Constructionist Learning using Spreadsheet based Models on Tablets

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Abstract

The use of the tablets is on the rise, and here to stay. Being portable, they make it easy for the user to engage in a mobile fashion. Learning can be greatly enhanced, if this new platform is harnessed to its maximum effect. This paper describes such an attempt, with the focus on learning by doing and learning by sharing. Building on these approaches, we have implemented a suite of software applications based on the familiar spreadsheet interface, which aim at a greater user interaction, thus facilitating learning. The design, development, and implementation of this attempt has been discussed.

1. Introduction

E.C. Tolman's field cognition model of learning pertains to the tendency to arrange our perceptual field in a certain configuration. According to him, these tendencies could be modified with experience. Our field cognition modes are our preferences for learning certain things faster than certain others [1]. With the right set of experiences, a seemingly complicated task can be made appealing and consequential at the same time.

Learner has to be seen as a pro-active agent of information and learning has to be visualized as a change in the way information is processed as the result of the experiences that the learner has had or is having [2]. The experiences that the learner is having can be supervised by understanding and providing a learning environment.

Self instructional learning can be productive in the present environment. It lays the groundwork for helping shape the internal locus of control, on one hand. On the other hand, it leads to self pacing, wherein the learner can learn according to his own levels of comfort. Combined, the effect is that it reduces the anxiety levels in the individual and at the same time, keeps him involved, occupied and motivated. The computer tries to bring various pedagogical approaches into the world of self-paced learning, whose impact is based on the change in the mental expectancies of the learner [2]. So, any computer assisted learning, which is not perceived as a favourable envision by the learner becomes hard to sustain. This is particularly true for a self-instructional learning program, where one has to charter the learning course with limited in person guidance from a local educator.

The tablet devices and their software platforms have been duly designed for self instructional learning. With their increasing complexities and computational abilities, they are fast gaining recognition in the field of learning. Being lightweight, the physical strain in carrying them is greatly reduced and with typical screen sizes ranging from 7"-10", they can be carried in person with ease.

According to a study, the top locations where people use tablet devices has been pointed out to be Couch (23.51%), Bed (16.54%) and Home (12.53%) [3], where the user tends to be more relaxed.

In a related study, it has been found, that the spreadsheet based apps for the tablets, though in their infancy are needed [4], and this can turn into a boon for educating the people. It has been argued, that simply increasing the technology available to the learner does not have a significant impact on education. It is the communication and interaction with it that has a long lasting impression [5]. Much of the present scenario in this direction does not address this problem. Using a spreadsheet like interface overcomes this handicap and allows for much more interaction, as the learner engages actively in the direct manipulation of objects [6]. Since formulas are calculated automatically, it helps the student learn the impact and the interrelatedness of the model very quickly. Graphs can also be used to visually present large information, which helps in its quick analysis and interpretation by the learner.

2. Motivation for Use-cases

The beauty of learning lies in the transfer of knowledge from the known to the unknown, from concrete to the abstract and from simple to complex. This can be achieved by making learning purposeful, transferrable and absorbing. Constructivist learning is a "learner-centric" approach, which utilises the past experiences the learner has accumulated, moulds them in the needed direction and integrates them with the present teachings. The individual tries and builds mental constructs during the exercise to gain an insight. Instructional Design pertains to creating instructional tools and content that helps in facilitating learning most effectively. It is based on the premise, that the teacher uses a certain strategy to teach, and the learner uses a certain strategy to learn. Learning is considered effective if these two strategies overlap. Instructional Design is an attempt in this direction so that the maximisation of learning takes place. It has been debated that innovative teaching methods make this more effective [7].

Learning at classrooms differs from e-learning, in the sense, that the lectures and activities are not directly reproducible and reusable by others. Since e-learning modules can be used again and again, Instructional Design ensures that the presented content rightfully explores its crucial concepts. Thus, the realisation of effective presentation of the content so that the learning needs of the user are served is of utmost importance.

2.1 ADDIE Model

It is a framework listing the generic process traditionally used in Instructional Design. Its five phases namely: Analysis, Design, Development, Implementation, and Evaluation constitute a guideline for building effective training tools [8] and define the outcome of the instructional materials. Figure 1 gives a pictorial representation of the model.
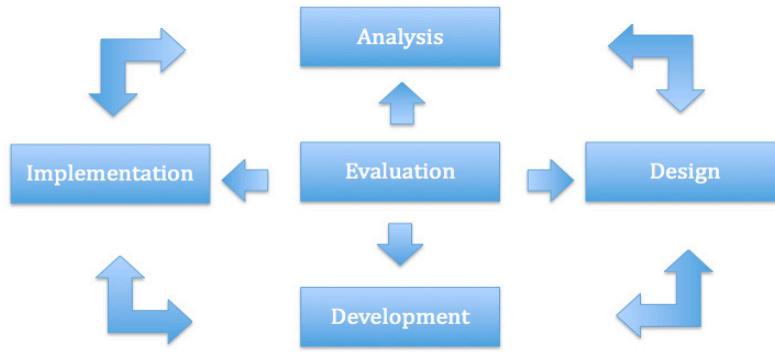
Figure 1: ADDIE Model

3. The Development Initiative

The use-cases have been constructed on a web based spreadsheet platform. Emphasis has been given on the features that would enable the learners to learn and interact in an easy, engaging and productive way [9].
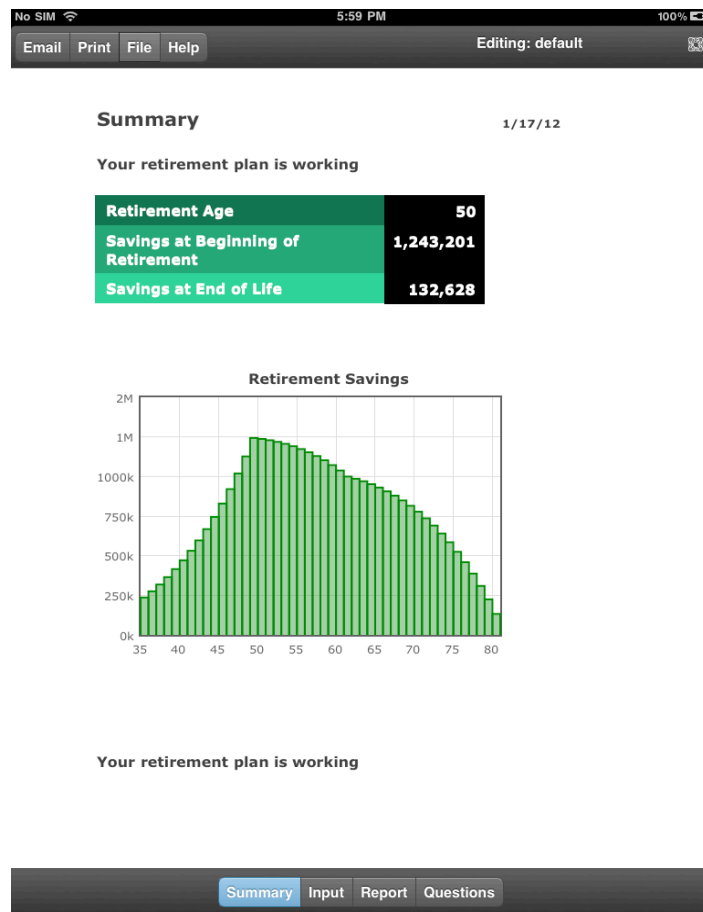

Figure 2: Retirement Planner using the Spreadsheet Platform

3.1 Analysis Phase

This phase involves delineating the main aim of the use-case, and establishes goals for educating the user and its desired behavioural outcome, that is, the pedagogical implications of the use-case are discussed. For example, The Financial Statements application highlights the financial accounting and book keeping process that needs to be maintained by an early stage enterprise user and a budding entrepreneur. The suite of enterprise web applications enables the large scale enterprises to integrate their complex business data, organize and edit key details, and access the information on both PCs and tablets. Charity Budget application help the individuals and foundations to plan and budget charitable donations, and share information with contributors, advisers and institutions. Valentine Cupcake application is a starting app for tertiary organizations to learn and share recipes for the Valentine Day.

Stock Value application helps the learner to understand the structure and workflow of financial valuation of a large scale publically traded organization through financial modelling and forecasting. The application has been designed on the iPad for teaching stock valuation using quantitative models in a simple, logical and an elegant manner.

The target audience of the use-case is identified and a certain level of prior knowledge and skill set on using spreadsheets and understanding the roles of the requisite business function is required. This helps in having a focussed effort towards imparting education. Other learning constraints are also analysed, like the interaction of the users with other people, objects, etc. in their immediate environment due to the mobile nature of the tablet. The method of user interaction is different on the tablet from the traditional laptops and desktops.

3.2 Design Phase

The applications have been made on a spreadsheet like interface, thus, no special skill is required. Moreover, a number of instructional videos have been prepared for use-cases, and are available on-line for free. They demonstrate the applications to the user. According to Miller, information has to be grouped into five to nine meaningful sequences [10]. Keeping this in mind, the different modules in the form of sheets have been restricted to six. The application is designed as a workbook of sheets. Brief descriptions are provided at the beginning, which give an overview of the application in a very concise form to the user. This is an important pre-instructional strategy which helps the user to store the framework of the lesson. This is important for enabling the user to learn, since the information is presented through the different sheets, which cover the different aspects of the entire application. We have initiated the 'Export' functionality, so the application data can be made interoperable with other spreadsheet formats. The data can be exported in a .csv, .pdf and .html format among others. 'Import' functionality has also been implemented, using which existing data can be imported into the application. At this juncture, data can be imported from almost all the spreadsheet formats directly or indirectly through a middleware spreadsheet format. This interaction between applications facilitates a collaborative approach towards learning.

A specific workflow for each use-case has been followed, so the user goes through the spreadsheets in a systematic way which helps him correlate the different sheets of the workbook with each other. As an example, "The Business Developer" application consists of the meeting agenda sheet followed by the price quote sheet, followed by the invoice sheets. The workflow of the application helps the learner not only understand a systematic way to conduct business practices but also brings him closer to the real business environment.

3.3 Development Phase

The applications have been developed on the cloud using the spreadsheet engine. They have been designed for the tablet keeping in mind the constraints and the usability issues that surround them. Mobile context, small screen size, and the edit and view modes of user interaction are some of them. The human interface guidelines are -

1. The font size has been kept reasonable from 9-10 points for the 7" tablets, and 11-12 points for the 10" tablets.
2. Same font type has been used throughout the use-case.
3. The use of the 'Bold' font has been minimized.
4. Adequate padding (4 pixels) has been used in the cells, so readability is easier. This also facilitates interaction with the user.
5. Effort has been made to keep the text as uniformly aligned as possible. The text portions have been left aligned, while the numerical cells have been right aligned.
6. Uniform colour scheme has been used as far as possible, and conforming to the intended user. For example, the color scheme of the "Holiday Budget" application has been designed keeping in sync with the festive mood of the target audience and is very different from that of a ticker valuation application, Stock Value, which has a steeper learning curve and requires more concentration on the user's side.
7. The right balance has been maintained for the borders of the particular cells, which successfully distinguish the cells from each other without overwhelming the user and maintaining an engaging user interface.
8. Alternate colouring of simultaneous rows has been done, to facilitate reading and entering the content.
9. The important fields have been created with a slightly larger font, so they are easily highlighted, for quick reference.

3.4 Implementation Phase

The use cases have been made available as tablet applications at a cost effective price in the different stores: iTunes store, Amazon Android Store, Google Play Store etc. making them accessible to all kinds of learners. The use-cases are manually tested to ensure that they are free from computational errors, as it is agreed by researchers that over 85% of evaluated spreadsheets contain errors [11].Then a test run is done manually on the intended device, and the application is checked against usability errors, which may include wrong formatting of the cells, missing borders etc. The metadata of the applications including but not limited to its description, logo, screenshots, support e-mail and links to external videos are added followed by uploading and submitting the application. This specific workflow ensures the quality of the content for consumption by a larger audience for a longer time period.

3.5 Evaluation Phase

We have a growing pool of user-reviews, and other statistics, which help understand the effectiveness of the described use-cases. Questionnaires are also being administered at the moment to gain further insights. Some reviews that were given to us:

On the Google Android Store, we received the following feedback for some our applications:

Home Budget: "Simple and to the point. Easy to fill out and understand…"

Invoice: "this is a very good app to start with especially when it comes to a small business. It definitely needs some upgrades. And overall function very good for a small business for independent it should be good to keep track of your friends and family in an organized fashion overall this is a very good app…"

Client List: "Very easy to manage and stay organized if you have or are starting a small business…."

A specific application has been considered below to further discuss the principles used by us towards developing an application.

3.6 The Financial Statements

The Financial Statements consists of 6 different sheets that cover the aspects of financial book keeping, which an enterprise needs to maintain. Education about these statements is essential for a business professional maintaining financial books of the company.

The application has been created for the small to mid-tier business owner, and for people who may be starting their own ventures. The basic knowledge about different kinds of revenues and expenses, assets and liabilities, financing and investing activities, etc. is a must know for the learner. Brief summary about the sheets has been included at the beginning. The application aims to educate the user about these different financial statements. The workbook has been designed in sync with its intended purpose.

Only the parts where the user is required to give an input have been made modifiable. The parts which are calculated automatically cannot be modified by the user. By changing the input parameters, the user can interact with the application, and see how the calculated values change, thus learning in the process. It follows a case-based approach to learning. The Word Cloud of application keywords and the screenshots have been included in the following figures.

Figure 4: Word Cloud of Cash Flow Statement

Figure 5: Cash Flow St. in The Financial Statements application

3.7 Financial Assessment Applications

Net Worth and Credit Card Payoff Calculator application have been designed on the iPad to enable a learner to understand and assess their personal savings and credit card debt, and set goals to improve their financial earnings.
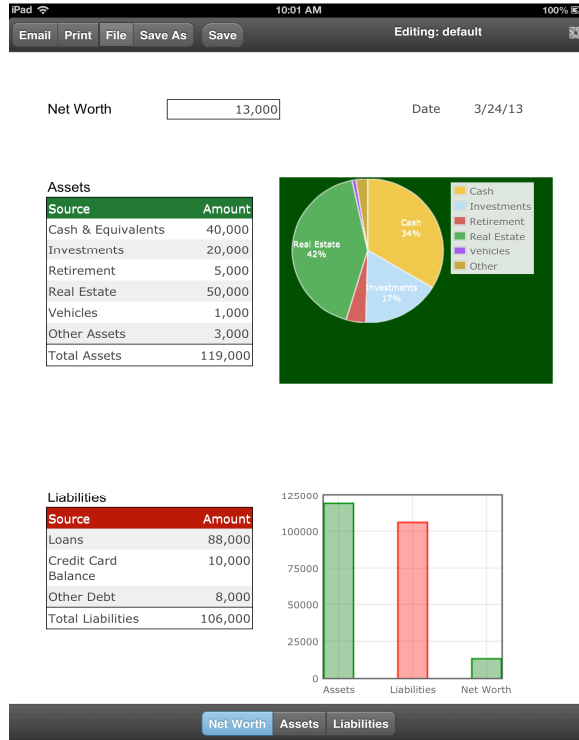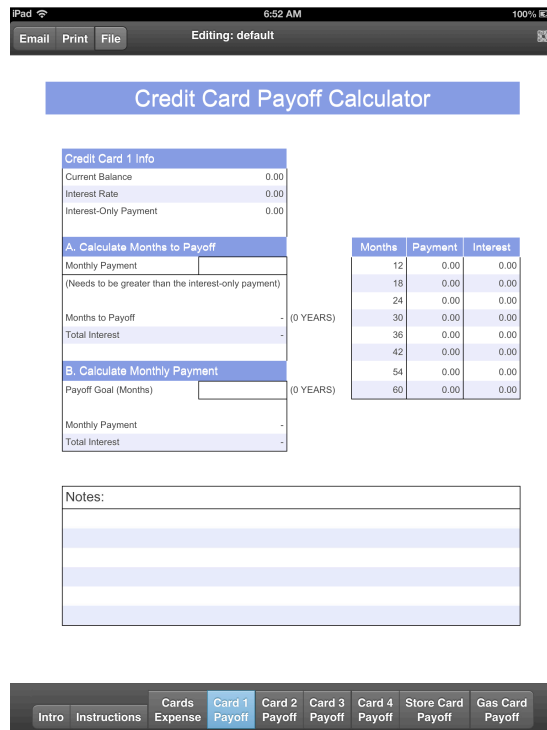
Figure 6: Net Worth application

Figure 7: Credit Card Payoff Calculator

4. Future Work

Through this paper, we have shared a learning model, which uses tablets as a platform, and a spreadsheet based model for interaction. The merits of this model have been explained, with a specific application. The use-cases have been developed for the English speaking user groups. The model can be easily expanded and used at a larger level to educate more target groups. It can be used at classrooms for teaching students, or educating and motivating people about their health, with the help of interactive applications. Work is being done in this regard at Aspiring Investments Corporation. Since, the model is based out of a cloud enabled spreadsheet it can also be used to foster collaborative learning at a larger scale. We are also building upon the interoperability of the spreadsheet data with other popular data formats.

5. Conclusion

Tablets are portable and handy tools, which have claimed their place in the post PC device segment category. Their mobility allows the user the freedom to interact with them on the go. Through this paper, we have envisioned spreadsheet based use-cases, which are helpful in imparting knowledge to learners. Following the principles of Constructionism, and embedding a set of Instructional Design practices, these self-learning applications allow mass emanation of knowledge in an engaging manner. These principles and methods can be applied to help achieve the learning objectives in a variety of environments.

6. References

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