -Posttest

Research hypothesis

The authors hypothesized that gaming can offer an adequate environment of learning to medical students in order to perform a critical appraisal of medical literature and could reinforce the factual knowledge received prior to the use of the game.

Study scheme

This was a prospective and descriptive study performed during a 1-year-period

Primary evaluation criteria

- The effectiveness of the game was assessed using pre and post-tests. Statistical tests used to compare the scores between pre and post-tests consisted in a Student

test with alpha levels set at 0.05. The authors used SPSS software (version 21.0).

- The students' satisfaction was assessed using a Think Aloud protocol and a likert-scale questionnaire containing 11 likert-scale questions about the organization and the scenario, the degree of scientific interest and the pedagogical value of the game. Every suggestion was scored from 1 to 4. During the Think Aloud protocol, the tutor (MM) tried to introduce the game, its purpose and to make the students as relaxed as possible. All their thinkings and comments were recorded. Three rounds were conducted over 12 months and each session lasted 1 hour. The students' comments and thinking concerned bugs, the design elements used and the interface elements. The game was improved after every round. The tutor helped also some students with some elements of the interface because they weren't used to digital interface.

Wireframes: the authors choose a simulation-based serious game with design elements consisting in avatars, scores and explanations. This game was performed using itystudio platform. The different scenes took place into a medical consultation. The students (players) have to choose the doctor's avatar. Three competences were evaluated: announcing bad news, the critical appraisal of a case report and the critical appraisal of recommendations. Every competency was scored and the player received the final scores represented into 3 axes in the end of the game. The scenario established to perform the game is represented in figure 1.

Prototype: a prototype was performed by the authors using the software after a 2-month period of self-training. Some illustrations of the game are represented in figure 2.

Iterative prototype: the authors and some students volunteers met three times to assess the usability of the game. Critical problems about bugs, content and spelling errors and scoring mistakes were fixed.

RESULTS

In order to design the game, the authors used a three-phase method reported by Olszewski, et al (6).

Preparation and design

**Team assembly:* the authors developed a schedule including frequent meetings and shared the different roles of finding the appropriate and costless software, thinking about the pedagogical scenarios, the assessment and the scoring system. No game developers were included because they were resource consuming.

**Medical Concepts:* the authors agreed to perform a patient-centred serious game and established a realistic scenario in order to include the approach of critical appraisal into a realistic health problem. The authors agreed that the students in the third-year of education had never red medical articles and had no idea about the different types of articles or the manner to deal with them. So that, they supposed, after free discussion with some

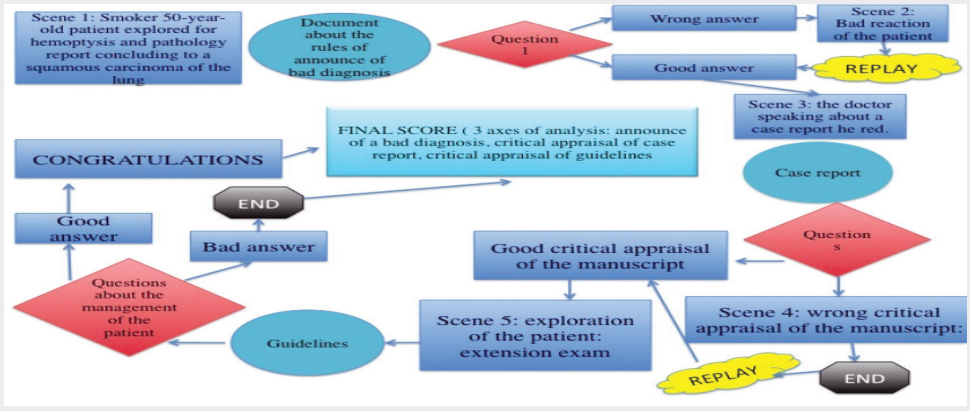

Figure 1. the scenario used into the serious game

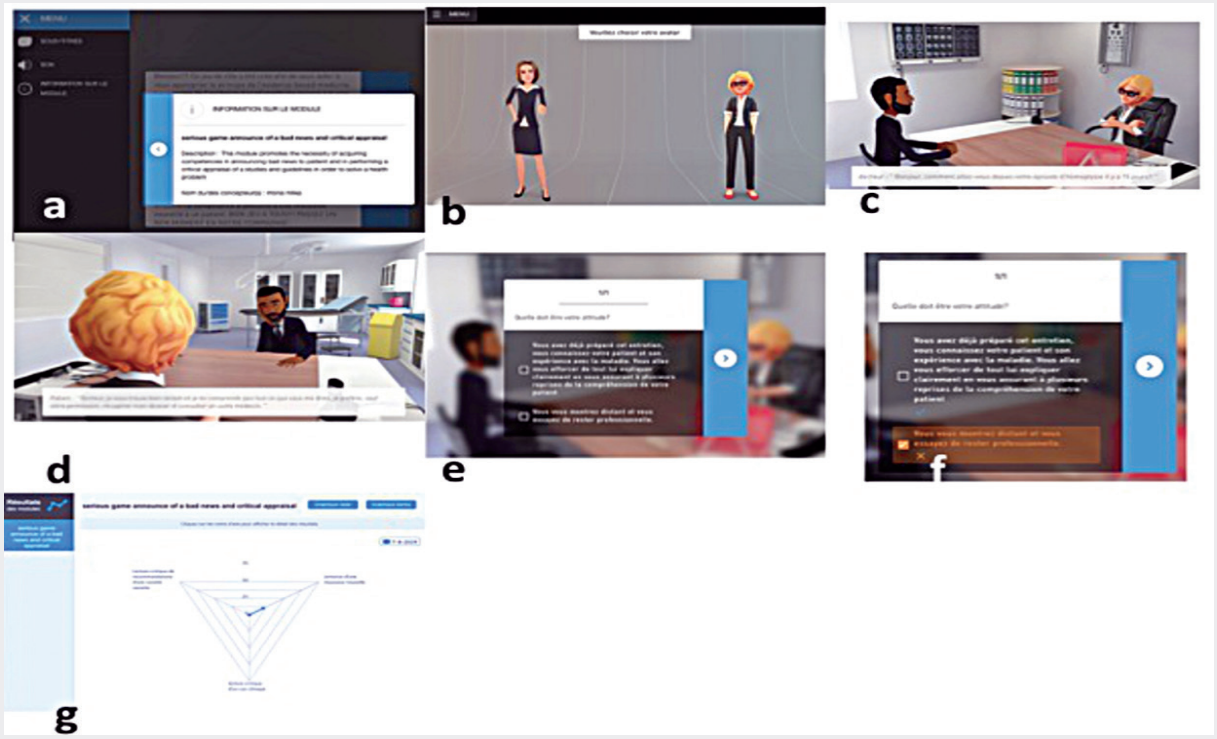

Figure 2: some screen casts of the serious game including a/the interface of the game presenting its purpose, b/ the avatars of the doctors that could be chosen, c/ screen cast of the game background consisting in a medical consultation, d/ screencast of the game showing the patient' behaviour when the player makes a bad decision based on the critical appraisal of an article, e/ an example of a multiple-choice-question asked, f/ a screencast showing a bad answer given by the students and the good answer highlighted, g/ a screen cast showing the scoring of the student according to the three axes of evaluation which are the announce of a bad news, the critical appraisal of a case report and the critical appraisal of recommendations.

students, that they needed to learn critical appraisal of case reports and guidelines. For that purpose, 2 articles centred on the same topic « lung cancer » were chosen. Then, a realistic scenario was performed.

**Content production:* the scenario performed was a 50-year-old-patient visiting his family doctor to explore an episode of haemoptysis. This episode was explored and the medical doctor had to announce the diagnosis of lung cancer to his patient. In order to explain the disease to the patient and to prepare him to the future investigations and to the treatment modalities, the doctor had to deal with a case report about a spontaneous regression of a lung cancer then recommendations of the ESMO (7, 8). With every article downloaded by the student, a series of questions were asked and scored. When the students gave the good answers, the game continued and if they failed the game was over. Every student had the opportunity to repeat the game. This step took three months to be fulfilled.

Development

The game was also made available through the Department site link: https://sites.google.com/a/fmt.utm.tn/externes-services-d-anatomie-pathologique-prof-mezni/. The major characteristics of the game are represented in Table 2.

Formative evaluation

**Usability testing:* ten female students and 3 men were enrolled. Four students were excluded because they didn't fulfil the satisfaction questionnaire and the post-test. The mean age of the participants was 21 years. Concerning the satisfaction questionnaire, 10/13 students coted the different likert-based questions with score 3 or 4. Three students coted the use of serious game using the scale 2 and 3 for the different other items. The highest scores were attributed to the improvement of the relation tutor-learner, the critical appraisal skills and the motivation by the serious game. Besides, the majority of the students

expressed their willing to share the experience with peers. Table 3 illustrates the results of the satisfaction questionnaire.

**Efficiency of the serious game:* the pre test score mean reached 4.6 (SD=1.34) versus 6.65 for post-test (SD: 1.41). There was a significant difference between the means scores of pre-tests and post-tests (t=-4.87, p=0.00).

Table 2. Characteristics of the game

General information	
Health topic	Lung cancer
Targeted students	Third-year-medical students
Short description of game idea	The game aims to train students with the rules of communicating bad news to patients and the practice of critical appraisal of medical literature in order to solve medical problems
Pedagogy approach	Cognitivism and behaviourism
Intended health behaviour changes	Players will improve their skills of communication with patients and will practice critical appraisal which will lead to improved patients' problems management
Learning objectives	- Communicating bad news adequately to patients - Perform a critical appraisal of case reports and recommendations
Assessment	Students are evaluated using multi-choice questions. Assessment involves the communication of bad news to patients, critical appraisal of case reports and critical appraisal of recommendations
Type of game	Simulation Active Educational
Story	
Synopsis	The story follows a 50-year-old patient consulting his family doctor for an episode of haemoptysis. The player meets the patient, has to announce the results of the diagnostic exams and to make decisions about the therapeutic management according to the literature review.
Virtual environment	
Setting	The game takes place into the doctor's consultation
Avatar	The players have to choose between 2 avatars
Game platforms needed to play	Tablet Computer
Estimated play time	1 hour

Table 3: satisfaction questionnaire scores

	Mean (SD)
The serious game (SG) has a realistic environment	15.09+/-1.1
I felt immersed in the SG environment	20.03+/-1.09
The design elements were adequate	30.13+/-1.3
The scenario used was realistic and motivating	40.14+/-1.04
The SG enhanced the learner-tutor interaction	42.2+/-1.16
The SG helped me to improve my communication skills when announcing bad news to patients	15.09+/-1.14
The SG helped me to improve my skills in critical appraisal of medical literature	45.13+/-0.97
SG enhanced my learning motivation	45.24+/-0.5
SG enhanced my learning interest	45.31+/-1.5
SG enhanced my problem-solving capability	20.4+/-1.2
I would like to share this learning experience with other learners	46.09+/-1.14

DISCUSSION

This study reports a simulation-based serious game about critical appraisal of medical literature. The game was created by the tutors using a costless software and was a scenario-based game. Performing a serious game was justified by the lack of students' motivation when dealing with critical appraisal of medical literature. This game reinforced a lecture-based learning delivered during a one-week period. During this week, the students were introduced to the elementary principles of evidence-based-practice and to the major article types. The serious games allowed them to contextualize their knowledge into a realistic competency, which is solving a medical problem. The scenario used by the authors was adapted to the period of internship, in which the students were asked to achieve a list of objectives centred on many diseases including lung cancer. The types of articles used including case report and guidelines were chosen because the students included in the authors' university weren't used to critical appraisal practice and faced for the first time such a kind of learning that's why the authors didn't use systematic reviews or meta-analyses. The think aloud practice and

the likert-scale questionnaire highlighted the motivation and the satisfaction of the students when using these kinds of games. Besides, the significant difference between pre-tests means and post-tests means reveals the short-term efficiency of these games. Serious games have been used in many specialties including surgery, rheumatology, family medicine and concerned also evidence-based-medicine (1-5, 9-15). They were also used for patient education and for improving empathy (10, 13). Many meta-analyses and reviews have been reported in the English literature and focused mainly on the satisfaction of the students when using serious games and rarely on the efficiency of these games (16-18). This fact could be explained by the heterogeneity of serious games and the different scoring methods of learning used. Besides, many games reported only short-term effects. These meta-analyses and reviews revealed that before 2013, the majority of serious games weren't consensual with blurred design and purposes. Since 2013, the authors made their goals clearer and the assessment tools more consensual. The majority of the meta-analyses put emphasis on the variable types of the serious games reported in the literature. They could be categorized into educative games aiming to reach pedagogical goals, persuasive games aiming to change behaviour, thinking and health game in order to help people heal. The majority of the games used were made available by game developers and the free games were rare (19-21). In this study, the tutors tried to develop the game by themselves. This step is the most challenging for many tutors that are less accustomed to digital learning than their students. Development of serious games is very important and pedagogical scenario seems to be as important as the design elements used. In a meta-analysis, Maheu-Cadotte et al. reported the positive effect on students' motivation of design elements, which consist in avatars, badges for achievement, hints, plots or time pressure (22). Some authors reported that the lack of use of serious games in medical education could be explained by the lack of knowledge of these technologies by the tutors. Making the students participate to the construction of their own game can solve this problem. In fact, the pedagogical strategy of almost all serious games reported in the literature is based on behaviourist or cognitivist approaches. The former is based on the analysis of the learner's behaviours and the latter is based on the analysis of the mind mapping made by the students. Some authors reported the necessity of introducing a new paradigm in serious games, which is the constructionism. The constructionism urges the students to construct their own game according to their pedagogical goals. Some authors compared the serious games use to traditional method use and reported an equal effect (15). In this experience, the serious games consolidated a face-to-face learning and were used to the formative assessment. The scenario used by the authors was realistic in accordance to many recommendations in the literature. The process of creating a serious game is time-consuming and necessitates thinking about the objectives of the process, then the establishment of the game. The experience described by the authors focused on the design steps of the game which were inspired by Olszewski, et al (6). Few authors have focused on the process of design of serious games. The majority of the authors focused on the game more than on the methods used to create it (12). Thomas TH, et al reported a six-step design process made of an open pilot study, serious game development by professionals, expert panel meeting, game learning and behavioural objectives, game content and flow, game play testing and a study of the acceptability of the prototype (10). More studies about the process of creating a serious game seem to be necessary in order to facilitate the dissemination of the approach of learning while gaming. This can enhance tutor to use the games, even if in a systematic review about serious games, Gorbanev I, et al. reported that tutors didn't demand to use sophisticated games and continue to prefer simulations and quizzes with skill development through repetition (16). The major limitation of this study is that the efficiency of this game has to be proved using a randomized trial comparing an intervention group and a conventional one.

This study highlights that serious games are able to enhance the learning process and seem to be motivating for medical students. Besides, it puts emphasis on the possibility of creating a serious game centred on critical appraisal of medical literature by medical tutors without an engineer developer and using an easy software.

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