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Technology-Enhanced Learning: Perception for Boosting Engagement Among College Students

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Abstract

This study explores how students' perceived ease of use, perceived usefulness, and attitudes towards technology enhance learning (TEL) affect their learning engagement in universities. The study collected data through a questionnaire survey and used quantitative analysis to explore the relationship between the three factors of usability, usefulness, and technical attitude and learning participation. The results indicate that perceived ease of use significantly affects students' acceptance of technology, and easy-to-use technology tools can effectively alleviate students' technology anxiety to improve learning engagement; Perceived usefulness impacts learning outcomes, and students who believe that technological tools are helpful for learning will be more actively involved in learning. A positive attitude towards technology among students is an important factor in enhancing learning engagement. The study provides practical guidance for educators to optimize technological tools and develop teaching strategies, and proposes research directions for cross-cultural studies in different contexts.

Keyword: Technology Enhanced Learning (TEL), Technology Attitude, Learning Engagement, Quantitative Analysis

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1 Introduction

In the era of rapid development of information technology, technology has an amazing speed to affect all aspects of our lives, and education is no exception. Traditional teaching methods have been unable to meet the needs of students for interaction and flexibility, and technologies such as mobile devices, online platforms and virtual classrooms have broken the limitations of space and time required for learning, students have a more diversified and personalized learning experience. Especially in higher education, Technology Enhanced Learning (TEL) has gradually become an important part of educational innovation. TEL refers to the deep integration of various Information and Communication Technology (ICT) tools and learning processes to improve the quality of education and learning outcomes. However, despite the great potential of technology in education, the effect varies greatly depending on students' acceptance and attitude towards technology. Hence, it is of great academic and practical significance to study the Perceived Ease of Use and Usefulness of Technology and the influence of students' attitudes towards technology on students' engagement (Dunn, T. J., & Kennedy, M., 2019; Daniela, et al., 2018).

1.1 Research Background

Under the background of high-level education in China, with the continuous reform of education, the application of educational Technology is gradually popularized, and TEL has become an important part of modern education. Educators are increasingly using a variety of digital tools and resources in the teaching process to students with more interactive learning opportunities. In practice, the implementation of technology faces many challenges, e.g., students' lack of confidence in using technology and the complex technical operation interface. Factors such as students' acceptance of technology, their motivation and attitude towards technology may affect the application effect and learning success of technology. It is essential to study how to improve students' participation through technology (Rosli, M. S., & Saleh, N. S.,2023; Han, J., & Geng, X., 2023).

The study focused on universities in Heilongjiang Province, China, where students were surveyed, such as the Perceived Ease of use, Perceived Usefulness of technology and how students' attitudes towards technology affect participation in the classroom. This study reveals the application effect of technology in teaching and provides a reference for educators to integrate technology tools in the classroom.

1.2 Problem statement

Although technology adoption in higher education is a growing phenomenon, doubts remain about the efficiency of this advancement in promoting student engagement and improving learning outcomes. Unlike technology-rich classrooms with unlimited opportunities for innovation and interactive learning models, the challenges include the effective implementation of technology and its integration in the classroom. The problem of not having the same access to technology, the presence of digital distractions, and consistency in teaching are the issues that indicate the complex nature of using technology for student engagement in college education. In addition, in the process of technological breakthroughs, ongoing research will be required to elaborate and apply best practices and to manage new challenges that will arise. This study focuses on the following questions:

RQ1: How perceived ease of use of technology influence student engagement?

RQ2: How perceived usefulness of technology influence student engagement?

RQ3: How do students' attitudes toward technology influence student engagement?

To solve these questions, this study adopts quantitative analysis methods through questionnaire surveys. Random sampling method was used to ensure the diversity of the sample students, so that the sample would cover students of different majors and ages, to improve the authenticity and reliability of the research results.

1.3 Research significance

This study has both theoretical and practical significance for higher education. In theory, it provides a new perspective for discussions on how learning technology affects student engagement in a technologically supported learning environment. By analyzing the attitudes, experiences, and learning outcomes of students and teachers, we interpret how different technological tools and learning theories affect students' learning engagement and effectiveness (Chein and Choo, 2021).

In practice, the research can provide specific recommendations for educators and policy makers. For example, educators can choose technology tools that are easy to operate and can improve students' learning motivation, and design learning activities that better meet students' needs; Policy makers can develop more targeted strategies and resource allocation plans for promoting educational technology.

In addition, this study can help teachers better utilize technology to enhance classroom experience. Teachers can draw on the experiences of others, create a learning environment that integrates technology, meet the diverse needs of students, promote collaborative learning, and encourage students to actively participate in classroom activities (Liu, Zaigham, Rashid & Bilal, 2022).

The structure of the paper is as follows. Section 2 reviews extant literature and the relevant theories and technologies. Section 3 describes the methodology and data collection. Section 4 addresses the empirical procedure and results. Section 5 provides discussions and potential implementations. Section 6 concludes the paper.

2 Background and the Relevant Technologies

This review mainly discusses the application of augmented reality (AR), collaborative learning, and mobile assisted language learning (MALL) technologies in education, as well as the acceptance of these technologies (TAM model). AR technology, due to its visualization effect and strong interactivity, can help students understand and remember complex content more easily; Collaborative learning promotes interaction among students to share knowledge during the learning process; MALL technology, due to its flexible learning approach and the addition of many interesting gamification elements, can effectively stimulate students' interest and autonomy in learning. In addition, different cultural backgrounds and motivation types can affect students' acceptance of these technologies. This reminds us that when designing learning tools and teaching methods, we could consider the needs of different students and designing learning methods that are more suitable for them to truly improve learning outcomes (Pickering, J. D., & Swinnerton, B. J.,2019; Jopp, R.,2020). The following is a conceptual model (Figure 1).

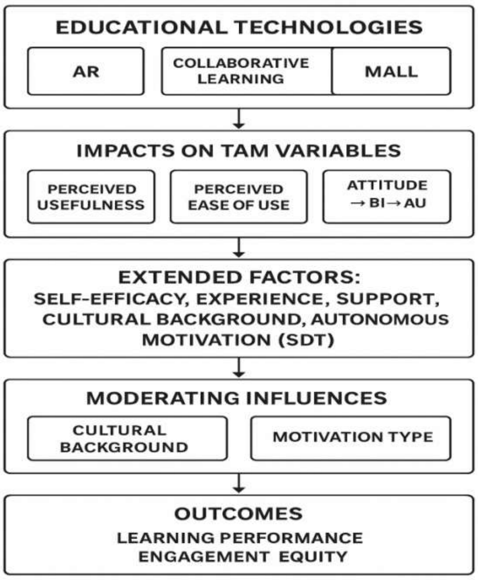

Figure 1. Conceptual Model of Technology-Enhanced Learning

2.1 Educational Applications of Augmented Reality and Collaborative Learning: A Multi-Dimensional Perspective

In recent years, the field of education has gradually adopted augmented reality (AR), Collaborative Learning (Collaborative Learning) and mobile learning resources (MALL) as the core tools of teaching reform. These technologies excel in visual, interactive and personalized learning for students' cognitive, emotional and social development. Combined with existing literature, this study analyzes the application potential and synergistic effects of these technologies in education. The results show that AR significantly improves academic performance by enhancing visualization and memory retention of complex concepts; Collaborative learning enhances students' participation and learning motivation by promoting social interaction; MALL provides a flexible learning environment for learners and promotes the realization of self-directed learning. These findings provide theoretical basis and practical guidance for the innovation and optimization of educational technology (Badilla-Quintana, M.G. and Salazar Arias, M., 2020; Qureshi, M. & Yousufi, S. Q., 2021; Gargrish, S., Mantri, A. and Kaur, D.P., 2022).

With the rapid development of digital technology, the traditional education model is facing changes. Augmented reality, with its ability to blend the virtual with reality, Provides A more intuitive learning experience for the teaching of complex subjects such as geometry and chemistry (Badilla-Quintana, M.G.Salazar Arias, M., 2020) (Gargrish, S., Mantri, A. and Kaur, D.P., 2022). Collaborative learning is seen as an effective teaching strategy that promotes learning motivation and cognitive ability through social interaction (Qureshi, M. & Yousufi, S. Q.2021), and mobile learning resources (MALL), by providing a platform for learning anytime and anywhere. It provides a new way of learning for language learners (Zhang, D., & Perez-Paredes, P. 2019)

2.1.1 Augmented Reality (AR)

I. Application in complex disciplines

AR shows great potential in disciplines that require high levels of visualization, such as geometry and chemistry. Students' understanding and memory retention of geometric concepts are significantly improved by 3D AR demonstrations (Gargash, S., Manteri, A. and Kaur, D.P., 2022). AR can effectively narrow the learning gap between ordinary students and students with special educational needs (Badilla Quintana, M. G. Salazar Arias, M., 2020)

This visual teaching method can effectively solve the problem of difficulty in conveying abstract knowledge. AR technology can narrow the learning gap between ordinary students and students with special educational needs. The importance of using AR is reflected in the following points. Firstly, the immersive experience of AR can enhance learners' sense of participation. Secondly, the interactive function of AR can help students dynamically observe and manipulate complex content in practice, such as the three-dimensional structure of chemical molecules and the spatial transformation of geometric shapes. This intuitive understanding process helps deepen their knowledge mastery. AR can also enhance students' learning motivation and confidence, especially for those who have difficulty learning, which is of great significance for educational equity and inclusiveness (Badilla, et al., 2020).

The application of AR in complex disciplines improves learning outcomes. It provides more possibilities for teaching. By combining AR technology, teachers can more effectively help students cope with the learning challenges of abstract knowledge, promoting innovation and development in education. In the future, with the further development of technology, the potential application of AR in more disciplines and teaching scenarios is worth exploring in depth.

II. The correlation between technology and learning outcomes

AR stimulates students' interest in learning and enhances knowledge retention through immersive learning environments. It enables students to become active participants in learning through dynamic interaction (Badilla Quintana, M. G. Salazar Arias, M., 2020). This technology enables students to personally experience the process of knowledge construction, such as mastering complex chemical reaction principles through virtual experiments, or understanding the dynamic changes of geography and ecosystems through simulated environments. This dynamic interactive feature helps students achieve better results in understanding and memory.

The integration of AR technology has also promoted innovation in instructional design. For example, teachers can use AR to develop personalized learning modules and design different levels of content based on the learning needs of different students. Meanwhile, by combining real-time feedback and adaptive learning functions, AR technology helps students better grasp knowledge points and overcome obstacles in learning. Hence, AR technology has advantages in enhancing students' interest in learning and improving academic achievements.

2.1.2 Collaborative learning

I. Social interaction and learning outcomes

Collaborative learning plays an important role in promoting students' social interaction and academic performance (Qureshi, M. & Yousufi, S. Q. 2021). Social interaction is a key factor in stimulating learning interest and enhancing academic performance. Through communication with peers and teachers, students can share knowledge and perspectives. For example, in group projects, students have increased their learning engagement and strengthened their teamwork skills through role allocation and task collaboration.

Collaborative learning provides students with diverse paths for knowledge construction. Students can form deeper understanding and even develop new ways of thinking through mutual inspiration and discussion. Collaborative learning is particularly beneficial for students from different backgrounds, as it can help disadvantaged groups or students with lower learning abilities receive more support. The advantage of this learning model is that it emphasizes the interactivity and participation of the learning process, rather than just being result oriented.

II. Application in Online Learning Context

With the popularity of online learning, collaborative learning has been further promoted as an important tool to support online interaction. Social media platforms provide students with more opportunities for collaboration and participation (Qureshi, M.&Yousufi, S. Q. 2021). Through these platforms, students can communicate and share learning resources in real-time, such as discussing homework issues through forums or collaborating on team projects using shared documents. The online environment increases the convenience of learning and makes the scope of collaborative learning more extensive and flexible.

Online collaborative learning also faces challenges, such as insufficient technical proficiency or uneven participation among team members. To address these issues, teachers can provide clearer task assignments and operational guidelines when designing courses and use learning analytics tools to monitor student engagement. Future research can further explore how the collaborative functions of different online platforms affect learning outcomes and develop more efficient collaboration tools to optimize applications in online learning contexts.

2.1.3 Mobile Learning Resources (MALL)

I. Support for self-directed learning

Graduate students tend to focus on short-term fragmented learning when using Mobile Assisted Language Learning (MALL) resources (Zhang, D., & P é rez Paredes, P. 2019), such as vocabulary memorization and exam preparation. This phenomenon demonstrates the flexibility and convenience of MALL, with the possibility of acquiring knowledge. However, this fragmented learning model also exposes the limitations of students in resource selection and long-term learning planning, which may lead to unsustainable learning outcomes.

To compensate for this deficiency, research suggests adding structured learning features to MALL resources, such as developing long-term learning plans and progress tracking tools. By introducing goal-oriented design, students can achieve systematic knowledge accumulation and skill improvement based on fragmented learning. This improvement enhances the functionality of MALL and provides learners with more comprehensive learning experience.

II. Interactivity and attractiveness

MALL significantly enhances students' learning interest and engagement by integrating interactive functions. For example, voice interaction, instant feedback, and gamified design in learning applications have attracted many active users. However, these features require stronger guidance to help students achieve learning goals more efficiently (Zhang, D., & P é rez Paredes, P. 2019). For example, by adding learning suggestions or personalized recommendation systems, students can be guided to allocate their learning time and resources reasonably.

In the future, MALL's design could further focus on personalization and diversity to meet the needs of different learners. For example, providing students with customized learning paths and personalized goal tracking tools will help optimize the learning experience. MALL tools that combine AR and social interaction functions can further enhance learners' motivation and learning outcomes. These improvements will make MALL a more comprehensive and efficient learning support platform.

2.2 Research on the application of Chinese as a second/foreign language education technology for normal college students based on technology acceptance model

With the rapid development of information technology, information and communication technology (ICT) has been applied increasingly widely in the field of education, especially in language teaching, and technology-assisted instruction (CALL) has become an important teaching means. Although educational technology shows great potential to improve learner engagement and learning outcomes, students are not making sufficient use of technology. This may be related to factors such as a lack of practical experience, a lack of awareness of the value of technology, and a lack of external support. In this context, it is of great significance to study the influencing factors of students' acceptance of educational technology for improving their ability of technology application (Zhao, et al., 2022; Pandita, A., & Kiran, R.,2023).

2.2.1 TAM and Technology Acceptance

Technology acceptance model (TAM), based on rational behavior theory and planned behavior theory, emphasizes that users' perceived usefulness and perceived ease of use of technology are key factors affecting their willingness to use. As research progresses, factors such as technology self-efficacy, supporting conditions, and use experience are incorporated into the model to enhance explanatory power (Bergdahl, N., Nouri, J., & Fors, U.,2020; Heo, H., Bonk, C. J., & Doo, M. Y.,2021). For university students, perceived usefulness and technology self-efficacy are important variables affecting technology acceptance. Studies have shown that these factors improve the intention to use technology by influencing attitudes.

2.2.2 Research methods and findings

This study used structural equation model (SEM) to analyze the data of 331 university students from two key universities in China, and explored the effects of perceived usefulness, technology self-efficacy, supporting conditions and technology use experience on technology acceptance willingness. The results show that model 3 has the best fitting effect in explaining the technology acceptance intention of students, in which perceived usefulness, technology use attitude and experience have significant positive effects on technology acceptance intention, while technology self-efficacy and supporting conditions have indirect effects on technology acceptance intention through affecting technology use attitude.

2.2.3 Research significance and prospect

Based on TAM and contextualized analysis, this study puts forward a technology acceptance framework suitable for teaching language. The results of the study provide strategies for schools and teacher training institutions to enhance the technology application ability of normal school students, including strengthening technical support, providing ICT training, technology application demonstration and practice opportunities, and improving the support conditions.

Future studies may expand the sample scope from more regions and cultural backgrounds to improve the universality. The causal relationship between variables can be revealed through longitudinal research and experimental design. In addition, we could explore other factors that may affect technology acceptance, such as cultural background, social norms and teachers' educational ideas, to build a more comprehensive technology acceptance model and provide stronger support for the promotion and application of educational technology.

2.3 Acceptance and practice of mobile Assisted Language Learning (MALL) technology in EFL teaching

The rapid development of information technology has brought revolutionary changes to the field of language teaching, especially the rise of mobile assisted Language learning (MALL). MALL provides learners with flexible and convenient learning methods through mobile devices, which greatly promotes students' independent learning and participation in EFL (English as a Foreign Language) teaching. With the proliferation of mobile learning applications, such as Busuu and Duolingo, which have attracted a lot of attention in academia with gamification elements and social networking capabilities. However, research on the technology acceptance (TAM) of these applications, especially in specific cultural contexts, remains inadequate (Han, Z., Tu, Y., & Huang, C.,2023; Wang, X., Tan, S. C., & Li, L.,2020).

2.3.1 Research on TAM and Acceptance of Gamified Learning

TAM is an important theoretical framework for analyzing users' acceptance of new technologies. Core variables include perceived usefulness (PU), perceived ease of use (PEOU), and behavioral intent (BI), which together affect the actual usage behavior of users. TAM's applied research in the field of education technology has covered many fields, such as online learning platforms and mobile learning tools. PU and PEOU significantly affected students' attitude and behavioral intention towards the application of Busuu among students (Wang, et al., 2021; Foshee, C. M., Elliott, S. N., & Atkinson, R. K.,2016).

Gamified learning enhances students' interest and engagement by introducing game elements such as points, rewards, and leaderboards. Chen et al. built a model based on TAM and self-determination theory (SDT) and found that autonomous motivation significantly affected students' PU and PEOU on gamified vocabulary learning applications, while external motivation only had a positive impact on PU.

The research shows that students from different cultural backgrounds have different acceptance behaviors towards MALL. Both Saudi and Chinese studies show that students' learning motivation is closely related to cultural characteristics. For example, Chinese students tend to pay more attention to the tool function of an app, while Saudi students emphasize more fun in the learning process.

2.3.2 Research methods and findings

Using structural equation model (SEM), (Lytras, M., Sarirete, A., & Damiani, E. 2020; Kurilovas, E., & Kubilinskiene, S.,2020). analyzed the data of 272 Chinese college students to reveal the relationship between autonomous motivation, PU, PEOU and actual use behavior. (Nicolaou, C., Matsiola, M., & Kalliris, G. 2019; Fazza, H., & Mahgoub, M.,2021) combined questionnaires and semi-structured interviews to explore the attitudes and usage behaviors of 58 Saudi middle school students towards the application of Busuu.

Key findings include, in the influence of motivation on perception, autonomous motivation has a significant positive effect on both PU and PEOU, while controlling motivation only has a positive effect on PU. This suggests that when students use apps for interest or intrinsic value, they are more inclined to view those tools as useful and easy to use.

In the effect of PU and PEOU on behavioral intention, studies supported a relationship between TAM core variables, with PU and PEOU significantly predicting students' behavioral intent, which in turn influenced actual frequency and duration of use.

In the Culture and user experience, Saudi students' acceptance of the Busuu app was also significantly influenced by ease of use and learning interactivity. In addition, some students worry about the effect of small screens on their eyesight (Kay, D., & Pasarica, M.,2019; Ironsi, C. S. ,2022).

2.3.3 Research significance and prospect

By integrating TAM and SDT, this study deepens the understanding of the acceptance behavior of language learning technology and enriches the research results of educational technology in the cross-cultural context. Research confirms that the type of motivation and perceived experience play a key role in the use of learning technology.

The practical significance is embodied in Optimize learning tool design. App developers could focus on increasing autonomous motivation, such as making learning fun through gamified design, while providing personalized learning paths to meet the needs of students from different cultural backgrounds. It is reflected in Teaching strategy improvement. By integrating MALL tools with classroom instruction, teachers can motivate students to learn, especially in a massive online education environment.

It is potential to expand the sample scope to cover learners of different ages and language levels to improve the universality of the study, and to explore the relationship between cultural characteristics and TAM variables and further reveal the moderating effect of culture acceptance on technology.

3 Methods and Data Sources

3.1 Research Design

Quantitative research design was adopted, and data was collected through questionnaire survey to discuss perceived ease of use, perceived usefulness and the influence of student's attitudes toward technology on student engagement. This quantitative method design is suited for this study, as it can explain the relationship between variables by collecting data, and it can verify the proposed research hypotheses through statistical analysis.

A structured questionnaire was used to collect data. The questionnaire consists of four parts: perceived ease of use, perceived usefulness and student's attitudes toward technology on student engagement. Each section uses Likert's (Jebb, A. T., Ng, V., & Tay, L. 2021) five-point scales ranging from strongly disagree to strongly agree.

Variables: Core changes in this study include ease of use, usefulness, attitudes and student engagement. Each variable is collected through multiple questions to ensure comprehensive coverage of different aspects. For example, the part of ease of use focuses on students' perception, complexity and friendliness of technology operation, while the part of usefulness pays more attention to students' degree of technology in learning.

3.2 Population and sampling

3.2.1 Population

In this study, all undergraduates in a university in Heilongjiang Province, China, which is a representative university as the research object, are from many different majors and grades. Students are familiar with various educational technology tools, such as online learning platforms, virtual classrooms, intelligent learning and other applications. The age range is 20-22.

Academic background: Education, business administration, computer science, accounting, etc.

Technology use level: The subjects of the study have rich experience in using technology, and students have been accustomed to using various digital learning tools, which enable them to objectively evaluate the ease of use and practicability of technology tools.

3.2.2 Sampling Method

To ensure the representativeness of samples and the wide applicability of research results, this study adopts stratified random sampling method, which can ensure the representativeness of different groups and reduce the bias of sample selectivity.

According to the study objectives, stratified participants follow criteria. First, students were divided into three categories based on age, to control for the potential impact of grade level on learning engagement and technology acceptance. Students are divided into five categories according to their professional background, namely, Department of Education, Department of Business Administration, Department of Computer Science, Department of Accounting and others. The purpose of this is to ensure that students from different majors can participate in the research. A simple random sampling method is used in each stratification.

3.2.3 Advantages and limitations of sampling

Advantages: Stratified sampling can ensure that each group in the sample can be reasonably represented, so that the research results can be widely applied to groups with similar backgrounds. Since each stratified student is produced by random selection, systematic bias in the sample is avoided. Stratified sampling can help researchers make comparative analysis between different groups.

Limitations: Since this study is limited to the sample of students from colleges, the generalization of the research results will be limited by a certain nature, and further verification may be required for its application in different colleges and universities in other regions. Although only stratified random sampling is used, due to the limited number of samples, there may still be a certain degree of sampling error.

3.3 Research Instruments

3.3.1 Instrument description

The main data collection tool in this study was structured questionnaire. The questionnaire was constructed based on the existing theoretical framework, the technology acceptance model, TAM (Davis, F. D., Granic, A., & Maranguniic, N. 2024), to ensure that target variables could be accurately collected for each question. The questionnaire content has been tested several times to improve the stable use of test links and the effectiveness of real-time submission.

3.3.2 Reliability analysis

Before data analysis, SPSS was used for reliability analysis of the questionnaire, and Cronbach's Alpha coefficient was used to evaluate the internal consistency of the questionnaire. If the mean value is greater than 0.7, the questionnaire has good reliability.

3.4 Data collection procedures

3.4.1 Questionnaire design and testing

Before the formal data collection, the questionnaire was tested to ensure that the questions were clearly linked and used properly.

Questionnaire release: Publish the questionnaire link through the online platform and publicize it through the school's internal network and social media to attract students to participate in the questionnaire. The purpose of the study was explained to the students and their privacy, and data security were assured.

Data collection and cleaning: Prior to data analysis, all data was cleaned, and incomplete questionnaires were removed to ensure the reliability of the analysis results.

3.4.2 Whether the data collection method is appropriate

For this study, the use of questionnaires to collect data is an appropriate way. Questionnaires can collect systematic data from larger students. Here, the form of questionnaire survey makes data collection more efficient and convenient to cover a wider area. Especially in the environment of higher education, students generally have a high ability to use the Internet, and online questionnaire surveys are suitable for the needs of target groups.

3.5 Data analysis technology

Quantitative data analysis technology is adopted in this study, and the specific contents are as follows:

Descriptive statistical analysis: Firstly, SPSS was used for description, and statistical analysis was carried out to summarize the basic characteristics of the sample and the mean and standard deviation of each key variable.

Reliability analysis and validity analysis: Cronbach's Alpha and factor analysis functions of SPSS were used to test the reliability and validity of the data to ensure the reliability of the measurement tool.

Correlation analysis: Pearson Correlation analysis is used to verify the ease of use of technology, the relationship between correlation and attitudes, and their impact on students' learning engagement.

Multiple Regression Analysis: Use multiple regression analysis to test the hypotheses of the study and determine the impact of technology ease of use, utility, and student attitudes on student engagement.

These data analysis methods are scientific and objective and can clearly reveal the relationship between each variable and the causal relationship, which provides sufficient substantive basis for verifying the research hypothesis.

3.6 Ethical Considerations

3.6.1 Informed consent

In this study, all participants were required to sign a consent form before participating in the data collection. The consent form clearly informed the participants of the following points:

1. Purpose of the study: The purpose and content of the study will be clearly explained to ensure that participants understand the purpose of the study procedure.

2. Data collection process: Participants will be told to fill in the questionnaire, and the approximate time required to fill in the questionnaire and the way to fill in the questionnaire and fill in the online way to ensure that the process is justified and will not bring unnecessary burden to students.

3. Voluntary participation and opt-out: Clearly inform participants that participation in the study is completely voluntary and that they can opt out of the study at any time and that they will not suffer any adverse effects. Participants' right to withdraw will be fully respected and will not affect any relationship with the researcher or the school.

4. Data use: Participants' personal information and research data will only be used for this study, and all data will be anonymized to ensure that participants' privacy is protected. Participants will be informed of the use of the results of the research and how the research may be made public and informed that the data will be used for academic research only and will not be used in other commercial or non-academic ways.

5. Privacy protection: All participants' personal information will be kept strictly confidential, and the data will be analyzed in an anonymous form. By assigning anonymous codes, the study data cannot be associated with the identity of the participants.

6. Data storage and protection: Research data will be stored in secure electronic devices, all data will be encrypted and stored to ensure the security of participants' information, and after the end of the study, the data will be destroyed or anonymized in accordance with regulations

3.6.2 Fairness

I, Jiu Jiang, assured that all participants are treated fairly in the study

Sample selection: The sample selection in the study will not involve any form of discrimination, ensuring that all eligible students have an equal opportunity to participate in the study subjects will cover students from different grade levels of professional gender and background to ensure the representative sample and the universal applicability of the research findings.

3.6.3 Participant Privacy Protection

Privacy protection is one of the core ethical considerations in my research. In the process of data collection and analysis, to ensure that the privacy of participants is not violated, the specific measures are as follows.

1. Anonymization: All survey data will be anonymized to remove participants' personal information and identifying characteristics. Participants' names, contact information and other information will not appear in data analysis and research reports.

2. Data encryption: Research results will be presented in the form of aggregated data, so that even if the research report is published publicly, it will ensure that no detailed information that can identify individuals will be exposed.

3.6.4 Transparency of research results

1. Open research methods: The design data receipt process data analysis of this study will be carried out in strict accordance with the standards of scientific research and detailed in the paper, so that other researchers can further expand this study.

2. Avoid conflict of interest: During the research process, ensure that there is no conflict of interest that may affect the results of the research, and avoid any form of plagiarism, falsification of data and other unethical behaviors.

3.6.5 Participant Benefits

1. Voluntary Participation: All participants clearly understand that participation in the study is voluntary and can withdraw at any time without any negative consequences

2. Principle of no harm: This study will not have a negative impact on the physical, psychological and emotional aspects of the participants, and the questions in the questionnaire will ensure that it will not involve any sensitive topics and will not cause any uncomfortable reactions of students.

3. Help and feedback: If participants have any questions or concerns about the study, they can ask the researcher, and the researcher will provide adequate answers and ensure that their privacy is protected. If there is any discomfort or discomfort, participants will be advised to seek appropriate support and help.

4 Survey results

4.1 Demographic analysis

The analysis of sample characteristics in this study (Table 1) showed that the gender distribution of the participants was 56.7% male and 43.3% female, and the age was between 20 and 22 years old, the concentrations of students are education, business administration, computer, accounting, etc. Such sample distribution provides representativeness for the study and ensures the universality of data analysis results.

Differences in gender distribution may reflect the acceptance and use of educational technology tools among different gender groups. This data background provides the basis for the subsequent difference analysis. The relatively balanced distribution of age and majors allows the study to more comprehensively observe the performance of technology acceptance in different student groups.

Table 1. The description of characteristics in sample

		Frequency	Percent
Gender	Male (1)	17	56.7
	Female (2)	13	43.3
Age	20	11	36.7

	21	9	30
	22	10	33.3
Major	BED	7	23.3
	BBM	6	20
	BIT	7	23.3
	BAD	8	26.7
	Other	2	6.7

4.2 Reliability test

The reliability test of a questionnaire is used to determine whether the questionnaire is reliable and whether the measurement results are reliable. It is to check whether the results obtained by the measuring tool are stable and consistent. Reliability is generally divided into two types: intrinsic reliability and extrinsic reliability. Intrinsic reliability mainly refers to whether a set of questions in the questionnaire are measuring the same concept, and whether the consistency between these questions is high. The higher the consistency, the better the credibility of the questionnaire.

This study evaluated the internal reliability of the questionnaire using Cronbach's Alpha coefficient. The results are shown in Table 2. The higher the coefficient, the stronger the internal consistency. The reliability of each part of the questionnaire was analyzed, and the results are shown in the table. The table shows that the Cronbach's Alpha of all parts is above 0.7, indicating good internal consistency. Hence, the questionnaire is a suitable tool for this study.

Table 2. Reliability analysis

Latent variables	Cronbach's Alpha	N of Items
Perceived ease of use	0.75	3
Perceived usefulness	0.725	3
Attitude towards technology	0.756	3
Engagement	0.784	3
Overall questionnaire	0.898	12

As shown in the table, the reliability analysis of each variable in the questionnaire is as follows: Ease of Use includes 3 questions, and Cronbach's alpha coefficient is 0.750. Perceived Usefulness consists of three questions, with Cronbach's alpha coefficient of 0.725. The attitude towards technology includes three questions, with Cronbach's alpha coefficient of 0.756. The participation rate includes three questions, and the Cronbach's alpha coefficient is 0.784. The entire questionnaire consists of 12 questions, with Cronbach’s alpha coefficient of 0.898. Overall, the reliability of the questionnaire is high, indicating good correlation and consistency between the questions. The questionnaire is suitable for research purposes.

4.3 Validity analysis

Exploratory factor analysis is a method used to evaluate the structural validity of a scale, with the main objective of determining whether the measured variables corresponding to each latent variable have stability and consistency. This is one of the most used indicators to measure the validity of a scale. This article analyzed the composition of each dimension using SPSS. Validity analysis results are shown in Table 3.

Exploratory factor analysis requires two conditions to be met: first, the KMO value should be greater than 0.7. Secondly, the significance level of Bartlett's sphericity test should be less than 0.05. If both conditions are met, it indicates a strong correlation between the observed variables and good construct validity of the questionnaire

Table 3. KMO and Bartlett's Test

Kaiser-Meyer-Olkin		0.724
Bartlett's Test of Sphericity	Approx. Chi-Square	183.159
	df	66
	Sig.	0.000

The inspection results show that the KMO value of the survey data is 0.724, exceeding the standard of 0.70. The approximate chi square value of Bartlett's sphericity test is 183.159, with a significant probability of 0.000 ($P<0.01$). This indicates that the questionnaire has good structural validity, and the data is suitable for factor analysis.

4.4 Correlation analysis

When there is a connection between objects, but it cannot be directly explained as a causal relationship, this relationship is called a correlation. This article uses Pearson correlation analysis to examine the relationship between various variables. Correlation analysis results are shown in Table 4.

Table 4. correlation analysis

	Perceived Ease of Use	Perceived Usefulness	Attitudes Toward Technology	Engage ment
Perceived Ease of Use	1			
Perceived Usefulness	.503**	1		
Attitudes Toward Technology	.507**	.516**	1	
Engagement	.698**	.690**	.684**	1

** Correlation is significant at the 0.01 level (2-tailed).

In the correlation analysis table, the results show that the correlation coefficients of ease of use, technology practicality, attitude towards technology and participation are 0.698, 0.690 and 0.684 respectively, and the corresponding P values are all less than

0.01, which has significant statistical significance, indicating that ease of use, technology practicality, attitude towards technology and participation are all significantly correlated.

The relationship between usability and engagement: Ease of use has a particularly significant impact on engagement, with a correlation coefficient of 0.698, indicating that users are more likely to invest time and energy in using technology when they perceive it as easy and uncomplicated to use. This result is consistent with the hypothesis in the Technology acceptance Model (TAM), which argues that users' ease of use and perceived utility of technology are important factors affecting their acceptance. Ease of use should be a priority in the process of technology promotion and design.

The relationship between technology utility and engagement: The correlation coefficient between the utility of technology and engagement is 0.690, showing that whether technology can help users achieve personal goals or tasks directly affects their engagement. This further emphasizes the functional importance of technology. Even if the technology is easy to use, user engagement can still be low if it lacks actual functionality or value. Therefore, technology design should focus on functionality and practicality to ensure that the technology can effectively meet the needs of users.

The relationship between attitudes towards technology and engagement: The coefficient correlation between user attitudes towards technology and engagement is 0.684, suggesting that positive attitudes and trust in technology contribute to engagement. People are often more willing to spend their time using technology that they find valuable. Positive attitudes are not only related to the ease of use and usefulness of the technology itself but may also be closely related to an individual's social environment, prior experience, and degree of awareness of technology.

4.5 Regression analysis

Regression analysis is a very commonly used statistical method in data analysis, mainly used to study the dependency relationships between variables. Its focus is on analyzing the patterns of change between variables and describing and reflecting this relationship through the establishment of regression equations. Through regression equations, it is possible to clearly understand the degree to which a variable is influenced by other variables, thereby providing reliable basis for further predictions. Results are shown in Table 5.

Table 5. Ease of Use, Perceived Usefulness, and attitude toward technology are regression tests of engagement

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	-0.128	0.287		-0.446	0.660		

Perceived Ease of Use	0.454	0.162	0.363	2.803	0.009	0.664	1.506
Perceived Usefulness	0.414	0.159	0.340	2.606	0.015	0.655	1.526
Attitudes Toward Technology	0.374	0.151	0.325	2.485	0.020	0.652	1.535
R Square			0.710				
Adjusted R Square			0.677				
F			21.255***				
Dependent Variable: Engagement							

Note: * means $P < 0.05$,** means $P < 0.01$,*** means $P < 0.001$,

The regression model is constructed with Ease of Use, Perceived Usefulness and attitude towards technology as independent variables and participation as dependent variables. The obtained R-square value of the model is 0.710 and the fit degree is 71.0%, which is greater than 20%, indicating that the goodness of fit is good and can explain the change of participation to a certain extent. In the F test, the F value is 21.255 and the significance value is 0.000<0.05, indicating that the model is valid.

The effects of ease of use, perceived usefulness and attitude towards technology on participation are mainly verified by establishing regression models. The standardized regression coefficient of Ease of Use on participation was (β=0.363; t=2.803; P<0.01), indicating that Ease of Use has a significant positive effect on participation. In other words, when users perceive that technology is easy to use, they are more willing to actively participate in its use. Therefore, the design and interface of the technology should be as simple and intuitive as possible to reduce the threshold of user use and improve the user's participation experience.

The standardized regression coefficient of the Perceived Usefulness of independent variables in the model to participation is (β=0.340; t=2.606; P<0.05), indicating that the Perceived Usefulness of independent variables has a significant positive impact on participation. If users can feel the real value and help of technology when using it, their engagement will be significantly increased. Technology developers should focus on the innovation and practical design of product features to ensure that the technology can truly solve the real problems of users.

The standardized regression coefficient of the independent variable's attitude towards technology and participation is (β=0.325; t=2.485; P<0.05), indicating that the independent variable's attitude towards technology has a significant positive effect on participation.

It shows that positive attitude and sense of identity can enhance users' willingness to participate. Attitudes are often influenced by a combination of personal beliefs, cultural background, and social influences, so how to build user trust and identity with technology is another key factor in increasing engagement.

4.6 T-test analysis

T-test is a method used to determine whether the difference between the means of two samples is significant. Before conducting a t-test, it is necessary to confirm whether the variances of the two populations are equal, as this directly affects the calculation method of the t-test. Simply put, the process of T-test should be based on the results of homogeneity of variance test to select the corresponding analysis path.

In SPSS, a Levene test of homogeneity of variance is automatically included when performing the mean t-test. In the Levene test, if Sig If the value is greater than 0.05, it indicates that the variances of the two samples are equal. At this point, it is necessary to look at the T-test results under the assumption of equal variances. If Sig is included in the mean t-test A value less than 0.05 indicates a significant difference in the mean between two samples.

If Levene tests Sig A value less than 0.05 indicates that the variances of the two samples are not equal. In this case, we need to refer to the T-test results assuming unequal variances. Similarly, if Sig A values less than 0.05 indicates that the difference between the means of two samples has reached a significant level.

Table 6. Differential testing of variables for different genders

	Gender	N	Mean	Std. Deviation	t	P
Perceived Ease of Use	Man	13	2.000	0.624	-3.008	0.006
	Female	17	1.385	0.448		
Perceived Usefulness	Man	13	1.882	0.754	-1.599	0.121
	Female	17	1.513	0.399		
Attitudes Toward Technology	Man	13	2.098	0.752	-2.404	0.023
	Female	17	1.539	0.420		
Engagement	Man	13	2.431	0.734	-3.399	0.002
	Female	17	1.590	0.580		

Through the independent sample test (Table 6), the differences of ease of use, perceived usefulness, attitude towards technology and participation in different genders are analyzed. There were significant differences in Ease of Use, attitude towards technology and participation among different genders ($P<0.05$). The results showed that female participation was significantly higher than male participation.

There is no significant difference in the Perceived Usefulness of research objects of different genders ($P>0.05$).

Women's significant advantage in participation may be related to sociocultural contexts that place greater emphasis on women's sociability, need for communication, and emphasis on experience. In technology application scenarios, women may pay more attention to the social and emotional value that technology can bring and thus show higher participation.

There is no significant difference in Perceived Usefulness between genders: Although there are differences between men and women in Ease of Use and attitudes, there are no significant differences in Perceived Usefulness. This suggests that the objective factor of whether the technology is "practical" is more consistent among male and female users, which may reflect that the practical utility of the technology design is equally important to users of different genders.

4.7 One-way analysis of variance

One-way analysis of variance (one-way ANOVA) is used to compare the means of multiple samples in a completely random design, and its statistical inference is to infer whether the means of each population represented by each sample are equal.

Table 7.Test the difference between different ages in each dimension

Descriptives

						95% Confidence Interval for Mean			
		N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
PerceivedEaseofUse	20	11	1.6667	.77460	.23355	1.1463	2.1870	1.00	3.00
	21	9	1.6667	.37268	.12423	1.3802	1.9531	1.33	2.33
	22	10	1.8667	.67036	.21199	1.3871	2.3462	1.00	3.00
	Total	30	1.7333	.62759	.11458	1.4990	1.9677	1.00	3.00
PerceivedUsefulness	20	11	1.7879	.87271	.26313	1.2016	2.3742	1.00	4.00
	21	9	1.4815	.33793	.11264	1.2217	1.7412	1.00	2.00
	22	10	1.8667	.54885	.17356	1.4740	2.2593	1.00	3.00
	Total	30	1.7222	.64376	.11753	1.4818	1.9626	1.00	4.00
AttitudesTowardTechnology	20	11	1.8182	.82143	.24767	1.2663	2.3700	1.00	4.00
	21	9	2.0000	.44096	.14699	1.6610	2.3390	1.00	2.33
	22	10	1.7667	.73786	.23333	1.2388	2.2945	1.00	3.00
	Total	30	1.8556	.68191	.12450	1.6009	2.1102	1.00	4.00
Engagement	20	11	1.7879	1.01404	.30575	1.1066	2.4691	1.00	4.33
	21	9	2.2222	.52705	.17568	1.8171	2.6273	1.33	3.00
	22	10	2.2333	.66759	.21111	1.7558	2.7109	1.00	3.00
	Total	30	2.0667	.78492	.14331	1.7736	2.3598	1.00	4.33

Through one-way ANOVA to test the differences of ease of use, perceived usefulness, attitude towards technology and participation at different ages, there were no significant differences in ease of use, perceived usefulness, attitude towards technology and participation among respondents of different ages ($P>0.05$).

Age has less effect on technology acceptance (Table 7): The finding flies in the face of conventional wisdom that young people are more receptive to new technologies.

However, this study shows that the ease of use and practicality of the technology design itself may make users of all ages converge in the experience of use. Therefore, when promoting technology, it is not necessary to put too much emphasis on age differences, and technology should be designed to meet the needs of all groups as much as possible.

Table 8. The difference test of different specialties in each dimension

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
Perceived Ease of Use	1	7	1.5714	.41786	.15793	1.1850	1.9579	1.00	2.00
	2	6	2.0556	.49065	.20031	1.5406	2.5705	1.33	2.67
	3	7	1.7619	.91721	.34667	.9136	2.6102	1.00	3.00
	4	8	1.5000	.39841	.14086	1.1669	1.8331	1.00	2.33
	5	2	2.1667	1.17851	.83333	-8.4218	12.7552	1.33	3.00
	Total	30	1.7333	.62759	.11458	1.4990	1.9677	1.00	3.00
Perceived Usefulness	1	7	1.6190	.40500	.15307	1.2445	1.9936	1.00	2.00
	2	6	1.7778	.54433	.22222	1.2065	2.3490	1.00	2.33
	3	7	1.4762	.42414	.16031	1.0839	1.8685	1.00	2.00
	4	8	1.7083	.62836	.22216	1.1830	2.2337	1.00	3.00
	5	2	2.8333	1.64992	1.16667	-11.9906	17.6572	1.67	4.00
	Total	30	1.7222	.64376	.11753	1.4818	1.9626	1.00	4.00
Attitudes Toward Technology	1	7	1.3333	.50918	.19245	.8624	1.8042	1.00	2.33
	2	6	1.8889	.34427	.14055	1.5276	2.2502	1.33	2.33
	3	7	1.9524	.65060	.24590	1.3507	2.5541	1.00	3.00
	4	8	2.0000	.50395	.17817	1.5787	2.4213	1.33	3.00
	5	2	2.6667	1.88562	1.33333	-14.2749	19.6083	1.33	4.00
	Total	30	1.8556	.68191	.12450	1.6009	2.1102	1.00	4.00
Engagement	1	7	1.9048	.31706	.11984	1.6115	2.1980	1.33	2.33
	2	6	2.2222	.68853	.28109	1.4997	2.9448	1.00	3.00
	3	7	2.0000	1.00000	.37796	1.0752	2.9248	1.00	3.00
	4	8	1.8750	.66518	.23518	1.3189	2.4311	1.00	3.00
	5	2	3.1667	1.64992	1.16667	-11.6572	17.9906	2.00	4.33
	Total	30	2.0667	.78492	.14331	1.7736	2.3598	1.00	4.33

Through one-way ANOVA to test the differences of Ease of Use, Perceived Usefulness, attitude towards technology and participation in different majors, There were no significant differences in Ease of Use, Perceived Usefulness, attitude towards technology and participation among survey objects of different majors ($P>0.05$).

The influence of professional background is not significant (Table 8): Although there may be differences in educational background and exposure to technology among users of different professions, these differences do not significantly affect their ratings of Ease of Use, utility, attitude, or engagement with technology. This may indicate that the popularization of modern technology makes the acceptance of technology by professional background no longer a significant barrier.

4.8 Results

The research results verify the theoretical hypothesis of the technology acceptance model. Perceived Ease of Use, Perceived Usefulness and students' Attitude toward Technology are key factors that influence technology acceptance and learning engagement. These findings suggest that students' views and attitudes towards technology in the learning environment do indeed affect their learning engagement, which is consistent with previous research findings. However, this study also identified some noteworthy issues. Gender differences are an interesting discovery. Research has shown that girls are much more engaged in learning than boys, which may be because girls value social interaction and learning experience more. This result suggests that educators and technology developers should consider gender factors more when designing learning tools. For example, collaborative features or emotional support designs can be added to encourage boys to actively participate in learning. At the same time, it is also necessary to study the psychological barriers that boys may encounter when using technology, such as technological anxiety or lack of interest, and find targeted solutions.

Furthermore, although studies have shown that age and professional background do not have a significant impact on learning engagement, this does not mean that these factors are unimportant. There are certainly differences in the demand for learning tools among students of different age groups and majors. For example, engineering students may prefer more complex simulation tools, while humanities students may require more intuitive and user-friendly tools. When designing technology, these requirements also need to be considered more. Future research could explore how technology tools can be optimized based on major and course content to maximize the diverse needs of students. Finally, the study also mentioned that attitude has a significant impact on learning engagement. A positive attitude toward technology often stems from successful use experiences and the perceived value of technology. Therefore, educators should cultivate students' confidence in technology through positive technology experience. In addition, schools can organize regular technical training, share best practice cases, and establish technical support networks among students. These measures will not only enhance students' technical skills but also enhance their trust and identity with technology.

The results of this study provide important theoretical support for understanding the role of technology in learning behavior but also expose some issues that deserve attention. Future research could further explore the differences in technology acceptance among different student groups and explore how to comprehensively enhance students' learning engagement and effectiveness through technology design and educational strategies.

4.9 Practical Application and Impact

The findings of this study provide clear practical guidance for the design, promotion and application of educational technology tools. Perceived ease of use and perceived usefulness are key variables that influence students' technology acceptance, so technology developers need to prioritize these factors during the design process. The easy-to-use user interface and the functional design that helps students learn can not only lower the threshold of technology use, but also effectively improve their learning motivation. In addition, by integrating functions such as intelligent recommendation and personalized learning path, the technology tool can better meet the learning needs of different students, thus further improving its application effect.

Educators should also make full reference to the conclusions of this study in technology selection and curriculum design. For example, integrating intuitive, feature-rich technology tools into the curriculum can effectively enhance student engagement and efficiency. At the same time, educators can help students realize the value of technological tools through case demonstration and guidance, to stimulate their learning motivation. Education and training should also focus on how to reduce students' anxiety about technology, for example by introducing new tools in a step-by-step manner that enables students to gradually build confidence in a familiar environment. In resource allocation and technology promotion, policy makers can learn from the results of this study to optimize strategies. To ensure equity and access to educational technology, policies should prioritize support for low-resource areas and schools by providing high-quality technical equipment and training.

In addition, policymakers can fund research projects to further explore the specific impact of different technologies on learning outcomes and adjust the direction of technology promotion based on the findings. For example, comparative research across professional and cross-cultural contexts could be funded to optimize the applicability of the technology in diverse Settings. In addition, this study highlights the profound impact of students' attitudes towards technology on learning engagement. To enhance students' positive attitudes towards technology, schools and educational institutions should focus on creating a supportive technology culture. This includes building convenient technology support services, organizing technology sharing and learning activities among students, and encouraging students to actively participate in technology learning through incentive mechanisms. This technological culture can not only enhance students' trust in technology but also form a benign technology use ecology in the whole school.

The practical application of this research covers many aspects such as technology design, education and teaching, and policy making. Through the synergy of technology, educators, and policies, we can provide students with better learning experience and improve the quality and equity of education across the board. This not only helps to improve students' learning results but also points out the direction for the further development of educational technology.

5 Discussions and Implications

The research results provide important implications for the application of educational technology. First, the design of the technology could focus on the user experience to meet the needs of students. Secondly, it is necessary to cultivate students' positive attitude towards technology, which can be achieved through regular technical training and the sharing of success stories. In addition, teachers need the flexibility to integrate technology tools in the classroom to create more engaging and interactive learning environments that motivate students to learn. The potential of educational technology to enhance student learning outcomes and engagement will be fully realized.

It is suggested that educators could pay attention to the ease of use and practicability of tools in technology selection and application and promote students' acceptance and trust in technology through reasonable instructional design. Policymakers need to invest in and promote educational technology, including technical training and resources for students and teachers. Technology developers could focus on improving the user experience of the tool. In addition, in the promotion of technology, special attention could be paid to the characteristics of different user groups, and more targeted solutions could be designed to enhance the universality and practicality of technology (Cushion, C. J., & Townsend, R. C.,2019; Alavi, S. M., Dashtestani, R., & Mellati, M.,2022).

This study provides insights into the perceived ease of use and perceived usefulness of technology and the impact of student attitudes toward technology on learning engagement. The study shows that perceived ease of use is the main driver of student acceptance of technology. Technology tools that are easy to use and have intuitive interfaces can greatly alleviate students' technological anxiety and make them more willing to invest time and effort in learning activities. Perceived usefulness, as another important variable, directly affects students' attitudes and behaviors toward technology. When students can clearly perceive the practical value of technology tools in enhancing learning efficiency and improving learning outcomes, their acceptance of technology and learning engagement will be significantly increased (Fowler, S., Cutting, C., Kennedy, J., Leonard, S. N., Gabriel, F., & Jaeschke, W.,2022; Busebaia, T. J. A., & John, B.,2020).

In addition, the results of difference analysis show that gender has significant differences in learning engagement and technology attitudes, and female students' participation is significantly higher than that of male students, while age and professional background have no significant differences in the above variables. This suggests that the ubiquity of modern technology is gradually reducing the influence of traditional demographic factors on technology acceptance (Blau, I., Shamir-Inbal, T., & Avdiel, O.,2020; Serrano, et al., 2019).

Based on the above analysis, this study validates the core assumptions of the technology acceptance model (TAM), emphasizes the importance of user-friendliness and functional utility in technology design, and points out the key role of positive technology attitudes in promoting learning engagement. These findings provide clear guidance for the optimal design and application of educational technology tools, and open possibilities for future research, such as exploring the profound effects of cultural context and technological synergies.

6 Conclusion

This study aims to explore the impact of technology on students' learning engagement in higher education, in particular Perceived Ease of Use, Perceived Usefulness and the role of students' attitudes towards technology. With the rapid popularization of technology in the field of education, the demand and dependence of teachers and students on technology is also increasing. However, there are still significant differences in the actual effects of technology, which are related to students' technological acceptance and learning motivation. Through quantitative data analysis, this study attempts to reveal the influence of different technical elements on learning engagement, to provide theoretical support and practical reference for the optimal design and practical application of educational technology.

This study found that there are significant differences in the degree of participation of different genders in the use of technology, and female students show higher sensitivity and involvement in the sociability and experience value of technology. However, in terms of age and professional background, the differences between different groups are not significant, which indicates that the design and popularization of technology have gradually broken through the limitations of traditional demographic factors to provide a similar experience for a wider group of users.

Although this study reveals the impact of technology on student engagement through quantitative analysis, there are still some limitations. For example, the study sample was limited to students from universities in China, which may limit the applicability of the findings to other regions or cultural contexts. In addition, the subjectivity of the questionnaire may have a certain impact on the accuracy of the data. Future research could consider expanding the scope of the study to include a more diverse student to further explore the effects of technology in different cultural contexts. In addition, longitudinal research methods can be employed to more deeply reveal the causal relationship between technological factors and learning motivation.

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