Interactive e-Books on Aakash Tablet

M.Tech. Project Stage-1 Report

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Abstract

We are living in an age of science and technology. We use various devices in our daily lives such as smartphones, tablets and other gadgets. With advancement in technology, there is a sudden increase in the demand of portable communication devices. Tablets and smartphones are all the rage in modern world. These hand-held devices have enabled us to read e-books anywhere and at anytime.

e-books are nothing but a digitized version of the book and they lack interactive features. To overcome these limitations, there emerged the concept of interactive e-books, which provides a better learning environment to the reader.
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Chapter 1

Introduction

We are living in an era of science and technology. Technology has made a huge impact in every aspect of our daily life. The field of education does not remain untouched with its impact. Use of Information and Communication Technology (ICT) is playing an important role in changing the way of teaching and learning. Traditional classrooms are becoming smart classrooms. Books have become digital and the concept of e-learning is growing among youths.

Use of portable hand-held devices like tablets, smartphones and PDAs (Personal digital assistant) have enabled us to read e-books anywhere and at any time. We don’t need to carry heavy books with us. All we need is, a small tablet device and an e-book. EduComp classrooms are the example of smart classrooms in India[10]. Technology has enabled us to take the courses of foreign universities while sitting in our rooms.

Effects of technology in the field of education.

1. Development of smart classrooms

2. Online courses (Coursera and NPTEL)

3. Course Management Systems (Moodle)

1.1 Learning by e-books: Possible shortcomings

Learning by e-books is a growing trend now-a-days, but it has certain limitations. We can summarize these limitations through following points.

1. There are more chances of distraction while reading e-books, as children may get attracted towards playing games and watching videos stored in the tablet. There must be some provision that engages them to the content of e-book.
2. According to ‘Cone of Experience’ (Figure 2.1), verbal symbols provide most abstract experience [11], while the involvement of both verbal and visual symbols like television, provides a better experience. If there is any method that makes it possible for students to listen and watch the course content, then it will be far better to grasp the concept.

3. It is very difficult for the teacher to explain concepts without any illustrative demonstration. If it is possible to get demonstrations along with reading material, it will lead to a better understanding of the course-content.

1.2 Motivation

To overcome the above mentioned shortcomings of textual e-books there emerges the concept of interactive e-books. Following are the features of interactive e-books, that has made it possible.

1. Interactive e-books have certain additional features that enables the reader to communicate with the book by watching animations, videos, and solving quizzes.

2. Interactive e-books contain interactive multimedia objects that makes them interesting to read.

3. Interactive e-books provide a much better learning environment as compared to textual e-books.

4. Interactive e-books made it possible to learn, not just by reading, but also by listening, watching, and doing.

All the above mentioned features make interactive e-books capable of bringing major changes in the method of teaching and learning.
Chapter 2

Learning and Interactivity

This chapter explains the process of learning. We will discuss the effects of interactivity on learning and will study Mayer’s rule for representing animations, to create maximum positive impact on the students.

2.1 Learning

Learning is a process of acquiring knowledge. Learning involves use of sensory organs. There are many ways by which a person can learn. Some of these methods are given below:

1. Reading: Use of Visual sensory organs
2. Listening: Use of Verbal sensory organs
3. Demonstrating: Use of Verbal and Visual sensory organs

2.1.1 Learning Hypothesis

There are two hypothesis of learning[2]. Active learning hypothesis believes, the way of teaching is a factor in learning, while passive hypothesis denies its role.

1. **Passive Learning Hypothesis**
   According to passive learning hypothesis, learning will remain same till the content to be taught is same. This hypothesis denies any role of interactivity in learning.

2. **Active Learning Hypothesis**
   According to the active learning hypothesis, learning should increase if the learner is engaged with the information content.
2.1.2 Cone of Experience

Edgar Dale, an American educationist, studied audio visual media and their concreteness in terms of experience. He displayed results in the form of a pyramid, having several layers[12]. The lower layer represents most concrete experience, while upper layer represents most abstract experience.

![Cone of Experience](image)

The cone can be divided into three main portions. Enactive means direct experience with the situation. Iconic means representing the experience while symbolic represents verbal or visual symbols.

We can observe from the Figure 2.1 that, direct purposeful experience is most concrete, while verbal symbol provides most abstract concept[11].

- **Direct Purposeful Experience**
  Direct involvement with the condition to be studied. All sensory organs are involved.

- **Iconic experience**
  It includes use of motion pictures, educational television and recordings.

- **Verbal Symbol**
  Verbal symbol is the most abstract concept e.g. narrating a concept in classroom.
2.1.3 Forgetting Curve[1]

Hermann Ebbinghaus, a German psychologist, performed several experiments to study memory. He plotted a graph, popularly known as ‘Forgetting curve’ to explain how fast the process of forgetting takes place in human beings. It shows an exponential loss in information (Black curve). The graph given below displays the forgetting curve.

![Forgetting Curve](image)

Figure 2.2: Forgetting Curve[1]

Figure 2.2 shows relationship between memory and time. It shows that, forgetting begins as soon as we learn. Grey lines represents that, if we revise the same thing each day, it becomes permanent in our memory[13].

2.1.4 Cognitive Theory of Multimedia Learning

It is based on the following three points[14]

- We have separate auditory and visual channels for processing information.
- Each channel has a limited capacity of processing, so if the channel gets overloaded, learning decreases.
- Learning is a process of filtering, organizing, and integrating. We filter relevant information, organize it in a suitable form, and integrate it with the existing source of knowledge.
2.2 Effect of Interactivity

2.2.1 Experiment of Evans and Gibbons[2]

- To analyze the effect of interactivity on students.

2.2.2 Experimental Setup

- Environment
  - Year: 2007
  - No of students 33 (22 male and 11 female)
  - Undergraduate students at a university in London
  - Topic Taught: Working of a Bicycle Pump
  - None of them had background in physics

- Procedure
  - Students were randomly divided in two sub groups
    1. Interactive Group (I Group, 16 students)
    2. Non Interactive Group (NI Group, 17 students)
  - Both groups were taught 12 stages of ‘Working of a bicycle pump’
  - Lesson was followed by two tests
    1. Memory Test (2 question, Total 14 marks)
    2. Transfer Test (3 question, Total 6 marks)
  - One hour duration for completing Lesson and quiz in a computer laboratory

2.2.3 Questions asked

- Memory Test (14 marks)
  Aim of Memory Test was to evaluate memory by recalling facts. There were 2 questions asked in this test. Question-1 was of 12 mark while Question-2 was of 2 mark. Asked questions are as below:\footnote{Questions are taken verbatim from the Paper-[2]}

  1. “Please type an explanation of how a bicycle pump works. Pretend that you are writing to someone who does not know much about pumps”
  2. “Why does air enter a pump? Why does air exit from a pump?”
Transfer Test (6 marks)
Aim of Transfer Test was to check thinking power of students. There were 3 questions, each having 2 mark, asked in this test. Asked questions are as below:

1. “What could be done to make the pump more reliable that is, to make sure it would not fail?”
2. “What could be done to make the pump more effective that is, to make it move air more rapidly?”
3. “Suppose you push down and pull up the handle of a pump several times but no air comes out. What could have gone wrong?”

2.2.4 Screen for Non Interactive Group

For non interactive group the screen contained a diagram of pump with a description of each stage in down phase and up phase. There we six stages in up phase and six stages in down phase.

Figure 2.3: Demonstration for Non Interactive Group

Questions are taken verbatim from the Paper.
2.2.5 Screen for Interactive Group

For interactive group, the first screen contained a diagram of a pump and a next button which when pressed repeatedly, shows various stages of working of pump. Interactivity was provided in three ways:

- Pace control (Learning at your own pace)
- Inclusion of two interactive self assessment questions
- Interactive simulation to inflate a balloon with the help of pump

![Diagram of a pump with interactive elements]

Figure 2.4: Demonstration for Interactive Group[2]

2.2.6 Test Result

1. Marks

<table>
<thead>
<tr>
<th></th>
<th>Transfer Test Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Group</td>
<td>2.5 (out of 6)</td>
</tr>
<tr>
<td>NI Group</td>
<td>1.8 (out of 6)</td>
</tr>
</tbody>
</table>

2. Time taken

<table>
<thead>
<tr>
<th></th>
<th>Mean Test time</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Group</td>
<td>785.5 seconds</td>
</tr>
<tr>
<td>NI Group</td>
<td>1160.8 seconds</td>
</tr>
</tbody>
</table>
2.2.7 Time spent on Lesson and Time spent on Test

Figure 2.5 shows the interactive group took more time for lesson, but took less time for Test as compared to non interactive group.

![Figure 2.5: Time spent on learning and time spent on test](image)

2.2.8 Conclusion

- In transfer test, Interactive group gained good marks as compared to Non-interactive group
- Interactive group took less time for attempting quiz.

2.2.9 Similar Work

Studying the Impact of Using Multimedia Interactive Programs on Children’s Ability to Learn Basic Math Skills[15]:

- This paper aims to check the effect of using multimedia methods on learning.
- Grade 1 students were selected for this experiment and were divided in two groups. Traditional group: 122 students, Multimedia group: 123 students
- One group was taught using multimedia containing animations, sound and cartoon characters while for second group, traditional approach was used. A test was organized to check the effect.
- Mean score of traditional group was 8.05 while that of Multimedia group was 8.47
2.3 Animation in Learning

Animation may work as a great tool in the field of education. According to Richard E. Mayer, a famous educationist, animations do not always lead to deep learning, but learning actually depends on the way animation is represented[14]. He proposed seven principles for representation of animations so that maximum learning can take place[14]. These principles are as follows:

- **Multimedia Principle**
  Animation presented with narration is more effective way of teaching, rather than narration alone. If a teacher is narrating some abstract concept, it takes a lot of imaginative power to understand the idea. Animation makes it possible to visualize the situation, and hence, students can grasp the concept very well.

- **Spatial Contiguity Principle**
  Animation should be close to relevant text. This helps in establishing a connection between animation and text, so that students can grasp the concept better.

- **Temporal Contiguity Principle**
  According to this principle, animation and narration should be presented simultaneously. If we are presenting animation followed by narration or vice versa, student will find it difficult to understand the concept.

- **Coherence Principle**
  According to this principle, sound, video and words that are irrelevant to topic, should be excluded, as learner may focus on these and may miss the actual content that needs attention.

- **Modality Principle**
  According to this principle, animation presented with narration is a more effective way of teaching, rather than using animation with text, as the former involves the use of both auditory and visual sensory organs, while the latter needs just visual.

- **Redundancy Principle**
  According to this principle, animation presented with narration is more effective way of teaching, rather than presenting animation and narration along with text.

- **Personalization Principle**
  The narration in class should be in conversational style (e.g, using I and We) rather than formal style. With conversational style, student feel engaged with the course content.
Chapter 3

Future of e-books: Bringing interactivity to e-books

With the growth of technology, the number of people reading e-books has also increased. Today, most of the e-books provide the facility of only text and images, but there is no feature of rich media content like audio, video, and interactive demonstrations. Technology has progressed a lot in the past few years, but the education system is still based on ‘chalk and talk’ method. With the passing of time, there is a need of interactive e-books, to make the learning more interesting and enjoyable. This was the main concept behind the evolution of interactive e-books.

While reading e-books, only visual sensory organ is involved, and thus, students do not feel engaged with the course content. Interactive e-books have an upper hand in this case.

Features provided by interactive e-books are as follows:

1. Support for audio content
2. Support for video content
3. Support for SVG (Scalable Vector Graphics)
4. Support for in-book quizzing
5. Support for reflowability of content
6. Better educational environment
7. Interesting to read
3.1 ePub[3]

ePub is a open standard e-book format developed by International digital publishing forum. File extension for ePub is .epub.

3.1.1 Features of ePub

1. Reflowability of Content
ePub provides the feature of reflowability i.e. an ePub document can adjust its content as per display of any device. For example, it will display the same content differently on mobile phone than a tablet.

2. Free and Open
ePub is a free and open standard format of e-books. It provides the following features

   - It can be used by anyone.
   - No proprietary rights
   - It is not restricted to particular hardware format

3. Support for interactive features
ePub provides support for

   - Audio Files
   - Video Files
   - Quizzes using JavaScript

4. Support for MathML
ePub provides support for MathML which is helpful in writing mathematical equations. It is a part of HTML5. MathML makes it possible to display mathematical equations in the form of text in the book, and thus, we do not need to use images for representation.

5. Styling based on CSS
   CSS i.e. Cascading Style Sheet, is used for managing the design of HTML page. ePub format is also based on HTML, so we can use CSS for its design.

6. Support for SVG
   The main feature of SVG i.e. Scalable Vector Graphics is, that their quality does not degrade even when they are zoomed.
3.1.2 Evolution of ePub

ePub is the official standard of International digital publishing forum since 2007. In 2011, there came another improved version of ePub.

3.1.2.1 Versions of ePub

The current version of ePub is 3, known as ePub3. The previous version 2.0.1 had certain limitations and was not interactive as ePub3.

1. Version 2.0.1
   The main feature of this version was reflowability of content.

2. Version 3
   It is the current version of ePub. It came to existence in 2011. It has certain additional features as compared to the previous version. The features are listed below[16].

   • Support for audio and video
   • Support for MathML
   • Support for CSS3
   • Support for HTML5
     It is actually HTML5 that allows integration of video and SVG in the e-book. It seems to be a much accepted version of HTML due to its features.
   • Support for SVG

3.1.3 Comparison of ePub and PDF[4][5]

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<th>ePub</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed by</td>
<td>Adobe Reader</td>
<td>IDPF</td>
</tr>
<tr>
<td>Rights</td>
<td>Open standard</td>
<td>Open standard</td>
</tr>
<tr>
<td>Text Reflowability</td>
<td>Not automatic</td>
<td>automatic</td>
</tr>
<tr>
<td>Popularity</td>
<td>More popular</td>
<td>still in development phase</td>
</tr>
</tbody>
</table>
### 3.2 Spoken Tutorial[6]

Spoken tutorials are video lectures with audio narration of the slides, which are demonstrated through the video. The audio can be changed to any language. These tutorials are like capturing a slide-show, used by teacher in class, in video mode. Following are the main points:

- Size is low
- People with poor English will be able learn
- Narration in Indian accent makes it easy to understand
- Learning at a speed that suits you better

#### 3.2.1 Tools for creating e-books[7]

1. iBooks Author[17][18]
   - e-book authoring tool
   - Organization: Apple
   - Year: 2012
   - License: Proprietary
   - Anyone having a Mac can create interactive e-books with help of iBooks Author

2. Pubbsoft[19]
   - online website (http://pubbsoft.com/) for creating animated books for i-pad and i-Phone
   - free to use
   - Interface based on drag and drop
   - No programming required, designed for non technical users

3. Sigil
   - Open-source
   - Allows WYSIWYG editing for ePub ebook
Chapter 4

Interactivity in e-Pub

ePub allows the use of HTML5, CSS and JavaScript. All these can be used for creating interactive ePub e-books. HTML5 allows an option for embedding videos. JavaScript can be used to create quizzes.

4.1 e-book with Video Demonstration

Figure 4.1 shows a snapshot of a created book, which has an embedded video for narration of story described in the book.

![The Ant and the Grasshopper](image)

One summer day a grasshopper was singing and chirping and hopping about. He was having a wonderful time. He saw an ant who was busy

Figure 4.1: A book having embedded video
4.2 e-book with quiz

Figure 4.2 shows a snapshot of a created book, which has an embedded quiz at the end of the chapter.

![Check or Understanding](image)

**Score =** [Blank]

Figure 4.2: A book having quiz

4.3 Structure of ePUB[3]

Epub is a zip archive that contains various files. It mainly contains a ‘mimetype’ file and two directories ‘OEPBS’ and ‘META-INF’. Figure 4.3 shows the structure of this archive.

1. mimetype
   mimicity, also known as Internet media type, is used for identifying a file format over Internet. mimetype has two parts separated by a Forward slash. epub format has application(epub+zip as mimtype. This file must be the first file in the zip archive in uncompressed form.

2. META-INF Directory
   This directory contains only single xml file named as container.xml. container.xml gives the path of a file, content.opf, which contains the address and mimtype of all the files contained in OEPBS folder.

3. OEPBS Directory
   This directory contains all the data files like audio, video, images, html, and CSS in respective directories. It also contains two xml files named as content.opf and toc.ncx.
Figure 4.3: Directory Structure of ePUB

- **content.opf**
  It contains the details like author name, title, date and publication in metadata section. It also gives the address and mimetype of all the files contained in OEPBS directory, inside manifest section. It contains a spine section that tells the order in which the files have to appear in the book.

- **toc.ncx**
  It is also a xml file that gives details like book title and author. It contains table of content.
Chapter 5

Problem Formulation

Interactive e-books can be a success, only if every student uses tablets and other similar devices for studies. Use of technology is not enough in India. Being a low cost device, Aakash Project may be a key factor in changing this scenario, provided useful study material is made available for every domain of study.

5.1 Contribution

During M.Tech. stage-1 project, I identified some methods that provides interactivity. I created some ePub interactive books. The created books contained

- embedded video
- embedded quiz

Figure 4.1 and 4.2 shows the snapshots of created book.

5.2 Problem Statement

Bringing Interactivity to e-books is a recent concept in education. Its success depends totally on the use of tablets and other similar devices, by the students. Interactivity in education can be a revolutionary idea, if implemented properly. The following are the possible works that will be done further in this project.

1. Searching other possible ways of making books interactive

   Interactivity in e-books can be embedded in many ways like

   - Embedding playful educational applications in books
   - Embedding quizzes in e-books
   - Embedding educational videos in the e-books
All these features are possible to embed and many other ways may also be possible. It is one of the goal for Project stage-2, to discover other possible methods of providing interactivity.

2. Creating a tool to automate the process of creating interactive e-books

There are very limited tools available for making interactive e-books, and most of them are having certain limitations. Some tools generate e-books that work only on some particular platform like pubbsoft creates e-books for i-Pad and i-Phones only. It is one of the goal for Project stage-2, to create a tool, that automates the process of creating interactive e-books.

5.3 Future Work

This section suggests the possible ways by which the goal describes in previous section can be attained in Project stage-2.

1. HTML5 and JavaScript will be explored to know various possible ways by which interactivity can be brought to ePub e-books.

2. An automation tool will be created, that takes text and interactive media as input and produces an interactive e-book.
Chapter 6

Conclusion

Today, most of the e-books provide the facility of only text and images. They lack interactive features like audio, video, and interactive demonstrations. Interactive e-books are needed to make the learning more interesting and enjoyable.

ePub brings interactivity to e-books and provides certain interesting features that can be helpful in understanding complex concepts by the students. It’s automatic reflowability feature allows text to be displayed on devices of all screen sizes. ePub is still in development phase, and thus, many more features may be added in future. Developing an interactive ePub e-book is also not so typical. It only requires knowledge of HTML and XML.
References


