IIAI Open Conference Publication Series
IIAI Letters on Informatics and Interdisciplinary Research
Vol.005, LIIR229
DOI: https://doi.org/10.52731/liir.v005.229

Development and Proposal of an Interactive Educational Platform Based on the Concept of Augmented Intelligence

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Abstract

This research proposes a new form of digital educational content model, "Dynamic Textbook," which combines artificial intelligence (AI) and education. In recent years, in distance learning, the proliferation of digital learning materials and online learning platforms has made it possible to optimize learning for individual students, irrespective of time and location constraints. However, this learning is predominantly in the form of on-demand teaching, which does not facilitate interactive learning between educators and learners. Therefore, this research proposes a "Dynamic Textbook," which incorporates learner feedback and new information. "Dynamic Textbooks" enable an interactive learning process rather than traditional one-way learning and promote learners' active participation. Moreover, it views the use of neuro-symbolic AI as a goal to create interactive and new digital educational content. In this research, we developed a prototype system with four main functions namely, presentation area, thumbnail navigation, interactive chat area, and AI-integrated response system and proposed its usefulness arising from its functionality and interactivity.

Keywords: Augmented Intelligence, Artificial Intelligence, Education, Dynamic Textbook, Neuro-symbolic AI

1 Introduction

Recent advances in digital technology and developments in artificial intelligence (AI) have made the educational experience increasingly personalized and interactive. We explore how AI can revolutionize the field of education. This research proposes the development of a new form of digital educational content model, the "Dynamic Textbook," which utilizes neuro-symbolic AI. This system aims to improve the learning experience by eliminating the problems faced by students in one-way lectures during distance learning. Traditional textbooks and web information have been used as a means of one-way knowledge transfer for students. Using the water metaphor to describe this, a static textbook is as quiet and motionless as a pond, whereas web information is as unstable and unpredictable as a rough sea. However, the "Dynamic Textbook" proposed herein considers a system with a constant flow and direction, like a stream.

It aims to incorporate new information flexibly and provide learners with a constantly fresh learning experience. Advances in digitalization and artificial intelligence (AI) have opened new possibilities for education, but innovation is needed in the educational infrastructure to properly utilize them and increase learner engagement. Therefore, this research proposes a new digital educational content model as a basis for furthering the use of AI in education.

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2 Background

The wave of digitization in education has improved accessibility and facilitated the diversification of learning styles. The proliferation of digital course materials and online learning platforms has enabled learners to have individually optimized learning experiences without being restricted by time and location. Despite these innovations, interactive dialogue between learners and educators is not always facilitated. In the traditional structure of learning, the educator is the mediator of knowledge and conveys information in one direction to the learner. However, the introduction of "Dynamic Textbooks" is expected to make learning more active by enabling feedback from learners and the incorporation of new information in real time. This process can be described as a circular learning content development process. We believe that the flow of the educational content is analogous to that of water. Web information is a rough sea of information characterized by rapid changes and unpredictability. By contrast, textbooks are like ponds wherein the flow of information has stopped, with minimal change and stability. The "Dynamic Textbook" proposed herein is a system that flexibly incorporates new information while maintaining a constant flow, like a stream. We believe that this method can provide learners with fresh knowledge consistently.

3 Purpose

This research's underlying aim is to open new horizons for interactive digital content in education by utilizing neuro-symbolic AI. Traditional education models focus on the one-way transfer of knowledge. By contrast, "Dynamic Textbooks" enable an interactive learning process and promote learners' active participation. The following are the items that we believe can be improved through this research.

3.1 Facilitating Learning Dynamism

Learning dynamism involves moving away from the static provision of information and providing learning content as a living entity, thereby keeping learners up-to-date and engaged in their learning.

3.2 Eliminating One-way Learning

To date, learning has been a one-way flow of information transfer, with teachers taking the lead. However, "Dynamic Textbooks" enable active learning by incorporating student feedback and new information in line with the times.

3.3 Improving the Learning Experience

For distance education students, one-way lectures detract from the learning experience. This research aims to improve the learning experience through interactive content and create an environment wherein learners are more actively engaged in the classroom.

"Dynamic Textbooks" function in a cyclical learning content development process and differ from static textbooks and web information. This system enables information to be constantly supplied to learners in a fresh and relevant form, like a stream of water. Consequently, the quality of education will improve, as will learners' critical thinking skills and creativity.

4 Prior Research

Neuro-symbolic AI has begun finding applications in various fields, but its practical use cases are still limited. This section examines the precedents of AI in education and discusses neuro-symbolic AI as a new and relevant educational method.

4.1 Augmented Intelligence

The concept of augmented intelligence, proposed by Ito of the MIT Media Lab in 2018, aims to achieve advanced problem-solving capabilities through collaboration between humans and AI. This concept has potential applications in the field of education and is expected to serve as a tool for enhancing interactions between educators and learners. Moreover, augmented intelligence shares some commonalities with neuro-symbolic AI, as discussed below; however, augmented intelligence does not simply refer to the use of AI by humans. We believe that this is true when human and AI capabilities are reasonably effectively developed and interact with each other.

4.2 Ready-made Integration

This work is posteriori research of the "Ready-made Integration" approach—a method of combining existing digital educational tools and content to instantly create a highly functional educational environment, inspired by Lévi-Strauss' concept of bricolage. This approach allows educators to design creative and effective educational experiences using limited resources. Bricolage is an important element of human health. Augmented intelligence refers to the collaboration between humans and AI; however, it is not simply a concept that describes the use of AI. Only in situations wherein human bricolage-like creativity is exhibited can this be the case for augmented intelligence. Therefore, the system proposed herein also aims to improve educational effectiveness and educational experience by combining old and new knowledge and crossing teachers' creativity with students' accidental discoveries.

Table 1: Comparison of "Dynamic Textbook" and existing learning content

Characteristics	Dynamic Textbook	Existing learning tools
Content Updates	Real Time	Routine, manual
Interactivity	High	Low
AI Integration	High	None
User Engagement	High	Low to medium
Customizability	High	Low
Accessibility	High	Platform dependent
Real-time feedback	Immediate	Lagging or none

5 Novelty of this Research

5.1 What is Neuro-symbolic AI?

Neuro-symbolic AI is a research field that combines the mathematical approach to deep learning with symbolic logic. This approach combines neural networks' powerful pattern recognition capabilities with symbolic reasoning's clear logical structure. Neuro-symbolic systems are intended to produce more interpretable and reliable AI models and are expected to have applications in complex domains, such as education.

5.2 Introduction in this Research

The application of neuro-symbolic AI in education has been touted as a solution to the "black box" problem faced by deep learning, namely, the opacity of its decision-making process. Neuro-symbolic AI clarifies the criteria for learning algorithms and helps educators and learners develop a deeper understanding of—and trust in—the information and recommendations provided by AI. This will enable more effective personalization and adaptation of educational content.

5.3 Differences between "Dynamic Textbooks" and Existing Systems

Traditional "known textbooks" provide fixed knowledge but do not dynamically update and adapt to learners' questions and interests. By contrast, "heuristic dynamic textbooks" utilize neuro-symbolic AI to update content in real time and incorporate information based on learner input. This system encourages learners to be actively involved in their own learning processes and acquire new knowledge through exploration and discovery.

6 Proposal System

6.1 System Overview

The "Dynamic Textbook" is an interactive digital platform that utilizes neuro-symbolic AI to revolutionize the educational process. The system can update content in real time and enhance two-way communication between educators and learners. Educators can easily upload, edit, and delete educational materials through this platform, and neuro-symbolic AI dynamically adjusts the content based on learner responses and progress. For example, if numerous students experience difficulty with a particular topic, the system can provide additional explanations and aid in filling the learning gap. Students actively participate in the learning process through a system of interactive quizzes, discussion forums, and immediate feedback. Educators can monitor these interactions and adjust the material according to their level of understanding and interest. Additionally, the platform uses artificial intelligence (AI) to analyze the collected data and recommend the most optimal learning methods and materials for individual students. Neuro-symbolic AI can be implemented to identify complex patterns in these data and provide a customized educational experience tailored to each student's learning style. With the introduction of neuro-symbolic AI, "Dynamic Textbooks" are not merely repositories of information but also function as facilitators of knowledge generation and understanding, combining logical reasoning and understanding of learning patterns in generating and updating educational content to transform educator–learner interactions into more meaningful ones. This system makes education more flexible and student-centered, helping each learner reach their full potential.

6.2 Development Environment

The implementation environment is as follows:

Programming languages: Python and JavaScript

- Frameworks: Flask, React
- Database: MongoDB

Natural Language Processing (NLP) engine: OpenAI's GPT-3

- Development tools and platforms: Git, Docker, AWS

Testing and Deployment: Jenkins and Kubernetes

We used the API of OpneAI for the demonstration; however, we believe that demonstrating another language model is necessary.

6.3 Use Cases

The interaction process of the experimental "Dynamic Textbook" system in this research is divided into four major steps.

STEP1: Teachers preparing for class and uploading course materials

Faculty members use the user interface to prepare for class and upload class materials, such as PowerPoint presentations.

STEP2: Student login and access to course materials

Students attempt to log in and request access to course materials after authentication.

STEP3: Student interactive participation and feedback

Students participate in interactive quizzes and submit FAQs regarding course materials. Additionally, student feedback is collected and analyzed.

STEP4: Faculty progress monitoring and updating of course materials.

Teachers monitor student progress and update course materials as necessary. The updated materials are reanalyzed, and suggestions for improving teaching effectiveness are made.

These steps illustrate how the "Dynamic Textbook" platform works and supports the educational process, aiming to enhance the interaction between students and faculty. A detailed use-case diagram is depicted below.

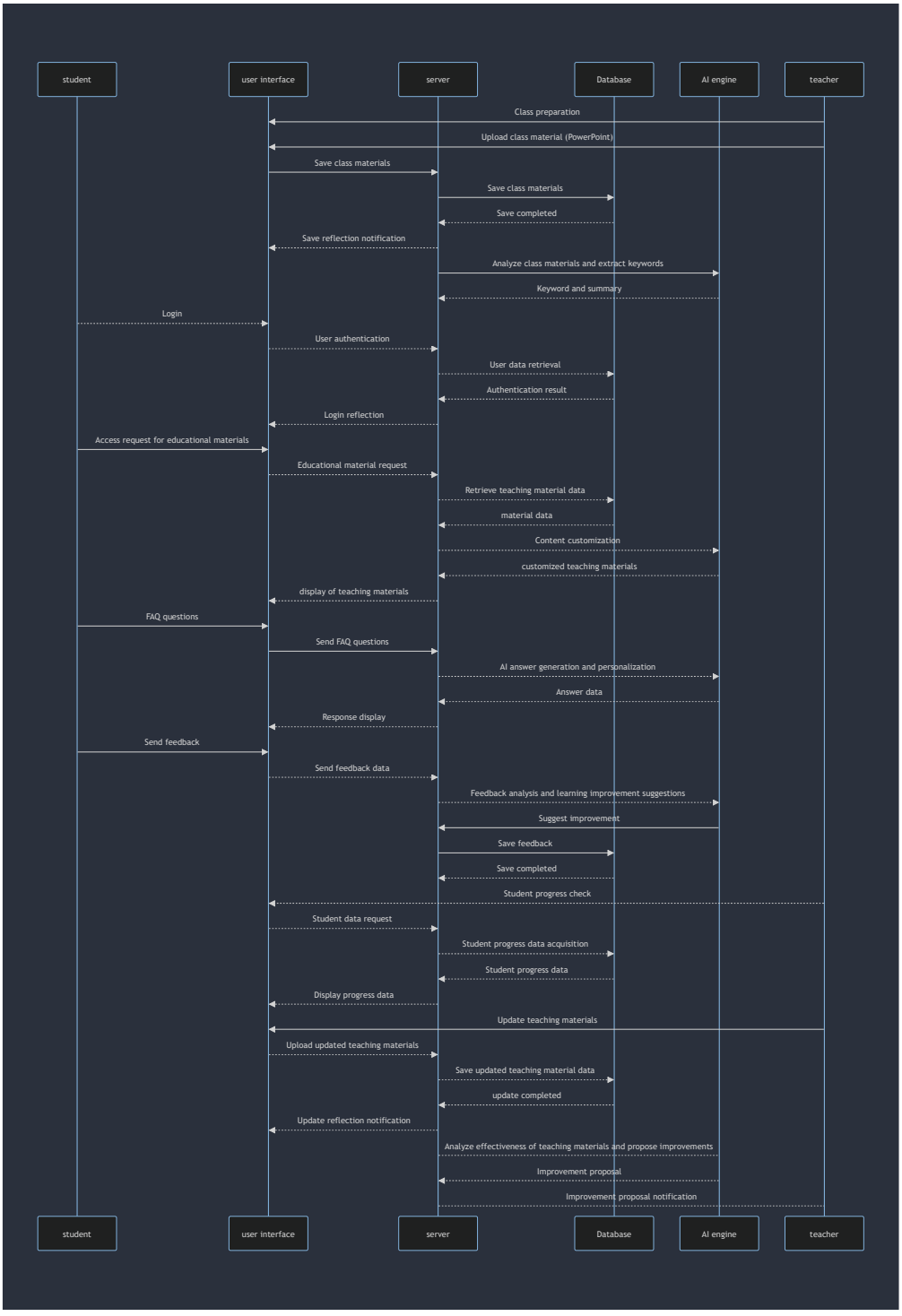

Figure 1: Use-case diagram on systems

6.4 Demo System Image

In this research, a demonstration system was constructed. The following is an image of the proposed system.

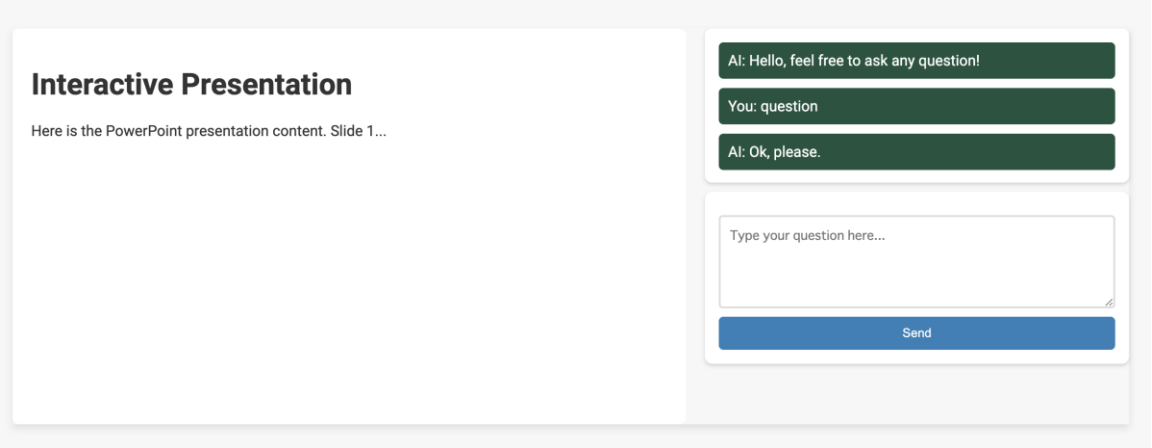

Figure 2: Demo Image of Interactive Presentation System

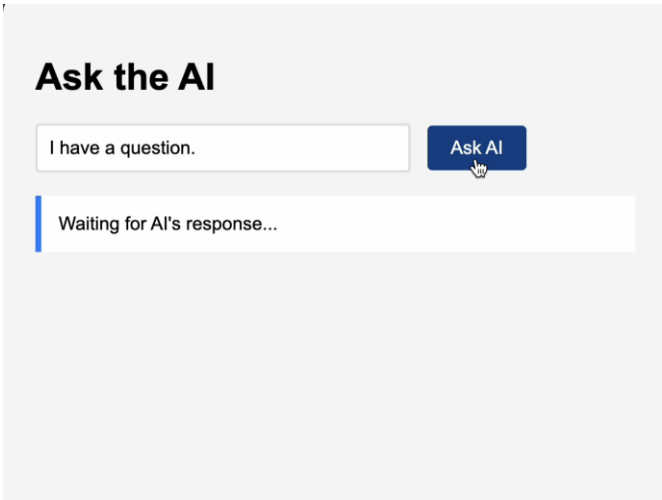

Figure 3: Asking Screen Image

In this research, a "Dynamic Textbook" demonstration presentation system was implemented to facilitate dialogue between students and faculty and provide a richer learning experience by utilizing digitized presentations. The system comprises four main core elements, each of which plays an important role in enhancing the learning experience's quality.

(1) Presentation area

The presentation area has a fixed size of 800 × 600 pixels and maintains a 4:3 ratio. PowerPoint slides are displayed in this area to convey the content of the material visually to the students. The faculty prepare the slides in advance, but the content may be dynamically updated in response to

active feedback and questions from the students during the session, thus making the class more interactive and participatory.

(2) Thumbnail Navigation

The thumbnail navigation is located directly below the presentation area and displays a 10-slide preview of the presentation to enable users to grasp the presentation's overall flow at a glance. It is designed such that users can click on these thumbnails to instantly access the relevant slides, which are enlarged on mouse-over to provide visual feedback.

(3) Interactive Chat Area

The chat area provides an interactive interface wherein students can post questions and comments in real time. In this area, questions entered by students are displayed in the form of "You:" and the message display area occupies a relatively large space. The system uses AI technology to generate an automatic answer to the student's question after 3 seconds, providing immediate feedback to the student's question.

(4) AI Integrated Response System

The AI response system uses natural language processing technology to respond instantly to student questions. It utilizes a natural language engine (e.g., the GPT-3 API) to generate appropriate responses based on user comments and questions. This system is expected to significantly improve the interactivity of presentations and facilitate student engagement.

7 Conclusion

7.1 Summary

This research explored how AI and digital technology can transform education, and specifically proposed and implemented a new form of digital content called "Dynamic Textbooks," which utilize neuro-symbolic AI to improve the quality of education. The system was designed to facilitate dialogue between learners and educators to overcome the limitations of static learning materials and unstable web information. It has the flexibility to update content in real time and incorporate learner feedback to keep learning fresh. In this research, we developed a prototype system with four main functions—namely, presentation area, thumbnail navigation, interactive chat area, and AI-integrated response system—and proposed its usefulness arising from its functionality and interactivity.

7.2 Future Tasks

Despite their potential, current e-books and digital textbooks are still criticized slightly more than digital versions of analog paper textbooks. This is because the benefits of interactivity, updatability, and customization made possible by digitization have not yet been fully exploited. The current situation, wherein these digital teaching materials remain static in content without taking advantage of their inherent flexibility and dynamism, indicates that the benefits of digitization in the field of education are not fully utilized. Therefore, in developing the "Dynamic Textbook," we consciously transcended paper textbooks' limitations. Digital materials must not simply be reproductions of print materials but must have the ability to respond to learners' interests and

needs in real time and adapt the content to their individual progress and level of understanding. By continually supplying fresh information, such as streams, customized learning experiences are expected for each learner. In the future, maximizing the inherent capabilities of digital textbooks to achieve personalization of learning, interaction, and ease of updating, which could not be achieved with analog textbooks, will be imperative. Future tasks include maintaining and developing current digital teaching materials that are quiet and unchanging as a pond, by transforming them into living teaching materials that flow like a stream. In this process, hopefully, our research will enable us to innovate educational content and improve learner engagement by taking advantage of the interactivity and ease of updating that is unique to digital media.

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