An interactive digital book for engineering education students

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ABSTRACT: Digital books are an in-demand future trend in books. One of the technical standards for electronic books, which has potential and which is beginning to be considered in academia and industry is the EPUB (an electronic publication in e-book file format with extension .epub) published by the International Digital Publishing Forum (IDPF). Compared to the PDF format, EPUB has a richer, interactive and reflowable content, so it is accessible through a variety of desktop and mobile devices. However, despite its potential, EPUB is still not widely used, especially in Indonesia. Therefore, proposed in this article is a design of an EPUB interactive digital book for engineering education. Test results show that the product is valid and error-free. Students were enthusiastic and highly interested in using the EPUB digital book and its interactive features.

INTRODUCTION

In the digital age, information retrieval is dominated by digital data. An example of information retrieval is that of reading a book where there has been a trend from printed to digital. Hence, digital books (e-books or electronic books) are growing in demand. In addition to being popular with the public, the e-book is also having an impact on education. Schools and higher education institutions have begun to introduce e-books into the teaching process. The industry has responded positively, with many textbooks including an e-book format [1][2].

Although the term, e-book, has been used for some time, there is still no definitive definition, but rather a variety of slightly different definitions. Hawkins argues that an electronic book is the contents of a printed or physical book made available in a digital or electronic form [3]. According to Landoni, an e-book is a digital medium in which information is organised and structured in order to be presented to the reader [4]. Morgan gives a more specific definition of an e-book as a combination of hardware and software/application aimed at supporting the reading of digital information on specially designed mobile devices [5]. The definition of an e-book has been expanded to include any information, file format or on-line book that can be retrieved by a mobile device or personal computer [6]. It can be concluded that digital books can be electronic/digital forms of printed books that may contain digital data content (e.g. text, images, animations, audio and video) and are accessed through an electronic reading device, whether fixed or mobile. However, electronic books can be born as e-books.

At present, there are dozens of electronic book formats. One with potential for academia and industry is the EPUB (electronic publication). Compared to the older and widely used PDF format, EPUB has a richer, interactive and reflowable content that is accessible through a variety of desktop and mobile devices (e.g. tablets, PCs, smartphones). The OEBPS (Open e-Book Forum Publication Structure) is an open standard document file format of the IDPF (International Digital Publishing Forum) for an electronic/digital book. The IDPF is an association of the digital publishing industry.

The IDPF officially approved EPUB in October 2007 and since 2008 it has been widely used by major publishers. The EPUB replaced Open e-Book as an open public format. The EPUB is not a new specification, but is built using XHTML and DTBook (Daisy XML) that represents the content of documents with the layout and formatting specified by CSS (Cascading Style Sheets) [7]. The EPUB format is widely used by publishers and application developers. Since version 2 in 2007, EPUB has been widely used including in academic journals [8].

Unfortunately, despite its potential, EPUB is still not globally used, especially in Indonesia. To produce EPUB documents requires following strict requirements and some knowledge of HTML, XML and XHTML. On the other hand, a user can create a PDF document with *the touch of a button* and no programming knowledge needed.

Therefore, much effort is required to introduce EPUB to the wider community. The aim of this research was to design an EPUB interactive digital book suitable for higher education. The selection of higher education is based on a TR (technology readiness) theory, which states that the TR level is influenced by the level of education [9]. So, higher education is most suitable for applying information technology.

METHODS

The product produced by this research was a design of an interactive digital book using the EPUB 3 document format. By comparison with the traditional textbook, EPUB 3 has richer content that can increase a student's interest and help learning [10]. The EPUB has interesting features, such as support for rich content, reflowable layout, read-aloud features and interactive content [11]. The internal document structure of EPUB has a public and open structure, so it is easy to create, modify and integrate them into documents [7].

The specifications for the product development were well identified, including the necessary supporting technologies. The software development used the waterfall process model. The waterfall model used was proposed by Pressman [12]. In his latest book, Pressman has revised this model into five main stages, viz. starting from communication, planning, modelling, construction and deployment.

The waterfall model was appropriate to use in developing the product. The stages of the waterfall model are as follows:

1) Communication

    Communication is the most important first stage on which the overall success of the project is predicated. There are two sub-stages; namely, project initiation and requirements gathering. The communication phase is important because, if there is miscommunication the project may fail or produce a product meeting the wrong requirements.

2) Planning

    Project planning identifies and organises the activities within a project. There are three planning activities; namely, estimating, scheduling and tracking. The estimate aims to measure the length of time and resources needed to complete an activity; the implementation schedule shows the order and organisation of the activities, while the tracking tracks the activities to ensure they are completed as planned.

3) Modelling

    Design and analysis are the two activities in the modelling phase. Results from the requirements gathering are used to establish the software design for the product. In this activity, all requirements gathered in the earlier phase are broken down into logical units for ease of implementation.

4) Construction

    Construction or software generation is the phase where the previous modelling results are translated into a machine-readable software application. The coding phase begins by defining the supporting technologies, such as the environment and programming language. Aspects related to product behaviour and structure are determined.

    Once the application has been built, it is necessary to make sure it meets the requirements specification through a series of tests. Evaluation ensures the product's compliance with the specifications. The product evaluation is divided into two activities; namely, internal and external evaluations. The internal evaluation is conducted by the product development team and the product may be subjected to further revision during this activity. The external evaluation involves experts testing the application. For the product developed here, these would be media experts.

5) Deployment

    The last phase aims to deliver the product for use by the target users. In this phase, technical support is provided and feedback garnered from the users.

The phases of the waterfall model of software development were carried out systematically and sequentially. Each stage in the model was required as input to the next stage until all the stages were completed [13]. This ensures a well-understood process was followed leading to the production of a highly cohesive product.

RESULTS AND DISCUSSION

In order to facilitate the use of the product e-book, its structure conformed to that of a general printed book. The first page was the cover page, then the copyright page, introduction page, table of contents page, chapters, and so on. As a textbook for general learning, the book contains basic materials and exercises. The main advantage of this e-book

is an interactive feature realised through the HTML text editor. This allows users to type in HTML code and view the result immediately without having to open the browser. Results are displayed using a *Preview Tab*. The digital book design with the interactive HTML text editor feature is shown in Figure 1.
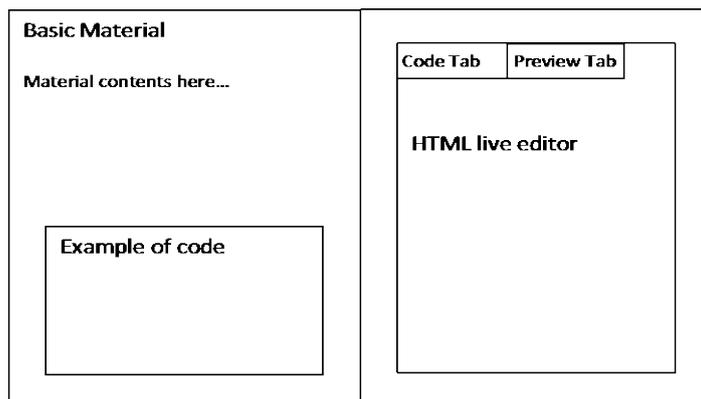

Figure 1: Content design of the digital book.

This digital book design supports text, pictures, audio, animation and video. Multimedia elements may increase a student's motivation and many studies have revealed that the implementation of multimedia content in learning provides tangible benefits. The multimedia-based learning system approach can effectively achieve resource sharing as well [14]. According to Ni, teaching with multimedia content improves learning and makes language learning more effective [15]. Figure 2 shows text and images in the developed digital book.
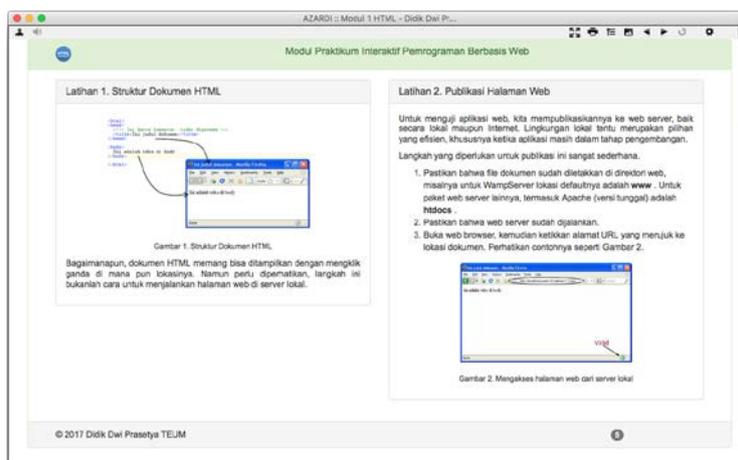

Figure 2: Learning material content.

The interactive HTML text editor (see Figure 3) is another useful feature, which simplifies the steps in creating HTML code. To develop a Web application requires at least three software tools, viz. a text editor, Web browser and Web server [16]. But, with this digital book, only one book page is required with no need to move to another window. In order to facilitate students typing HTML code, line numbers are provided in the text area. In addition, the text editor supports highlighting tags, where each HTML tag type is given a different colour from that of plain text.
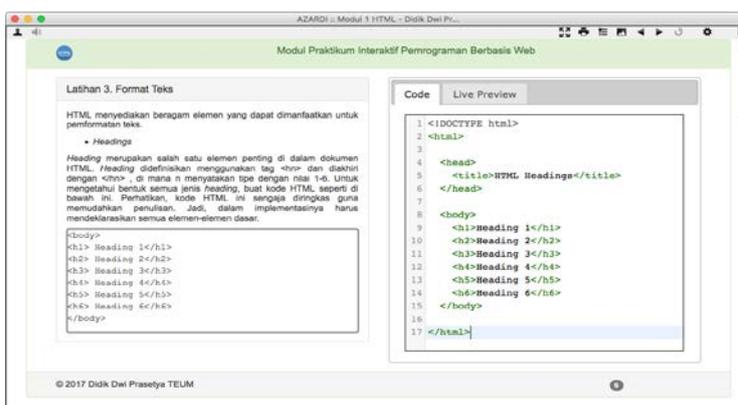

Figure 3: Interactive HTML text editor.

This interactive text editor allows students to write HTML codes and view the results directly using a preview tag. The use of tabs is intended to help students by not requiring them to move to other pages or sections. The preview results of an interactive HTML text editor are shown in Figure 4.
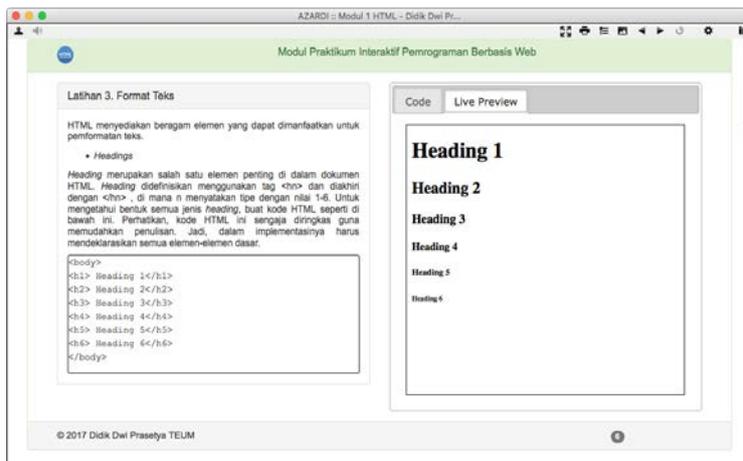

Figure 4: Preview result of the interactive HTML text editor.

Interactive is often used to describe the relationship of two things influencing each other. Interactive media can be defined as the integration of various digital media content including multimedia elements (text, graphic, audio, animation and video) into a structured, attractive digital computerised content, which facilitates a dynamic interaction for specific purposes [17]. The interactive digital book allows users to interact dynamically [18]. An interactive approach is interesting and desirable, because users will get dynamic or unpredictable reactions to their actions. Interactive content is also highly favoured by educators who want to involve their students in an ICT (information and communications technology) learning environment [19].

Another feature provided by the digital book is a reflowable design, in accordance with the EPUB 3.0 specifications. In contrast to a fixed layout (for example PDF), reflowable content will present the book corresponding to the screen size of the reader device [11]. For example, the size of an image in portrait and landscape is not the same. Thus, mobile devices (e.g. smartphones and computer tablets) get a best display when accessing a reflowable design. In the reflowable layout design, page views when accessed with a smartphone generally will be in the form of a single column, for example, as seen in Figure 5.

Figure 5: The view of the digital book on a smartphone.

At present, there are two main types of e-book, fixed layout and reflowable formats [11]. As the name suggests, a fixed layout is fixed like a printed book, so it also will be fixed on the user's reader, e.g. a PDF document format. Standard or reflowable formats are known as fluid e-books. In contrast to fixed layout, reflowable formats will present the book corresponding to the screen size of the reader device. The EPUB specifies a reflowable format, which allows the user to

use various electronic reader displays without the need to reformat the content of the electronic book [20]. Fixed layouts do not have control over fonts, font sizes and margins for different screen sizes making it potentially uncomfortable for the reader.

Small-scale testing was conducted to ensure that the design of the interactive digital book met the specifications. The test was limited to ten students on the Web programming course who should be able to distinguish the classical approach from the interactive use of this digital book. The students are shown in Figure 6.

Figure 6: Testing the developed digital book.

The students used the digital book, and then answered a simple questionnaire that asked whether the design of the product was interesting and feasible to use or not. All participants expressed satisfaction with the product and thought it very helpful.

CONCLUSIONS

The implementation of digital books has great potential and has become a trend in today's society. Digital books are compact and accessible anytime, anywhere using a variety of electronic devices, both fixed and mobile. The EPUB format digital book is well-suited for use as a future textbook format. The EPUB has a rich, interactive and reflowable content, so is accessible through a variety of desktop and mobile devices. This supports flexible mobile learning and makes it suitable for today's learning, which relies heavily on electronic equipment.

Therefore, the approach to digital book design described here is appropriate and can be used as a reference for anyone who wants to develop a digital book. This format has rich features making the content of digital books more varied and accessible. The interactive HTML text editor allows students to learn and practise coding in a practical and easy-to-use way. The interactive EPUB digital book solution is most precise in guiding and assisting the user to write practical HTML code. Test results show that this product can support electronic learning. Students were enthusiastic about using this product and expressed interest in its supplementing their learning.

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