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Cuizz – In-Class Probing of Learning Bits

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ABSTRACT

This paper addresses the use of technology in the classroom, more specifically of pen-based devices such as Tablet PCs. It describes Cuizz, a Classroom Presenter plug-in that facilitates the teachers' immediate assessment, during class, of the students' learning. Cuizz allows the teacher to change the course of their class based on a quick, activity-based evaluation of the students' learning of a certain piece of class material. It provides the additional benefit of helping to create a repository of questions, answers, and explanations about the class material that can be reused across classes and class periods. The selection of assessment questions can be made manually by the teacher or automatically by the system, which then adapts the questions presented to each student based on their previous performance, as an attempt to avoid boredom in more advanced students or lack of interest in students of poor performance.

Categories and Subject Descriptors

K.3.2 [**Computer and Information Science Education**]: Computer Science Education

General Terms

Measurement, Design, Experimentation, Human Factors

Keywords

rapid learning assessment, adaptive assessment, active learning

1. INTRODUCTION

Technology has helped people capture, record, evaluate and reuse information in an unprecedented scale. The amazing proliferation of computer devices and applications is ever increasing the number of users that are exposed to this new reality.

The world today is changing at an astonishing pace. Everyday new technologies arise, new forms of interaction and communication defies the previous ones. Yet, some scenarios of our lives have been pretty much the same for dozens of years. Although we can identify new equipment, gadgets and machines inside our classrooms, unfortunately the teaching process has changed very little. Most of the classes are still given in presentation style, where a teacher presents a fixed set of slides in a predefined order to passive students who get bored easily.

However, much research and effort has been driven towards new methods, techniques and tools to support learning, which have been slowly changing our teaching and learning practices. Most of this research has been dedicated to e-learning, but this paper focuses on the support of in-class learning.

The use of presentation software such as Microsoft Powerpoint® has undoubtedly brought about benefits for the teachers in the preparation, reuse and maintenance of their teaching material. However, it still encourages old-style teaching, where students are a passive audience, whereas it is well known that passive learners struggle more to apprehend content and learn than those in more active environments. In addition, presentation-based classes often do little to motivate students, who are now increasingly interested in richer multimedia experiences.

To enrich the students' learning experience, many schools have been equipping classes with PCs, notebooks, and now Tablet PCs. A few schools even require their students to bring their own notebooks or Tablet PCs to class. The use of computers and notebooks in class have allowed students to more actively engage in class, taking notes and collaborating with other students during class. However, it requires students specific skills in typing. Tablet PCs are now an option that reduces this problem, by allowing students to handwrite their notes and annotate the class material with the pen (digitizer). Tablet PCs have a great potential to help transform presentation-based lectures into active learning, i.e., interactive activity-based learning experiences that not only engage students during class, but allow them to further explore and review the material after class as well [8].

By means of a more natural input device such as the pen, students may focus less on the technology itself and more on the note-taking activity. It is important however to develop software specifically for Tablet PCs and their usage in the classroom, for which there are many opportunities as well as challenges. One of the most frequently used applications for Tablet PCs in classrooms is Classroom Presenter, an open source software developed by the University of Washington.

Classroom Presenter is an application developed specifically for the Tablet PC which facilitates annotation and some forms of active learning in the classroom [1]. It allows

instructor and students to exchange slides and digital ink annotations in real-time during lectures. It can use previously prepared slides and also allows teachers to elaborate additional ink-based slides during class. It also enables instructors to make use of students' notes as an aid to promote discussion in class, encouraging them to participate more.

Although Classroom Presenter allows teachers to assess students' learning by inspecting the students' annotations over slides sent through the system, in larger classrooms with more than a dozen students it becomes challenging to inspect all students' work during class, due to its freeform, unstructured nature.

In this context, we have developed Cuizz, a plug-in for Classroom Presenter that allows teachers to pose multiple-choice questions to student during class and collect their answers. This way, they can immediately assess the students' learning of specific material content. The goal is to quickly evaluate how well certain contents were grasped by (how many) students. It is important that this is done in time to change some aspects of the current class, such as to review previously presented material, to present additional examples, and to clarify specific doubts detected in the assessment, for instance.

Cuizz was designed to go beyond a simple polling capability. It allows teachers to create a repository of questions, answer choices, and explanations, as well as to collect students' answers across classes and over time, forming a history of learning performances that may help teachers to improve their learning material based on real data about the mistakes learners have made and difficulties they have had with certain contents.

In the next section of this paper we briefly describe Classroom Presenter, and explore why this kind of technology is a key element in the classroom. In Section 4 we describe the Cuizz plug-in. Section 5 explores the plug-in's adaptability and how it may benefit both students and instructors. A fictitious scenario of Cuizz is presented in Section 6 as an effort to show how the system can be successfully applied in HCI education. Finally, we focus on the conclusions and prospect some of our future work.

2. CLASSROOM PRESENTER

2.1 The system

Classroom Presenter is a Tablet PC application that facilitates active and collaborative learning in the classroom. Both instructor and students are equipped with Tablet PCs, enabling the exchange of digital data between them.

This interaction system provides bi-directional sharing of information with students devices through slide synchronization. The instructor prepares the slides using standard slides design software, such as PowerPoint®, and, as for the later versions of the tool, they can create a *deck* and directly load the presentation in the Classroom Presenter [7] [10]. The slides, then, can be shared and viewed by all students. More than that, instructors can share with students, in real-time, ink-based annotations (i.e., annotations made with the digital pen), and students can submit their ink-based annotations back to the instructor.

Every student submission will be stored in the instructor's deck and will be appropriately identified for the instructors' eyes only. If desired, instructors can opt to anonymously share with students some of the materials submitted, improving therefore the interaction and exchange of data in classroom.

Figure 1. Classroom Presenter's main window.

Classroom Presenter has several features that instructors can benefit from during presentations. Among them are [1]:

- the annotation tools, designed especially for tablet-based presentation. These tools allows teachers to emphasize certain points in their slides, to complement their slides with additional text, images or examples to create a richer learning experience;
- space-creation tools. The ability to create new ink-based slides or to resize a slide results in additional writing and annotation space, as in a digital whiteboard that will later be saved and made available to students;
- the collaboration tools. The ability to receive students' annotated slides and to present them to the class to illustrate certain aspects of the class content engages students and provides opportunity for active learning, learning by doing and by examining other students' examples.

2.2 Advantages of Using Classroom Presenter

Although almost every activity in classrooms could be done in pencil and paper, or in a non-digital whiteboard, the Tablet PC technology, combined with Classroom Presenter (CP), provides several advantages over the usual passive class. Logistics and integration can be improved significantly by the

use of networked pen-based computers. The logistic contribution is primarily due to the easier way of distributing and collecting content materials between instructors and students, while the better integration is accomplished once instructors and students continuously interchange artifacts, bringing students closer to the discussion. Another main advantage of using technology in classrooms is that it allows both students and instructors to keep digital copies and archives of their work [8].

Compared to traditional lectures, CPpresents several advantages. Using CP encourages students to put their thoughts into the answers before seeing any responses. Due to its virtual characteristics, it also gets students used to contribute to the class anonymously, giving equal voice to both timid and extroverted students. The system provides a strong motivation for participation, encouraging students to work on a problem and giving a sense that they can influence how the class material is explored by the instructor.

After some courses where the students used Classroom Presenter, they have responded very positively to the system. It encourages them to participate, increases their engagement and integrates more easily student materials into classroom discussions. The system demonstrates that it is an efficient alternative to the usual paper-and-pen classes.

3. CUIZZ

Cuizz is a new plug-in built, initially, into the Classroom Presenter. Its main purpose is to allow instructors to, whenever desired, pose multiple-choice questions to students in classrooms, and collect their answers over the wireless network. The accomplishment of this simple operation, nevertheless, can be of great benefit to both instructors and students.

Cuizz provides several benefits to instructors. The plug-in allows them to:

- evaluate, *just-in-time* and *in loco*, the students' understanding of certain learning material whenever desired, by gathering their immediate feedback through the multiple-choice questions;
- measure teaching methodologies efficiency, by immediately viewing the students' misconceptions revealed by the incorrect answers;
- compare the performance among students of the same class;
- compare performance between distinct classes, by analyzing after class the history of the students' performances across classes and class periods;
- keep and maintain an ever-growing pool of questions with metadata that identifies the degree of difficulty of each questions, so as to apply questions suitable to the level of the students;
- keep an electronic history of classes performances, that will help teachers to analyze their own teaching practices and improve their teaching material.

In addition, students also benefit from Cuizz. The plug-in provides them not only with the feedback of correct/incorrect answer, but also an explanation about the question in general and specifically to each answer (why each answer is incorrect, and how the correct answer may be judged so), as well as an opportunity to review the content corresponding to the question at hand.

There are two ways in which Cuizz can be used: the instructor may manually preselect the questions that will be posed to all students or she can turn on an adaptive feature that will select the questions based on the lesson's content. The adaptive feature can be switched on/off by the instructor at any time. When this feature is disabled, the instructor chooses the question(s) to be answered by all students, i.e. all students will be asked the same question(s). This is very useful for comparing the learning performance across students on a given class content. When the adaptive feature is enabled, Cuizz chooses from the pool of all available questions which one(s) will be shown to students, based on the following information:

- the total amount of time the instructor has set aside for using Cuizz at that moment;
- the amount of questions in the repository available that are related to the current topic, as defined by the instructor;
- the estimated time to answer each question, based on the degree of difficulty assigned to it by the instructor;
- the previous performance of the students. If the student has performed well in previous usages of Cuizz, it selects more difficult questions for that student. If, however, the student's performance decreases in a certain topic, it selects average to easy questions for them.

There are two configuration options for this adaptive feature. First, the instructor may select one or more questions as mandatory, so that they will be posed to all students, regardless of their profile. Second, she may choose whether the adaptive mechanism will applied individually or collectively. If the instructor wants to compare students' performance on a given topic, she can ask for a collective adaptation, in which all students will be considered in the adaptation mechanism and all of them will receive the same set of questions. If, however, the instructor's goals is to let the students self-assess their learning (for instance, in the last few minutes of a class), she can ask for an individual adaptation, where each student will receive questions better suited for his/her performance level.

The two main purposes of the adaptability algorithm are to improve student's comprehension of the content being taught and to improve the assessment process by customizing it according to the student's performance. All questions answered by the student are registered, and the results are computed, so Cuizz knows how each student is performing.

If the students are doing well on less difficult questions, Cuizz considers that they are not being assessed at their maximum. The algorithm then chooses from its pool of

questions, at real-time, other questions at higher difficulty levels, classified on a scale from "*Easy*" to "*Challenging*". Cuizz then displays the chosen question to the student.

Conversely, if the students' performance is not as expected, meaning they chose wrong answers, Cuizz considers that the students might have misunderstood the contents of the material. It then shows them relevant background information concerning the question topic and, if the student makes a second mistake, after providing the correct answer and opportunity to get explanations about all answers, Cuizz presents another, easier question on the same topic, if available.

We believe this background information about the topic can be helpful to students as another way of elucidating the content being assessed, and for instructors to prepare questions and answers that address a wider range of common misconceptions that they observed students having in the past.

3.1 How does Cuizz work?

Since Cuizz is a plug-in addressed to and operated mainly by instructors, the Cuizz menu item is visible in the "Instructor Role" mode only, under the *Decks* Menu (Figure 2).

Figure 2. Accessing Cuizz menu item.

In its first implementation, Cuizz only allowed textual questions and answers. For HCI classes, however, it is paramount to be able to include diagrams, wireframes and user interface sketches and other representations in both questions and answers. Therefore, Cuizz has been redesigned. This section presents the already redesigned version of Cuizz.

When preparing their presentation, the instructor may inform the topics that are presented in which segments of the presentation, to have Cuizz suggest the questions after each segment (**Figure 3**). According to Anderson [1], there is usually time to fit four to five activities in one-hour long lecture.

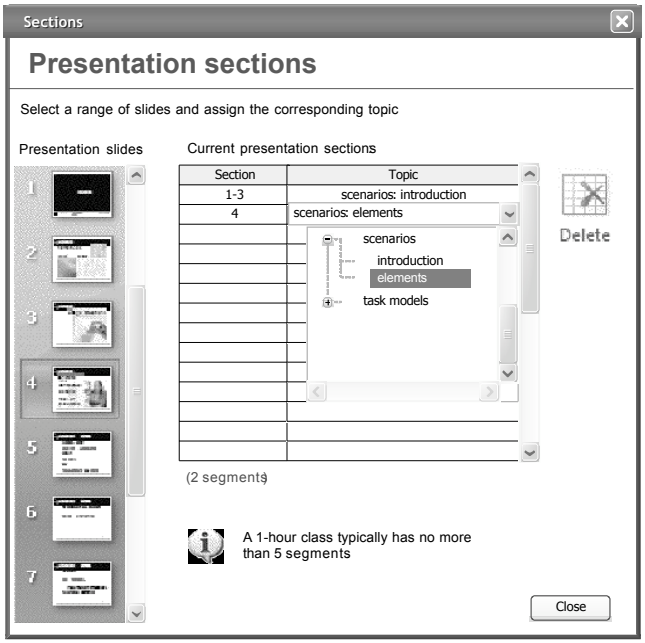

Figure 3. Sample definition of *Presentation sections*.

To define a section, the instructor selects a contiguous set of pages and then assigns a topic to this range. In the previous figure, only 2 segments were defined, the first one from pages 1 to 3, and the second comprising only page 4.

The topics associated to the sections will be used in filtering the questions to be presented to students, during the execution of Cuizz, thus speeding the process. After the presentation of the last slide in each segment, Cuizz will suggest the instructor that it is time to pose the questions to the students.

Otherwise, if the presentation sections are not prepared beforehand, the instructor will have to go through the whole list of questions during class to select which ones to apply, which may become a time-consuming process as the pool of questions grows. The topics are organized hierarchically, and managed in a specific window, as depicted in **Figure 4**. Each topic has a title and an explanatory background text, that may be provided to students when answering questions on that topic.

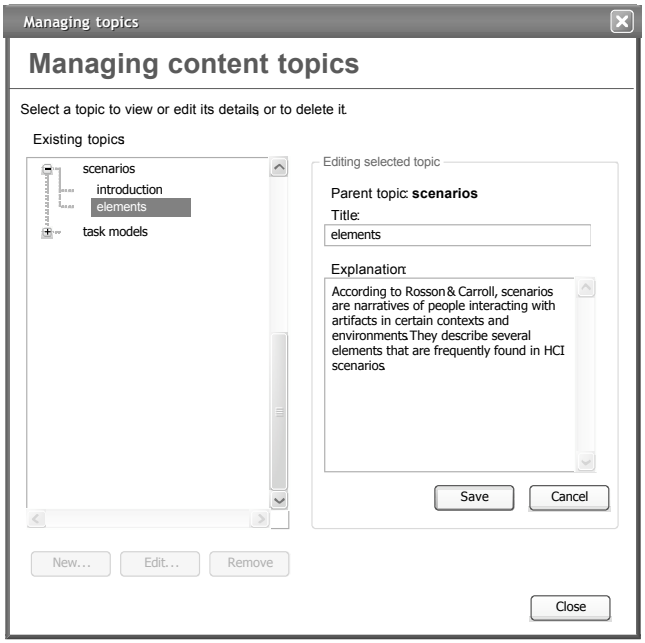

Figure 4. Managing topics.

Questions have a mandatory text and optional image, whereas each answer may be represented by a text, an image, or both. When defining the answers, the instructor selects a radio button next to the correct one, so Cuizz will be able to capture whether students have done well or poorly.

As previously mentioned, it is important for the adaptive algorithm to be informed of the questions' degree of difficulty. It is based on this information that the algorithm, if enabled by the instructor, will compute and decide for the new upcoming questions when submitting to the students. Therefore, the instructor must classify each question in a 5-point scale ranging from *easy* to *challenging*.

Also, each question will be associated to one of the previously-defined topics. This means the question is relevant to the contents covered in all segments related to that topic, and may be applied to students along with all the other questions of the same topic, once triggered by the instructor. If the adaptive algorithm is enabled, though, there is no guarantee that all questions will be applied and in which order, but Cuizz guarantees that all questions set as mandatory in that topic will be submitted to students.

Besides the explanatory background text associated to the topic, the instructor may also provide a hint for each question. **Figure 5** and Figure 6 illustrate the user interface for managing and editing questions.

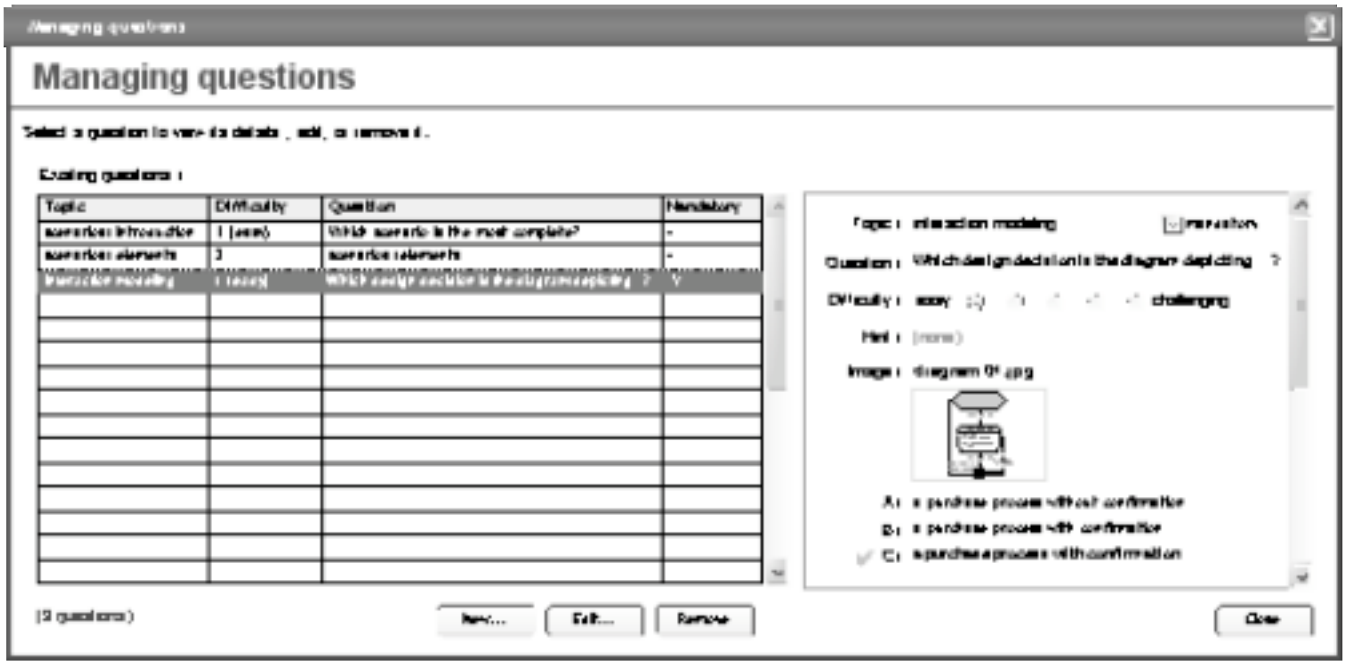

Figure 5. Managing questions.

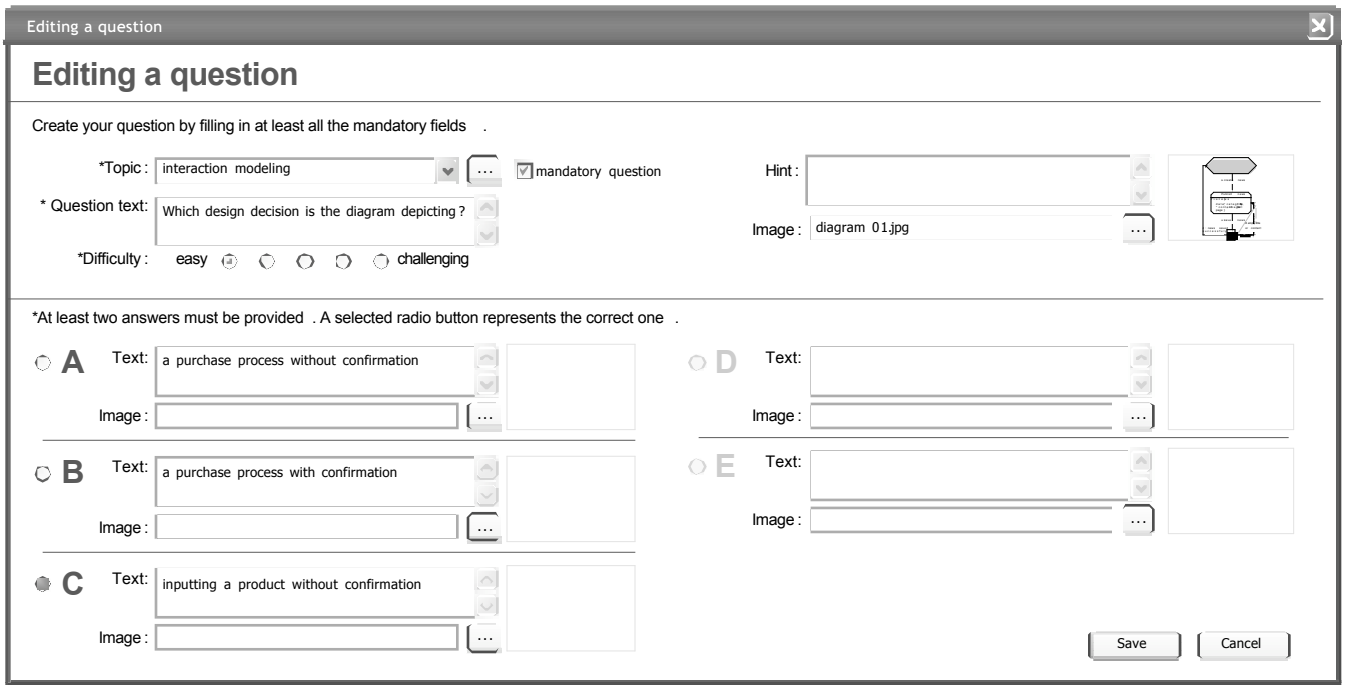

Figure 6. Question editing form.

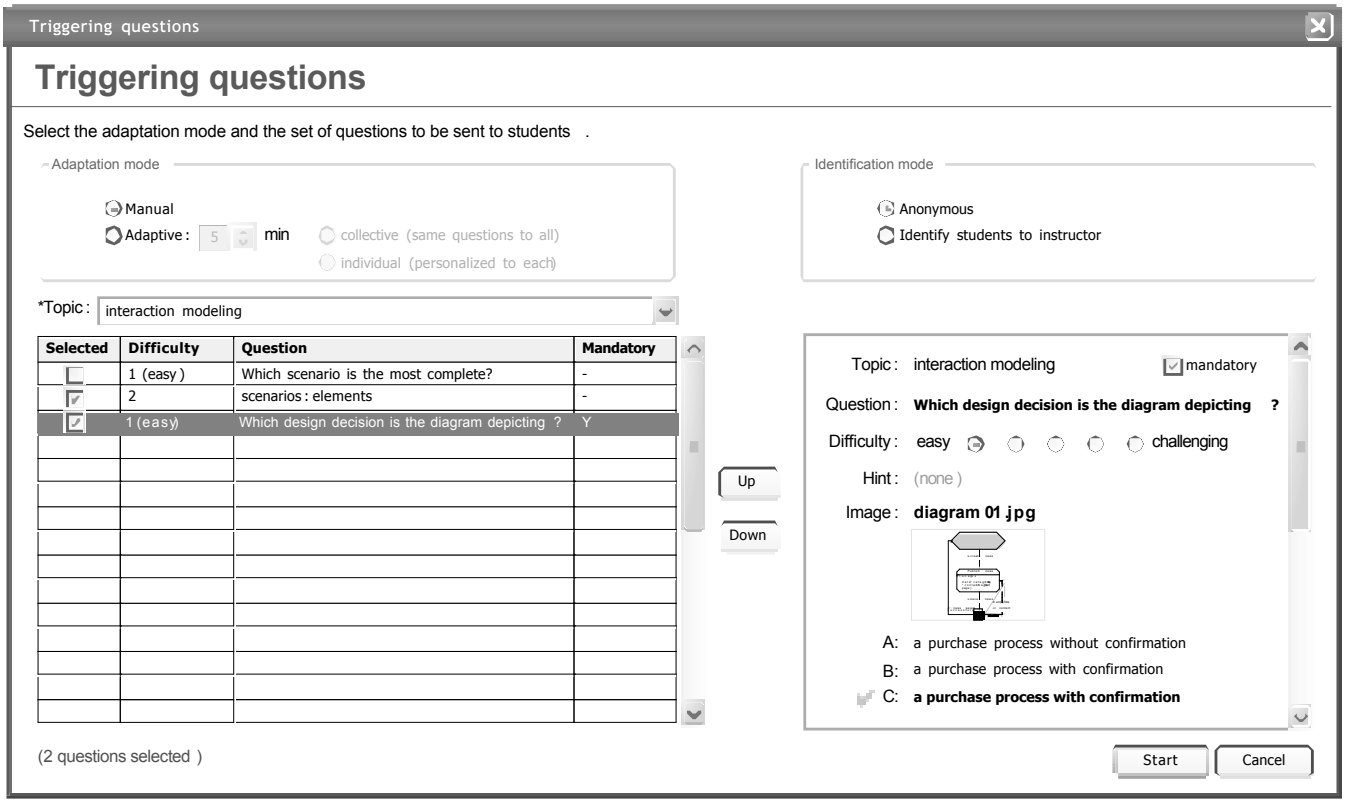

Figure 7. Selecting and triggering questions to students.

When time comes to send questions to the students, the instructor may select Cuizz's manual or adaptive mode. In the manual mode, the instructor defines which questions will be asked, and in which order. In the adaptive mode, the instructor

needs to configure the following parameters: the mandatory questions; the time allotted for students to answer the set of questions; and the individual or collective nature of the adaptation, i.e. whether the adaptive mechanism will produce the same set of questions for all students or it will adapt to each students' performance. Figure 7 illustrates the user interface for triggering the questions to students.

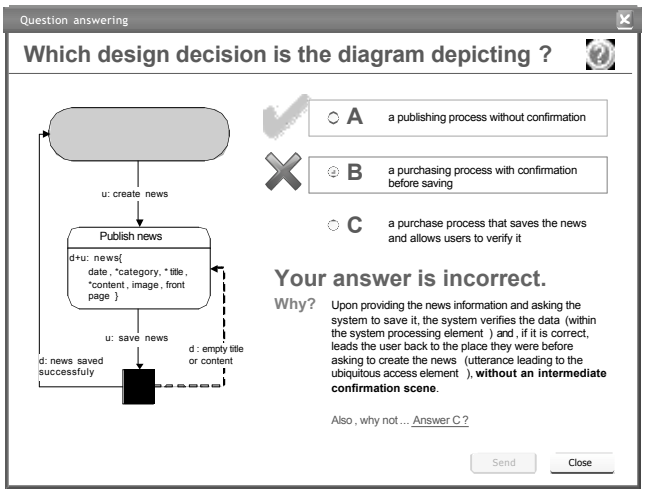

Figure 8. Student answer.

When a student answers a question, he gets immediate feedback on his answer (Figure 8). If the answer was incorrect, he is presented with an explanation about why it is a wrong question. He may also explore the problems with the other incorrect answers as well. When he has finished exploring this content, he may proceed to the next question.

If all the students are answering the same questions (the *default*), the instructor can view the partial results in a specific window, where they can also control when time is up. **Figure 9** illustrates the instructor's monitoring user interface.

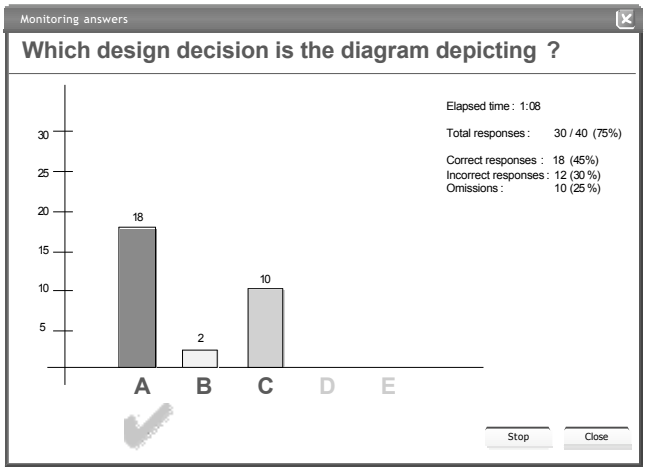

Figure 9. Monitoring students' answers.

4. CUIZZ'S ADAPTABILITY

The concept that software should be capable of suiting the needs of different classes of users has appeared several years ago [5][6]. In most cases, computer systems can be difficult to learn and use, as well as impervious to users' individual and changing characteristics or needs.

According to Benyon and Murray [6], computer applications tend to embody specific characteristics which make the chosen design solution better suited to some users than others. Some developers propose universal system interfaces, to satisfy the needs of most or all of its users. Others offer adaptation mechanisms such as customization options or macros, thus allowing users to adjust the interface design and features according to their individual preferences. Adaptive systems are systems which can alter aspects of their structure, functionality or interface in order to accommodate the differing needs of individuals or groups of users and the changing needs of users over time [5].

In this context, Cuizz was designed with the capability to consider students' errors as misconceptions, and to attempt to evaluate how much each student 'understands' each topic. The instructor provides questions to the students by the end of each presentation segment using the Cuizz plug-in, aiming to evaluate their understanding of the presented contents. Cuizz provides real-time feedback to the instructor, collecting students' answers and saving them in a log archive, so as to adapt the future selection of questions to the students' previous performance.

This is a big contribution of this plug-in. It helps the instructor to explore students' individual misconceptions, offering extra contents and opportunities to review and learn the specific misunderstood lesson. The instructor, in their turn, has the possibility of computing statistics from the logs and further improve their teaching material.

As an example, suppose the students who answered a question provided more than 50% wrong answers. Once the instructor notices this, they will be able to modify the way they were conducting the lecture, by slowing the pace down, going back to explain again the previous slides in a different way, or by involving the students in different activities to further explore the lesson content.

5. TEACHING HUMAN – COMPUTER INTERACTION WITH CUIZZ

Classroom Presenter is a very powerful tool, and has been extensively used to support both traditional and interactive lectures [4]. A wide range of Computer Sciences courses in various universities have already made use of Classroom Presenter [2], and it is easy to find a suitable scenario where the tool can be useful.

Based on the already proven success of Classroom Presenter and the vast application possibilities of the Cuizz plug-in, we present here a scenario in which the pair Classroom

Presenter / Cuizz can contribute to the education of Human Computer Interaction.

As mentioned before, the combination Classroom Presenter + Cuizz may improve teaching and learning in various ways. Considering an HCI lecture, we present a situation in which the instructor exposes some HCI design models for students to analyze in class. The slides are shared with the students, so the instructor presentation is visualized in their Tablet PCs. Students may make notes on the slides, draw on them, and submit the design models back to the instructor. If desired, the instructor can make use of the students' submissions and show them to the rest of the students, as an aid to foster group discussions and interaction. This scenario represents the classical use of Classroom Presenter, in which the Cuizz plug-in was not used.

After this "traditional" use of Classroom Presenter, the instructor may want to get specific data regarding the students' understanding of that kind of design model. In this case, they would use Cuizz to ask multiple-choice questions about one or more design models. A sample question would be "What design decision is the model depicting", where the incorrect answers are somewhat plausible and explore specific misconceptions the instructor has already encountered in previous classes. This way, the instructor would gain instant feedback from the students about their understanding of the models, and by detecting misconceptions they would thus be able to immediately deal with them.

This type of information can be of great value in lectures, as well as in other niches. It could be used in a design review, for instance, where participants of a meeting would provide their opinion about certain design alternatives through Cuizz.We believe the Cuizz plug-in will be of much worth for lectures in all disciplines in general and, in particular, for HCI lectures.

6. CONCLUDING REMARKS

In this paper we have described the Cuizz plug-in built on top of Classroom Presenter, and how it can benefit both instructors and students in lectures. Although we have not yet run experiments with the redesigned Cuizz, we believe it will significantly enrich interaction and nurture collaborative learning. To sum up, the major contributions of the redesigned system are:

- Immediate, structured evaluation and feedback of students: Cuizz enables instructors to gather prompt information about students understanding;
- Explanatory background text to students: whenever they have mistakenly answered a question, students will be assisted with extra content explanation, therefore improving their learning;
- Adaptive teaching: if enabled, Cuizz adaptive system will customize the assessment process by selecting questions according to the students' level;
- Measurement of teaching methodologies efficiency: once instructors collect information concerning students performance, they can more easily evaluate the efficiency of new teaching techniques;
- Statistics and comparison of students performance: Cuizz enables instructors to better and faster gather statistics about students' performance;
- Statistics and comparison of class performance: instructors that apply the same assessment to distinct classes can easily compare their performance;
- Ever-growing pool of questions: it makes it easy for instructors to maintain and reuse an evolving set of questions and answers;
- Digital track of classes performances: since questions, answers and results are digitally recorded, instructors will be able to maintain a digital history of all classes, facilitating future information retrieval.

We have shown in this paper that the plug-in possibilities are vast, and we hope Cuizz will prove itself as a powerful tool inside classrooms by effectively aiding in teaching and learning processes.

In the next class period we will run experiments with Cuizz in an HCI design class. The initial evaluations of Cuizz in the classroom will be of a more qualitative nature. It is important to conduct an exploratory qualitative research before diving into quantitative analysis, because otherwise the risk of measuring the wrong things is far too great. We intend to explore how teaching and learning differ qualitatively when the system is used, as compared to regular lectures. Regarding learning, it will be interesting to analyze how students perceive and benefit from a regular use of Cuizz inside the classrooms: whether it engages and motivates them more, and whether it reflects on the quality and depth of their learning, as compared to previous periods when the same class was given. Regarding teaching, we will analyze how much effort (actual and perceived) the teacher will invest in creating the repository for each class content, how she will benefit both from in-class assessment and after-class analysis of the history of Cuizz usage and, more importantly, in which ways the usage of Cuizz helps to improve her learning material and practices.

If the repository created is large enough, we may also investigate how Cuizz's adaptive behavior contributes to or hinders its usage. This investigation will allow us to evaluate and fine tune the underlying adaptation mechanism and algorithm.

In the future, we intend to make Cuizz available for students outside the classroom as well, where they will be able to review the class material and proceed to self-assessment, thus coupling in-class with off-class usage of the system. To make better use of this feature, however, it is important that teachers build larger repositories of questions so that students will have a comprehensive set of questions for each class material, otherwise students may lose interest in the system.

7. ACKNOWLEDGMENTS

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The authors thank PUC-Rio, Microsoft, HP and CNPq for the support that made this project possible.

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