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Serious game based on Clinical cases: A multidisciplinary Approach for Self-assessment in Dental Education

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Abstract.

Serious games have taken up an important place in the field of health. The aim of this work was to design and to develop a serious game for students in Dental Education.

The interest is to perform a multidisciplinary approach of patients. Several clinical cases are available online and each of them concerns patients treated by students in Dental Hospitals. After choosing the e-patient, the serious gamer progresses in the game step by step. The game-play simulates the similar methodology as a dental practitioner in clinical reality. E-learners have to make a diagnosis in a limited time. Finally, the goal is to treat the e-patient deciding the ideal treatment plan.

The collaborative network between students and teacher(s) achieves an interactive learning and improves the quality of undergraduate Dental Education. The perspective is to promulgate dental education and to train young practitioners giving better dental care to patients after dental studies.

Keywords: serious game, dental education, self-assessment, clinical case reports, multidisciplinary approach.

1. Objectives

1.1. Context

The evolution of numeric technologies is a true revolution in health professions, particularly in oral health care. Besides, learning-play and role-play games are recognized as an efficient teaching method [1]. For years, video games have invaded our daily life and serious games have taken place in all the fields [2], and especially in Health Education [3].

Nowadays, Internet is everywhere and can no longer be ignored in Dental Education [4-5]. Indeed, prosthesis e-learning is possible thanks to web-campus pre-clinical and clinical assisting teaching (fig.1).



Fig. 1. Pre-clinical and clinical Dental Education in (a) Faculty of Odontology with simulator and (b) Dental Hospital with patient.

Our experience shows that blended learning is better than singular learning whatever the student's level [6-7]. The online and remote learning increase self-training, self-assessment, and knowledge acquisition [8]. The concept is based on pedagogic learning paths in dental virtual courses [9]. Information and Communication Technologies (ICT) are used as word documents, PowerPoint files, photos, images in 3D, videos, recorded audio tapes, podcasts, and rich media (fig.2).

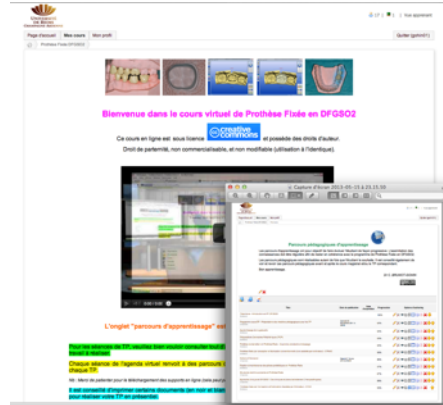


Fig.2. Online-learning in Odontology – Virtual course of Fixed Prosthesis in undergraduate Dental Education [7].

The final goal is to develop the e-pedagogy integrating dental serious games in virtual courses [10].

1.2. Motivation

To date, serious health games have taken up an important place in oral medicine [1] and in dental training [5-9-10].

According to this pedagogical dynamic, the motivation is to develop a multidisciplinary approach of the patient, to perform prosthesis assessment, and to show the interest of a global treatment plan in Dental Education (fig.3).

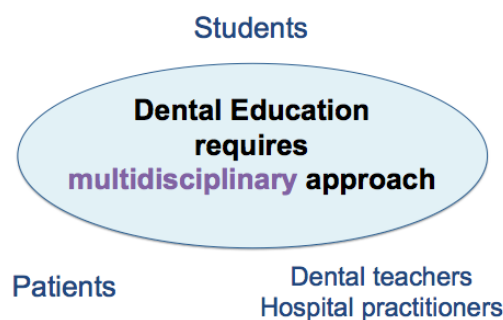


Fig.3. Multidisciplinary approach of patients by students and hospital practitioners in Dental Education.

The perspective is to promulgate Dental Education based on simulation taking into account the ethical imperatives when a treatment is proposed to the patient [11].

To perform an interactive work, each clinical case of this serious game was treated by dental students in the Polyclinic Department (Dental Hospital in Reims).

2. Serious game design and development

2.1. Initial list of functionalities

From a functional point of view, the main idea is to allow the player (student and future practitioners) to examine and solve many cases in successive manners. For each case, the player will have to follow the classical path of a case study [12], i.e.:

- ⤴ make the diagnosis (questioning of the patient, examination, etc.),
- ⤴ achieve a prognosis,
- ⤴ finalyse a treatment plan.

As far as the diagnosis is concerned the game will have to take into account the variety of information one can collect during the diagnosis: text answers to practitioner's questions, pictures, sounds, radiographs, videos, text documents. Furthermore, diagnosis and therapeutic choices are totally determined by the serious gamer. The e-learner evolves in the game step by step thanks to various questions to validate acquisition of scientific data and clinical knowledge.

A web page displays the player's progression along the different cases that have to be studied. Another important functionality is related to the edition of new cases or the updating of old ones. This task has to be as user-friendliest as possible, for domain experts may not have strong IT skills.

From a technical point of view, in order to assure a broad use, game and editor should be web-based. Moreover, in order to achieve multiplatform use (laptops, tablets, smartphones) the technology should be HTML5.

Consolidated budget is here limited to a few thousands euros.

2.2. Data model

The picture below depicts the data structure of the game engine (fig.4).

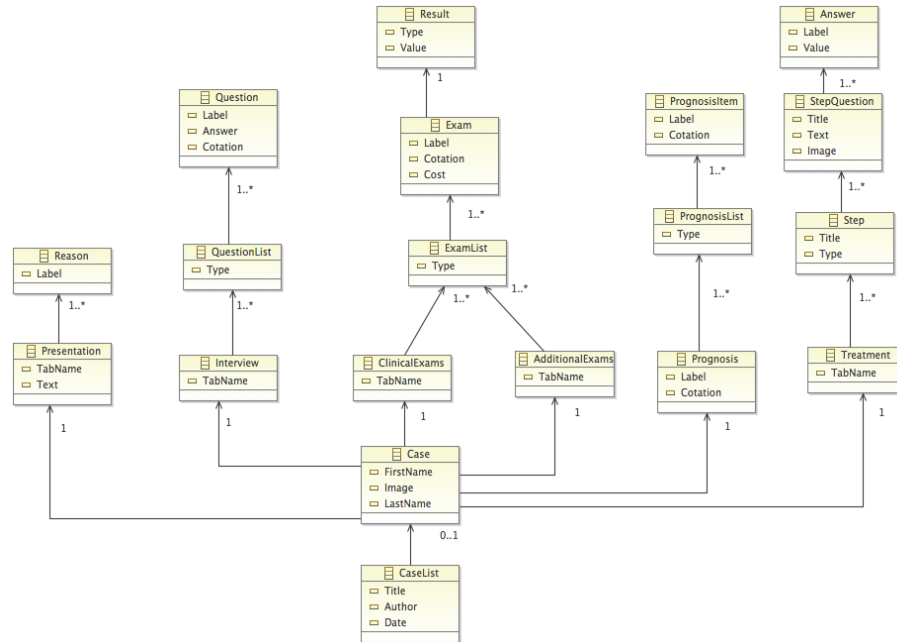


Fig.4. Data model of this serious game.

Here, is a brief description of the model:

- ⤴ an exercise is a set of cases,
- ⤴ a case is related to a given patient (information, pictures, etc.) and contains several parts.

A multidisciplinary approach is necessary for each treated patient. Besides, the serious game is composed by 5 parts related clinical approach (fig.5).

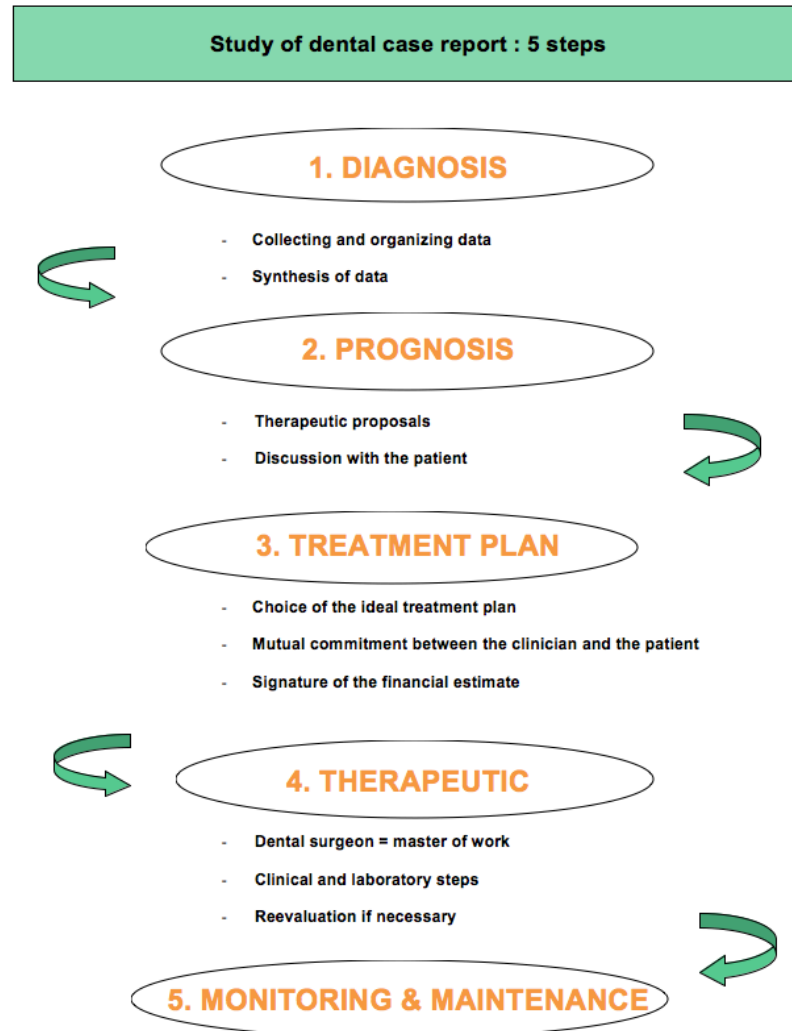


Fig. 5. The 5 steps to manage patient for a prosthetic oral rehabilitation.

Each part is composed with different points that are clinical actions (tabl.1). The gamer has to realize a diagnosis to finally decide a treatment plan for each clinical case. The aim is to choose the ideal treatment plan. Nevertheless, the therapeutic that is presented is not necessarily the only possible one because of the patient's decision in clinical practice.

Table 1: Game-play of this serious game.

| Part | Title | Description | Contents |
|-------------|--|---|--|
| 1 | Patient's request | Information related to the questioning of patient: it lists several categories of possible questions that the practitioner could choose to raise | A question is described by a text, an answer and a value that reflects the pertinence of the question |
| 2 | Anamnesis | Presentation of clinical case report | A sentence said by a patient and a list of items that characterize the case more formally |
| 3 | Diagnosis - Clinical exams - Radiographic exams - Other exams | Several categories of possible exams that the practitioner could choose to perform the best treatment plan. Clinical and X-ray exams have to be realized. Complementary exams could be perform or not by the practitioner taking into account each clinical case report. | An exam is described by a title, a value that reflects the pertinence of the exam, a cost and a ressource that is going to be made available to the player if the case arises. |
| 4 | Prognosis and therapeutic proposals | For a given case, the treatment is not unique and depends on many factors (like experience, context...). | List a set of possible prognosis that the player has to select and order with respect to pertinency. |
| 5 | Treatment plan and clinical results | Devoted to the clinical treatment that was realized on the patient. | The treatment chosen by the expert is here a list of steps, each step being the occasion to ask several questions to the player. Multimedia supports all clinical steps (figures, pictures, schema, photos, videos, podcasts, courses pdf, website, etc.) |

Consultation en odontologie - Liste de cas n°1

Auteur : C. Brunot-Gohin (28/03/13)

Cas : Patricia D.

00:00:16

The screenshot shows a web interface for a dental consultation. At the top, there is a navigation bar with six tabs: 'Motif' (highlighted in blue), 'Anamnèse', 'Examens cliniques', 'Examens complémentaires', 'Pronostics', and 'Traitement'. Below the tabs, the patient's name 'Patient : Patricia D.' is displayed. To the left of the text is a small image of a person's teeth. Below the name, there is a text box containing the patient's statement: '"Bonjour Docteur, mon sourire est disgracieux. Je ne trouve pas mon incisive supérieure droite très jolie. Je :'. Underneath this, the word 'Motifs :' is followed by a bulleted list: '• Douleur' and '• Esthétique'. At the bottom of the interface, there is a section labeled 'Noter ci-dessous vos observations personnelles.' with a text area containing three dots '...'. The entire interface is enclosed in a light gray border.

Fig.6. Homepage of serious game online.

Different buttons of actions are proposed in each part:

- ⤴ part 1: no interaction is required from the player (presentation of the clinical case)
- ⤴ part 2: the player has to select among the various questions the ones that are at most pertinent, i.e. penalties come with the selection of less or non-pertinent questions and time is lost. From a pedagogical point of view this way of doing forces the player to be efficient.
- ⤴ parts 3 and 4: the player has to select among the various exams the ones that are at most pertinent; again penalties come with the selection of less or non-pertinent exams and time as well as money are lost.
- ⤴ part 5: a particular treatment is proposed by the expert; the player goes through a set of steps, each step being the occasion to answer a quiz

This serious game places students in a real clinical situation and forces them to make their self therapeutic choice. The aim is to treat real patients in a virtual environment but close to clinical reality and in limited time.

2.3. General architecture

The architecture of the application classically follows the architecture of an editorial chain [13-14]. The figure below depicts this general architecture (fig.7).

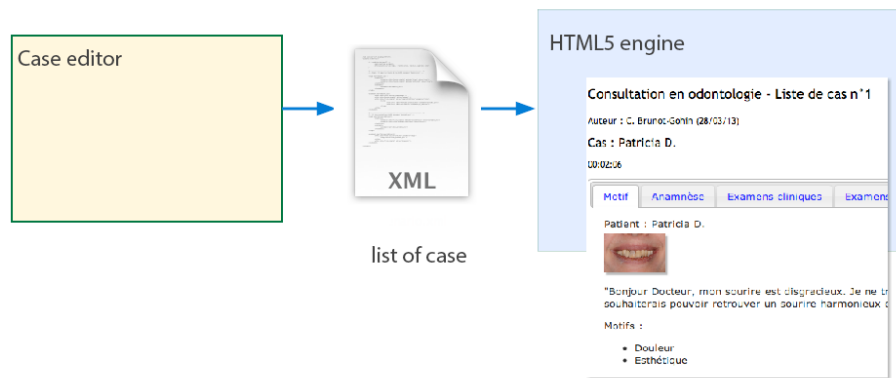


Fig.7. General architecture of this serious game.

It is used first by the expert in an editing mode that allows to create new sequences of cases or to update existing ones. This produces an XML file containing all the information of the sequence of cases (according to the model described before) as well as a folder containing all the ressources displayed (images, sounds, videos, PDF files, etc.); the game engine loads the xml file and instanciates the sequence of cases; after each case, a result is sent to a monitoring page, which can be displayed in real time to a group of players.

2.4. Framework

The game engine is based on HTML5. This language has been chosen for several reasons. First, it becomes a new standard when developing Internet applications; moreover, for the game situations we are dealing with the development is faster and cheaper than with any other solution (like Java Applets or Flash, for example). Finally, HTML5 is now widely supported by mobile devices and does not require any plugin or add-on. This is a very important point as far as academic environments are concerned, because it warrants a good deployment of the game among the target users.

3. Discussion

This serious game performs an online self-assessment. Nevertheless, this teaching tool could be used in face to face learning to complete the self online-learning. The clinical results of treatment can be discussed with

students thanks to online or in face to face forums according to blended learning.

Visualization effects, simulation, and virtual reality in 3D could increase the quality of serious game design [15]. However, we would like to show by this work that a singular serious game can be designed without a lot of high technologies and financial budget. Here, the contents are clinical case reports and the interest is to encourage a multidisciplinary approach by undergraduate dental students.

4. Conclusion

In the near future, these new teaching tools will emphasize dynamic and promising innovation of learning game, awareness game and serious games in Dentistry.

A similar approach has also been successfully studied for geriatrics ; a large of other clinical applications could be possible in the field of health care without changing game-play and design.

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