Unlimited Learning: The *Mutable Learning Assistant*

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Abstract

We propose a new software tool that enables the dynamic creation of learning materials through the collaboration between professors and students. The tool can be used by a single professor or within a department since it sores all data in the cloud. Students can create virtual libraries of learning materials that can also be shared with their peers from a desktop or from mobile platforms. In this paper we show the design methodology and some preliminary results from a small test pilot and discuss the initial design iterations that were followed.

Keywords: adaptive learning, cooperative learning, cloud technology, mobile applications.

1. Introduction

Active learning is a set of methodologies that promote the recognition of concepts, the understanding of the relationships among ideas, and the development of critical thinking skills. The main goal is to involve students in the learning process, preferably complementing other techniques that have proven effective in the classroom. At the Tecnológico de Monterrey, several of these active learning methodologies have been identified and proposed for the new educational model "Modelo Tec21" [1].

One of those models is Adaptive Learning which in essence uses computer algorithms to adapt the format of the learning materials to match the students learning styles. The use of computer algorithms is needed because it is very difficult to tailor the learning experience to large groups of students [2][3].

Adaptive learning has been implemented in many different ways because researchers decided on models that met their specific goals. However, it is difficult to evaluate the effectiveness of each solution because there is no common ground for comparison. We decided to implement a platform that could support different recommendation algorithms so they could be evaluated fairly against each other. This approach is more time consuming since the platform needs to be validated and tested before it can be implemented. The platform needs to be flexible enough so that it can scale depending on the demands of the classes but at the same time present the same interface to the end user. Because of this we soon realized that the original goal of producing a simple web application was not going to work.

In this paper we describe the *Mutable Learning Assistant*, which is our Adaptive Learning platform, then we explain the approach that was followed to validate the general idea and how we designed the overall architecture of the implementation. Then we present how we involved several groups of students in the general requirements engineering and overall user interface design through several use case scenarios using Software Engineering methodologies. We present the overall architecture and how we plan to proceed with the actual implementation of the platform.

2. The Mutable Learning Assistant

The *Mutable Learning Assistant* is a web-based tool that helps the student learn by complementing the original class materials handed in by the professor with any media documents that are publicly available. The goals of the software tool areas follows:

- Enable the student to add their own notes, and share them with their friends. The resulting document combines all additional class materials into a single unit so the student doesn't have to keep track of each individual component.
- Create a virtual library of these documents which can be accessed from any computer or mobile device at any time.
- Documents are stored in the cloud so students don't have to search for them in their devices.
- The student receives suggestions on those learning materials that fit their learning profiles.
- Offer a cloud based site that holds curated content that has been vetted by a staff of education experts.
- Documents are *mutable* because as they are shared among students they have the capability of adding or removing material as they create their own versions of them.

The application workflow is simple. The student starts with the class notes from the professor or from some other document that is freely available on the internet. Note that we encourage users to only work with documents that are in the public domain or that follow the Creative Commons license. The student proceeds to add extra material that helps them learn a particular topic. The material can be videos, HTML documents, audio files, PDF documents, or some other media file. The tool provides several input panes that can be reshaped to accommodate the media files. The tool

then proceeds to encapsulate all these documents into a single unit that can be shared with the student's peers or with his/her professor. In the latter case the professor can incorporate back those materials that prove effective in easing the learning process from the students point of view. The tool provides information about which topics, and what materials, were used by the students to enhance the original class materials. This information should help professors in developing better class materials. The above flow is depicted in Figure 1.

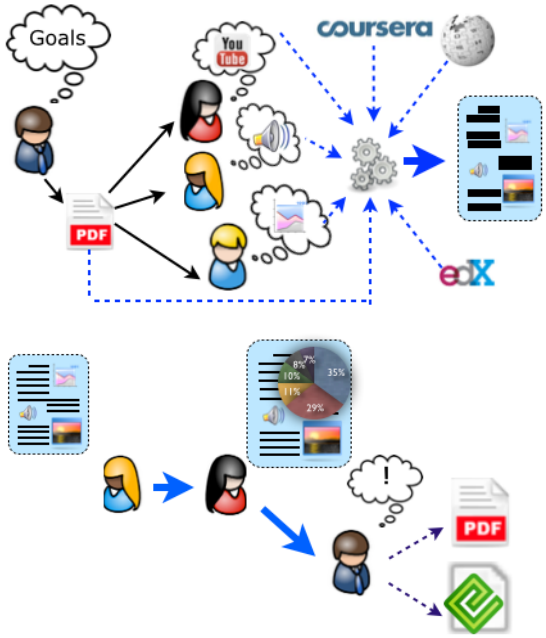

Figure 1. Simple workflow example.

3. Idea Validation

We wanted to make sure our general idea was valid and valuable so we decided to systematically test it. Thus, one of the authors enrolled in the Technology Entrepreneurship class, a two-part MOOC offered by Stanford in the NovoED platform [4]. In this two-part course the goal is to simulate the process of a technology startup by forming interdisciplinary groups that develop an idea, create a business plan around it, and then market it to large groups of people to obtain feedback. Our adaptive learning project was called the *Mutable Learning Assistant* and after the completion of the first course it was selected for an interview with Scott Slater, founder & CEO of Trusight, a Silicon Valley company who gave us valuable feedback on how to actually market our idea and form a company. On the second part of the course we developed the project Canvas and the marketing plan [5]. One of the authors of this paper was the team leader for both classes so that we could get as much information about possible shortcomings and limitations of the *Mutable Learning Assistant*.

A landing web page [6] was created for the project so that we could present the general idea and track the interest of our target audience. The web page is capable of tracking visits, has links to social media (Facebook and Twitter) and even accepts Bitcoins for those interested in helping in the development of the original idea. The Bitcoin support was a requirement of the marketing experiments in the NovoED courses. As expected, the web page visits were limited to our students and the NovoED course participants, but we also got a few hundred visits from the general population. No Bitcoins were received and although that option is still in the web page the account was deactivated early on to prevent any complications with handling money from external sources.

This web page also served as an example for our students of how prototypes could be implemented. We selected the students in the Software Engineering class at Campus Toluca as part of our target audience to further validate and test the idea, we also used students from the Programming Languages and Operating Systems classes at Campus Toluca as beta testers for the application user interface and to get feedback on the overall system architecture.

4. Analysis and Design

Developing a web application that can scale depending on the target class size requires the use of dynamic allocation of storage and computing resources. Therefore, early on we decided to use Amazon Web Services (AWS) [7] to implement the server side of the application. Unfortunately, scheduling problems with the disbursement of the NOVUS funds prevented us from using this platform for the extended periods of time required to fully validate the idea and its implementation. Therefore, we explored several options and decided on using Heroku [8] as a temporary solution until we could guarantee continuous funding for the actual implementation of the idea. We also purchased a small server as a development platform which allows us to test our application features before we submit the application onto Heroku.

The authors decided on using conventional web technologies, such as HTML5, CSS3, and JavaScript for the front end and for the landing page of the application. To reduce development time the authors also decided on a JavaScript development stack for the backend of the application (Node.js/Extend.js).

One of the authors developed a simple mobile tool on the Android platform to access documents on our database to verify that the platform could deliver the information to the mobile device, but no in-depth interface analysis was done for that test. Figure 2 shows two screen captures of a database accesses on the mobile application.

The authors used documents that were created by professors from the Department of Basic Sciences at Campus Toluca to test the central database of documents since all of them are in the public domain and are a good source of curated content.

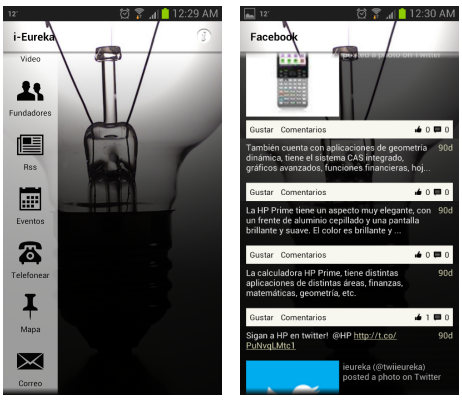

Figure 2. Mobile Platform access examples.

The actual requirements analysis and overall design of the web application was discussed, validated and tested in the Software Engineering class. The students were involved in developing competing ideas or to enhance the original design of the *Mutable Learning Assistant* as part of their course work. This gave them a real world experience that closely followed the Challenge Based Learning methodology [9]. Figures 3 and 4 show some of the students and the early user interface prototypes. A more detailed presentation of the prototype is found on the *Mutable Learning Assistant* web page [6].

Figure 3. Software Engineering students on the UI discussion & development process.

Figure 4. Prototype of the User Interface for the Mobile Application.

5. Implementation plans

At this point we are working on the backend of the application. Due to time and budgetary constraints we have not been able to finish the entire platform at this time. However, we have implemented the backend of the application to support the landing web page [6] and to test some basic document transfers between the mobile application and the databases. Once we have finished with the development of the backend of the web application we plan to deploy it on AWS, since it offers a better cost/benefit compared to Heroku. We have explored other cloud platforms, but AWS offers the best cost/benefit given our budget constraints. It also offers the most flexibility and granularity of control for both the processing and storage management although it has presented us with a more difficult learning curve.

We also plan to develop mobile applications capable of accessing the backend of the web application for iOS and Android platforms using the latest user interface designs that were validated and tested by our students. Once the first implementation is finished we plan to show the application to another group of Software Engineering students as well as to a the more advanced class of Analysis and Modeling of Software Systems to receive additional feedback. It also will help to engage those students with their learning through a challenging and complex software project.

Finally, once the platform is finished we can begin with the actual research of the different recommendation algorithms used for the adaptive learning portion of the application. There are many implementations of recommendation algorithms [10] but we believe that our main problem is going to be extracting context from non-textual documents. To begin with, we will use meta-data to annotate non-textual documents to feed the recommendation algorithms but eventually we will implement more complex methods for extracting information from non-textual documents.

6. Discussion

We decided to develop our own platform instead of using existing ones because we believe that with this platform it would be easier to quantitatively evaluate the effectiveness of particular adaptive learning methodologies and algorithms. Also, different classes will require different algorithms and methodologies and thus the *Mutable Learning Assistant* will enable a quantitative analysis for each of them helping the professor in selecting the best choices for each class. This is clearly an ambitious goal but even if the platform is not completely functional it will give valuable insights on how the students learn. As professors, we can use this additional information to facilitate their learning process quantitatively.

Finally, the development of the platform has already made an impact on our students by exposing them to the experience of developing a complex piece of

software. This helped them appreciate the need for Software Engineering methodologies first hand.

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