



Enhancing Learning Outcomes of Undergraduates with Cloud-Based Textbook in Higher Education

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Abstract. Learning Outcomes have been attracting more and more attention from higher education. Many scholars have adopted related learning theories and cognitive theories to improve teaching and learning. But few studies on enhancing learning outcomes with textbooks are available so far. Our research aims to discuss improving the learning outcomes of undergraduates with cloud-based textbooks in higher education. We designed a book for the C programming language as an instance of a cloud-based book. The contribution of this research is that we present a novel approach to enhancing students learning outcomes in higher education by integrating the advantages of E-textbooks and the practice of learning theories into a cloud-based textbook. Our research helps teachers to understand the characteristics of cloud-based textbooks. The application encourages instructors to design or use cloud-based textbooks to improve learning outcomes.

Keywords: Cloud-Based Textbook · Higher Education · Learning Outcome · Undergraduate

1 Introduction

The outcome-based education paradigm seems to have permeated every corner of most universities globally. Instructional strategies or approaches based on learning outcomes have been attracting increasing interest. Various methods have been advocated to improve the learning outcomes of students. Different active teaching tools were introduced for higher education in an online course during the COVID-19 pandemic [13]. Methods abound about how to assess learning outcomes. Fuzzy relations have been adopted to evaluate the learning outcomes of students [11]. Susanna and colleagues reviewed the concept of active learning and the measure of learning outcomes in higher education with 347 selected papers published from 2000 to 2018 [5]. Besides approaches for assessing learning outcomes, models have been designed to predict learning outcomes. For instance, a neural system has been applied to successfully predict students learning outcomes in a computer science course [10].

Those studies are valuable for improving students learning outcomes in higher education. However, textbooks are an essential resource for both students and instructors. There is a lack of research on how creative or novel textbooks enhance students learning outcomes. Therefore, this paper presents a cloud-based system for developing innovative textbooks with rich resources for higher education. A cloud-based textbook named C programming language is also created through the platform, which demonstrates the application of the designed system.

2 Literature Review

Although textbooks have been a critical pedagogical tool for centuries, there are some disadvantages to traditional textbooks. The increasing costs of textbooks are a financial burden for many students [9]. One or more textbooks often are required for a course in higher education. Most faculty identify cost as an essential factor in selecting books needed for their classes because the high cost of educational resources and textbooks is a barrier to many students [14].

The other disadvantage is the lack of interaction. Traditional paper-based textbooks are static and cannot provide interactive tasks for students. Some vital learning resources, such as videos and quizzes, cannot be embedded in books.

With the emergence of the internet, people are used to accessing information on the network. There are many advantages of electronic books [16] and E-textbooks find their place in universities. One of the benefits is a low cost. An electronic book usually costs lower than its printed counterpart. Moreover, some e-books are available freely online. The other advantage is the convenience of carrying and storing e-books. One can have many books on reading devices and at fingertips. An E-textbook can also be updated more quickly than paper textbooks. The feature without printing makes E-books more environmentally friendly.

However, there are some disadvantages to E-textbooks [16]. For example, an E-book usually requires a particular reading device. Students still perceive textbooks as their primary learning resources because of time restraints and the demands of the course assessment even though instructors recommend textbooks produced by commercial publishers to students in higher [6].

The advantages and disadvantages of electronic textbooks inspired us to develop cloud-based books by keeping the benefits and reducing the burdens of E-textbooks.

3 The Design of a Cloud-Based Textbook Editor

3.1 Cloud Computing

The technology term “cloud computing” has been pervasive in different domains and has attracted attention. Cloud computing is a model instead of a single technology. A user can assess computing resources, such as servers, applications, development tools, and more, through the internet on-demand. Although most of us have been using cloud computing services almost every day, there is no uniform definition of cloud computing. Definitions from commercial groups try to describe cloud computing from the view of

end-users, and definitions in the scientific literature include both the end-user perspective and architectural facets [15]. Madhavaiah and Bashir collected and studied thirty-six definitions of cloud computing and provided the following definition for cloud computing [8].

Cloud Computing is an information technology-based business model, provided as a service over the internet, where both hardware and software computing services are delivered on-demand to customers in a self-service fashion, independent of device and location within high levels of quality, in a dynamically scalable, rapidly provisioned, shared and virtualized way and with minimal service provider interaction.

Despite abounding definitions, they share some characteristics of cloud computing such as service-oriented, loose coupling, strong fault-tolerant, business model, ease of use, and so on [4].

There are three typical service models for cloud computing, including software-as-a-service (SaaS), platform-as-a-service (PaaS), and infrastructure-as-a-service (IaaS) [12]. A software application runs on the cloud, and multiple end-users use it in the SaaS model. The online office document and Gmail services are good examples of SaaS. The PaaS model provides developers with remote environments, in which developers create and deploy applications in the PaaS model. One of the PaaS services is Azure provided by Microsoft. And IaaS gives users virtual servers. Amazon EC2 is an example of the IaaS model.

The benefits of cloud computing in education include personalized learning, reduced costs, accessibility, no extra infrastructure, and so on [7]. To lift the burden of maintenance and installation with traditional systems, we adopt SaaS in our research because textbook creators need access to and use the application to create textbooks from anywhere. Furthermore, the SaaS model will facilitate the use of textbooks for learners.

3.2 The Architecture of the Cloud-Based Textbook Editor

We keep the following principles in mind when designing our Cloud-based textbook editor (CBTE). Concerning material resources, authors would be able to create all types of content that appeared in traditional textbooks with the CBTE, such as texts, pictures, formulations, etc. Besides, audio and videos should be placed in the textbook through the CBTE. Of course, the basic features of Hyper-Text Mark Language (HTML) are provided in CBTE. One of these features is the hyperlink. With a hyperlink mark, a creator can link different resources, either in the same book or other network web page, into the book.

Regarding access, textbook creators could access the editor anywhere and anytime as long as the internet is available. As for the usage, authors can use the editor to create or view their books through any web browser on their devices by accessing the cloud application.

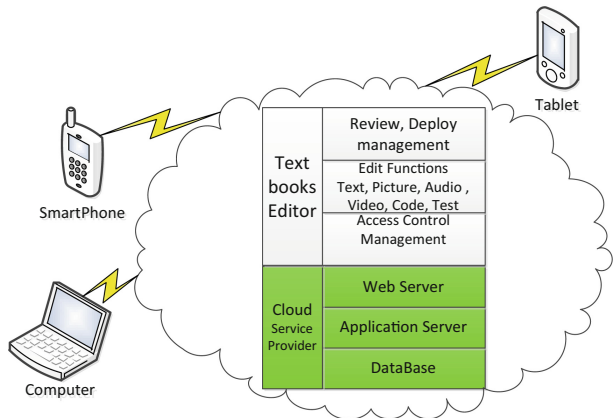


Fig. 1. The architecture of cloud-based textbooks.

The primary functions of the cloud-based textbook editor consist of access control management, edit model, review, and deploy management. However, the access control model works in the background without causing notice from users. But control management plays a critical role in preventing illegal access or operation. The edit area is where an author works most of the time. An author can type, copy, and paste texts as operations in office word. Moreover, various kinds of content can be added, such as programming code, hyperlinks, and tests.

The review and deploy management includes adding a book, previewing undertaking books, and deploying a book. Learners or readers can access a book only if the author has deployed the book.

Cloud providers are responsible for other requirements needed. These resources include database, application server, web server, network, etc. Textbook creators can assess the platform through a web browser from different devices, such as smartphones, tablets, and computers. The architecture of the cloud-based textbook edit system is shown in Fig. 1.

This platform provides a flexible approach to organizing books. A creator can develop one or more books independently with the system. Each book contains one or more chapters, and one chapter is composed of sections. Different kinds of resources have places in an area. The relationships among elements for a cloud-based textbook are shown in Fig. 2.

We incorporate related learning theories into our artifact when designing the cloud-based textbook editor. The first one is that prior knowledge influences learning [2]. Therefore, we consider how textbook creators use the editor and readers use textbooks when designing this platform. Another principle is that instant feedback combined with goal-directed practice enhances the learning quality [1]. According to this principle, we present the quiz and explanation function on the platform. With this model, a book creator can insert quizzes, answers, and explanations into the book.

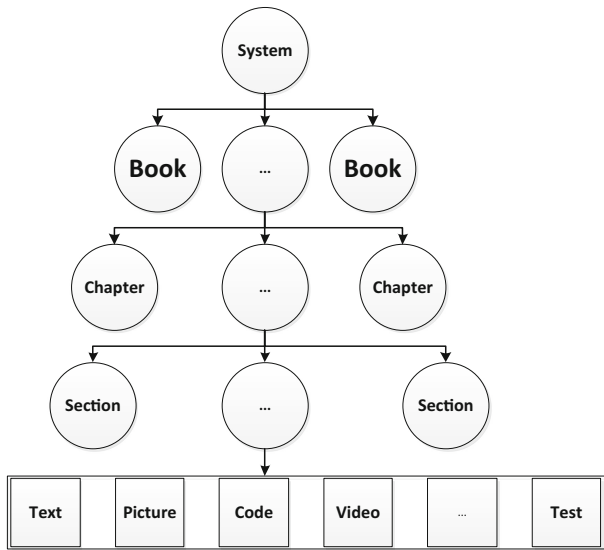


Fig. 2. The relationships among elements.

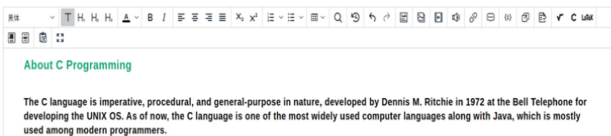


Fig. 3. The editor for cloud-based textbooks.

4 An Instance of Cloud-Based Textbooks

C language is a general and basic programming language. C programming language has been a compulsory foundation course for majors in science and engineering [3]. In our university, the Beijing Institute of Graphic Communication, C language is the first programming language for students. It is a 48-hour compulsory course for majors such as computer science, logistical engineering, and mechanical engineering. And it is also a 32-hour course on the list of alternative courses for all non-engineering majors, such as art and design and new media.

It is challenging even for engineering students to learn the C language in such a short time course. Therefore, instructors assume it is normal when non-engineering students complain that the C language is too hard. We believe that if we could organize the textbook in a different way aligned with learning theories, even non-engineering students can achieve better learning outcomes. And we explored designing a cloud-based book for C language courses for students who enrolled in the course as an elective.

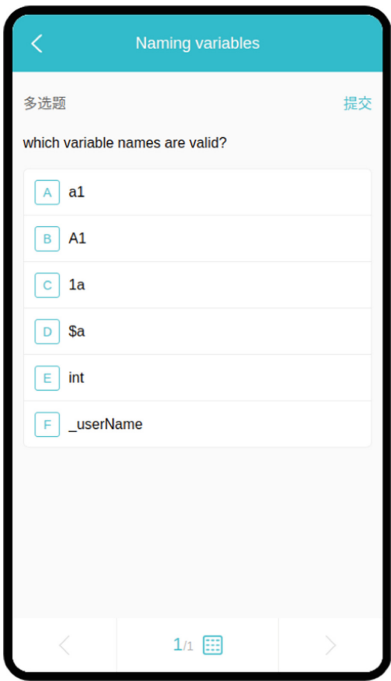


Fig. 4. Quiz function.

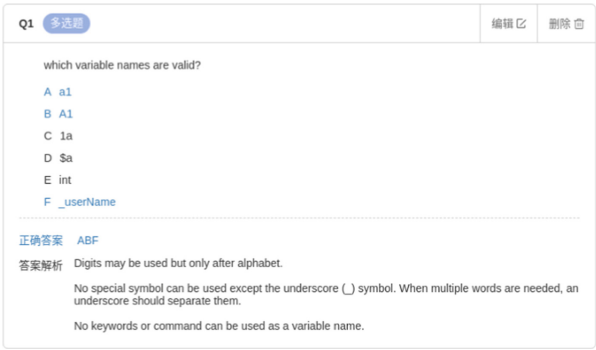


Fig. 5. Quiz and explanation.

An author can edit a textbook online just like editing an office document as shown in Fig. 3. This feature lowers the barrier to editing cloud-based textbooks. Authors proficient in office document software can develop a book without difficulty.

Another characteristic is that an author can insert an assessment into the textbook, as shown in Fig. 4.

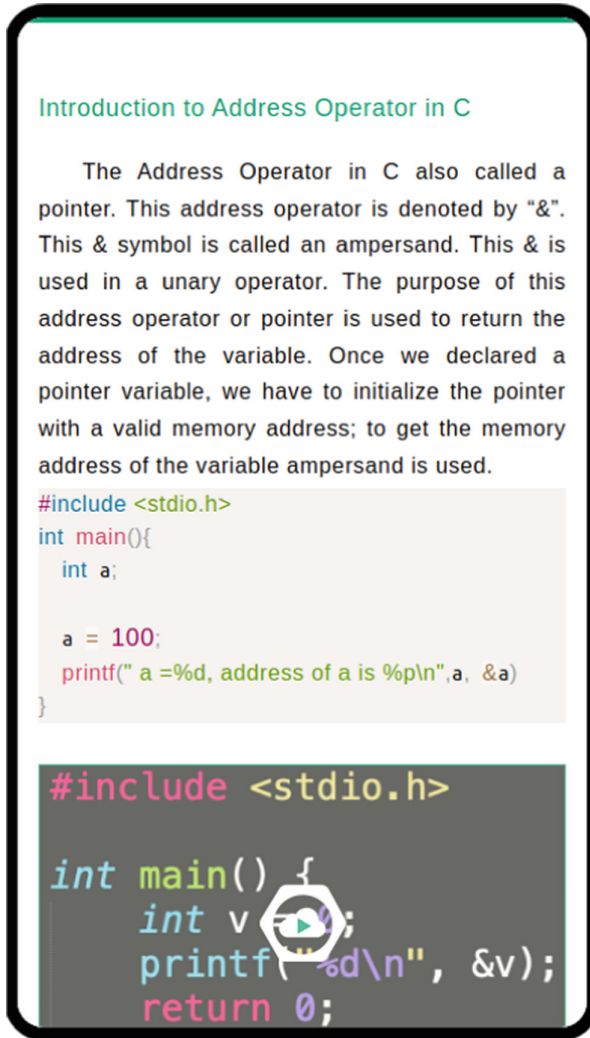


Fig. 6. Access the cloud-based textbook from a mobile phone.

For example, when learning variables, a student reads text content about the rules of naming a variable. Then students can take a quiz to assess their understanding. This instant evaluation and feedback help students learn efficiently.

Besides text and quizzes, other import learning resources for learning the C language, such as code and videos, can also be inserted into cloud-based textbooks.

The author can choose different types of questions, such as single choice, multiple-choice, blank filling, and coding, with answers and explanations, as shown in Fig. 5.

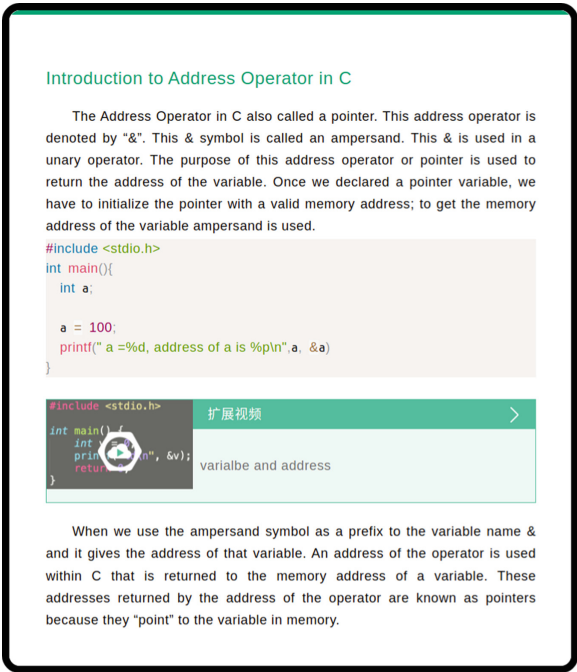


Fig. 7. Access the cloud-based textbook on a tablet.

This cloud-based C language textbook provides students with many advantages to enhance students learning outcomes:

Firstly, students can access the books from anywhere on various devices as long as network access is available, thanks to the features of cloud computing. For example, students access the textbook from a mobile phone and a tablet, as shown in Fig. 6 and Fig. 7, respectively.

Secondly, students can watch videos provided in the cloud-based textbook along with code, as shown in Fig. 8. Videos help students understand some complicated concepts in C language, such as the fundamental concept of the pointer.

Thirdly, the cloud base textbook provides students with instant feedback with quizzes. Prompt feedback is a key to encouraging learning. Also, students can copy and try the C programming code contained in the cloud-based textbook flexibly. This learning by doing method enhances students' learning outcomes too.



Fig. 8. Video and C programming code.

5 Conclusion

This paper presents an online editor for authors to create cloud-based textbooks. The application of the designed editor is also demonstrated by developing a C language programming textbook. The benefits of a cloud-based book include low cost, easy use, and rich learning resources such as quizzes, feedback, and videos. The contribution of this research is that we present a novel approach to enhancing students learning outcomes in higher education by integrating the advantages of E-textbooks and the practice of learning theories into a cloud-based textbook. However, we have not provided any empirical data on students learning outcomes, which we will carry out in the future.

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