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EDITED BY
Sergio Ruiz-Viruel,
University of Malaga, Spain

REVIEWED BY
Rabab Mizher,
Al-Balqa Applied University, Jordan
Annalene Grace Co,
Quirino State University - Maddela Campus, Philippines
Marek Nahotko,
Jagiellonian University, Poland

*CORRESPONDENCE
Ruifeng Yan
✉ yanrf@bjut.edu.cn

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# Student's acceptance of artificial intelligence eBooks using LCA and SEM: a case study of medical book in China

Haijin Xie[1], Gongquan Zhang[2,3] and Ruifeng Yan[4]*

[1]Department of Philosophy, National Academy of Governance, Beijing, China, [2]School of Traffic and Transportation Engineering, Central South University, Changsha, China, [3]Harvard Medical School, Harvard University, Boston, MA, United States, [4]College of Marxism, Beijing University of Technology, Beijing, China

The proliferation of eBooks has significantly impacted traditional paper books. With the development of emerging technologies like artificial intelligence (AI), AI eBooks have an even greater impact on traditional paper books, influencing aspects such as reading and learning methods, the dissemination of textual content, and book design, especially in education. To explore the students' acceptance of AI eBooks, this study utilizes a latent class analysis (LCA), dividing the student sample into groups with weak and strong digital literacies. Subsequently, the entire sample, as well as subgroups of students with weak and strong digital literacies, are examined as distinct entities to construct a multi-class structural equation model (SEM) incorporating the technology acceptance model and theory of planned behavior. Three SEMs aim to investigate the acceptance of AI eBooks among student groups with varying levels of digital literacies. Results reveal significant heterogeneity in the acceptance of AI eBooks among the student population, with groups possessing weak and strong digital literacies accounting for 30.62% and 69.38%, respectively. For the entire student sample, perceived usefulness emerges as the most crucial factor influencing their acceptance of AI eBooks. For students with weak digital literacies, enhancing the practicality of AI eBooks could increase their acceptance levels; similarly, for those with strong digital literacies, improving the ease of use of AI eBooks could improve their acceptance.

KEYWORDS

**AI eBooks, acceptance, digital literacy, latent class model, structural equation model**

## 1 Introduction

Since the dissemination of cultural content requires specific mediums, various methods to document knowledge are employed. At different historical stages, stone walls, oracle bones, bamboo slips, and paper serve as the primary reading mediums (Delgado et al., 2018; Furenes et al., 2021). Due to the difficulty in obtaining and storing materials of mediums, past reading mediums were often limited in form, with reading spaces being relatively fixed. With the enhancement of productivity and the development of technology, paper gradually replaces other mediums to become the main form of books and reading (Ronconi et al., 2022). At this stage, the spread of knowledge and culture shifts to a portable plane, making reading spaces more flexible. However, it was not until the early 20th century, with the advent and evolution of computer electronic technology, that the form of reading underwent a revolutionary change (Bresó-Grancha et al., 2022). The public could free

themselves from physical books and access the information needed through computer terminals. As paper book reading gradually declines, the form of reading books through computer terminals is known as eBooks (Gibson and Gibb, 2011; Rao, 2001).

The core of eBooks lies in information technology, electronic technology, and Internet culture, focusing primarily on two aspects: the dissemination channels and reading platforms of eBooks (Wilson, 2003). Some perspectives view eBooks as digitized translations of printed books because eBooks mainly refer to electronic publications consisting of text or simple graphics and layout (Fry, 2019; Harpur and Suzor, 2014; Jent et al., 2021). However, paying attention to eBooks requires electronic devices such as computers, smartphones, e-readers, and tablets for reading, so equating eBooks simply with e-readers or similar devices is not accurate. With the development of artificial intelligence (Yang et al., 2022), technologies such as speech recognition, natural language processing, image recognition, and generation will further enhance the implication level of eBooks, which enables users to read eBooks or choose audiobooks (Huang, 2019; Ukri, 2020). Furthermore, the dynamic generation of images combined with textual descriptions in eBooks further enhances the dissemination effectiveness of knowledge and culture.

Despite the powerful functionality offered by AI eBooks, providing a more convenient way for book reading, AI eBooks are only utilized on a range of intelligent electronic devices such as smartphones, tablets, and computers, limiting their user base and usage scenarios, especially in the education sector where printed books remain the primary learning medium (Brueck and Lenhart, 2015; Day and Pienta, 2019). Meanwhile, AI eBooks require users to have a certain level of digital literacy, with the digital divide acting as a barrier (Hsieh et al., 2022). The definition of the digital divide originates from concepts such as the knowledge gap and information inequality, aiming to explain the disparities in individuals, households, businesses, and geographical regions in accessing information and communication technologies, as well as utilizing the opportunities provided by the Internet in various activities (Lythreatis et al., 2022; Scheerder et al., 2017). Due to varying levels of economic development and educational attainment in different regions, the digital literacy of student populations, and consequently the possibility and acceptance of using AI eBooks, also vary (Greenhow et al., 2022).

Hence, considering the limitation of paper books in dynamically integrating text and images, and the barrier eBooks face due to their dependence on electronic devices, which hinders their widespread adoption for educational purposes, this study proposes a novel AI eBook. Specifically, it retains the design aesthetics of traditional paper books but incorporates embedded electronic screens. Utilizing AI technology, the proposed AI eBook animates original images in sync with the textual content, facilitating reader comprehension and making it particularly suitable for classroom education. Building on this innovation, the study explores the effectiveness of this AI eBook in enhancing student learning outcomes and its acceptance among learners. Such approach marries the tangibility of paper books with the interactive capabilities of eBooks, potentially revolutionizing educational methodologies and improving accessibility and engagement in learning environments.

Existing research has delved into the acceptance of eBooks among student populations. According to Shepperd et al. (2008), eBooks are not the primary choice for university students, as eBook-based teaching is a relatively new innovation that has only recently been introduced into the educational settings of some countries and regions. Kang et al. (2009) conducted an Internet survey among students and teachers at five universities in the United States where electronic textbook projects were implemented. Their findings indicate that students are willing to use eBooks because they are less expensive than paper books; however, many students reported that eBooks are not conducive to interaction with other students or professors, and navigating through eBooks can be challenging. While there is extensive research on student acceptance of eBooks, studies focusing on AI eBooks are comparatively scarce. Additionally, research into the factors affecting students' acceptance of eBooks often overlooks the impact of the digital divide among student groups. In terms of influencing factors, Pham and Tran (2020) found that performance expectancy, effort expectancy, social influence, and facilitating conditions are closely related to the acceptance of eBooks. Research by Arham et al. (2021) shows that lecturers, students' computer competency, the content and design of the course, accessibility, infrastructure, and university support significantly affect students' acceptance of eBooks. Regarding research methodologies, commonly applied methods include descriptive statistics, simulation analysis, and structural equation modeling. Park and Lee (2021) investigated the acceptance of eBooks and e-learning systems among students using the unified theory of acceptance and use of technology model. Akpokodje and Ukwuoma (2016) discovered an increasing preference among students for downloading electronic materials on smartphones over using library facilities.

Here, this study, premised on the newly proposed AI eBook, employs a latent class analysis (LCA) approach to categorize students based on the digital divide into groups with weak digital abilities and those with strong digital literacies. Subsequently, we construct separate structural equation models (SEM) for the technology acceptance model and the theory of planned behavior for these distinct student groups. The analytical framework facilitates an in-depth investigation into how students with varying levels of digital literacy accept the introduced AI eBook. By tailoring the analysis to recognize the disparities in digital divide, this study aims to provide nuanced insights into the factors influencing the adoption of AI eBooks across different segments of the student population.

# 2 Theory framework

## 2.1 Theory support

The technology acceptance model (TAM) is a theory designed to simulate how users accept and utilize information technology (Kelly et al., 2023; Sohn and Kwon, 2020). TAM posits that behavioral intention (BI) is influenced by attitude (ATT) and perceived usefulness (Harpur and Suzor). The attitude toward a system or technology is determined by perceived usefulness

(Harpur and Suzor) and perceived ease of use (PEU). The theory of planned behavior (TPB) is a psychological theory that takes a comprehensive view of behavior and beliefs (Ong et al., 2022). Individual behavior depends on behavioral intention, which in turn is influenced by attitude (ATT), subjective norm (SN), and perceived behavioral control (PBC). Both the TAM and TPB can be applied to investigate individual behaviors. As a novel technology, AI eBooks are currently in the stage of commercial demonstration operations and have not yet been fully commercialized and popularized. Therefore, it is reasonable to study students' acceptance of AI eBooks by integrating the TAM and TPB. The theoretical framework is illustrated in Figure 1.

## 2.2 Latent class model

The latent class model (LCM) transforms the probabilities of categorical variables into model parameters, thus dividing the sample into different classes to explain the heterogeneity within the population (Su et al., 2022). The model is constructed on two fundamental assumptions: (1) any individual belongs to only one latent class, with different latent classes being mutually independent; and (2) observed variables within a latent class are independent of each other. Latent Class Analysis primarily involves three steps: probability parameterization and model construction, parameter estimation and model fitting, and latent classification:

Step 1: probability parameterization. The LCM includes latent variables and observed variables, with corresponding parameters being latent class probabilities and conditional probabilities. As the LCM includes three observed variables A, B, and C, the joint probability $\pi_{ijk}^{ABCT}$ of an individual choosing $i, j, k$ options is given as:

$$\pi_{ijk}^{ABCT} = \pi_t^X \pi_{it}^{A|X} \pi_{jt}^{B|X} \pi_{kt}^{C|X} \tag{1}$$

where $\pi_t^X$ is the latent class probability, i.e., the probability of an individual belonging to the $t$-th latent category. $\pi_{it}^{A|X}$, $\pi_{jt}^{B|X}$, and $\pi_{kt}^{C|X}$ are conditional probabilities, representing the probability of the A observed variable being $i$, B being $j$, and C being $k$, respectively, under the condition of belonging to the $t$-th latent category.

$$\begin{cases} \pi_{it}^{A|X} = P(A = i|X = t) \\ \pi_{jt}^{B|X} = P\left(B = j\middle|X = t\right) \\ \pi_{kt}^{C|X} = P\left(C = k\middle|X = t\right) \end{cases} \tag{2}$$

Step 2: parameter estimation and model fitting. Two main methods for estimating parameters of the LCM are the expectation-maximization (EM) algorithm and the newton-raphson (Waeterloos et al.) algorithm, with the EM algorithm being more widely used due to its insensitivity to initial values. The main indicators for model fitting verification include Pearson $\chi 2$, likelihood ratio (Waeterloos et al.), Akaike information criterion (AIC), and Bayesian information criterion (BIC). In the LCM, AIC and BIC are most widely used, with smaller values indicating a better model fit. Generally, as the sample size is less than 1,000, the AIC is preferred over BIC; as the sample size is greater than 1,000, BIC is preferred over AIC.

Step 3: latent classification. Latent classification divides all individuals into appropriate latent categories based on the probabilities of belonging to each latent category, according to Bayesian theory. Therefore, using the LCM to determine the heterogeneity of students' digital literacy, six observed variables were initially selected to measure the digital divide among students: whether they own a smartphone, whether they have used the Internet to chat or video with friends and family in the past week, whether they use the Internet to listen to music or watch videos, whether they use the Internet to browse news and search for information, whether they use the Internet for learning courses, professional classes, questions, and other related knowledge, and whether they use AI-related applications (Waeterloos et al., 2021).

## 2.3 Structure equation model

The structure equation model (SEM) encompasses two fundamental models: the measurement model and the structural model. The measurement model primarily delineates the relationships between latent variables and observed variables, whereas the structural model outlines the relationships among latent variables (Becker et al., 2023; Muller et al., 2018). Measure model is defined as:

$$\begin{cases} X = \Lambda_X \xi \ + \delta \\ Y = \Lambda_Y \eta + \varepsilon \end{cases} \tag{3}$$

where $X$ represents the vector of observed values for the independent variables; $\xi$ denotes the vector of latent exogenous variables; $\Lambda_X$ is the regression coefficient of $X$ on $\xi$; $\delta$ is the error for $X$; $Y$ represents the vector of observed values for the dependent variables; $\eta$ is the vector of latent endogenous variables; $\Lambda_Y$ is the regression coefficient of $Y$ on $\eta$; $\varepsilon$ is the error term for $Y$.

$$\eta = B\eta + \Gamma\zeta + \xi \tag{4}$$

where $B$ represents the relationships among endogenous latent variables; $\Gamma$ denotes the impact of exogenous latent variables on endogenous latent variables; $\zeta$ is the error term for the structural equation.

Therefore, by employing the SEM and considering both the TAM and TPB, this study investigates the acceptance of AI eBooks among the student population. It selects six latent variables: PU, PEU, ATT, SN, PBC, and BI.

# 3 Methodology

## 3.1 AI eBook design

Informed by the strengths and weaknesses of traditional paper books and eBooks, and incorporating AI technology, we design a novel type of AI eBook. The proposed AI eBook enhances reading and educational efficiency by combining the tactile familiarity of paper with the interactive and dynamic content facilitated by digital technology. Such design broadens the application and contexts in which new materials can be used and introduces a versatile learning tool that caters to diverse learning styles and preferences, to enrich the educational landscape.

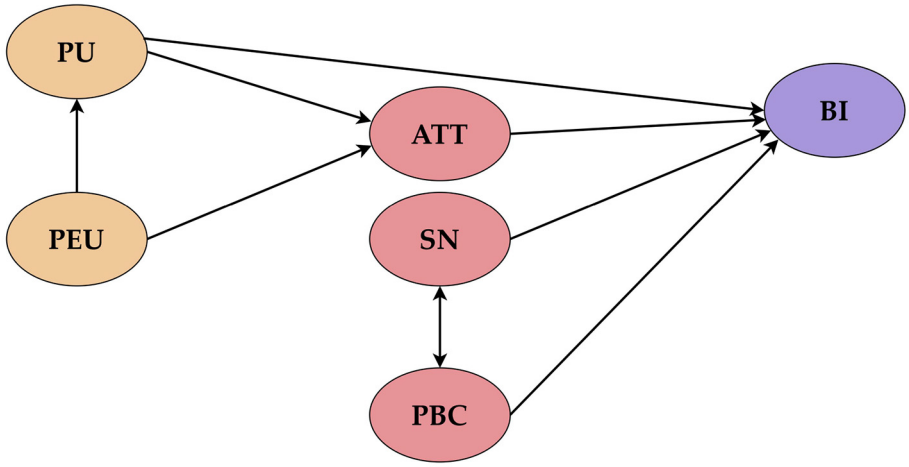



FIGURE 1
Research theoretical framework.

Specifically, the external design retains the appearance of a traditional paper book, facilitating easy portability and widespread adoption among students. While the textual content remains in written narrative form, corresponding images employ AI image generation technology to make traditional illustrations interactive and dynamic, thereby enhancing students' comprehension and learning. The AI visualization screen adopts an ultra-thin flexible display, with a thickness perfectly matching that of paper, embedded between the pages of the book, without affecting the use and portability of the paper book. Additionally, the book is equipped with a control panel to generate various dynamic images on demand. Solar cells are utilized for charging the screen, ensuring the book's sustainable use. Detailed design specifics and conceptual illustrations are presented in Figure 2.

Considering the diverse educational stages from primary and secondary schooling to higher education, and the need for medical culture and science popularization education to be tailored to students at each level, this study has designed an AI eBook based on medical knowledge from the Song Dynasty. The production of this AI eBook has involved the creation of samples and videos, facilitating an intuitive understanding and experience of the AI eBook's design for research participants, enabling them to provide objective evaluations. The choice of a Song Dynasty medical book as the basis for this AI eBook example is deliberate. This period is renowned for significant advancements in medical knowledge and practice, making it an ideal subject matter to demonstrate the potential of AI technology in enriching educational content. Through this AI eBook, students can explore ancient medical wisdom in an engaging and interactive format, enhancing their learning experience. The design effectively bridges historical medical culture with modern educational technology, offering students a unique opportunity to delve into the medical practices of the Song Dynasty, understand their historical context, and appreciate their relevance to contemporary medical knowledge.

It is worth noting that the selection of medical books from the Song Dynasty as the basis for AI eBooks is due to the rich historical background of this period, which requires imagination and a large amount of evidence, such as illustrations and historical literature. This type of book can expand imagination and supplement evidence, making dynamic images and videos more vivid and persuasive in history education, making it very suitable for the theme of AI eBooks. In addition, medicine, especially traditional Chinese medicine, involves complex concepts such as human anatomy and meridians, requiring dynamic demonstrations to enhance understanding, create more lasting impressions, and promote deeper memory, in line with the process of AI image dynamic generation.

## 3.2 Sample and measures

In this survey, we incorporate six latent variables and eighteen observed variables, all derived from previous studies, illustrating the relationship between latent and corresponding observed variables as shown in Table 1. Using a 5-point Likert scale, where 1–5 correspond to "Strongly Agree," "Agree," "Neutral, No Opinion," "Disagree," and "Strongly Disagree," respectively, to represent the measure of variables for a nuanced capture of participants' attitudes toward the survey's focal topics, providing insights into various dimensions of the research subject (Yang et al., 2022). The survey utilizes an online questionnaire format from February to April 2024 by leveraging established variables and a widely recognized measurement scale, aiming to ensure the reliability and validity of the collected data.

In LCM, observed variables are directly measurable indicators (e.g., whether students own a smartphone, use AI-related apps) that provide tangible data, while unobserved variables (i.e., students' digital literacy levels in this study) are abstract constructs that cannot be measured directly and need to be inferred through the combination of observed variables. The core purpose of applying LCM here is to use these observable indicators to identify and classify the unobservable digital literacy subgroups among students, thereby revealing the heterogeneity in their acceptance of AI eBooks.

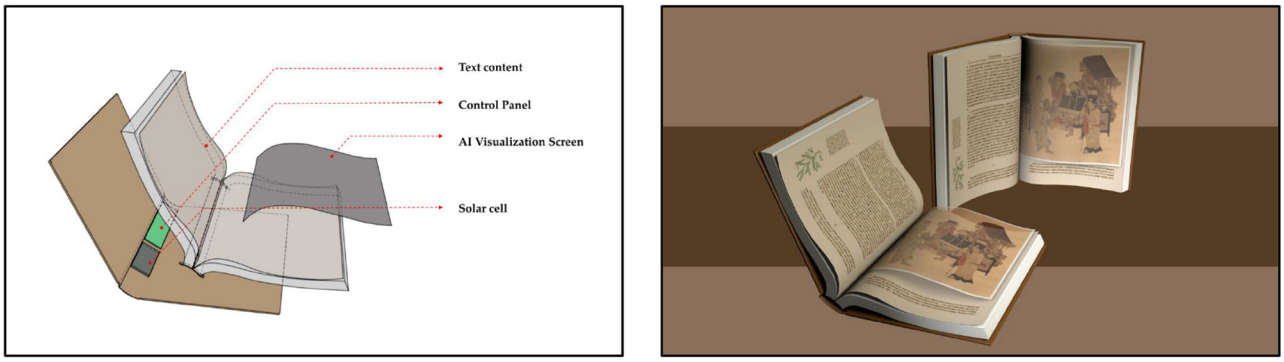



FIGURE 2
Conceptual design of the novel AI eBook.

This survey is conducted in two phases: a pilot study and the main survey. The pilot study takes place in February 2024 via an anonymous online survey on the Internet, with observed variables drawn from questionnaires previously utilized in research. Based on the feedback from this initial phase, the final questionnaire is determined. From February to March 2024, a total of 595 questionnaires are collected online after the participants watch the sample and video of AI eBooks about Song Dynasty. To ensure respondents could properly familiarize themselves with the core functions of the AI eBook and form informed judgments on acceptance, the video presentation with a 3-min guided explanation was supplemented before the survey, including key details such as how dynamic images synchronize with textual content, the operation of the embedded control panel for customizing visuals, and the practicality of solar charging in daily learning scenarios. Notably, to avoid potential blurred evaluations between the AI eBook's print (paper-book form, physical portability) and electronic (dynamic AI features, embedded screen) components, the survey explicitly emphasized the "integrated synergy" of the two technologies in the guided explanation: the print form is designed to reduce adaptation barriers for users less familiar with digital tools, while the electronic features enhance learning effectiveness, and guided respondents to assess how the two parts work together to support their learning needs, rather than viewing them as independent elements.

After removing duplicates, logically inconsistent responses, and invalid questionnaires, 516 valid responses are retained, resulting in a validity rate of 86.72%. Among the respondents, 53.49% are male, and 46.51% are female. Those under 18 years of age account for 50.78%, and those over 18 account for 49.22%. In terms of educational levels, the proportions of primary school, secondary school, junior college, undergraduate, and postgraduate students are 24.22%, 26.55%, 17.64%, 24.61%, and 6.98%, respectively, covering student groups at various stages with an even distribution. The group owning smartphones constitutes 69.38%, while those without comprise 30.62%. Among the student population, the proportion that uses the Internet to chat or video call with friends and family in the past week is 65.70%, the proportion that uses the Internet for studying courses, professional subjects, problems, and other related knowledge is 71.9%, and the proportion that uses AI-related applications is 59.69%.

## 3.3 Reliability and validity analysis

To ensure the designed questionnaire could accurately measure the concepts or variables under investigation, it is crucial to assess its reliability (i.e., the consistency of the questionnaire data) and validity (i.e., the stability of the questionnaire data). Initially, the reliability of the questionnaire is tested using Cronbach's alpha coefficient ($\alpha$) and the corrected item-total correlation (CITC). The Cronbach's alpha should exceed 0.7, and the corrected item-total correlation should be greater than 0.3. Subsequently, the validity analysis is divided into two parts: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). EFA employs the Kaiser-Meyer-Olkin (KMO) test, requiring a KMO value greater than 0.6 and a significant Sig value. Following this, the validity of the measurement model is assessed through convergent validity and discriminant validity analysis. The validity analysis aims to evaluate the degree of alignment between the questionnaire items and the measured content, typically assessed using the average variance extracted (Waeterloos et al.). Discriminant validity is evaluated based on empirical standards to assess the degree of differentiation between the latent variable and other latent variables. Specific values for the reliability, composite validity, convergent validity, and discriminant validity of the measurement model can be found in Table 2. This comprehensive approach underscores the rigor with which the questionnaire's capacity to capture the intended measures is evaluated, ensuring its effectiveness in the research context.

The overall Cronbach's alpha coefficient of the questionnaire is 0.828, and the CITC ranges from 0.386 to 0.554, indicating good consistency of the questionnaire. The KMO coefficient is 0.851, with Bartlett's Test of Sphericity yielding a value of 4839, degrees of freedom of 300, and a Sig value of 0.00, indicating the stability of the questionnaire. Each item of the questionnaire, assessed according to PU, PEU, ATT, SN, PBC, and BI, undergoes reliability and validity testing. The Cronbach's alpha coefficients range from 0.700 to 0.749, and all CITC values exceed 0.3. The KMO coefficients range from 0.660 to 0.690, with all Sig values being 0, indicating the representativeness of the questionnaire items. The AVE values are all greater than 0.4, demonstrating an acceptable level of convergent validity for latent variables and reasonable item design. The boldfaced values represent the square

root of AVE, which is greater than both the corresponding row and column data, indicating reasonable discriminant validity.

# 4 Results and discussion

## 4.1 Latent class analysis

This section constructs a latent class model (LCM) that necessitates the selection of appropriate observed variables.

TABLE 1 Latent variables with corresponding observed variables.

| Latent variables | Observed variables |
|---|---|
| Perceived usefulness (Harpur and Suzor) | AI eBooks can enhance reading interest (PU1) |
| | AI eBooks can improve reading effectiveness (PU2) |
| | AI eBooks can improve reading methods (PU3) |
| Perceived ease of use (PEU) | Learning to use AI eBooks is easy for you (PEU1) |
| | The content of AI eBooks is clear/easy to understand (PEU2) |
| | There are no technical barriers to using AI eBooks (PEU3) |
| Attitude (ATT) | You enjoy using AI eBooks (ATT1) |
| | You are actively using AI eBooks (ATT2) |
| | You aspire to use AI eBooks (ATT3) |
| Subjective norm (SN) | Parents or friends may support you to use AI eBooks (SN1) |
| | Parents or friends may want you to use AI eBooks (SN2) |
| | People around you use AI eBooks, and you will also use it (SN3) |
| Perceived behavioral control (PBC) | Whether to use AI eBooks is entirely up to you (PBC1) |
| | You can pay for using AI eBooks (PBC2) |
| | Using AI eBooks is not difficult for you (PBC3) |
| Behavioral intention (BI) | You will use AI eBooks in the future (BI1) |
| | You will purchase AI eBooks in the future (BI2) |
| | You will recommend AI eBooks to people around you in the future (BI3) |

To investigate the impact of students' digital literacy on their acceptance of AI eBooks, several rounds of classification comparison experiments are conducted to filter out observed variables with poor performance. Ultimately, four observed variables were selected: (A) whether the student owns a smartphone, (B) whether the student has used the Internet to chat or video call with friends and family in the past week, (C) whether the student has used the Internet for learning courses, professional subjects, solving problems, and acquiring other related knowledge in the past week, and (D) whether the student has used AI-related applications in the past week. These observed variables respectively represent different aspects of digital literacies, including the physical divide, digital communication skills, learning and reading digital skills, and daily life application digital skills. The selection process underscores the multifaceted nature of digital literacy, highlighting the importance of considering various dimensions of digital skills as assessing the readiness and willingness of students to engage with innovative educational technologies such as AI eBooks.

We employ Mplus 8.3 software to estimate the parameters of the LCM. Given that the number of latent classes is unknown, each model with 1 to 5 latent classes is constructed and assessed based on its Akaike information criterion (AIC) and Bayesian information criterion (BIC) values, with specific results presented in Table 3. As the number of latent classes is set to 2, the model exhibits the lowest AIC and BIC values, indicating the highest model fit (Kang, 2019). Consequently, we divide the sample into two latent classes. Parameter estimation is then conducted using the maximum likelihood method.

The first and second classes accounted for 30.62% and 69.38% of the total population, respectively. Students in the second class significantly outperformed those in the first class in terms of possessing smartphones, using the Internet to chat or video call with friends and family, engaging with online courses, and utilizing AI-related applications for learning purposes. This delineation suggests that students in the first class belong to a group with weak digital literacies, while those in the second class belong to a group with strong digital literacies.

Such classification illuminates the digital divide within the student population, providing a nuanced understanding of how digital literacies influence students' interactions with educational technology. The significant disparity in the usage of digital tools and platforms between the two groups underscores the necessity of adopting targeted educational strategies. For educators and policymakers, these findings highlight the importance of tailoring

TABLE 2 Reliability and validity analysis of the questionnaire.

| Latent variable | $\alpha$ | CITC | KMO | Sig | AVE | Discriminant validity | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | PU | PEU | ATT | SN | PBC | BI |
| SN | 0.741 | 0.544–0.581 | 0.687 | 0.00 | 0.490 | 0.700 | | | | | |
| PEU | 0.749 | 0.554–0.594 | 0.689 | 0.00 | 0.499 | 0.000 | 0.706 | | | | |
| PBC | 0.700 | 0.472–0.566 | 0.660 | 0.00 | 0.447 | 0.516 | 0.000 | 0.669 | | | |
| PU | 0.715 | 0.508–0.547 | 0.676 | 0.00 | 0.449 | 0.000 | 0.623 | 0.000 | 0.670 | | |
| ATT | 0.704 | 0.495–0.556 | 0.669 | 0.00 | 0.445 | 0.000 | 0.513 | 0.000 | 0.524 | 0.667 | |
| BI | 0.744 | 0.561–0.576 | 0.690 | 0.00 | 0.450 | 0.298 | 0.342 | 0.378 | 0.496 | 0.390 | 0.671 |

TABLE 3 LCM comparison and parameter estimation.

| Latent class | Freedom (df) | AIC | BIC |
|---|---|---|---|
| 1 | 4 | 2,616.070 | 2,633.054 |
| 2 | 9 | **1,963.038** | **2,001.253** |
| 3 | 14 | 1,970.240 | 2,029.686 |
| 4 | 19 | 1,979.214 | 2,059.890 |
| 5 | 24 | 1,988.596 | 2,090.502 |
| **Classification criteria** | **Option** | **First class** | **Second class** |
| Whether owing a smartphone | 1 (No) | 0.002 | 1.000 |
| | 2 (Yes) | 0.998 | 0.000 |
| Whether using the Internet to chat or video call with friends and family | 1 (No) | 0.164 | 0.875 |
| | 2 (Yes) | 0.836 | 0.125 |
| Whether using the Internet for learning courses | 1 (No) | 0.279 | 0.914 |
| | 2 (Yes) | 0.721 | 0.086 |
| Whether using AI-related applications | 1 (No) | 0.152 | 0.794 |
| | 2 (Yes) | 0.848 | 0.206 |
| Potential category probability | | 30.62% | 69.38% |

The bold value indicates the best results of AIC and BIC

TABLE 4 Goodness of fit for all SEMs.

| Model | CMIN/DF | CFI | RMSEA | GFI |
|---|---|---|---|---|
| Reference (Marsh et al., 2014) | <3 | ≥0.800 | ≤0.080 | ≥0.800 |
| SEM 1 | 2.826 | 0.911 | 0.060 | 0.938 |
| SEM 2 | 2.018 | 0.880 | 0.077 | 0.917 |
| SEM 3 | 2.069 | 0.911 | 0.056 | 0.940 |

educational resources and interventions to bridge the gap in digital literacies, thereby ensuring equitable access to digital learning opportunities.

## 4.2 Multi-class SEM

This section constructs three structural equation models (SEM 1, SEM 2, SEM3) to comparatively analyze the acceptance of AI eBooks among different student groups. The subjects of the three models are the sample as a whole, the first group of students (those with weak digital literacies), and the second group of students (those with strong digital literacies). The parameter estimation for the SEMs is performed using the maximum likelihood estimation method. The chosen fit indices for evaluating model fit primarily included the comparative fit index over degrees of freedom (CMIN/DF), comparative fit index (CFI), goodness-of-fit index (GFI), and root mean square error of approximation (RMSEA), with the fit results of the three SEMs presented in Table 4. The evaluation measures of three SEMs meet the requirements, indicating a high goodness of fit.

The construction and analysis of these models revealed insightful differences in how distinct student groups perceive and accept AI eBooks. Notably, the model encompassing the entire sample provides a baseline understanding of overall student acceptance of AI eBooks, laying the groundwork for more nuanced analyses. For the first group, students with weak digital literacies, the model likely highlighted specific challenges and reservations they might have toward adopting AI eBooks, potentially influenced by their limited digital engagement and proficiency. Conversely, the model for the second group, consisting of students with strong digital literacies, likely indicated a higher level of openness and enthusiasm toward AI eBooks, reflecting their comfort and familiarity with digital technologies. The application of SEMs enabled a comprehensive evaluation of these differences, capturing the complexity of factors influencing AI eBook acceptance.

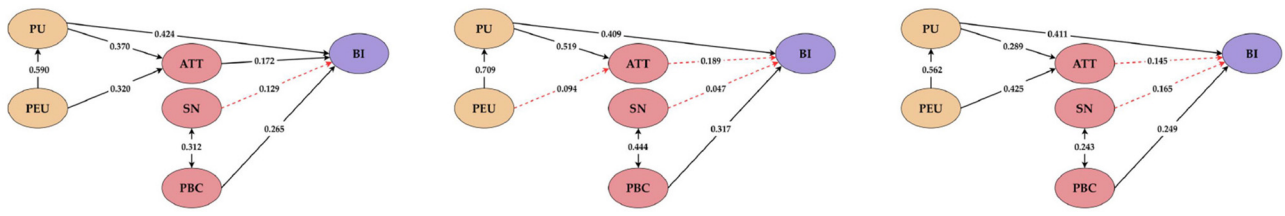
(1) SEM 1 for all students: the parameter estimation results of SEM 1 are presented in Table 5 and Figure 3a. Solid lines indicate significant causal relationships at the 5% significance level, while dashed lines indicate non-significant causal relationships at the 5% significance level. The model explains 48.4% of the covariance in behavioral intention. Perceived ease of use (PEU) has a significant positive effect on perceived usefulness (Harpur and Suzor), with both PEU ($\beta = 0.320$, $p < 0.05$) and PU ($\beta = 0.370$, $p < 0.05$) jointly influencing overall student attitudes toward AI eBooks, consistent with previous findings. Attitude (ATT) ($\beta = 0.172$, $p < 0.05$), perceived usefulness (Harpur and Suzor) ($\beta = 0.424$, $p < 0.05$), and perceived behavioral control (PBC) ($\beta = 0.265$, $p < 0.05$) directly impact students‘ acceptance of AI eBooks. However, subjective norm (SN) ($\beta = 0.129$, $p = 0.051$) does not significantly influence students' acceptance of AI eBooks, and there is a significant correlation between SN and PBC ($\beta = 0.312$, $p < 0.05$). Among these, PU has the highest explanatory power for behavioral intention (BI).

(2) SEM 2 for students with weak digital literacies: the results of SEM 2 are presented in Table 5 and Figure 3b. This model explains 44.2% of the covariance in behavioral intention. Perceived ease of use (PEU) has a significant positive effect on perceived usefulness (Harpur and Suzor), but its effect on attitude (ATT) ($\beta = 0.094$, $p = 0.527$) is not significant. PU ($\beta = 0.519$, $p < 0.05$) influences the attitude of students with weak digital literacy toward AI eBooks. PU ($\beta = 0.409$, $p < 0.05$) and perceived behavioral control (PBC) ($\beta = 0.317$, $p < 0.05$) directly impact the acceptance of AI eBooks among students with weak digital literacy. In contrast, attitude (ATT) ($\beta = 0.189$, $p = 0.159$) and subjective norm (SN) ($\beta = 0.047$, $p = 0.647$) do not significantly influence the acceptance of AI eBooks among students with weak digital literacy. SN and PBC have a significant correlation ($\beta = 0.444$, $p < 0.05$). Among these, PU has the highest explanatory power for behavioral intention (BI).

(3) SEM 3 for students with strong digital literacies: the results of SEM 3 are presented in Table 5 and Figure 3c. This model explains 50.4% of the covariance in behavioral intention. Perceived ease of use (PEU) has a significant positive effect on perceived

TABLE 5 Results for SEM 1, SEM 2, and SEM 3.

| Model | Explained variable | Explanatory variable | Estimate | S.E. | Est/S.E. | *P*-value |
|---|---|---|---|---|---|---|
| SEM 1 | PU | PEU | 0.590 | 0.067 | 8.859 | 0.000 |
| | ATT | PU | 0.370 | 0.098 | 3.771 | 0.000 |
| | ATT | PEU | 0.320 | 0.090 | 3.578 | 0.000 |
| | BI | ATT | 0.172 | 0.072 | 2.401 | 0.016 |
| | BI | PU | 0.424 | 0.090 | 4.727 | 0.000 |
| | BI | SN | 0.129 | 0.066 | 1.948 | 0.051 |
| | BI | PBC | 0.265 | 0.065 | 4.048 | 0.000 |
| | SN | PBC | 0.312 | 0.043 | 7.226 | 0.000 |
| SEM 2 | PU | PEU | 0.709 | 0.116 | 6.103 | 0.000 |
| | ATT | PU | 0.519 | 0.169 | 3.072 | 0.002 |
| | ATT | PEU | 0.094 | 0.148 | 0.633 | 0.527 |
| | BI | ATT | 0.189 | 0.134 | 1.408 | 0.159 |
| | BI | PU | 0.409 | 0.140 | 2.918 | 0.004 |
| | BI | SN | 0.047 | 0.102 | 0.458 | 0.647 |
| | BI | PBC | 0.317 | 0.089 | 3.562 | 0.000 |
| | SN | PBC | 0.444 | 0.090 | 4.913 | 0.000 |
| SEM3 | PU | PEU | 0.562 | 0.091 | 6.138 | 0.000 |
| | ATT | PU | 0.289 | 0.118 | 2.453 | 0.014 |
| | ATT | PEU | 0.425 | 0.119 | 3.574 | 0.000 |
| | BI | ATT | 0.145 | 0.083 | 1.762 | 0.078 |
| | BI | PU | 0.411 | 0.105 | 3.907 | 0.000 |
| | BI | SN | 0.165 | 0.084 | 1.955 | 0.051 |
| | BI | PBC | 0.249 | 0.090 | 2.753 | 0.006 |
| | SN | PBC | 0.243 | 0.047 | 5.171 | 0.000 |




(a) SEM 1 for all students

(b) SEM 2 for students with weak digital literacies

(c) SEM 3 for students with strong digital literacies

FIGURE 3
Parameter estimation of SEM 1, SEM 2, and SEM 3.

usefulness (Harpur and Suzor), with both PEU (β = 0.425, $p < 0.05$) and PU (β = 0.289, $p < 0.05$) jointly influencing the attitude of students with strong digital literacy toward AI eBooks. PU (β = 0.411, $p < 0.05$) and perceived behavioral control (PBC) (β = 0.249, $p < 0.05$) directly impact the acceptance of AI eBooks among students with strong digital literacy, while attitude (ATT) (β = 0.145, p = 0.078) and subjective norm (SN) (β = 0.165, p = 0.051) do not significantly influence the acceptance of AI eBooks among students with strong digital literacy. SN and PBC have a significant correlation (β = 0.243, $p < 0.05$). Among these, PU has the highest explanatory power for behavioral intention (BI).

Through the comparative analysis of three SEMs, we gain a clearer understanding of the impact of perceived ease of use (PEU) and perceived usefulness (Harpur and Suzor) on students' attitudes (ATT) toward AI eBooks, as well as the heterogeneity in responses among students with varying levels of digital literacies.

Initially, the overall sample demonstrates that both PU and PEU have a similar degree of influence on attitudes toward AI eBooks, indicating that students generally regard the usefulness and ease of use of emerging technologies as equally important. However, further analysis reveals that students with weak digital literacy place more emphasis on PU. This may be attributed to their lack of sufficient technological knowledge, yet they still recognize the potential value of emerging technologies. Conversely, students with strong digital capabilities prioritize PEU, suggesting they are more concerned with the operational and convenience aspects of technology. This could be because they already possess certain digital skills and focus more on the practical application of technology. Moreover, we discover that PU is one of the most significant factors affecting students' Behavioral Intentions (BI), indicating that whether students perceive AI eBooks to be useful directly influences their willingness to adopt them. Additionally, the impact of PEU on PU is also significant, highlighting that students' perceptions of technological ease of use directly affect their perceptions of its usefulness. As analyzing the influence of subjective norm (SN) and perceived behavioral control (PBC) on the acceptance of AI eBooks, we found that SN does not have a significant impact on the overall sample, but PBC significantly affects BI, with a notable correlation between SN and PBC. This suggests that while SN might not directly drive students' decisions to adopt AI eBooks, their perceived control over using this technology (PBC) plays a crucial role in their behavioral intentions. This complex interplay of factors underscores the multifaceted nature of technology acceptance and the importance of understanding individual and collective influences on students' engagement with digital learning tools.

## 4.3 Discussion and implications

To delve deeper into the acceptance of emerging educational methods and technologies such as AI eBooks among students with varying digital literacies, this study analyzes and discusses two categorized groups. Based on the result of the latent class model in section 4.1, the sample of 516 students is divided into 170 students with weak digital literacies and 346 students with strong digital literacies.

### 4.3.1 Practical and theoretical implication

In the student group with weak digital literacies, the sample comprised 98 primary school students, accounting for 57.64%, and 67 secondary school students, making up 39.41%, along with a small number of junior college and postgraduate students. Despite the era of digital proliferation, the education system in Chinese primary and secondary schools still relies on traditional paper textbooks. Additionally, the use of smart devices and various AI functionalities among primary and secondary school students is not widespread, which explains why the group with weak digital literacies primarily consists of these younger students. The AI eBook proposed in this thesis retains the design of traditional books while employing AI to dynamically generate images. This approach not only fits within the education system of primary and secondary schools but also promotes the dissemination of emerging technologies like AI in teaching, enhancing students' visualization of knowledge beyond text-based learning. According to the results from the structural equation model (SEM2), the group with weak digital literacies places greater importance on the usefulness of AI eBooks. The attitudes and opinions of others do not significantly influence their use of AI eBooks, suggesting that the spread of emerging technologies can improve students' learning conditions. This finding supports the further rational development and design of AI eBooks tailored to specific curricula and their implementation in actual educational settings. The AI eBook used in this survey, based on the medical knowledge of the Song Dynasty, serves an educational and introductory purpose for students.

Among the students with strong digital literacies, the sample included 27 primary students (7.80%), 70 secondary school students (20.23%), 88 junior college students (25.43%), 127 undergraduate students (36.71%), and 34 postgraduate students. Such distribution confirms the previous conclusion that students with strong digital literacies mainly consist of junior college and undergraduate students, whose age and educational stage allow them to continuously learn about and engage with emerging technologies. According to the results from SEM3, the perceived usefulness and ease of use of AI eBooks are the main factors influencing their attitudes toward AI eBooks. The opinions of others do not impact their willingness to use AI eBooks, with perceived usefulness and perceived behavioral control being the primary influencers of their acceptance. The possible reason is the debatable application value of AI eBooks in university courses and considerations regarding the pricing and usage models of AI eBooks for students who can readily access the internet and other digital resources, warranting further research and discussion.

### 4.3.2 Connection between AI eBook design and pedagogical principles

Integrating AI into eBooks to develop the proposed AI eBook is a new development in educational media, but its core goal of using technology to enhance learning aligns with long standing and widely recognized pedagogical principles in educational technology research.

First, the AI eBook's dynamic image generation feature which synchronizes visual content with text to boost comprehension directly reflects the core ideas of multimedia learning. The fundamental logic of multimedia learning suggests that coordinated visual and verbal information eases learners' cognitive burden and helps them integrate new knowledge into existing cognitive frameworks. For the Song Dynasty medical knowledge focused on in this study, complex concepts such as human anatomy and meridians require learners to grasp both spatial and temporal relationships. Static illustrations in traditional paper books often fail to fully convey these relationships, while the AI eBook's dynamic visuals address this limitation. Notably, students with weak digital literacy mostly primary and secondary school students prioritize the usefulness of these dynamic features. This shows that technology design following multimedia learning principles can

overcome barriers caused by limited digital skills. Even students accustomed to traditional paper books recognize the value of dynamic visuals in understanding complex medical concepts, proving the design's innovation and pedagogical effectiveness.

Second, focusing on the impact of digital divide heterogeneity on AI eBook acceptance responds to a long standing concern in educational technology that is ensuring equitable access to and adoption of digital tools. The third level digital divide refers to differences in the results of technology use beyond just having access to devices first level or knowing how to operate them second level. The study's findings show that students with weak digital literacy need targeted improvements in perceived usefulness such as clear connections to curriculum goals, while students with strong digital literacy care more about ease of use such as intuitive control panels. These insights provide practical strategies to reduce the third level digital divide. Previous discussions on eBook acceptance have noted that user competency with technology and infrastructure support are important, but they rarely consider how to tailor support based on digital literacy levels. This study advances this line of thinking by showing that support measures must be customized. For students with weak digital literacy like primary schoolers, integrating AI eBooks into existing classroom activities such as replacing static textbook illustrations with dynamic AI content during regular lessons can help them see the practical value of the technology. For students with strong digital literacy such as undergraduates, optimizing device compatibility like ensuring the AI eBook works smoothly on different types of smartphones or tablets can make the technology easier to use. This tailored approach aligns with the idea that educational technology design should be responsive to context, emphasizing that the effectiveness of a tool depends on matching its features to the characteristics of its users.

Third, the finding that subjective norm has no significant impact on behavioral intention across all structural equation models adds new insights to the application of theories related to planned behavior in educational technology. Some previous discussions on eBook acceptance thought social influence similar to subjective norm had a moderate effect on student adoption, especially in educational environments where group opinions matter. However, this study shows that regardless of digital literacy level, students' decisions to accept AI eBooks are not significantly influenced by the opinions of others such as parents or friends. Instead, they focus more on whether the AI eBook is useful. This suggests that in the context of AI educational tools, the practical value of the technology whether it can directly help improve learning outcomes matters more to students than social pressure. Even younger students who might be expected to be more influenced by their peers or family prioritize the usefulness of the AI eBook. This finding highlights a key direction for educational technology design that is focusing on functional benefits that directly support learning rather than relying on social approval to drive adoption.

## 5 Conclusion

Utilizing internet survey data on AI eBooks, this study applies a latent class model to categorize student groups, subsequently constructing structural equation models based on the technology acceptance model and theory of planned behavior for the overall sample, the first group of students (with weak digital literacies), and the second group of students (with strong digital literacies), aiming to investigate the impact of the digital divide of students on the acceptance of AI eBooks.

(1) As the latent class number is set to two, the latent class model demonstrates the highest fit. Based on the digital literacy characteristic of latent class 1 and class 2, the first group is defined as students with weak digital literacies and the second as those with strong digital literacies, accounting for 30.62% and 69.38% of the population, respectively. A significant digital divide exists between these two student groups.
(2) Students with weak digital literacies show that perceived usefulness has a greater impact on their attitudes toward AI eBooks than perceived ease of use. Conversely, for students with strong digital literacies, perceived ease of use has a greater influence on their attitudes toward AI eBooks than perceived usefulness. Therefore, it is necessary to optimize the design and usage of AI eBooks for students with weak digital literacies to facilitate their use in primary and secondary education. For students with strong digital literacies, improving the ease of use of AI eBooks could enhance their widespread adoption.
(3) Perceived usefulness was identified as the primary factor affecting students' acceptance of AI eBooks, while subjective norms had no significant impact. The student group's acceptance of AI eBooks is less likely to be influenced by others and more dependent on the practical value of using AI eBooks. Thus, by optimizing technical design, the actual value and advantages of AI eBooks can be enhanced.

Considering the heterogeneity in students' digital literacies, this paper divides the student population into two latent categories: students with weak and those with strong digital literacies, offering a new perspective for research on the acceptance of new technologies. Future studies could further explore the impact of mediating and moderating variables on the psychology of different respondents, deepening the understanding of technology acceptance across varied student demographics. This research underscores the importance of considering individual differences in digital proficiency when developing and implementing educational technologies, ensuring they meet the diverse needs and preferences of students.

Looking ahead, this study guides EdTech firms to develop tiered AI eBooks (simplified for weak digital literacy students, advanced for strong ones) and supports embedding digital literacy guidance with AI eBooks in curricula. Future research could use longitudinal designs, experimental setups, or cross-country comparisons. Ultimately, it achieves its goal of exploring how the student digital divide impacts AI eBook acceptance, with novelty in combining LCM and SEM to address traditional one-size-fits-all limits, while offering a replicable framework for education-focused heterogeneous technology acceptance research.

## Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

## Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements. Using anonymous online questionnaires, this study does not collect or disclose any personal information of the participants.

## Author contributions

HX: Methodology, Writing – review & editing, Writing – original draft, Conceptualization. GZ: Methodology, Writing – review & editing. RY: Writing – review & editing, Conceptualization.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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## Publisher's note



## Supplementary material

The detail design and demo of AI eBooks is public at: https://github.com/Sekiro23268/Student-s-Acceptance-of-Artificial-Intelligence-eBooks.

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