Educational software to teaching and learning pharmacology

Introduction

Ever since computers became available, they have had a profound impact on society with a virtual number of applications. In the educational context the computers and its resources are already inserted. It may be a useful tool for information searches, data analysis and storage, and can help provide an attractive learning environment. Additionally, in science education, computer-based learning can be used for describing, explaining, and predicting scientific processes. Abstract scientific phenomena occurring in the macroscopic or in the microscopic level can be attractively illustrated and discussed by computational resources such as educational software. Also, educational software can be used to facilitate the learning of specific concepts at the cellular and molecular levels in biological and health sciences All these Information and Communication Technologies (ICTs) are of great importance as tools for teaching several scientific subjects like anatomy and histology as well as other non-descriptive subjects as physiology and pharmacology . Among them, pharmacology is a mainstream, basic science in the study of medicine and other health courses . Additionally, pharmacology is more than a distinct subject in science education; it is an interdisciplinary subject that integrates basic and clinical sciences . However, teaching and learning pharmacology is a complex task. Students are expected to learn a significant amount of information by the time that they undergraduate. In this context, researchers has highlighted the need to review the teaching practices in pharmacology education .

Considering these facts, an educational software was developed as a tool to help pharmacology teachers as well as to promote an active and motivated learning environment to students. The purpose of this study was therefore to evaluate both the subjective (student perception) and objective (student exam results) usefulness of this computational tool. Additionally, some software characteristics (navigability, usability, friendly and others) were also evaluated.

Material and Methods

Software Development

The educational pharmacology software called PHARMAVIRTUA was developed using combination of Adobe® Director® and Adobe Flash® software. They are both powerful, interactive authoring programs.

The software was distributed in a CD-rom media and its executable file can run both in MACs or PCs machines. Our version was designed to run in a Microsoft Windowsâ environment.

Usually, the pharmacology software currently available can be classified into six major categories (E. Hughes, 2002). There are pharmacology Quizzes, electronic books, tutorial, simulations, animations and video material and finally electronic learning environments. These categories are not mutually exclusive in that some software packages may contain material drawn from more than one category as the Pharmavirtua software. The basic pharmacology content is presented as tutorial (hypertext and static figures), animations of important pharmacological phenomena, simulations and a quiz.

The educational and software characteristics were integrated and validated by cross-functional design life cycle software. For firms competing in markets characterized by high rates of technological change and high rates of market change, product development cycle time is being recognized increasingly as an important source of competitive advantage. A major category of contributors to the reduction in product development cycle time is effective cross functional integration with concurrent product development processes . Our cross-functional model was modified for educational purposes. Each content module was analyzed both for students and teachers who filled questionnaires with usability and educational issues (data not show) Thus, we could provide greater flexibility in managing design changes. Furthermore, it potentially reduces the need for design changes resulting in a reduced rework.

Educational Aspects and final evaluation

The Pharmavirtua software use was evaluate in a summer course supported by the Oswaldo Cruz Institute – FIOCRUZ, Brazil. This course titled “ Pharmacology: An Integrated Approach” was planned to cover the Basic Principles of Pharmacology (pharmacokinetics and Pharmacodynamics) with an interdisciplinary basis. The time course load was 45 hours over a week and 5 pharmacology teachers were involved directly with the course.

Two months before the course, students of all parts of country might file a participation application. During this period 78 applications were registered and 30 students were enrolled to participate to the pharmacology summer course. Additionally, 4 listeners were included to the previous selected students resulting in a total of 34 students. The major enrolment criteria were undergraduate students from biological and health area, general mean grade > 7. 0 and a subjective curriculum analysis.

At the first day, all students performed an exam with 20 questions containing basic pharmacology subjects. During classes there were two pedagogical moments; 1. lectures with case-discussions (common to all students) and 2. a moment planned to students study the previous contents discussed using the software or using other tools including textbooks, their notes or Internet content, except the software. These two moments were equally distributed along total course load. Thus, four groups were created as follows:

PNS – students with previous pharmacology experience (during they undergraduate course) with no use of the software (n= 8)

PS – students with previous pharmacology experience (during they undergraduate course) with use of the software (n= 9)

NPNS – students with no previous pharmacology experience with no use of the software (n= 8)

NPS – students with no previous pharmacology experience with use of the software (n= 9)

Pre- and pos-test

The students enrolled in this study were evaluated objectively through grades obtained in pharmacology exams. They performed a pre- and pos-test (before and after summer course). The test contained 20 questions with basic pharmacology topics divided in three cognitive levels according

Anderson and Krathwohl (2001). The same exam was performed by all students before – and a different one were created and applied after the summer course. The tests were randomically created from our database containing over 500 questions (pre- and pos-test).

The 20 questions test were created with three different cognitive level as follows .

Type 1 questions: Remembering – Learners are able to recall the definition or meaning of pharmacological concepts (6/20 questions).

Type 2 questions: Understanding – Learners are able to explain, paraphrase or exemplify the pharmacological concepts (7/20 questions).

Type 3 questions: Applying – Learners are able to solve application problems based on pharmacological concepts (7/20 questions).

Subjective and qualitative analysis

A likert's scale was used to evaluate the students' perception involving learning characteristics and the usefulness of the software as a pedagogical tool. Additionally, some questions involving usability characteristics also were collected. The students were requested to strongly agree, agree, neither agree or-disagree, disagree and strongly disagree statements concerning all of these characteristics above mentioned.

In addition user's opinions, suggestions and criticism were recorded in order to perform a qualitative analysis.

Statistical Analysis

Statistical analysis and graphs were performed using the GraphPad Prism version 5. 00 for Windows, GraphPad Software, San Diego California USA (www. graphpad. com). Results were considered significant when $p < 0.05$.

Results

Thirty four students participate of our summer course and were divided in two major groups (students who had finished pharmacology in their undergraduate courses and other who were no enrolled yet.) Than, each group was divided in respect to the use of software. (See methods).

All off students at the moment of our summer course were officially enrolled in a public Brazilian university from the medicine, pharmacy and biomedical sciences undergraduate courses. There were 22 females and 12 male students with an age of 21 ± 2 years old. No socio-economic differences were found between groups (data not show).

Objective analysis (pre- and pos-test)

The objective analysis consisted by pre and pos-test grades and the time spent to complete the exams (after and before summer course).

The overall grades were increased after course both in students of the pharmacology experience groups (P or NP) with use of software. The group with experience in pharmacology with no use of software did not show grade improvement.

Considering all questions (with no type question stratification) use of the software apparently show better results on exams performance. On the other hand, an improvement only could be observed in students with pharmacology experience in the group that use software.

The absolute grades were: 6. 8 ± 0. 6 for the pharmacology students that no use software (PNS) before course and 7. 4 ± 0. 9 after course; 5. 2 ± 1. 0 for the pharmacology students that use the software (PS) before and 7. 3 ± 0. 5 after; 5. 5 ± 1. 1 for the students with no experience in pharmacology that no use software (NPNS) before and 6. 8 ± 0. 8 after and 4. 8 ± 1. 2 for students with no experience in pharmacology that use the software (NPS) before and 7. 1 ± 1. 0 after pharmacology summer course.

The questions used in this study were divided in 3 groups according Anderson and Krathwohl (2001). (See methods) When the students' performances were analyzed by separated questions a different profile was found. For the type 1 questions (remembering questions) an improvement was reached in PS and PNS groups. Here the software apparently did not show any effect on grades' performances (Figure 2.). Otherwise, considering both type 2 and 3 questions (understanding and applying questions, respectively) we could clearly observe a positive effect of the use of software, since NPS groups showed significant increase on its grades (Figure 2.) In fact, the students with no pharmacology experience showed better performances (before and after tests) compared to students with previous pharmacology experience. Even all groups had showed better results in pos-tests, only the students with no previous pharmacology experience that used software showed differences statistically significant (Figure 2.).

Additionally, all students spent less time to conclude the pos-tests when compared with the time spent to conclude the pre-tests (Figure 3.).

Subjective analysis (likert's scale and other qualitative data)

Discussion

During the last decade wealth of pharmacology software were developed. For instance, over 250 software packages can be obtained from the British Pharmacological Society (BPS; www. bps. ac. uk). A significant number also can be found through Internet searches, like academic Google etc.

Equally important to develop educational pharmacology software is the need for more rigorous research to provide a scientific and pedagogical foundation in respect to general contents and its usability. Currently, most published articles on educational pharmacology software have been descriptive accounts rather than empirical investigations. New qualitative and quantitative research should examine the impact on the use of these tools in the teaching and learning environment.

Software packages can be used in a variety of contexts: in tutorial and small group teaching; in lectures; to better prepare students for practical work; as a replacement for practicals; to provide options within a limited course

Teaching and learning of the pharmacological sciences within health science curricula requires a novel, effective, and holistic approach to motivate students to learn the essential objectives of this subject.

Equally important is the need for more rigorous research to provide a scientific foundation to guide future practices in classroom. Currently, most published articles on active learning have been descriptive accounts rather than empirical investigations, many are out of date, either chronologically or methodologically, and a large number of important conceptual issues have never been explored. New qualitative and quantitative research should examine strategies to enhance student's learning form presentations; explore the impact of previously overlooked, yet educationally significant, characteristics of students, such as gender, different learning styles, or stage of intellectual development; and be disseminated in journals widely read by faculty.

Computer-based learning is often regarded as a teaching method in its own right but in fact it is simply a delivery mechanism capable of being used to provide access to a variety of learning aids involving many different teaching methods.

Software Evaluation

The evaluation of educational software should include an analysis of the interfaces characteristics concerning basically to usability and its implications and impacts on teaching and learning environment.

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Legends

Figure 1.

Figure 2.

Figure 3.

Figure 4.

Tables

Table 1.

Software/Source

Aim/Content

Classification

Endpoint*

Results