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Junfeng Yang · Dejian Liu · Kinshuk · Ahmed Tlili · Maiga Chang · Elvira Popescu · Daniel Burgos · Zehra Altınay *Editors*

Resilience and Future of Smart Learning

Proceedings of 2022 International Conference on Smart Learning Environments

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Preface

Smart education is the current hot area of education technology research, and is an important aspect of the process of education development. The International Conference on Smart Learning Environments (ICSLE) has been held past in Hong Kong of China, Sinaia of Romania, Tunis of Tunisia, Beijing of China and Denton of the United States, bringing together international experts in intellectual learning and research, with important international influence. ICSLE 2022 will be jointly held on August 18-20, 2022 at the Hangzhou Normal University (China), The International University of La Rioja (Spain), and Near East University (Cyprus).

ICSLE2022 aims to bring together researchers, practitioners, and policy makers to discuss issues related to the resilience and future of smart learning in the post-pandemic period. The focus is on the interplay of pedagogy, technology and their fusion towards the advancement of smart learning. The conference invites scholars from domestic and abroad to participate in the conference to conduct in-depth exchanges and discussions on cutting-edge and hot issues such as artificial intelligence in education, Internet of Things (IoT) and multimodal learning analytics, precise education assessment supported by AI and big data, digital literacy in education in the Intelligent Era, etc. Various components of this interplay include but are not limited to:

• Track 1 Pedagogy: learning paradigms, assessment paradigms, social and cultural factors, biases, ethical considerations, policy issues and implications
• Track 2 Technology: emerging technologies, innovative uses of mature technologies, adoption, usability, standards, and emerging/new technological paradigms (open educational resources, cloud computing, blockchain, artificial intelligence applications in education, etc.)
• Track 3 Fusion of pedagogy and technology: transformation of curriculum, transformation of teaching and learning behavior, transformation of administration, best practices of infusion, piloting of new ideas

ICSLE2022 received 45 papers. The International Program Committee (IPC) is formed by 51 members from 11 countries. Each paper with author identification anonymous was reviewed by at least three IPC Members. Related sub-theme Chairs then made recommendation on the acceptance of papers based on IPC Members' reviews. With the comprehensive review process, we are pleased to claim that 25 accepted papers are presented (18 full papers and 7 short papers) at the conference.

On behalf of the Conference Organizing Committee, we would like to express our gratitude towards all partners and participants for their contribution to the success and smooth operation of ICSLE2022. The successful program would not be possible without authors, reviewers, and the local organizing team.

Through all the efforts made by authors and reviewers in this process, we believe that this year's ICSLE Proceedings will immediately win the status as the most advanced and indispensable review, and will have important archival value in the long run.

We hope all of you enjoy your participation in the conference and social activities designed online.

With best wishes,

Hangzhou, China	Junfeng Yang
Beijing, China	Dejian Liu
Denton, USA	Kinshuk
Beijing, China	Ahmed Tlili
Edmonton, Canada	Maiga Chang
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Contents

A Critical Evaluation on the Use of Podcasting in Education in the Field of International Development and Education

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Abstract. Currently, social media has become a dominant source of information inflow. It breaks down physical barriers between people around the world and transmit all sorts of information instantly. Podcasting, as a form of social media, engages users with multiliteracies has become an increasingly popular tool in education in recent decades. In this essay, the importance of educating critical media and global literacy through podcasting would be discussed and evaluated with reflection on the group podcast production process.

Keywords: Technology In Education · Podcasting · Social Media · Multiliteracies

1 Introduction

In the current era, social media has undoubtfully become a dominant source of information and a platform for producing and spreading ideas and news [1]. Social media breaks down barriers between nations, engages users in heated events, and allows information to flow freely across the globe. However, as social media allows uncontrolled content production by users, it brings on the quick spreading of untrue and misleading information [2]. It is then crucial for media consumers to develop a critical global view towards media communication [3]. Therefore, traditional education faces urgent change with the need to pack learners with critical media literacy and global literacy to meet the challenge of the media-driven, globally connected world [3]. Podcasting as an increasingly popular tool in education in recent decades is suitable for fostering learners with multiliteracies [4]. In this essay, the importance of educating critical media and global literacy through podcasting would be discussed and evaluated with reflection on the group podcast production process.

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2 Podcast production integrated in learning

2.1 Developing critical media literacy

"The twenty-first century is a media-saturated, technologically dependent, and globally connected world" [3]. The majority of information people receive is lesser from print texts, but more from digital images, audio, video, and multimedia sources [3]. Numerous posts are generated on a daily basis with a single tap on the 'repost' or 'send' button and ideas are sent to the globe. No special skills are required for people to use social media and the easiness of content creating and information receiving adds to the attractiveness [5]. Nevertheless, the ability to effortlessly create and share content without control leads to the appearance and quick spreading of untrue information, fake news, and misleading articles.

The progress of our podcast production was a vivid demonstration of the false and distorted portrayal of information by mass media. In our podcast, we delivered the rise and doom and the truth behind the movement '#Bringbackourgirls'. #Bringbackourgirls was a movement started in Nigeria aimed to prompt the government's action on a schoolgirls kidnapping incident that happened in Chibok. However, this wasn't our original idea. We changed our topic halfway during the podcast task due to false information we found in an online news report. The focus of our podcast was originally on religious and cultural discrimination in education where we researched the Chibok incident and found, in one news article, that the terrorists only kidnapped Christian girls. However, we were quickly informed by our seminar leader that the news was fake and in reality, the terrorists kidnapped schoolgirls no matter their age or religious backgrounds and the Chibok incident was an anti-government action [6].

This small interlude has inspired us into focusing on false and distorted media portray of international news and the effects it has on media consumers. In hindsight, our research process was a demonstration of learning and developing critical media literacy where we gradually learned to keep a critical mind when approaching media sources. Team members were more careful when handling information gathered from non-academic online sources and most information was fact-checked multiple times before they were put into the podcast script. This has also illustrated the importance to which learners in the 21st, media-saturated and globally connected, century should be taught more than conventional literacy, reading, and writing, but new literacies, such as critical media literacy and global literacy to keep up with the fast-paced, information overwhelming society.

Critical media literacy education empowers learners the ability to 'discern the nature and effects of media culture', critically analyze media portrayed information, critically evaluate the relationship between media and media consumers, the 'abilities to criticize stereotypes, dominant values and ideologies' and the ability to adequately produce or use media in constructive ways [3].

One way to accomplish the goal of teaching critical media literacy is for education to fully integrate with digital media [7]. In recent years, podcasting has become an increasingly popular tool in learning, it carries the 'potential of complementing, improving, and adding new collaborative dimensions' to nearly all forms of education [4]. Podcasts enable learners to engage with material whenever and wherever they want, the easy access to material with only a device that connects

to the internet, podcast lowered the threshold for learning and has become a powerful tool for delivering information to the general public [8]. Research has found that podcasting delivers optimal learning outcomes when it is placed in the hands of students [9]. The creation of podcasts as an assignment could foster students with multiliteracies through the combination of 'traditional academic pedagogies' and media and technology-related skills (Wiggins et al., 2016).

In the preparation of the script, we have completed thorough research using different sources, ranging from academic literature, relevant websites, news articles, YouTube videos to posts and hashtags on social media. Since we were producing an academic podcast and there was great variety in accuracy and reliability of our sources, the first thing to do was to evaluate and conduct fact-checks with every piece of information we found relevant and useful. This process not only enhanced our research skills but due to the uncertainty of media and online information we were aware of, also developed us into critically-minded media users.

2.2 Developing global literacy

The podcast task also provided fundamental technical skills of media production. We chose to present our story using a calm and firm monologue in response to the serious nature of our topic and our aim to raise awareness in the audience. To engage our audience with the topic and maximize the sense of immersion, we have extracted sound from live reports of the #Bringbackourgirls movement. Audiotapes were downloaded from different websites and imported into garage band for editing. The soundscapes we found were edited in between, to contrast and support the calm storytelling narrative. During this phase of podcast production, we gained hands-on experience with recording facilities in the recording studio and technical skills such as editing and file downloading and converting. The podcast task allowed us to actively explore mass media and produce original work by combining multimedia sources using technical skills.

To further develop on the aim of educating for 'critically minded consumer of global media', learners would benefit from the teaching of global literacy. The education of global literacy includes the 'teaching of global knowledge, skills and values' which would equip learners with the 'awareness of multiple perspectives, willingness to learn to become a global citizen, and knowledge to make judgments on various global matters' [10]. Students are expected to communicate and cooperate with people from different linguistic and cultural backgrounds, apply critical thinking skills to problem-solving and approach global issues with comprehensive attitudes [10].

Using podcasts as an assignment in the course of International Development and Education is a perfect example of teaching global literacy. In the group podcast task, we work with people from different cultural backgrounds, we exchange ideas and debate over issues, we listen to different viewpoints, and reflect on our own identities. The level of interaction between group members paired with the practical task of podcast production gradually developed a more open-minded perspective and a more considerate attitude in ourselves. The podcast task under the

international academic setting has successively created 'in-class individual interaction and a global experience' [4]. The production process fostered us not only with multiliteracies but more importantly, enhanced our understanding of global issues by training us into critical, open-minded thinkers. This in turn illustrates the value of using podcast as an effective learning tool in education to encounter the rapid development of increasingly international societies.

2.3 Conclusion

In conclusion, learner-created podcasts have great potential in preparing learners for the fast-developing, increasingly globally connected world by fostering new literacies demanded by the present era. Such literacies do not rest at conventional literacies such as reading and writing but refer to new literacies such as critical media literacy and global literacy. Considering the constant exposure of mass media in our daily life and the relatively low reliability of media sources, it is essential for us to develop a critical and global mind towards media communication to save us from media manipulation or reckless judgment towards global events. Podcasting as a learning tool combines traditional coursework format, literature researching, and report writing, with new skills that are essential for learners to acquire in the digital era, such as media evaluating and production skills, and provides learners with multi-faceted development.

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A Systematic Literature Review of Synchronous Classroom in 2011-2021

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Abstract. Synchronous classrooms use video conferencing systems to connect students in physical classrooms and online classrooms to the same class. With the development of Internet technology, the research and application of synchronous classroom has developed rapidly since 2010. The study retrieved and screened 59 sample literatures from Chinese and English electronic databases, and conducted a systematic literature review. The study found: (1) From the perspective of research topics, the research on synchronous classroom mainly focuses on theoretical research, teaching mode, teaching strategy, classroom interaction design, support of environmental technology, teaching effect, synchronous classroom Intercultural learning in classroom support, teacher professional development, teaching and learning experiences, and more. (2) From the perspective of application effects, the implementation of synchronous classrooms has a good effect on improving students' academic performance, promoting teachers' professional development, promoting school informatization construction, and sharing regional high-quality educational resources. (3) From the perspective of hindering factors, remote students have low classroom participation; teacher and assistant's information teaching capabilities need to be improved; school technical environment support is not yet perfect; education administrators lack multidisciplinary collaboration and organizational management capabilities.

Keywords: Synchronous Classroom • Systematic Review • Application Effect • Obstacles Factors

1 Introduction

Synchronous classroom was defined as the combination of online classroom and physics classroom by means of video conference system or virtual reality system with teaching function [1]. Wang adapted the definition of blended synchronous classroom and believed that hybrid synchronous classroom is a learning method that allows online students to participate in classroom learning activities in real time by using communication technology [2]. In addition, from the perspective of learning environment, synchronous classroom can be considered similar to physics classroom. It is a synchronous learning environment with computer as the media. It usually uses online video conference to complete various real-time interactions in physics classroom, and can also record and broadcast the contents of the classroom in real time [3]. Previous studies have shown that synchronous classroom can achieve

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the same learning effect as physics classroom [4], such as test scores [5], learning motivation, satisfaction and achievement [6].

Based on the above analysis, there are two types of reviews of synchronous classroom. One is to use the content analysis method [7], and the other is to use visual analysis software [8]. Compared with the traditional literature review, the research process of systematic literature review is rigorous and transparent, the search strategy can be copied, and the retrieval results are scientific and reliable [9]. Therefore, the research aims to analyze the relevant research of synchronous classroom from 2011 to 2021, explore the current research status, and response the following three research questions: (1). what are the research status of synchronous classroom? (2). how effective is the practical application of synchronous classroom? (3). what are the obstacles with synchronous classroom?

2 Research Methods

2.1 Search Strategy

This study was searched from the following seven electronic databases: CNKI, Web of Science, Science Direct, EBSCO Eric, Springer Link, Taylor & Francis and Wiley Online Library. The following keywords and Boolean logic are used in the search: "synchronous classroom" or "mixed synchronous classroom" or "blended synchronous learning" or "blended synchronous teaching" or "blended synchronous classroom" or "synchronous hybrid learning". After elimination, 347 results were obtained from the initial search.

2.2 Inclusion and Exclusion Criteria

In order to ensure the scientificity and reliability of the results, according to the research problems, the inclusion and exclusion criteria of 347 studies were formulated. The literature inclusion criteria are as follows: (1) the study includes clear research questions, research methods and conclusions; (2) the study is peer reviewed journal articles; (3) the study is written in Chinese or English.

A total of 152 Chinese journal papers and 195 English journal papers were retrieved. After the preliminary screening of the literature completely unrelated to the research topic and the removal of duplicate literature, the remaining 282 articles. After the second screening according to the title and abstract, there are 147 articles related to the subject of this study. Through further reading of the full text, and the remaining 99 valid articles are available for reference. According to the definition of synchronous classroom in this study, 59 articles closely related to the theme were selected for analysis.

3 Results

3.1 Current Situation of Synchronous Classroom

Through the analysis of relevant literature, it is found that the current research focuses on the teaching mode of synchronous classroom [10], teaching strategies [11], classroom interaction and environmental technology support [12], the influencing factors of acceptance and use intention of synchronous classroom, cross-cultural learning supported by synchronous classroom [3], teachers' professional development [13], teaching experience and learning experience [14] and competence developing. By analyzing the development context of synchronous classroom, it is found that synchronous classroom has experienced three stages: embryonic, initial and development.

Embryonic stage: the first study, which began in 2003, aims to observe the quantity and quality of interpersonal interaction between teachers, present students and distance students in mixed learning courses [15]. Initial stage: In 2012, China's Ministry of education proposed for the first time to focus on "Three Classrooms", promote the sharing of high-quality teaching resources and improve the quality of education in remote areas. Development stage: in 2015, Bower's definition of blended synchronous learning attracted great attention in the field of synchronous classroom research abroad. In 2018, China's "education informatization 2.0 action plan" clearly proposed that "Three Classrooms" is an important way to promote accurate intellectual support with the support of technology.

3.2 Application Effect of Synchronous Classroom

Students: improve academic performance and promote competence developing. On the one hand, it can balance the conflict between learners' work and family [16], be able to consider the needs of different types of student groups; On the other hand, it can ensure that students have access to educational opportunities, so as to provide more inclusive education and equal educational opportunities [17]. Synchronous classrooms make distance students truly part of the classroom, thereby reducing their sense of isolation [18]. Previous studies have shown that synchronous classroom learning creates a good learning environment to a certain extent and promotes the classroom interaction of students [19]. Synchronous classroom creates a more flexible, fascinating, friendly and convenient learning environment for students [20]. Distance students believe that participating in synchronous classroom learning can expand their knowledge, stimulate their learning motivation [21]. Synchronous classrooms improve interpersonal communication skills [22]. Synchronous classroom helps to improve students' awareness of cross-cultural learning [23].

Teachers and school: The development of synchronous classroom provides new approach for assisting teachers' professional development. Synchronous classroom

can help to improve the professional quality and ability of assistant teachers [22]. The information technology ability and information literacy of the lecturer and assistant teachers have been improved in the synchronous classroom teaching practice. The development of synchronous classroom has promoted the construction of information infrastructure and the in-depth application of information technology in the school, and provided a technical and practical basis for promoting the construction of a new smart campus.

3.3 Obstacles of Synchronous Classroom

Students: the participation of distance students in the classroom is low, and the students present are vulnerable. Distance students can't keep up with the classroom, and their subjective initiative is hit [24]. Distance students will feel the pressure from the present students, they feel neglected or unpopular because of present students [21]. In addition, synchronous classroom learning increases their screen time, and long-term online teaching will have a negative impact on students' physical and mental health [25]. Present students may be influenced by distance students. When students on the scene and distance students carry out cooperative learning, they are easily distracted by the need for continuous classroom interaction with distance students, which affects their participation in classroom activities [20].
Teachers and school: teachers' collaborative management and information literacy need to be further improved. The teacher is biased in the balance of synchronous classroom interaction [8]. The teacher’s information literacy is a problem, such as equipment operation [26]. The learning environment infrastructure needs to be upgraded. The biggest challenge in synchronous learning environment is audio, which is also the decisive factor for the success of synchronous classroom [27]. Due to the insufficient network bandwidth, problems such as network interruption, unclear video picture and delayed sound transmission may occur in the teaching process, which will distract students' attention [28].

4 Conclusion, Limitation and Future Work

This study summarizes the relevant research of synchronous classroom from 2011, and analyzes the research status, application effect and obstacles. And the findings are:

From the perspective of research theme, the research on synchronous classroom mainly focuses on theoretical research, teaching mode, teaching strategy, classroom interaction design, support of environmental technology, teaching effect, influencing factors of acceptance and use intention of synchronous classroom, cross-cultural learning supported by synchronous classroom, teachers' professional development, teaching and learning experience. Classroom interaction has attracted the attention

of many researchers. The learning effect of students in the mixed learning environment is also very important.

From the application effect, the implementation of synchronous classroom plays a good role in improving students' academic performance, promoting teachers' professional development, promoting school information construction and regional high-quality education resource sharing. From the perspective of obstacles, distance students' classroom participation is low, and the students present are vulnerable. The coordination and management ability of main and auxiliary teachers is insufficient, and the information-based teaching ability needs to be improved.

However, there are some limitations in this study, which are mainly reflected in the screening of research samples, which only includes journal articles, and the lack of corresponding analysis of books, conference papers and reports. There is no in-depth discussion on the relationship between the factors hindering the development of synchronous classroom.

The existing research shows the potential of synchronous classroom as an emerging teaching method. Although there are still some challenges, the current research shows an optimistic attitude towards synchronous classroom learning. The future research on synchronous classroom can be carried out from the following aspects. First, there are more and more empirical studies on synchronous classroom, but most of them are small samples or case studies, and there are few studies on the large-scale application of synchronous classroom. Second, the current research has only explored from the perspective of learning achievement. In the future, researchers need to consider the learning effect from multiple perspectives, such as the cultivation of emotion, the improvement of ability, the change of learners' psychology and so on.

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A Systematic Review of Smart Learning Environments

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Abstract: In the era of rapid technological development, the traditional learning environment can no longer meet the needs of contemporary people's learning, and the research enthusiasm of scholars from all over the world on a smarter and more personalized SLE remains high. In order to fully understand the current research status of the international SLE, this paper conducts a systematic review based on the 37 articles retrieved and screened in the Web of Science database, exploring the current trend of SLE, the technical support of SLE, and the impact of SLE on learning style. The research shows: (1) The current research on SLE mainly focuses on the technical support of SLE, model design of SLE, evaluation of SLE, teaching and learning in SLE, and construction of SLE. (2) Technology plays an important role in SLE, with data processing technology facilitating intelligent analytics and high-interaction technologies optimizing the learning experience. (3) SLE creates conditions for students' collaborative learning and independent learning which improves student learning outcomes.

Keywords: Smart Learning Environments • Technology • Learning Styles • Systematic Review • Smart Learning

1 Introduction

With the rapid development of global informatization, Smart Learning Environment (SLE) has gradually become a research hotspot in education. Traditional classrooms have been unable to support the development of teaching models with information technology [1], new era learners also put forward intelligent and personalized requirements for the learning environment. The emergence and development of technologies such as artificial intelligence and big data provide the possibility of building a new learning environment, therefore the development of SLE has become the trend of the times.

Recently, International Association of Smart Learning Environments (IASLE), International Conference of Smart Learning Environments (ICSLE), and SLE Journal have all conducted research on SLE, attempt to define, absorb and integrate emerging technologies in educational environment to build SLE which can improve learning outcomes. Technologies such as IoT [2] and neural networks [3] contribute to the construction of SLE. Dai uses AHP-FCE and GA-BP neural network algorithm methods to assess the environment [4].

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In order to sort out the development status of SLE in the past ten years under the background of the ever-changing technology of informatization, the current development trend and shortcomings of SLE are described, which provide valuable reference information for the follow-up research on SLE. Based on the relevant literature on Web of Science, this paper analyzes the current international research status and trends, including the technical support of SLE, new SLE model, evaluation of SLE, teaching and learning in SLE, and the construction of SLE.

Therefore, the research focuses on the following three questions:

Q1. What is the current situation and trend of international SLE research in the past 10 years?

Q2. How can technology be used to support the construction of SLE?

Q3. Whether the learning method in SLE is effective?

2 Background

With the development of information technology and the integration of teaching practices, the learning environment is becoming more and more intelligent. SLEs are considered an advanced degree of technology-enhanced environments, with a considerable number of new improvements [5]. Adu sorted out the development of technology-enhanced learning, which are e-learning, mobile-learning, u-learning, smart-learning. It can be seen that the technology-enhanced learning environment has gradually evolved from e-learning environment to SLE [6].

International scholars have proposed the concept of SLE from different perspectives, but there's no consensus to the definition. Chin first proposed that SLE is a learner-centered environment based on the application of information and communication technologies, which can adapt to different learning styles and learning abilities, supporting learners for lifelong learning and their development [7]. From a technical perspective, SLE integrates physical and virtual learning environments which is usually promoted by information technology, therefore it contains a plenty of information devices aiming to provide supports for both traditional and non-traditional learning [8]. From the perspective of pedagogy, Zhu believes that SLE is guided by the ideas and theories of learning, teaching, management and utilization, and supported by information technology, learning tools, learning resources and learning activities, which can scientifically analyze and mine the data formed in the learning process, and flexibly generate a new learning environment with the best suitable learning tasks and activities [9]. From the perspective of learning, Huang [10] and Gros [11] pointed out that SLE is not only a system which can be applied for learning anytime and anywhere, but also an adaptive support environment which can identify learner characteristics, automatically record the learning process, evaluate learning results, and promote effective learning of learners.

Benkiran believes SLE is always designed for learners, with characteristics of independence, facilitating, communication, adaptive, and cooperative [12]. Huang believes SLE is a fusion of physical and virtual environments, supporting learning inside and outside the school, and providing personalized services [13].

It can be seen that technology, construction, teaching and learning of SLE are research hotspots, but the current research on SLE is not limited to these three aspects, there's a broader space worth exploring. Therefore, this article aims to clarify the research topics and cutting-edge issues of SLE in the past decade, then identify strengths and weaknesses of existing studies, summarize the evolutionary trends of the research and give suggestions for the future.

3 Methods

3.1 Search strategy

The search is executed in databases that are well-known: Web of Science. The search time is 2012-2021. The search terms are constructed by Boolean logic as follows: smart learning environment OR intelligence learning environment OR smart learning space OR intelligence learning space.

3.2 Study selection

The selection process consisted of two stages. Stage 1 is a preliminary screening, focusing on whether the title of the literature is relevant. Stage 2 develops screening criteria based on research questions (see Table 1).

Table 1. Inclusion and Exclusion Criteria.

Inclusion criteria	Exclusion criteria
Articles based on ILE/SLE.	Articles that are not related to the topic (such as u-learning, e-learning, m-learning, etc).
Empirical studies.	Theoretical work, such as frameworks, reviews, etc.
Articles in the field of education.	Articles that study non-educational fields or are not related to educational teaching.
Articles that provide results.	Articles that don't offer results of a study.

3.3 Data analysis

The search terms in the databases generated 1408 articles. The screening in Stage 1 excluded 1307 articles and 101 articles entered Stage 2. The application of inclusion and exclusion criteria leaving 37 eligible studies finally (see Fig.1.).

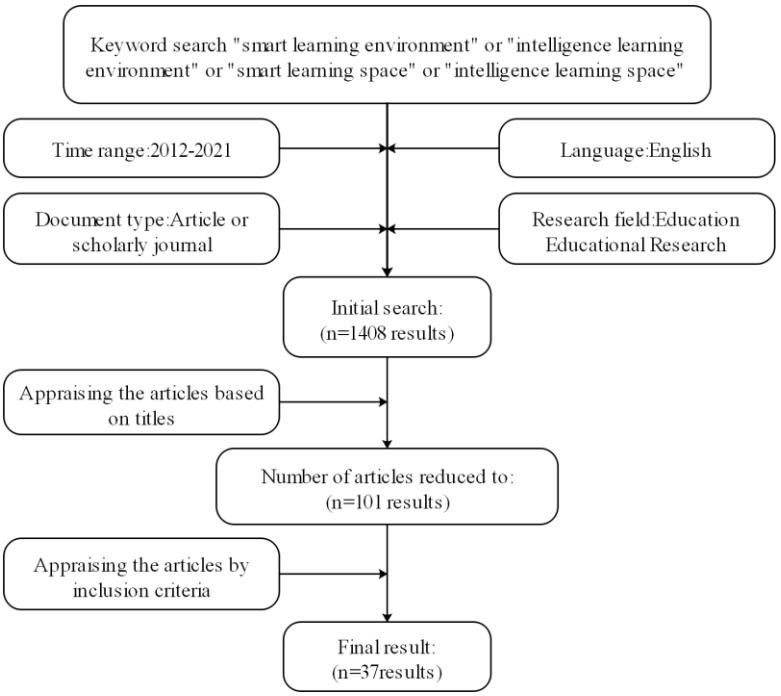

Fig. 1. Review process.

4 Results

4.1 Current Situation of Smart Learning Environment

Through the analysis of relevant literature, it is found that the current research on SLE mainly focuses on the technical support of SLE, new model of SLE, evaluation of SLE, teaching and learning in SLE, construction of SLE (see Table 3).

According to the content analysis results of literature, the basic context of the current international research on SLE can be outlined. The research is concentrated at the university and secondary school levels, and students above the middle school level can better adapt to the new learning environment, which is conducive to exploratory research on SLE. On one hand, the current research of SLE focuses on

the development and application of technology. The development of technologies such as artificial intelligence [14], the IoT [15], face recognition [16], and big data [17] has made it possible for SLE to be intelligent. These technologies are mainly applied in diversified classroom presentation, adaptive learning methods, classroom monitoring of the whole process, process evaluation and other aspects of education and teaching. On the other hand, the current research of SLE also focuses on teaching and learning. SLE has changed the way of teaching [18], the way of learning and how students interact [19], which is conducive to improving the teaching effect and cultivating students' high-order thinking [20].

Table 3. Research Themes of SLE.

Order	Topic content	Number of included articles
1	Technical support for smart learning environments	18
2	A model of a smart learning environment	3
3	Assessment of smart learning environments	1
4	Teaching and learning in smart learning environments	11
5	The construction of smart learning environments	4

4.2 Technical Research in Smart Learning Environment

There are many limitations to the effectiveness of simple infrastructure construction in SLE. Therefore, to improve the effectiveness of student learning, many state-of-the-art technologies have been applied. 30 of the 37 literatures selected for this study addressed technology's support for SLE, to gain insight into the supporting role of technology. This study divides the technology in SLE into two types: hardware devices and software devices (see Table 4). Most of the research is involved in hardware and software technology, and the frequency of using hardware devices is higher. Because mobile learning devices such as mobile phones, tablets, computers are essential hardware products in SLE.

From a hardware perspective, all kinds of learning equipment and interactive support devices that support wireless access and mobile communication are the most frequently used in SLE. Universal learning support technologies such as smartphones, tablets, and Computers are the basic technologies. Interactive support technologies such as camera equipment, video conferencing, and sensors are necessary technologies to optimize teacher-student interaction in SLE. In the smart classroom built by Vimir, cameras, sensors, RFID, projectors and computers are the most basic devices [21]. In addition to common hardware facilities, intelligent equipment is also important in SLE. William studied the application of chatbots in smart campuses and found that chatbots can facilitate student interaction [22].

Table 4. Frequency of Software Device Usage and Hardware Device Usage.

Technical classification	Hardware device example	Hardware frequency	Software device example	Software frequency
Universal learning support technology	A wifi enabled computer Smart phone The tablet	15	Intelligent learning system Online learning platform	8
Interactive support technology	Cameras RFID Chatbot Video conference The sensor	14	Graphical user interface Virtual reality Semantic Web technology Real-time interactive software Speech recognition software	7
Collaboration support tools	Shared whiteboard A computer that supports collaborative activities Intelligent writing pad	3	Email Online multi-user, multi-role playing software	1
Information presentation support technology	A big screen The projector	7	Multimedia content rendering tool	4
Professional discipline tools			Adobe Premiere Pro CC VC tools and C language programming skills The cloud service	7
Intelligent agent and decision technology			Data analysis software Data mining technology Decision tree technique Neural network technology Facial detection technology	6
Total		39		33

From a software perspective, the development and use of universal learning support technologies such as intelligent learning systems and online learning platforms are hot topics, but the research on collaborative support tools is lacking. Intelligent learning systems and platforms build an adaptive learning environment to students. The education paradigm is changing into the form of acooperative, sharing, participative, and customized education. Thus an optimized integrated solution is necessary to create a smart class for new educational environment. In this study, a structured, plug-in ITLA system was applied to the smart class, which can improve the effects of education by maximizing cooperative, sharing, participative learning, reflecting the characteristics of the learning environment and digital natives as learners. Teachers and students can participate in lectures through effective personalized and customized education [23]. ICollab platform is an adaptive environment, Oliveira found that students had a higher level of interaction on the

platform [24] which means formal learning can be intertwined in informal cyberspace, enhancing student interaction. IoT is worth mentioning, it not only allows us to understand the state of objects, but also intelligently enables education. New and smart ideas to fetch facility and improvement in the students' and teachers' lives have been presented through using IoT in education domain. Moreover, the challenges, which face education field, have been handled via using IoT, such as minimization of cost, better management, and great security [25].

The development of SLE is closely related to technology, which is manifested in data processing and learning experience:

Data processing technology facilitates intelligent analysis. Powerful data processing technologies in SLE include situational awareness, data collection, processing and analysis of data. RFID tags [26], sensors, eye trackers and other equipment, as well as emotion analysis, expression recognition and other technologies can not only collect information such as temperature, geographical location of the learning environment, but also data such as physiological indicators, emotional states, and learning characteristics of learners [27]. Through the mining of educational data, data modeling, natural language processing, finally based on big data to make teaching decisions, can give learners anthropomorphic feedback and adaptive learning support, thus making personalized learning possible.

High-interaction technology optimizes the learning experience. Display devices such as large screens can provide high-quality information display, increasing the channel of information transmission. The use of virtual reality technology [28] and wearable device technology will enhance learner's perception of information presentation, their ability to interact and manipulate external learning objects. The use of intelligent learning systems and platforms will create a more freedom learning environment for learners which breaks time constraints, increasing the path to learning. The application of high-interaction technology [29] expands traditional learning space to digital virtual space, expands simulation experiment with a lower sense of experience to a more interactive and realistic experience.

4.3 Learning Styles in Smart Learning Environment

SLE supports the generation of various learning styles, all these learning styles have remarkable influence on learning effect in SLE. Innovative applications and teaching models such as augmented reality [30], virtual reality, and educational robots [31] in SLE promote learners to learn more intelligently. Depending on how students learn in the literature, we divide the learning styles into four categories: cooperative learning, gamified learning, independent learning, and traditional lecture learning (see Table 5).

SLE is designed to enhance learning from a technical point of view, collaborative learning has a direct impact to the learning effects, and technology provides a variety of paths for collaborative learning. Lu found that peer interaction and learning

motivation directly affect students' learning "hot spots" in smart classrooms [32]. Hu found that LAD promotes the motivation and possibility of cooperative learning in SLE [33]. Liu proposed a collaborative learning mechanism built through architecture and algorithm design in the Web environment to achieve personalized learning resource recommendation [34]. Andri believe that students benefit from a multimodal learning environment that enables hybrid interactions across physical and digital learning tools, configurations, and networks [35].

Many studies have demonstrated that IoT, augmented reality, and educational games can be used to augment traditional learning processes. Luka proposed a game-based IoT learning model implemented in SLE for determining students' interests, willingness to participate, and feedback on game-based learning in the interaction of smart classrooms [36].

Table 5. The Learning Style in SLE.

Order	Learning style	Number
1	Collaborative learning	7
2	Gamified learning	1
3	Autonomous learning	7
4	Traditionally taught learning	3

Under the impact of the COVID-19, the cultivation of students' self-directed learning ability and the construction of personalized learning systems are becoming more and more important to learners. Zhan found that compared with traditional multimedia classrooms, smart classrooms significantly triggered more student autonomous behavior and student-driven teacher conversations, which showed that students' autonomy in smart classrooms increased [37]. In addition, teachers in SLE using mobile devices to try new teaching methods, resulting in a reduction in workload and better teaching results. Through the iCollab platform [38], Linda provided students with an adaptive environment for personalized learning. The study opens up a new possibility of incorporating student personality and other personal factors, such as self-regulating learning, into SLE design.

The analysis shows that SLE is mainly based on students' collaborative learning and independent learning, which means SLE creates conditions for students' collaborative learning and independent learning. Learning analysis technology and learning perception technology provide learners with personalized guidance, real-time feedback and help matching learning resources, learning paths and learning methods, which promote the emergence of student collaboration and independent learning. However, the traditional learning method still exists in SLE, teachers do not make full use of SLE to guide students to communicate, and do not break the traditional rigid model, limiting the role of SLE in the teaching field.

5 Discussion

Taking the field of SLE as the research object, this study analyzes the literature of SLE on Web of Science from 2012 to 2021, and draws the following conclusions:

(1) In the past 10 years, international research on SLE is mainly focused on technical support of SLE, model design of SLE, evaluation of SLE, teaching and learning in SLE, construction of SLE. In addition, most of the research is based on application, the research on theory is not rich enough. Therefore, it is necessary to strengthen the theoretical research and model construction of SLE in the future, for theory is the foundation of practice.

(2) Technology provides a strong guarantee for the realization of SLE, big data promote intelligent learning analysis, virtual reality optimize the learning experience of students. However, the current technical research is relatively scattered, a complete support technology system has not been formed. There are many studies using single key technologies such as cloud computing and big data, but there is a lack of research on the interaction and common application of multiple technologies. It is difficult to support the construction of the entire SLE by a single technology, new research should be carried out by integrating multiple technologies and disciplines in the future.

(3) SLE provides an effective way for students' collaborative learning and independent learning, which is of great help to students' learning. However, traditional teaching and learning methods are still common and cannot play to the advantages of SLE. It is necessary to strengthen the information literacy of both teachers and students, improve the ability of teachers to apply information technology, improve students' interest in technology and learning ability.

Since the literature of this study is based on the Web of Science database, the sample has limitations, so the institute only represents the current status of the research on the SLE supported by the Web of Science database, and does not represent the research of the entire international environment.

Finally, it is worth emphasizing that, future reviews might classify SLE not only examining the affordances specified in empirical articles but also the affordances as identified in theoretical articles.

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Achieving Change through Diversity Reformations in School Management

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Abstract. Globalization has led many organizations to transition from a monocultural life to a multicultural life. Therefore, the management of differences and the tolerance level has gained importance, especially in educational institutions. This study aims to evaluate school management as a case study about the management of diversity following a qualitative research design. The study's participants were chosen with the maximum diversity, as the purposeful sampling method. The study sample consists of 8 school administrators, seven teachers, and five participants from unions for primary schools. The obtained data were analyzed by the content analysis method. As a result of the research, it was found that there are differences in schools, especially in culture, religion, language, and socio-economic aspects, but tolerance education for this is insufficient.

Keywords: Diversity Management • School Management • School Administrators • Teachers • Unions

1 Introduction

With the development of technology, intercultural communication tools have also evolved and become more accessible than ever [1]. Education is considered the most

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effective method of preventing intolerance. In this context, to achieve the goals of tolerance education, it is necessary to review the education policies, increase the quality of the curriculum, update the teacher training programs, pay attention to the teachers' teaching methods and arrange the content of the coursebook accordingly. Particular emphasis is placed on the quality of educational technology and the use of modern materials [2].

It is challenging to develop a democratic culture or facilitate the acceptance of difference by changing the textbooks. Thanks to the technology used in education and the diversity of stimulants in learning environments, it is possible to enable students to communicate and interact with people from different cultures. Today, technology-based endurance training research is gaining more and more importance [3].

Organizations consist of employees with different characteristics such as race, gender, ethnicity, age, physical and cognitive ability, sexual orientation and identity, religious belief, learning and working style, and work/life obligations. The necessity of managing these differences effectively and using them for the organization's benefit has revealed the concept of diversity management. Knowing what diversity management means is necessary to have a practical diversity management approach. A review of the literature on the subject revealed that there are different definitions of diversity management. Below are some definitions and explanations of diversity management.

Thomas [4] expresses diversity management as the ability to make quality decisions in situations of all kinds of differences and similarities and the midst of the tensions and complexities associated with them. Diversity management is the latest development in a series of strategies aimed at better representing excluded minorities in the business sphere. However, diversity management differs from equality at work approaches to underrepresented minority ethnic groups, such as equal opportunity and positive discrimination approaches [5].

2 Benefits of Diversity Management

Managing diversity effectively provides benefits for managers as well as employees. As employees do not engage in confrontational relationships, do not show absenteeism, make fewer mistakes and concentrate their attention and energy on their work, senior managers will not have to deal with personal problems. They will focus on more severe problems and business development issues. Supporting differences also keeps individuals from negative emotions such as fear, anxiety, shame, and guilt [6]. Today, organizations are actively increasing the difference in their structures as a result of demo- graphic developments and global mobility, or by increasing their innovation potential, accessing new markets, and attracting the most qualified employees [7], new and different perspectives to be successful and maintain their existence, they need ideas and approaches. Managing differences following the

organization's strategies and mission benefits organizations in many ways. Differences play an active role in shaping and developing creativity and innovation and ultimately adding value to business performance [8].

When discrimination, prejudices, exclusion, and the tension and conflict arising from them disappear in a society, people will feel more peaceful and secure. Increasing trust, understanding, tolerance, cooperation, communication, support, and solidarity among people will create new synergy opportunities, and people will contribute more to themselves, their immediate surroundings, and society. Especially women, members of minority groups, the disabled, and other disadvantaged groups will be able to participate in economic activities more intensely [6].

Community populations are in constant motion under the effect of globalization; parallel to this, a multicultural structure occurs in educational institutions as the demographic characteristics of the population change due to the increase in migration. In addition, since gender, status, academic status, socio-economic status, parents, and environmental profile are effective in achieving education goals, the need for managers with sufficient equipment to manage these effectively and many other differences are increasing. Gaining awareness of respect for the differences in educational institutions is effective with tolerance education starting at school at an early age. In this context, this research is carried out to reveal the opinions of teachers, school administrators, and members of unions who are among the education stakeholders on the issue of managing differences in tolerance education in school management in Northern Cyprus and to shed light on the clarity in this field. Therefore, this research is vital in evaluating stakeholders' views and practices regarding managing differences in tolerance education in school management. The study looked into the following research questions:

- What are the negative and positive situations for education stakeholders on diversity management for tolerance education?
- How are the practices of education stakeholders in awareness diversity management for tolerance education?

3 Materials and Methods

Method. This research is a qualitative study conducted to reveal the opinions of school administrators, teachers, and members of education unions on the management of differences between teachers, students, and the school environment of tolerance education in school management. A case study methodology was adopted. It is explained as expressing a situation, a document, or the subject that causes this situation in detail that emerges and arouses interest in the case study [9].

Sample. The sample for the study consisted of 8 school administrators, seven teachers, and five members from education unions working in state primary schools in the Nicosia district of the Ministry of National Education in the 2020-2021

academic year. This was selected as a purposeful sampling. In this context, the study group of the research consists of 20 people in total.

Data collection. To collect the data of the research, a semi-structured interview schedule as the data collection tool was used. This was prepared by examining the related literature and getting it validated from three field experts. This interview form consisted of two parts. The first part gathered personal information about the demographic characteristics of the participants, and the second part had interview questions soliciting participant's views on different dimensions on diversity management for tolerance education. The data thus obtained were analyzed by content analysis method.

4 Results

Demographic characteristics of respondents. Participants of this research represented a vast diversity. The demographic characteristics of the participants are as follows; 11 of the participants are women, and 9 of them are men. When the age distribution of the participants is examined, 5 participants are between 26-30 years old, 5 participants are between 31-35 years old, 2 participants are between 36-40 years old, and 8 participants are between 41 years old and above. The distribution of professional experience is 4 participants with 6-10 years of professional experience, 6 participants with 11-15 years of professional experience, 6 participants with 16-20 years of professional experience, and 4 participants with 21 years or more professional experience. When the educational status of the participants is examined, 11 participants are undergraduate graduates, 7 are graduate graduates, and 2 are doctoral graduates.

4.1 Differences Encountered in Schools

"What are the differences (school environment, teacher, and student) you encounter in schools?" the themes that emerged from the participants' answers are examined in Table 1 below.

Table 1. Participants' views on the differences encountered in schools.

Unionists	f	Teachers	f	Administrators	f	All Participants	f
Religion, language, and race	3	Religion, language, and race	4	Religion, language, and race	4	Religion, language, and race	11
Cultural differences	2	Cultural differences	5	Cultural differences	4	Cultural differences	11
Socio-economic situation	3	Socio-economic situation	4	Socio-economic situation	4	Socio-economic situation	10

Teacher's equipment, training, organizational commitment	1	Teacher's equipment, training, organizational commitment	2	Teacher's equipment, training, organizational commitment	4	Teacher's equipment, training, organizational commitment	7
School location and condition	1	Family education level	1	Family education level	5	Family education level	7
Differences of opinion	1	Family support	1	Family support	4	Family support	5
Disabled individuals	1	School location and condition	1	School location and condition	2	School location and condition	4
		Disabled individuals	1	Differences of opinion	1	Differences of opinion	2
						Disabled individuals	2
Total	12		19		28		59

Participants' views on the differences encountered in schools, religion, language and race (f11), cultural differences (f11), socio-economic status (f10), teachers' equipment, education, organizational commitment (f7), family education level (f6), family support (f5), location-condition of the school (f4), differences of opinion (f2), and disabled individuals (f2). Participants made a total of 59 views.

4.2 Positive and Negative Situations Arising Due to Differences in Schools

The views of the participants on the question, "What do you think about the positive and negative situations that may arise from differences (school environment, teacher, and student) in schools?" about the positive situations are shown in Table 2, and their views regarding the negative situations are given in Table 3.

Table 2. Participants' views on positive situations in schools that arise due to differences.

Unionists	f	Teachers	f	Administrators	f	All Participants	f
Gathering differences	2	Gathering differences	4	Wide variety of learning environments	3	Gathering differences	6
Wide variety of learning environments	1	Wide variety of learning environments	1	Provides open-minded and tolerant	2	Wide variety of learning environments	5
Provides open-minded and tolerant	1	Provides open-minded and tolerant	2	Supports the development of teachers	2	Provides open-minded and tolerant	5
				Stakeholder support is provided	2	Supports the development of teachers	2
				Contributes to the development of social awareness	1	Stakeholder support is provided	2
						Contributes to the development of social awareness	1
Toplam	4		7		10		21

Participants' views on positive situations arising from differences in schools, the coming together of differences (f6), a wide variety of learning environments (f5), providing open-minded and tolerant (f5), support for the development of teachers (f2), support of stakeholders (f2), contributes to the development of social

consciousness (f1). Participants were also asked about their views on the negative situations arising from differences in schools which are shown in Table 3.

Table 3. Participants' views on negative situations arising from differences in schools.

Unionists	f	Teachers	f	Administrators	f	All Participants	f
Conflict	2	Conflict	2	Conflict	1	Conflict	5
Language barrier	1	Language barrier	2	Language barrier	1	Language barrier	4
Language barrier	1	Lack of time and communication	2	Lack of time and communication	2	Lack of time and communication	4
Inequality of opportunity	1	Religion barrier	1	Teacher qualification	2	Religion barrier	2
Standardization effects of education	1	Inequality of opportunity	1			Inequality of opportunity	2
		Prejudices	1			Teacher qualification	2
						Standardization effects of education	1
						Prejudices	1
Total	6		9		6		21

Participants' views on negative situations arising from differences in schools were gathered under eight themes. Negative situations are as follows; conflict (f5), language barrier (f4), time and lack of communication (f4), religion barrier (n4), inequality of opportunity (f2), teacher competence (f2), standardization effects of education (f1), prejudices (f1).

Unionists made four positive and six negative statements about the positive and negative situations caused by differences in schools. Negative statements of these; positive statements while conflict (f2), language barrier (f1), religion barrier (f1), inequality of opportunity (f1), standardization effects of education (f1); the combination of differences (f2), a wide variety of learning environments (f1) pro vide open-mindedness and tolerance (f1).

The opinions of the teachers participating in the research about the positive and negative situations arising in the schools are as follows. Positive views; convergence of differences (f4), diverse learning environment (f1), provides open-mindedness and tolerance (f2), negative opinions; conflict (f2), language barrier (f2), lack of time and communication (f2), religion barrier (f1), inequality of opportunity (f1), prejudices (f1).

School administrators participating in the study shared their views about a wide variety of learning environments (f3), open-mindedness and tolerance towards positive situations arising from differences in schools (f2), support for the development of teachers (f3) while expressing their opinions, conflict about negative situations (f1), language They reveal the barrier (f1), lack of time and communication (f2), teacher competence (f2).

4.3 The Practices and Policies of School Administrators in Managing Diversity

The participants were asked about fulfilling their responsibilities regarding the practices and policies put forward by school administrators in managing differences. Additional question put to them was what kind of applications can be done? Their opinions on this issue are shown in table 4 below.

Table 4. Participants' views on the practices and policies put forward by school administrators in managing differences.

Unionists	f	Teachers	f	Administrators	f	All Participants	f
No policy applied	3	No policy applied	1	No policy applied	1	No policy applied	5
Stakeholder interaction	1	Stakeholder interaction	1	Stakeholder interaction	3	Stakeholder interaction	5
School administrators should be educated in this direction	2	Curriculum should be organized	2	Curriculum should be organized	2	Curriculum should be organized	4
Must have executive equipment	1	School administrators should be educated in this direction	1	School administrators should be educated in this direction	1	School administrators should be educated in this direction	4
It differs according to the method.	1	Must have executive equipment	1	Must have executive equipment	1	Must have executive equipment	3
Raising awareness in teachers	1	Equal treatment and affirmative action	1	Equal treatment and affirmative action	1	Equal treatment and affirmative action	2
		Raising awareness in teachers	1	It differs according to the method.	1	It differs according to the method.	2
						Raising awareness in teachers	2
Total	9		8		10		27

Regarding the practices and policies put forward by school administrators in managing the differences, the respondents revealed that no policy applied (f5), the interaction of stakeholders (f5), the curriculum should be organized (f4), school directors should be educated in this direction (f4), administrative equipment should be equipped (f3), behave equally, and positive discrimination (f2), it differs according to the method (f2), creating awareness among teachers (f2). Twenty-seven statements of unionists, teachers, and school administrators are presented in table 4.

5 Discussion and Conclusion

With this research, according to the opinions of the participants; They explained the views on the differences encountered in schools as religion, language, race, cultural differences, socio-economic status, teachers' equipment, education, organizational commitment, education level of the family, support of the family, location-condition of the school, differences of opinion and persons with disabilities. While teachers among the participants primarily focused on the cultural differences of both employees and students, school administrators emphasized the importance of family support. It is observed that the views of unionists, teachers, and school administrators are in the same direction. Tozkoparan and Vatansever [10], while defining the

differences according to the participants' opinions, stated that the expressions "education, religion, disability, and culture" show similarities. It is observed that the participants of this study did not include expressions such as sexual orientation and gender. As can be seen, the participants' views on this study's differences are similar to the findings of many studies.

Participants' views on positive situations that may arise from differences in schools, the combination of diversity and a diverse learning environment provide open-mindedness and tolerance, support teachers' development, support stakeholders' development, and contributes to the development of public awareness. Likewise, Guillaume et al. [11] stated that the development of individuals and institutions is supported by creating a wide variety of learning environments thanks to employee differences.

Participants regarding negative situations arising from differences in schools; express opinions in the form of conflict, language barrier, lack of time and communication, religious barrier, inequality of opportunity, teacher competence, standardization effects of education, and prejudices. In addition, unionists pointed out that the possibility of conflicts arising due to differences is inevitable. In this direction, it is seen in the studies of Balyer and Gündüz [12] that the perceptions of school administrators and teachers on diversity management are not positive.

As a result, many studies in this field show that the participants generally agree positively against differences in theoretical terms; however, when it comes to business implementation, conflicts are inevitable due to differences. The most effective way to minimize these conflicts and for the parties to obtain positive implications is the practices and policies put forward in managing differences.

In this study, the participants expressed that there is no policy applied to the practices and policies put forward by school administrators in managing differences. They indicated that the interaction of stakeholders and the curriculum should be organized, school teachers should be trained in this direction, administrative equipment, equal treatment, and positive discrimination, which differ according to the rule. Teachers expressed their views on creating awareness.

In this direction, the teachers in the study emphasized the importance of informing school administrators about the management of differences, being equipped in this direction, drawing attention to the issues of equal treatment and positive discrimination, while at the same time raising awareness of teachers on this issue will be beneficial. In this context, Stringfellow [13] stated in his study that equal treatment, improving the existing communication, and maintaining practices within the framework of a policy that values its employees in line with the principle of equality are effective in managing differences.

Among the findings of this research, the lack of policy and practice applied as a common opinion of teachers, school administrators, and unionists, and the view that school administrators should be trained in this direction in managing differences are similar to the results of Tayfur's [14] study. At this point, they express that the participants and school administrators should be informed, and environments that would allow the development of teachers should be organized.

Similar to the findings of this study, the principal should be tolerant, open, and behave equally; Polat [15] found similarities in school administrators' tolerance, openness to innovation, self-development, acceptance of differences, respect, equal treatment, and participation.

Some studies point to the view that the differences should be accepted from the findings of this study. It is seen that the participants in the study of Genç[16] have a positive perspective on the administrative dimension of differences in schools. In addition, according to Rabl, del Carmen Triana, Byun, and Bosch [17], it is stated that a common denominator can be achieved in the corporate culture with employees by creating a positive perception of differences in the organization.

The themes formed in line with the answers obtained regarding the concept of tolerance, which were asked what the concept of tolerance evokes to the participants, are tolerance, acceptance-manage- ment, tolerance, tolerance, the coexistence of different religions and cultures, ignoring, being patient, and understanding, social dialogue and giving opportunity. Participants' views about the activities that the school administration can do to develop tolerance awareness are in the form of training, conducting group and project work with students, conducting lessons in this direction more effectively, seminars for stakeholders, empathy studies, and organizing social activities, positive approach. As many of the participants of the study put forward, school administrators also put forward the opinion that training should be given in this direction. In the study of Mutluer [18], who reached similar findings to this research, teachers see themselves as insufficient intolerance and demand education.

In the study, teachers emphasized that students with differences should be brought together with activities and activities to be organized, which will make a difference in students' perspectives and behaviours related to differences. Winarni and Rutan [19] conclude that using cooperative learning, not the classical method but one of the active learning methods, is effective in increasing students' tolerance and empathy skills.

Most research participants emphasized that the resources and materials are insufficient in this direction. Teachers stated that internet resources can be used for activities that can be done in this direction. In addition, while the opinions of the participants should be supported with stories, case studies, and games, the curriculum should be insufficient, teachers should be supported, the education system should not be supported, cooperation and solidarity should be increased, and the teachers should be transformed into behaviors, it is also seen that the teachers' opinions are sufficient resources, the teacher should be educated. He tries to point out that the materials at hand can be used in tolerance education, but if the teacher is not sufficient in this regard, he will not know how to evaluate what he has. Some studies have reached similar findings to these findings. Coşkun [20], in his study on increasing the knowledge and competence of teachers on this issue, emphasized the importance of adding courses that include this subject in institutions that train teachers to train teachers who can provide tolerance training, and increase the sharing between teachers.

In the research, some studies show that it will be beneficial to develop the curriculum to gain tolerance awareness and to include multiculturalism in parallel with the participant views stating that the curriculum is inadequate [21]. Similar to the findings of this research, Čučković, and Ohnjec [22] emphasized that according to teachers' beliefs, they respect human rights, differences in issues such as democracy and citizenship and that the curriculum is an essential building block in tolerance education.

Participants regarding the problems that may be encountered while providing tolerance education in schools, lack of material, lack of teacher and administrator education, stereotypes, bullying, different race, determination of student needs, prejudice, socio-economic differences, student unwillingness, cultural differences, TV-PC games, and Covid-19 They stated their opinion in the form. Türe and Ersoy [23] stated that different socio-economic levels of students and how their families raise them to cause them to think self-centered and exhibit reluctant attitudes in this direction.

Participants, positive classroom and school climate, more understanding and happy children, self- confident and self-expressive individuals, develop friendship relations for the contribution of gaining the awareness of tolerance to education in the management of differences, the settlement of the concept of human first is intertwined concepts, does not contribute to the relationship of stakeholders. It improves, increases academic achievement, and saves from prejudices. Unionists express the opinion that improvement in the relations of teachers, principals, and parents in the school environment will contribute to raising happy children.

The views of all participants participating in the research on the benefits of the society for the formation of tolerance towards differences: respect for differences and emotional awareness; understanding, happy and tolerant society; problem-free coexistence with multicultural structuring, supports cooperation and solidarity. In addition to these views, teachers and school administrators put forward opinions that conflict, bullying, and losses decrease. Union members express a different perspective from other participants that it may be helpful but not an absolute method.

It may be helpful in the unionist views in the research findings. Still, the tolerance content intended to be explained in the finding, not the absolute method, contains tension due to its nature and is mentioned without tolerance. Much tolerance shown in the later stage may cause the individual to enter high expectation demands and experience burnout when not met. This concept's importance is increasing daily to live in harmony and respect for differences, despite the tension it has due to its nature.

Many studies reveal the necessity of tolerance education. Studies emphasized that differences are accepted as natural. Individuals can live in a multicultural society, understand another person, look at events objectively, and have a broad perspective, thanks to the development of tolerance awareness with education [24, 25, 26, 27].

The development of information technology, communication, and transportation requires intercultural interaction. With the changes in information technologies, the social structure will develop in a direction shaped by information and communication technology, which means that humanity will undergo significant changes, and

education will be affected by these changes. Considering the findings obtained in this direction, it is predicted that the use of today's educational technologies in tolerance education will be beneficial.

As a result of the data obtained in the research, studies can be carried out to make the tolerance consciousness that respects differences in schools become an organizational culture as a value. While establishing the vision and mission of the school, a culture of respect for differences and tolerance can be taken as a basis. Tolerance training practitioners and school administrators are recommended to receive in-service training to reach competence in this area.

6 Conclusion

One of the vision of diversity reform is to achieve a high quality education for every child. However, it is now being demonstrated that various factors play a role, including current demographic changes in schools, and that the educational process encompasses all segments of society and requires educators, parents and the larger community to come together. In this respect, it is important to redefine the roles in education programs and to act jointly with the stakeholders. Thus, diversity reform is expected to be successful.

The differences in race, ethnicity, language, nationality, socio-economic status, religion are represented within a school as the globalization brings a great diversity to the educational contexts. While diversity provides many benefits to the organisation, it is also essential for education stakeholders to understand how to manage diversity to the organisation's as well as their own benefit. The current study examined teachers' opinions about diversity and diversity management in their schools with a qualitative research technique. The research reports that there are differences in schools, especially in culture, religion, language and socio-economic aspects, but tolerance education for this is insufficient.

The finding has several implications. First, the results in terms of advantages and disadvantages of diversities provides the target areas for diversity management, i.e., the areas that cause conflicting. Second, the finding that tolerance education is insufficient could improve school administrators' awareness of diversity management, thus consciously take steps and initiatives to promote better understanding and decision making. Nevertheless, the study has several limitations. First, the participants of the study were limited to a small number of people so that the findings from this study cannot be generalized to our schools. Second, the study recommends a structured tolerance education curriculum for developing people's skills for diversity management, including independent judgment, critical thinking, and ethical reasoning.

It is important to provide resources to the school for tools, materials, books, films and posters to be used in tolerance education. In this regard, the contributions of both the school administration and the ministry of education are considered important.

Studies have emphasized that it is important to raise awareness of tolerance at an early age. In this context, it is recommended that tolerance education be added to the curriculum by the Ministry of Education. In addition, for the development of tolerance awareness, it is important to provide teachers with educational environments in which the lessons are taught in a more effective way by the use of modern teaching methods in which the students are active and technology is used, apart from the classical method.

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An Empirical Study of Intelligent Feedback Mechanism in Promoting College English Translation Learning

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Abstract. It is common for students to have low learning engagement, low learning motivation, and difficulty in improving translation performance due to insufficient feedback information, single form of feedback, and untimely feedback, etc. How to improve students' translation ability and learning engagement becomes the key to improve translation learning effect. In the translation teaching based on the intelligent joint feedback mechanism, the translation learning activities including the conceptualization stage, the writing stage, the feedback stage and the revision stage are designed by incorporating the theory of process writing method. The results of the empirical analysis showed that the translation learning based on the intelligent joint feedback mechanism significantly improved students' translation performance and enhanced students' learning engagement; compared with the translation learning based on the online automatic feedback mechanism, there was a stronger correlation between students' reading tendency and translation performance in the translation learning based on the intelligent joint feedback mechanism. It can be seen that translation learning based on intelligent joint feedback mechanism can help promote students' learning engagement and the transfer of reading accumulation to translation ability, and realize the improvement of translation learning effect.

Keywords: Feedback Mechanisms · Translation Learning · Learning Engagement · Process Writing Approach

1 Introduction

Translation is a skill and a science, not as the university English community believes that translation can be learned by grasping reading and inputting sufficient language knowledge, but requires the joint improvement of various abilities, including bilingual ability (English expression ability, Chinese comprehension ability), knowledge ability (encyclopedic knowledge, relevant professional knowledge), information search ability (the ability to search information by using tools and internet resources, etc.), and translation function (conversion ability, translation revision ability) . (ability to use tools and internet resources, etc.), and translation function (ability to convert, ability to revise the translation) . It can be

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said that translation is one of the most complex skills in university English learning, but the marginalization of translation teaching in university English teaching makes traditional English translation teaching face many problems, and the main factors affecting translation learning are as follows: First, the feedback of translation learning is not timely. The time limit of English translation study at university is short and the class time is extremely insufficient. In traditional translation classes, it is difficult for teachers to provide immediate feedback to all students on their translation learning status, so it takes a certain amount of time before they can provide feedback to students. The lack of class time makes the time for learning and the time for feedback conflict, which makes it difficult for university English translation teaching to accomplish the set teaching tasks. Second, the feedback form of translation learning is single. In traditional English translation teaching, the teacher is the only one who provides feedback to students, but it is time-consuming and labor-intensive to correct translations, and the large amount of homework will increase the teacher's burden; however, the small amount of homework will lead to the lack of training for students and limit the improvement of translation ability. Third, the feedback information is not comprehensive and lacks personalized feedback. In traditional English translation teaching, due to the limitations of the feedback subject, i.e., the teacher's energy, the difference in level and the diversity of teaching, the feedback most students receive depends entirely on the teacher's mental state or the teacher's ability level, and it is difficult to obtain stable and comprehensive feedback information. At the same time, because traditional teachers of English translation in universities teach in a holistic way, it is difficult to take into account the individual, and students basically cannot enjoy personalized feedback.

With the development of artificial intelligence, computer-assisted English translation learning has become the current trend in university English translation learning, and has promoted the application of intelligent joint feedback mechanism in university English translation teaching. It is found that, compared with manual feedback, the intelligent joint feedback mechanism can provide students with timely, accurate and comprehensive feedback on translation training, improve the efficiency of university English translation teaching and enhance students' learning motivation, and is an effective mechanism to promote university English translation learning. For example, Lv analyzed the effectiveness of online automatic feedback on students' English writing level by testing the changes of grammar, structure, length and grade of students' translated writing texts in a teaching experiment, which can help students improve their writing level and independent writing ability. Although the application of traditional automatic translation scoring system has many advantages, there are still problems such as low translation accuracy and lack of comprehensiveness, thus making it difficult to promote the intelligent feedback mechanism in university English translation teaching. And with the gradual maturity of artificial intelligence technology, the automatic feedback system has been improved and updated, and researchers have conducted new experimental studies based on the defects from the traditional

system to promote the application and promotion of the intelligent joint feedback mechanism in university English translation teaching. For example, Fen Huang designed an automatic feedback scoring system based on XML structure to solve the problem of low accuracy rate of business English text translation, and the comparative feedback results showed that compared with the manual feedback scoring of traditional feedback, the XML structure-based feedback scoring system for translation information could evaluate standard and subjective questions more efficiently and accurately, and give relatively objective scores. Aiming at the problems that the analysis of traditional automatic translation scoring methods is not comprehensive enough and the accuracy rate is not high, Pan Tingting et al. proposed an automatic Chinese to English scoring model based on hybrid semantic space and carried out an empirical study of translation with automatic feedback, and the experimental results showed that the average error of the method and manual scoring was only 1.13, and the Pearson correlation coefficient was 0.87, showing a high accuracy rate.

Based on the above-mentioned problems in translation learning and related studies, this study provides students with immediate, comprehensive and accurate feedback information on translation learning by designing an intelligent joint feedback mechanism based on a criticism network to promote students' translation ability. The study attempts to answer the following questions: (1) Can the intelligent joint feedback mechanism improve students' translation performance compared to the traditional translation learning feedback mechanism? (2) Does students' engagement in learning affect their translation performance? (3) Are students' reading habits significantly related to their translation performance?

2 Key Concept Analysis

2.1 Intelligent joint feedback mechanism

Feedback on translation writing is an important aspect of teaching English translation, providing learners with information on how to revise the translated text, such as "errors in words and tenses," "errors in grammatical structure," "better word or phrase choices," etc. The feedback content is partly focused on the translation of the text. These feedback contents are partly corrective feedback for the surface-level errors of the translated text, such as the feedback of linguistic errors of vocabulary, grammar and case, and partly summative feedback based on the discourse level of the translated text, such as the feedback of organizational structure and content articulation. The feedback mechanism mainly includes automatic feedback from machines, written feedback from teachers and joint feedback from humans and machines.

Automatic machine feedback means that students' translated texts are instantly evaluated by an automatic grading system and scores are automatically generated, while feedback information is given to students on grammar, vocabulary, structure, etc. Its function is both summative and formative in terms of evaluation, which has obvious effects on improving students' English translation and writing skills. However, some related studies point out that automatic machine feedback is rather mechanical, difficult to make feedback flexibly according to the logic of text structure, and can only facilitate the revision of formal errors, which is still insufficient for the construction of text content.

Teachers' written feedback means that teacher provide feedback for students by revising students' translation texts with the help of texts, mainly includes corrective feedback (text revision) and non-corrective feedback (teachers' comments), which can work together with students' internal factors to promote students' language development and thus improve their translation skills. However, some studies have found that teacher feedback is not specific enough and weakly targeted, students are easily misled, and most teachers' feedback only goes to remind students of superficial errors (e.g. language errors, etc.), neglecting students' deeper development (e.g. cognitive skills development). However, teachers' feedback is an essential part of English translation teaching, and the key to the problem is how to make teachers' feedback effective.

In response to the shortcomings of automatic machine feedback and the shortcomings of written teacher feedback, a few studies have been conducted on the use of human-computer combined feedback mechanisms in English writing instruction. For example, Huang, Jing, and He, Huaqing (2018) explored the effects of human-machine feedback on students' writing behaviors and found that combined human-machine feedback could improve students' text quality and enhance students' independent learning ability; Wu, Yong, and Zhang, Wenxia (2016) conducted a study on how to provide effective feedback to students and pointed out that students used teacher feedback more frequently when revising text and automatic machine feedback was more effective in enhancing students' self-directed learning ability; Li, Guangfeng (2019) studied the effects of machine feedback, peer feedback, and teacher feedback on students' revision of text, and proposed that human-machine multiple feedback can make up for the shortcomings of each and have a positive effect on students' text revision. However, few studies have applied the combined human-machine feedback mechanism in college English translation teaching, and this study follows the research on human-machine feedback in English writing teaching, proposes the combination of intelligent joint feedback mechanism, i.e., online automatic feedback and teacher written feedback, explores the impact of intelligent joint feedback mechanism on college English translation learning, and explores how to effectively combine in two feedback mechanisms in translation teaching to promote students' The study explores how to effectively combine the two feedback mechanisms in translation teaching to promote students' translation ability.

2.2. Learning engagement

Student engagement in the classroom is an effective guarantee for the completion of learning activities. Engagement is an important indicator of the quality of students' learning process and is highly related to students' learning continuity, student satisfaction, and learning effectiveness. Engagement, cognitive engagement, and affective engagement. Behavioral engagement mainly refers to the level of students' engagement in the learning process, which is purely procedural; cognitive engagement refers to the high level of cognitive strategies and mental engagement that learners adopt in the learning process; and affective engagement is the emotional engagement of learners in the learning process.Jerry Chih-Yuan Sun, Shih-Jou Yu, Chih-Hsuan Chao (2018) explored how intelligent feedback affects learners' engagement (behavioral, affective, and cognitive) and cognitive load (mental load and mental effort). The results showed that feedback led to higher emotional and cognitive engagement, suggesting that intelligent feedback should be combined to increase students' emotional engagement and thus their willingness to learn when designing intelligent learning environments. This study examines the effect of college students' learning engagement on their English translation performance in English translation classrooms.

3 Design of translation learning activities based on the theory of process writing method

3.1 Process writing method theory

Wallace Douglas, a professor at Northwestern University, proposed the process approach to writing and regarded writing as a complex, cyclical mental cognitive process, thinking process and social interaction process, considered writing activity as a social communication activity, and emphasized the role of feedback revision in the writing process. The process approach theory of writing divides writing teaching into five stages: pre-writing preparation, first draft, feedback, revision, and re-writing, each of which intersects with each other and repeats in a cycle, linking the whole writing teaching process. The process approach theory of writing has been widely used in English writing teaching and has been proven to be effective in improving feedback and learning outcomes. Hu's novel research shows that using the process writing method to teach English writing can motivate students to write in English and let them experience the fun of writing in English, which can really improve their English writing ability. Chen Jing et al. found that the multiple-draft feedback mechanism of the process writing method was more helpful in improving students' writing, and that the process writing method had a positive impact on

students' writing habits, writing strategies, and writing feedback attitudes. Wu Lin used the process writing method to guide the teaching of English writing, and the organic combination of teacher and peer feedback significantly improved students' English writing skills.

3.2 Design of learning activities

Based on the intelligent joint feedback mechanism, this study proposes a framework for English translation learning activities that incorporates the process approach theory, as shown in Figure 1.

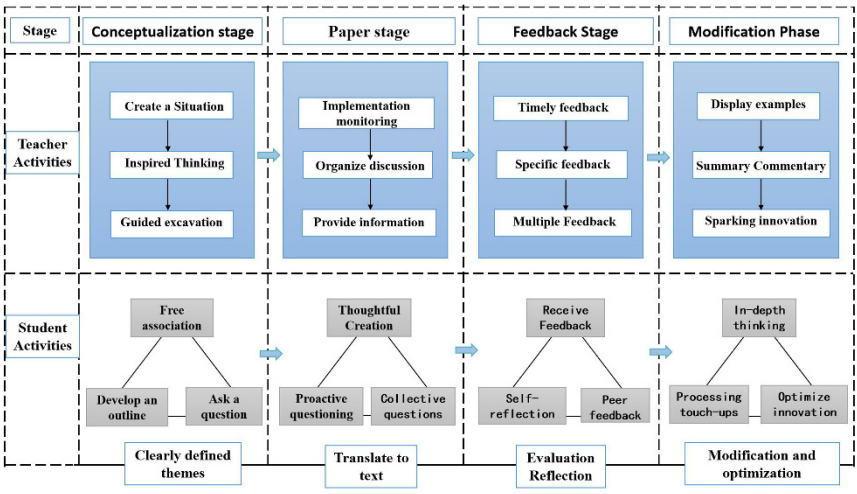

Fig. 1. Learning activity map

Conception stage. This stage is the initial stage of English translation activities, which is mainly the process of teacher's guidance and students' conceptualization. On the one hand, the teacher guides and inspires students to explore and clarify the direction of the translation topic by creating a situation. On the other hand, students clarify their ideas through free association and asking questions to the teacher, and finally draw up an outline, determine the direction of translation, and complete the translation idea of the whole text.

The stage of writing. This stage is the editing-into-text stage, a process in which the teacher monitors and the students translate. On the one hand, the teacher needs to monitor the students' translation process, organize the students' discussion and answer their doubts. On the other hand, students need to translate the

The idea of translation is expressed in phrases, and the focus of consideration is on the expression of the content, without thinking too much about whether the choice of words or sentences is correct or not, and constantly conceiving and revising until the first draft is completed.

Feedback stage. This stage is the core stage of translation learning activities, a process of human-machine feedback and student reflection. On the one hand, the teacher and peers give delayed and specific feedback, while the machine gives timely and diverse feedback. On the other hand, students learn the strengths and weaknesses of their own writing through the feedback information, and modify the translated text according to the feedback. This stage not only enhances students' translation awareness and reduces translation anxiety, but also promotes students to make up for their own shortcomings.

Revision stage. This stage is an extremely important stage in translation learning activities, and is the process of students revisiting, identifying problems, touching up the text, and re-creating it. First, students re-examine the translated text through the feedback and find out the problems, including sentence usage, vocabulary spelling, and paragraph structure. And then, the problems or inappropriate contents found in the translated text are revised and embellished.

This study uses the translation writing environment provided by intelligent criticism and adopts an intelligent joint feedback mechanism to achieve the purpose of giving students multiple feedback, which not only enables students to get timely feedback, but also helps them to obtain multi-dimensional feedback information and improve their learning efficiency and motivation.

4 Study Design

4.1 Experimental participants

The experimental participants in this study were first-year non-English majors at a university with an average age of 19 years old, with 34 students (12 male students) in the experimental group and 34 students (10 male students) in the control group. The experimental and control groups were taught English translation at different times but in the same classroom by the same teacher. The experimental group was taught using a human-computer multiple feedback mechanism, and the control group was taught using an online automatic feedback mechanism.

4.2 Experimental tools

The main function of the Smart Review System is to provide translation or writing services for college teachers and students. By registering their platform accounts and logging in to the website and joining the classes created by teachers, students can find translation assignments in their classes, practice translations on the platform, and submit their translated texts for multiple revisions and resubmissions

based on feedback from the Smart Critique System (including error hints, question alerts, extended discernment, etc.). The intelligent correction system can provide feedback on the English translation text in terms of words, grammar, sentence structure, score and content, etc.

4.3 Experimental procedure

To verify the research questions posed in the previous paper, this study designed an experimental procedure as in Figure 3. First, students in six candidate classes were tested for translation, and the two classes with relatively small differences in translation scores were selected as the experimental group (M=75.57) and the control group (M=70.94), respectively. Before formally starting the experiment, students in the experimental and control groups were familiarized with the use of the intelligent correction system and the content of feedback provided by the clear correction website, questionnaires on study engagement and reading habits were administered to students in the experimental and control groups, and interviews were conducted on the translation learning of some students. In the formal experiment, five translation learning activities were conducted: "Tai Shan", "Dream of the Red Chamber", "Chinese Dream", "Beautiful China "The first time, the translation assignments that were required to be completed within 30 minutes in class were used as the pre-test translation texts, which were automatically scored by the criticism website and then scored by the teacher, and the final average was taken as the pre-test score of the experiment participants. From the second to the fifth translation text, the experimental group took the form of human-computer multiple feedback, while the control group took the form of automatic feedback from intelligent correction, and the last translation score was used as the post-test score, which had to be completed in class within 30 minutes. After the completion of the translation learning activities, the students were again surveyed on their learning engagement and randomly interviewed in the experimental group. The experimental process lasted for five weeks, and the duration of the course was approximately 90 minutes per week.

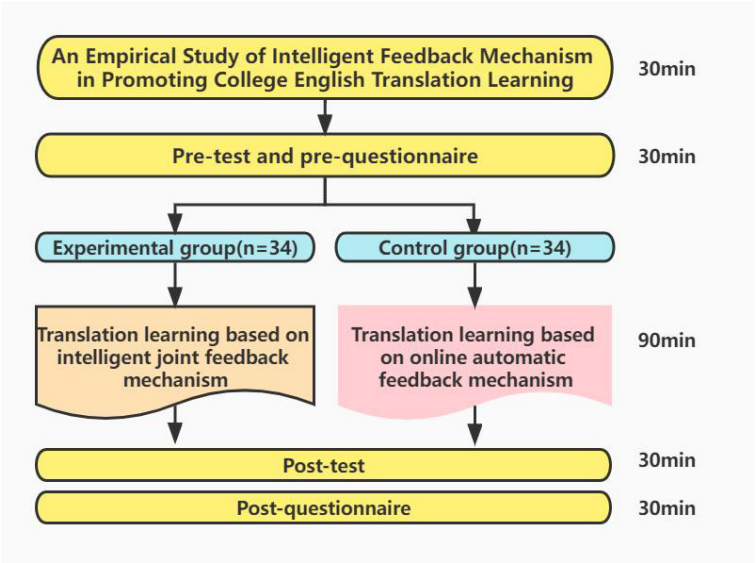

Figure 3. Experimental flow chart

4.4 Measurement tools

Learning engagement scale. To investigate the effect of students' learning engagement on their translation performance, the study drew on the Learning Engagement Scale developed by Sun et al. (2018) based on an adaptation obtained from the scale, which contains 5 questions. The scale was scored on a 5-point Likert scale, and its Cronbach's α coefficient value was 0.764, indicating that the scale had high internal consistency.

Learning experience interview syllabus. To investigate students' perceptions of English translation learning based on the intelligent joint feedback mechanism, the study drew on an interview outline from a similar study by Huang et al. (Huang & Hwang et al., 2019), including "Do you like using the intelligent joint feedback mechanism for English translation learning?" "What aspects of your translation learning do you think using the intelligent joint feedback mechanism has helped you the most?" "Would you recommend this feedback mechanism to your friends or classmates?" and other 5 questions.

English Reading Tendency Questionnaire. The questionnaire was revised on the basis of an existing study (Su Yuan, 2003), and involved the measurement of four dimensions, including propensity to read, length, self-consciousness, and sharing. The Cronbach's α coefficient of the questionnaire was 0.785, indicating that the questionnaire has a high internal consistency.

5 Study results and discussion

5.1 Analysis of translation performance

Table 1. Differences in translation scores between the pre-test and post-test of the experimental and control groups

		Pre-test results		Post-test results					
Group		M	SD	M	SD	MD	t	df	p
Experimental group	34	75.57	3.838	82.98	3.764	-7.411	-9.498	33	0.000
Control group	34	74.10	3.942	75.94	5.716	-1.838	-1.649	33	0.109

To analyze the effects of the intelligent joint feedback mechanism and the automatic machine feedback mechanism on students' translation performance, paired-sample t-tests were done on the pre-test and post-test scores of students in the experimental and control groups, respectively. The results showed (see Table 1) that the mean performance of the experimental group was significantly higher (MD=-7.411) and the difference between the pre-test and post-test performance was significant (t=-9.498, p=0.000<0.05); there was no significant difference between the pre-test and post-test performance of the control group (t=-1.649, p=0.109>0.05).

5.2 The effect of learning engagement on translation performance

In this study, the independent samples t-test was used to compare the pretest learning engagement levels of the two groups of students, and the results are shown in Table 2. Table 2 shows that there was no significant difference in the pretest learning engagement levels between the two groups (t=1.171,p=0.246>0.05), which indicates that there was no significant difference in their original learning engagement levels. Paired-samples t-test was then used to analyze the pre and post-test learning engagement levels of the two groups of students, and the results are shown in Table 3. From Table 3, there was a significant difference in the pre-test and post-test learning engagement levels of the experimental group (t=-6.534, p=0.000<0.05), while there was no significant difference in the learning engagement levels of the control group (t=-0.095, p=0.925>0.05), and the post-test learning engagement levels of the experimental group increased more significantly. This indicates that the intelligent joint feedback mechanism based on translation

classroom learning can better promote students' learning engagement compared with the automatic machine feedback alone.

Table 2. Results of independent sample t-test for pretest learning engagement

Group	N	M	SD	F	df	t	p
Experimenta1 group	34	77.85	5.57120	1.932	66	1.171	0.246
Control group	34	76.38	4.74830				

Table 3. Results of paired-sample t-test for pre-test and post-test learning engagement

Group	N	M	SD	F	df	t	p
Experimental group	34	77.85	5.57120	1.932	66	1.171	0.246
Control group	34	76.38	4.74830				

5.3 Correlation analysis between reading tendency and translation performance

To investigate the association between students' reading tendencies and translation scores, this study first compared the reading tendencies of the two groups using the independent samples t-test, and the results are shown in Table 4. it can be seen that the results of the independent samples t-test ($t=1.169$, $p=0.246>0.05$) shown in Table 4 indicate that there is no significant difference between the two groups of students in terms of their reading tendencies. And then, Pearson correlation analysis was conducted on the reading propensity and translation scores of the students in the experimental and control groups, and the results are shown in Tables 5 and 6. It can be seen that the reading propensity of the students in the experimental group showed a certain correlation with their translation scores, $r(34)=0.350$, $p<0.05$, while the correlation between the reading propensity of the students in the control group and their translation scores was not significant, $r(34)=0.278$, $p>0.05$.

Table 4. Results of independent sample t-test for reading propensity

Group	N	M	SD	F	df	t	p
Experimental group	34	20.32	2.543	0.011	66	1.169	0.246
Control group	34	19.59	2.641				

Table 5. Pearson correlation analysis between reading tendency and translation performance in the experimental group

Group	N	M	SD	r	p
Experimental group	34	20.32	2.543	0.350	0.042

Table 6. Pearson correlation analysis between reading propensity and translation performance in the control group

Group	N	M	SD	r	p
Control group	34	19.59	2.641	0.278	0.111

6 Concluding remarks

In this paper, through an empirical study, we find that university English translation teaching based on the intelligent joint feedback mechanism is more conducive to the improvement of students' translation ability and linguistic thinking than university English translation teaching based on the online automatic feedback mechanism, and students' translation performance and learning engagement are significantly higher, and the correlation analysis finds that students' translation performance and reading tendency are significantly correlated under the intelligent joint feedback mechanism. The intelligent joint feedback mechanism has a significant effect on the improvement of students' translation performance, but how to integrate this mechanism with English translation teaching and give full play to its unique advantages is a question worth exploring. This paper proposes the following aspects through the above-mentioned study.

From the perspective of translation teaching, teachers must improve their own information literacy, keep abreast of new technologies, and guide students to learn new technologies. However, teachers must be clear that the intelligent joint feedback mechanism does not only rely on the automatic feedback function of the

machine alone, and cannot rely entirely on automatic feedback, but must also give full play to the role of teacher feedback, and combine the two organically for creative teaching. First, the timely nature of the machine feedback allows students to make their first revision according to the feedback information; second, the practicality and completeness of the teacher's feedback helps students to make their second revision; finally, the teacher provides students with sample analysis through the excellent model essays recommended by the machine feedback, which not only improves students' learning motivation, but also promotes students' self-learning ability.

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Digital Twin technology in the field of education—— Take the management of the HTC Vive as an example

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Abstract. Digital twin technology is one of the key technologies in the age of intelligence, which became a hot topic in the industry and academia domain. After analyzing its applications in various fields, we found that digital twin technology is less studied in the field of education, especially in the management of teaching and research equipment. Based on this, this study a) summarizes the definition and theoretical research progress of digital twin, b) analyzes the application of digital twin in aviation, ships, vehicles, education, etc. and c) takes HTC Vive, a teaching, and research device, as an example, to build a digital twin in terms of component, key technologies, and implementation paths to realize its full lifecycle management.

Keywords: Digital Twin · Teaching and Research Equipment · HTC Vive · Whole Life Cycle Management

1 Introduction

Since the mid-20th century, technologies like microelectronics, automation, and artificial intelligence have rapidly developed, giving rise to new technology revolution and the concept of digital manufacturing emerged. Recently, China, the United States, and Germany have formulated development strategies respectively, aiming to use the IoT information system to inform the manufacturing industry and activate traditional industries. Traditional manufacturing has gradually transformed into intelligent manufacturing. Thus, digital twin (DT) which has been the key technology of intelligent manufacturing has attracted extensive attention from industry and academia.

NDRC and CAC jointly issued the implementation plan on promoting the action of "using numbers to enrich intelligence in the cloud" in April 2020 to cultivate new economic development, which raised the DT to the level of parallel with big data, AI, cloud computing, 5G and the Internet of things, and proposed to carry out the DT innovation plan. At present, the world has already realized the high integration of the physical world and the virtual digital world. Especially with the outbreak of the COVID-19 worldwide, online learning is becoming more and more popular. Digital twin technology is known as one of the key technologies for building a new online learning platform, which will play a vital role in the field of

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education and has forward-looking value in cultivating innovative talents and creating a smart learning space.

This paper systematically expounds on the emergence and development, definition, and application field of DT. Finally, taking the specific teaching and research equipment HTC Vive as an example, a systematic expression of the components, key technologies, and implementation paths of the conceptual digital twin model was then formulated to provide a reference for the educational application of DT.

2 Related Work

2.1 Digital Twin

Emergence and Development. The concept of "Twin" can be traced back to the Apollo project of NASA in 1969 [1]. In 2003, Professor Michael grieves put forward the concept and composition of DT in the product lifecycle management (PLM) course of the University of Michigan [2]. In 2011, Michael Grieves and John Vickers of NASA jointly published a white paper, which first put forward the clear concept of DT and identified it with the term "Digital Twin" (DT) [3,4,5]. Subsequently, institutions and scholars have each proposed the idea of constructing DT [4], [6,7,8]. (See Fig.1)

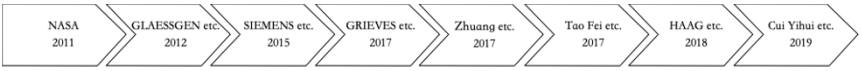

Fig. 1. Development Path Diagram

Definition. Since the birth of DT, academia has defined it differently from the perspectives of equipment manufacturing, aircraft, product life cycle, etc. No matter from which perspective, DT mainly includes three elements: the physical entity in physical space, the data model in virtual space, and the dynamic data connection between them. Based on this, from the perspective of equipment life cycle management, the paper defines the equipment DT in the field of education: Accurately describe and map the multi-dimensional attributes of physical entities such as geometry, physics, behavior, and rules to form a high-fidelity three-dimensional virtual model in the virtual space which is supposed to manage the whole life cycle process of corresponding physical equipment, including design, building, service, maintenance, repair, scrapping and so on（See Fig.2）.

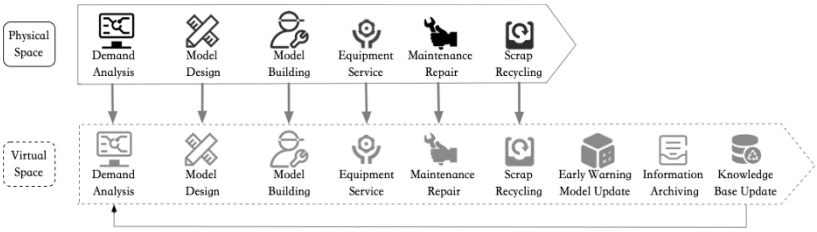

Fig. 2. DT model for whole life cycle management

Application field. At present, the application field of DT technology has shifted from military industry and aerospace to a wider range, and gradually from large-scale equipment manufacturing to daily consumer goods manufacturing. After sorting out and summarizing the relevant literature and combining the focus of this research, this section focuses on the research and application of DT in aerospace, intelligent ships, vehicles, and other fields in recent years (See Table 1).

Table 1. Application Fields [9,10,11,12,13,14]

Fields	Scholars or Institutions	Application
Aerospace	US Air Force Laboratory	DT model of super fidelity aircraft
	Tao etc.	Combined with the DT five models, optimized the structure of aircraft landing gear, and proposed the concept of DT satellite
	China Aviation Group	Applied to Aeroengine intelligent production line
	Zhang etc.	Applied to spacecraft on-orbit assembly and aerospace manufacturing workshop production control
Intelligent Ships	Meng etc.	DT flight companion system framework
	Li etc.	The overall framework of the digital ship
	Cai etc.	Application architecture of ship life cycle based on DT
Vehicles	Tao etc.	Vehicle anti damage evaluation method based on DT technology
	Yu etc.	The DT model and test platform are used for tracking test, behavior prediction analysis, and diagnosis of intelligent networked vehicles

2.2 Application of DT Technology in the field of Education

The application of DT technology in the field of education started in 2017. After sorting and analyzing the relevant literature, we found that the research is mainly distributed in Smart Learning Space, Teaching and Training Mode, and Learner Twins.

Smart Learning Space. Professor Ren first proposed to carry out a "DT" of normal classrooms and build a DT classroom in 2018 in China [15]. Since then, many scholars have continuously proposed the idea of building a smart learning space based on DT and as follows. Dashkina et al. and Tian et al. respectively proposed the idea of building a digital virtual laboratory based on DT technology, which is proved to be an effective method to help students achieve better learning

effects in the virtual laboratory [16,17]. In addition, ubiquitous smart learning spaces [18], DT venues [19] and holographic twin classrooms [20] which enrich the application of DT in learning spaces based on DT technology have also emerged one after another.

Teaching and Training Mode. Sepasgozar applied DT technology to the education and training of tunnel construction [21]. Meanwhile, Zheng et al. and Yang et al. introduced the concept of DT into the practical training of vocational education [22,23]. DT technology has also been introduced into daily teaching besides practical training. For example, Professor SHI built a corresponding auxiliary teaching system based on virtual reality image recognition technology and DT technology [24], Nikolaev, etc. designed project-based teaching based on it while Zhang combined DT technology with holographic teaching methods [25]. In addition, mixed teaching research based on DT technology, such as the number twin mixed intelligence teaching model system [26] and mixed practical teaching platform [27], is also mentioned.

Learner Twins. It is a general trend that the application objects of DT research in the field of education gradually shift to learners. Based on this, the idea of constructing corresponding learner twins has been successively proposed. For example, Wang et al., Zheng et al. have successively put forward the concepts of "learner twin" [28] and "cognitive DT" [29]. Chen proposed to build a learner twin based on the learner's real-time data, while Ai proposed to build a "DT learner" based on the learner's portrait but higher than the learner's portrait [30,31].

Conclusion. The advantages of the application of DT technology in education are obvious. First, DT-based smart learning spaces can provide richer and more realistic learning contexts, support multi-sensory immersive learning for learners. Secondly, the DT-based teaching and training mode can complete the simulation training process that is difficult to complete with traditional training, present a comprehensive and multi-dimensional evaluation method, and iteratively optimize the practical training teaching and practical steps. Finally, based on the feedback of the learner twins, teachers can optimize and improve teaching strategies, and at the same time provide students with scientific and accurate analysis of the learning process, learning content delivery, learning evaluation, etc.

However, the application is still in the exploratory stage where there are still many problems to be solved. Although the learning space is no longer limited by location and time, the requirements for the learning experience are higher, and there are still many problems such as real-time data collection, feedback, and interaction that need to be solved. At the same time, the conceptual connotation and realization mechanism of DT learners are not only restricted by technology but also tested by privacy and ethics. Moreover, the current application of DT technology in the field of education focuses little on related research on educational equipment management. Thus, this research focuses on the whole life cycle management of teaching and research equipment is of certain practical significance.

3 Teaching and research equipment twins for whole life cycle management

With the rapid development of computer and network technology, education has entered a new era of development. In recent years, many VR devices that are widely used in teaching and research activities have appeared, such as data gloves, eye trackers, etc. and the most representative of which is the HTC Vive device jointly developed by HTC and Valve. Because teaching using VR equipment such as HTC Vive is safer than traditional laboratory teaching and more situational than traditional situational teaching, VR simulation teaching laboratories have become a key project that major universities pay attention to and build. However, there are also plenty of shortcomings among HTC Vive and other VR devices such as the expensive price and it is difficult to maintain, etc., so how to manage VR devices and reduce unnecessary losses needs to be solved urgently. Fortunately, the emergence of DT technology provides a new idea for solving those problems. This section takes the HTC Vive device as an example to briefly describe the methods and ideas for building a DT of teaching and research equipment and realizing its whole life cycle management.

3.1 Component

DT and whole life cycle management promote each other and complement each other. Based on this, this chapter takes HTC Vive equipment as an example to analyze the composition of the HTC Vive twin from the perspective of object-oriented model and process data and discuss the realization of the DT of teaching and research equipment from the perspective of equipment life cycle management.

Object-Oriented Model. This section proposes the application model framework of HTC Vive twin which is combined with HTC Vive devices in the whole life cycle based on the theoretical model of DT proposed by Tao Fei, etc. As shown in Figure 3, the model which can meet the needs of whole life cycle management consists of five parts: Physical Entity (PE), Virtual Entity (VE), Digital Data (DD), Service System (SS) and Connect (CN), And it does not exist in isolation. For example, DD can drive PE, VE, and SS, and get feedback from each connected object. The twin data also continues to expand, improve, and iterate along with the data entry at each stage of the equipment life cycle, forming a more reasonable and effective data model.

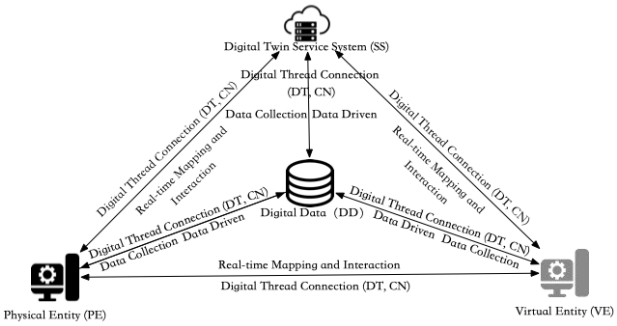

Fig. 3. Object-Oriented DT 5D Model

Process-Oriented Data Model. The application of DT technology in each stage of PLM can support the needs of PLM, such as multi-level collaboration, whole life cycle data management, knowledge iteration, and sharing. The data composition of HTC Vive twin is analyzed from the perspective of the product life cycle and divided into the following five parts: Product Design Data, Process Design data, Equipment Manufacturing Data, Equipment Service data, and Equipment Scrapped Data (See Fig. 4).

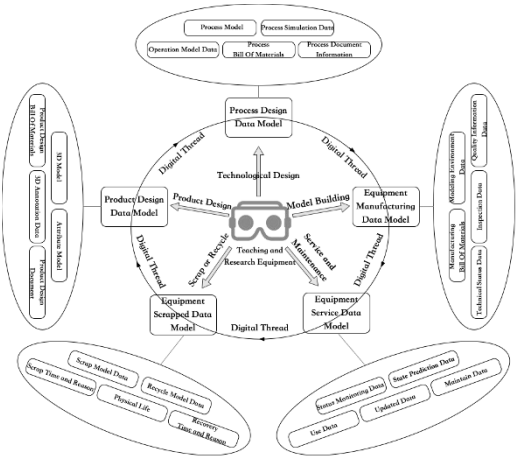

Fig. 4. Process Oriented DT Data Model

In addition, each part of the data does not exist in isolation: The data of the previous link has an impact on the data of the following link while the latter also provides support for the improvement and improvement of the previous. The emergence of digital thread technology provides technical support for the interconnection of various data models. And the data model of the HTC Vive twin

is not static, but a dynamic model and a process model, which will evolve with the generation of data.

3.2 Implementation

Key Technology. The key technologies of DT construction mainly are as follows: Multi-dimensional Modeling Technology, Virtual Simulation Technology, Virtual Reality Technology, Digital Thread Technology, Whole Life Cycle Data Management Technology, Equipment Warning Model (See Fig. 5).

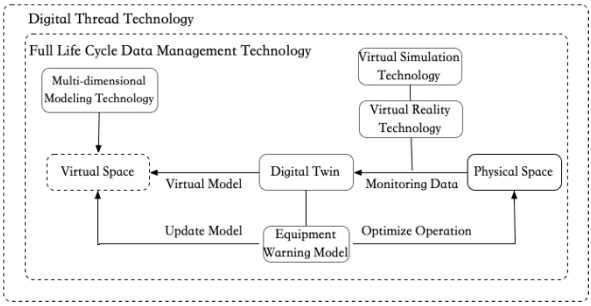

Fig. 5. DT Key Technology

First, building a DT with multi-dimensional modeling technology. The core of it is based on the Model-Based Definition (MBD) technology, which maps the Geometric and Physical properties of the product, and then combines virtual reality technology and virtual simulation technology, using computer algorithms that can convert data models into methods and forms to simulate the model, so that DT is constructed from multiple dimensions. Secondly, managing the equipment by making the equipment warning model. Equipment failure is often related to service life, maintenance times, average total maintenance times of the equipment, and other factors which can be used to build a warning model and predict the probability of failure and scrap. In addition, data plays a vital role in all stages of life-cycle management. The whole life cycle data management technology and digital thread technology are used throughout.

Implementation approach. Whether the HTC Vive model is object-oriented or process-oriented, both of them do not exist in isolation and cannot only run through each process of the entire product life cycle with a single model but combine and relate the data of each stage with the HTC Vive Twin to promote and integrate. Thus, the paper divides the whole life cycle into three stages: Design Stage, Manufacturing Stage, Service Stage. Combined with the object-oriented HTC Vive model and the process-oriented HTC Vive data model, the implementation methods and functions of the HTC Vive twin are analyzed. (See Fig. 6).

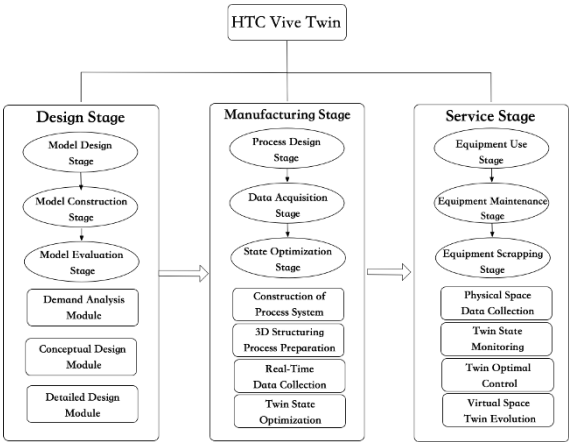

Fig. 6. Implementation Path of DT

HTC Vive Twin Design Stage. It can be divided into three stages as follows:

Model Design Stage: Designers analyze the requirements of HTC Vive and collect relevant historical geometric information, non-geometric information, usage data, fault data, etc. to form a requirements analysis report.

Model Construction stage: According to the requirement analysis report formed in the previous stage, the conceptual design and detailed design of the HTC Vive model were carried out.

Model Evaluation Stage: The purpose is to evaluate the HTC Vive model built in the previous stage and provide timely feedback and changes to the defects and deficiencies in the design and construction process, to achieve rapid interaction between the design and manufacturing stages, thereby shortening the design and manufacturing cycle to achieve the best effect and efficiency.

HTC Vive Twin Manufacturing Stage. It consists of three stages are as follows:

Process Design Stage: This stage consists of two parts that can be associated with each entity model: the Construction of the Process System and the preparation of the 3D Structuring Process Preparation.

Data Collection Stage: This stage is mainly about the real-time acquisition of dynamic data which is encapsulated for other links to call.

State Optimization Stage: This part is mainly about the state optimization of the HTC Vive twin which includes the evolution of the HTC Vive twin in virtual space and the state monitoring and process optimization of the HTC Vive manufacturing stage.

HTC Vive Twin Service Stage. It can be also divided into three stages:

Use Stage: It is necessary to obtain the measured data, use data and maintenance data of products in physical space through various technologies, and map this to the HTC Vive twin of virtual space to realize real-time state updates.

Maintenance Stage: On the one hand, an equipment warning model is built according to the historical data to give a fault early warning to the HTC Vive that has not failed or is about to fail.

Scrap Stage: Combined with historical data, dynamic Bayesian, and other data mining methods and optimization algorithms, the equipment scrap warning model is constructed to make the early warning information more accurate and practical.

4 Conclusion

4.1 Advantages and Shortcomings

DT technology provides new ideas and methods for the development and innovation of the current manufacturing industry is becoming a representative of new technologies in the intelligent era. First, the decision information formed based on the digital model can better analyze, make decisions, control, predict and optimize the products in the physical world, thereby realizing the two-way flow of information and data. Secondly, the DT can be regarded as the link between intelligence and physical objects, which helps to improve the reliability of product service, prolong the service life of products, and ultimately reduce the cost of use and maintenance. Moreover, the realization of the DT facilitates the deep integration, parallel development, and control of physical space and virtual space and expands the space for understanding and controlling production resources and processes.

Although DT technology has attracted extensive attention and research Domestic and foreign, its construction and application are still in the preliminary stage when some unavoidable problems still need further research. First, the digital design level of DT technology in most industries needs to be improved urgently. Second, complex systems and device data are less valuable. Furthermore, there is a huge gap between the bright prospects described by DT technology and the actual technology. Due to the key technical issues involved, the research on DT mainly focuses on design and service, and the realization of DT is still the bottleneck of its application. Finally, the particularity of the application field of DT technology makes it difficult to bridge the problems of unequal research and application, cost, and benefit in the short term.

4.2 Summary and Outlook

In general, the emergence of DT technology has attracted extensive attention, research, and application and has caused changes in traditional manufacturing,

production, management, and other modes. This paper reviews the research status of DT technology and summarizes the definition and theoretical research progress of DT technology. By analyzing the application fields of DT, especially its research on equipment management in the fields of aerospace, ships, vehicles, etc., we found that its application in the field of education is still in its infancy. On this basis, the application of DT in education is further elaborated and analyzed, and we found that its research mainly focuses on three aspects: smart learning space, teaching and training mode, and learner twin, while using DT technology to manage educational equipment studies are still rare. Therefore, this paper takes the VR teaching and research device HTC Vive as an example to briefly describe the component, key technologies, implementation methods to apply DT technology to the field of education in the future, especially to provide certain theoretical and method reference for the whole life cycle management of educational equipment.

All aspects of the physical world, from macro to micro, are believed to gain revolution in the research and application of digital twins, eventually forming a complete DT world in the future. Everything that can be twinned will no longer remain in theory and it will be possible to build a "metaverse" based on the real world and independent of the real world through DT. The transformation and application of DT in the field of education will be more in-depth.

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Exploring the effectiveness and moderators of artificial intelligence in the classroom: A meta-analysis

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Abstract. The application of artificial intelligence in education (AIEd), such as intelligent tutoring systems (ITS) and chatbots, has been used to assist teaching, learning, pedagogical innovations, educational data mining, and learning analytics. To explore the overall effects of AI in the classroom on students' learning achievement, the final analysis included 21 empirical studies (extracting 23 effect sizes) using experimental or quasi-experiments from 2012 to 2021, incorporating 4996 students. As can be seen, AI has a small to medium significant positive overall mean effect size (FEM g = 0.326; REM g = 0.515) of the use of AI with respect to students' learning achievement. In addition, the overall mean effect size was significantly affected by educational stage; and discipline. However, the technology type does not have a significant impact on learning achievement.

Keywords: artificial intelligence · meta-analysis · learning achievement

1 Introduction

AI in education (AIEd) has been used to assist teaching, learning, pedagogical innovations, educational data mining, and learning analytics [1]. With regard to the classroom, OECD highlights how AI can accelerate personalized learning, the support of students with special needs [2]. A meta-analysis, which can systematically combine previous research results [3] and revealed the moderator analysis contributed to exploring the relationships between potential variables and learning achievement [4,5], was carried out to explore the effects of AI in classroom on learning achievement, in comparison with a traditional (i.e., non-AI) classroom. Thus, this study conducted a meta-analysis to answer the following research question:

RQ1: What are the overall effects of AI in classroom on students' learning achievement?

RQ2: Are these effects significantly affected by educational stage, discipline, and technology type?

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2 Method

2.1 Data source and search results

The data sources of this study were from four databases that include high-quality journal articles. Researchers conducted a keyword search combination (see Table.1.). The Boolean operator "AND" was adopted to integrate the three sets of keywords. Researchers selected the articles following the criteria in Table 2. Finally, 21 articles with 4996 participants were included for further analysis, as shown in Fig.1. The same two researchers carefully screened the full texts of 58 articles according to the criteria. This resulted in 84% total agreement, which was high agreement between the coders [6].

Table 1. Search keywords.

Topic	Keywords
AI	AI OR Artificial Intelligence OR machine intelligence OR intelligent support OR intelligent virtual reality OR chat bot OR machine learning OR automated tutor OR personal tutor OR intelligent agent OR expert system OR neural network OR natural language processing OR chatbot OR intelligent system OR intelligent tutor
Subjects	child OR K-12 OR children OR childhood OR student
Effectiveness	satisfaction OR achievement OR effect OR effectiveness OR impact OR outcome

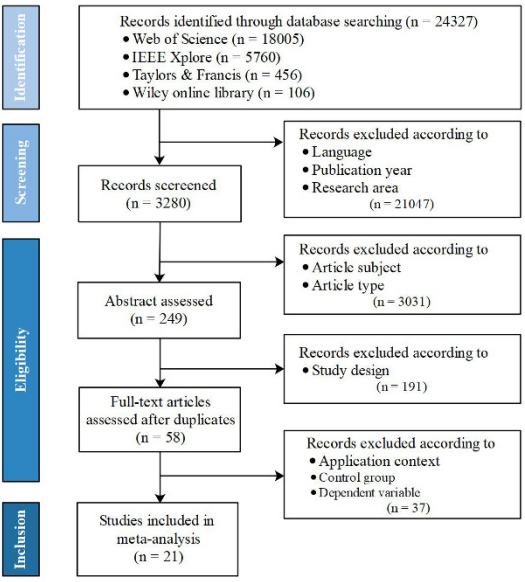

Fig. 1. Review process.

Table 2. Criteria for inclusion and exclusion.

Criteria	Inclusion	Exclusion
Language	English	Except in English
Publication year	2012-2021	Before 2012 or after 2021
Research area	Education	Non-education, i.e., medicine
Article subject	AI	Non-AI, i.e., virtual reality et al.
Article type	Empirical research	Non-empirical studies, i.e., reviews et al.
Study design	Experimental studies or quasi-experimental studies	Other studies, i.e., conceptual studies
Application context	Classroom	Other context, i.e., lab et al.
Control group	A traditional control group	Not making use of a traditional control group, i.e., using AI technology
Dependent variable	Learning outcomes, performance, achievement, or score	Other dependent variables, i.e., satisfaction et al.

2.2 Data analysis

This article uses Comprehensive Meta Analysis V3 (CMA) for data analysis. There are five processes to calculating the effect size [7]. The impact size of each item was first determined. Second, Hedges' g was used to obtain the overall weighted effect size. Third, a random effect model was used to obtain the average effect size's confidence interval. Fourth, the QB value was used to calculate the effects of moderator factors.

3 Results

3.1 Effect sizes of each selected study

Figure 2 shows that 23 effect sizes were used to analyze the learning achievement of students' test scores, representing 4996 participants. In the meta-analysis, the studies using learning achievement apply experimental control group design and can be calculated to obtain the Hedges' *g* effect size. Among these, 9 of the 23 effect sizes (39.13%) showed statistically significant positive effects, indicating that AI to intervene in the classroom significantly increased students' learning achievement as compared to traditional teaching classroom; 14 of the 23 (60.87%) failed to reveal significant effects.

3.2 Overall effect on learning achievement

The results of the analysis of the overall effect size and the heterogeneity test are reported in Table 4. For 23 learning achievement effects, meta-analysis of the fixed -effect model showed a mean effect size of 0.325 (95% confidence interval 0.269-

0.381); the random-effects model showed an mean effect size of 0.510 (95% confidence interval 0.368-0.652) [8]. According to the heterogeneity test, the results indicated that there was heterogeneity $Q_{(23)} = 82.556$ ($p = 0.000<0.05$), $I^2 = 73.178\% > 50\%$, indicating that there was moderate heterogeneity between the literature selected.

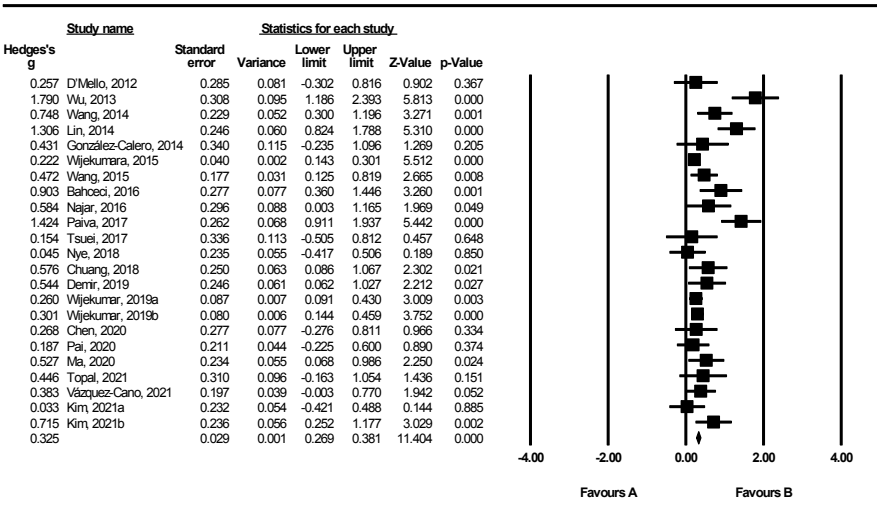

Fig. 2. Forest plot.

Table 5. Meta-analysis of pooled effects values (REM).

				95% CI		Test of homogeneity		
Model	*N*	*k*	Hedges' g	Lower	Upper	Q_T	*df*	I^2
FEM			0.325	0.269	0.381			
REM	499	623	0.510	0.368	0.652	82.021*	22	73.18%

Note. FEM = fixed-effect model; REM= random-effect model; K = total number of effect sizes; CI = confidence interval.

3.3 Moderator Analyses

Educational stage. The results showed a small effect size for elementary school students ($g = 0.255$, $z = 7.72$), a large effect size for high school students ($g = 0.86$, $z = 5.27$), and a medium to large effect size for university students ($g = 0.59$, $z = 8.61$). Disciplines. While ignoring the "others" category (including 1 applying to accounting, 1 applying to social research), math (g = 0.43, z = 3.62) was associated with a small to medium significant effect size, and science (g = 0.80, z = 4.63) was associated with large significant effect size. However, linguistics ($g = 0.26$, $z = 8.42$) and computer ($g = 0.59$, $z = 4.99$) did not show a significant effect size.

Technology type. When ITS was used in classroom, the significant effect size was small to medium (g = 0.32, z = 10.89). By contrast, when chatbot was used in classroom, the effect size also was small to medium (g = 0.37, z = 3.40), but it did not show a significant effect size.

Table 6. Effect sizes by moderator variables on students' learning achievement.

Model variables	k	Hedges' g	z	95%CI	Q_B	Q_W	Contrast
Education stage	23				31.38*	50.64*	2 > 3
1.Elementary school	8	0.25	7.72	0.18-0.31		3.19	
2.High school	3	0.86	5.27	0.54-1.18		12.74*	
3.University	12	0.59	8.61	0.45-0.72		34.73*	
Discipline	23				29.44*	52.58*	4>3
1.Linguistics	9	0.26	8.42	0.20-0.33		12.10	
2.Computer	4	0.59	4.99	0.35-0.80		1.783	
3.Math	5	0.43	3.62	0.20-0.66		19.11*	
4.Science	3	0.80	4.63	0.46-1.14		15.26*	
5.Others	2	0.26	5.40	0.60-1.29		4.323	
Technology type	23				0.16	81.86*	
1.ITS	18	0.32	10.89	0.26-0.38		77.42*	
2.Chatbot	5	0.37	3.40	0.16-0.58		4.44	

4 Discussion and Conclusion

Meta-analysis results showed that AI can effectively improve learning achievement, and the effect value was higher than 0.5, showing a moderately significant effect, which was consistent with the conclusions of previous studies [9]. Due to its intelligent, alternative, interactive and integrated characteristics [10], AI can create interactive learning situations for individuals, and enhance the personalized experience of learning.

AI has a positive effect on the learning achievement of learners in various educational stages. However, it works better for university and high school level students and has only a small effect on primary level students. In the primary school stage, the knowledge learned at the primary school level is mainly declarative knowledge (what is) and AI is not effective in teaching this type of knowledge. Artificial intelligence is having a positive pedagogical effect on all subjects. Although AI is widely used in language subjects and mathematics, our study found small effect sizes, suggesting that AI in future research needs to be further optimized to suit these subject contexts. The application of AI in computer science learning allows learners to explore independently, practice infinitely and achieve good results in communication and interaction with AI products [11]. In

addition, AI also has good application prospects in language disciplines, which can greatly enrich the learning methods of language disciplines, such as the use of chatbots for one-on-one tutoring to learn Chinese vocabulary [12]. According to the statistical results, the different technology types of AI technology have a positive effect on students' learning performance. Meanwhile, the main applied technologies were intelligent tutoring systems and educational robots. However, the impact of ITS was more significant, while the impact of educational bots was smaller, reaching only a small effect. Much of the focus of the research we included was on the use of ITS in education, and the deeper integration of AI technologies with education should also facilitate the promotion of more types of technology integration with teaching and learning in the future.

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Learner Engagement in Online Learning During Covid-19 Period for Future Projections

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Abstract. The effects of the Covid-19 pandemic process, which is spreading rapidly all over the world, on health as well as on social life, and education, with this process, determining the factors affecting the participation of university students in the online learning process is important. In line with this purpose, it was tried to determine the factors affecting the online learning participation of university students. Within the scope of the research, data obtained from 588 university students were analysed statistically. When the findings were examined, it was seen that the most important variable affecting online learning participation in the Covid-19 pandemic period was internet access and speed in the regions where students live. It was observed that as access to the internet and internet speed increased, university students' participation in online learning increased. It was concluded that as the factors restricting access to online learning decreased, students' participation in learning increased. Another important finding of the research is that students' level of feeling comfortable in the environment they are in during the online learning process increases social interaction, integrative behaviour and group interaction during online lessons. In the online learning process, the level of social interaction between students shows that it significantly increases learning participation.

Keywords: Covid-19 · Digital Transformation · Learner Engagement · Online Learning · Social Interaction

1 Introduction

Covid-19 has changed the nature of learning and teaching. Digital transformation and reskilling the generations through intergenerational learning have become apparent. Students and teachers have faced the merits of online education in crisis times. This situation makes researchers internalize online education practices in Covid-19 [2] Because future directions of education will be shaped through Covid 19 parameters for the lives of people, especially in education. In this respect, cultural change in educational institutions in terms of online pedagogy and management become important to be considered as the study of [3] gives insights

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into the bibliometric analysis related to online learning and management. The discussion has arisen on whether Covid-19 is a threat or an opportunity for online education [4].

2 Learner Engagement in Online Learning

Engagement in learning and learning activities is essential to acquiring satisfaction and ongoing learning motivation [6]. [10]. It is seen that online self-efficacy, emotional well-being, computer anxiety, online student engagement, and student perceptions of instructor confidence with transitioning online are parameters of positive outcomes of online learning teaching experiences. The study [10] discusses the importance of social interaction and the effectiveness of online learning. It is stated that social interaction has a positive effect on online learning and instructors and educational institutions need to focus on strategies to enhance social interaction in online learning. The study of [12] revealed that there are strategies for engagement in learning. Student–content engagement strategies, e.g., screen sharing, summaries, and class recordings are stated as the most effective; student-teacher strategies, such as Q and A sessions and reminders; student-student strategies, such as group chat and collaborative work are stated as the least effective.

Significance of the Study. In the Covid-19 crises time, creating engagement in online learning is a highly important focus in online education to enroll students and make continuous active participation in their learning. Studies focus on dimensions of online learning, but they stay partial to examining learner engagement of students and basic reasons for learner engagement and challenges in the online learning process. The literature review sheds light that few studies were conducted on factors affecting learner engagement in online learning during Covid-19. Most of the studies have conducted "learner engagement within the online learning process without detailed reasonings on the factors affecting learner engagement [8] [9]. In this respect, this research study aims to evaluate the factors affecting learner engagement of students during the Covid-19 crisis time in the online learning process for the quality of online pedagogy. Following research questions are considered to be answer

1. How effective are technological opportunities for university students' participation in online education during the Covid 19 period?
2. The level of feeling comfortable in the environment of students participating in online education during the Covid-19 period; How effective is it on social interaction and participation in learning?

3 Methodology

During the Covid-19 pandemic process, the relational screening method, one of the quantitative research methods, was used to determine the learning participation of university students in the online learning process.

3.1 Data Collection

Within the scope of the study, a questionnaire form and the "evaluation tool for online learning and teaching process" developed by [14] were used as data collection tools. The Cronbach's alpha reliability coefficient for the overall scale is 0.91 [14] When the reliability coefficients of the scale are examined, it is seen that the measurement tool is highly reliable. After determining the independent variables, the questions were written by the researchers in the online questionnaire tool google forms to be used in the research. An online questionnaire was prepared by the researchers involved in this study, in 6 different universities in North Cyprus, Turkey 14 different universities in academics and e-mail and WhatsApp sent via mobile communication application. Within the scope of the research, 651 university students were reached through academicians during the two-week data collection period. The data obtained from the questionnaires were analysed and the data of 63 university students who did not complete the questionnaires were extracted. The data of the remaining 588 university students within the scope of the study were included in the analysis process.

3.2 Data Analysis

The collected data were transferred to the Spss 24 program. Skewness values were examined in the homogeneity test. Skewness values above -1 and +1 indicate a skewed distribution [19] It can be interpreted that the scores of the data do not deviate significantly from the normal distribution [19]. Within the scope of the research, structural equation modelling analysis with path analysis was performed via Spss Amos 24 software to measure the direct effect and mediation effect of the variables on learning participation. The Cronbach's alpha reliability coefficient of the data collected within the scope of the study was calculated and the alpha score obtained from the scale used was calculated as .940. One-way analysis of variance ANOVA were used for comparisons between groups.

4 Findings

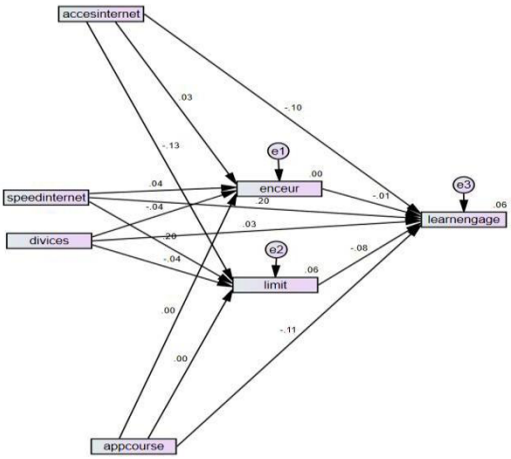

Fig1. The effect of technological opportunities on encouraging and limiting factors and the mediating effect of these factors on participation in learning

Table1. Regression values of path analysis showing the effect of technological opportunities on learning participation.

			Estimate	S.E.	C.R.	P
Encourage	<---	Acces internet	0.033	0.293	0.791	0.429
Encourage	<---	Speed internet	0.041	0.155	0.996	0.319
Encourage	<---	Divices	-0.044	0.096	-1.074	0.283
Encourage	<---	App course	-0.005	0.029	-0.118	0.906
Limit	<---	Acces internet	-0.126	0.29	-3.147	**0.002**
Limit	<---	Speed internet	0.196	0.153	4.899	***
Limit	<---	Divices	-0.037	0.095	-0.928	0.353
Limit	<---	App course	0.005	0.028	0.12	0.904
Learn Engagement	<---	Encourage	-0.007	0.008	-0.179	0.858
Learn Engagement	<---	Limit	-0.081	0.008	-1.96	**0.05**
Learn Engagement	<---	Acces internet	-0.1	0.054	-2.478	**0.013**
Learn Engagement	<---	App course	-0.112	0.005	-2.81	**0.005**
Learn Engagement	<---	Divices	0.025	0.018	0.629	0.529
Learn Engagement	<---	Speed internet	0.201	0.029	4.924	***

Internet access and internet speed have a significant impact on the limiting factors in participating in online education. ($p<0.05$). Limiting factors, internet access, App course and internet speed have a significant impact on online learning engagement ($p<0.05$). Reducing limiting factors significantly increases online learning participation ($p<0.05$).

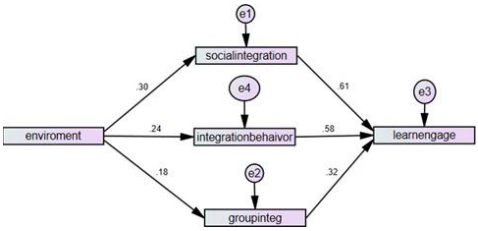

Figure2. The effect of students' environment during online education on social, integrative behaviour and group participation and the effect of these factors on learning participation.

Table2. The level of students feeling comfortable in their environment during online education; The regression values of the pathway analysis showing the mediating effect of social interaction, integrative behaviour, and group interaction behaviours on learning participation.

			Estimate	S.E.	C.R.	P
Social integration	<---	Enviroment	0.299	0.035	7.599	***
Group interaction	<---	Enviroment	0.184	0.032	4.536	***
Integration behaivor	<---	Enviroment	0.245	0.034	6.12	***
Learning engagement	<---	Social integration	0.612	0.007	46.847	***
Learning engagement	<---	Group interaction	0.316	0.008	24.272	***
Learning engagement	<---	Integration behaivor	0.58	0.008	44.463	***

The increase in students' level of feeling comfortable in their environment during online education significantly increases social interaction, integrative behaviour, and group interaction participation ($p < 0.05$). Increasing social interaction, integrative behaviour and group interaction significantly increase participation in online education. Particularly, as social interaction increases, participation in online learning increases at a high rate ($p < 0.05$).

Table3. Differences in learning engagement among students' learning environments

Group	N	$\bar{X}$	*sd*		**Sum ofSquares**	**df**	**Mean Square**	F	p
Not comfortableat all	40	3.1779	.92100	**BetweenGroups**	13.888	3	4.629	13.841	**.000**
Not comfortable	130	3.6122	.60721	**WithinGroups**	195.324	584	.334		
Comfortable	264	3.6520	.51605	**Total**	209.212	587			
Very comfortable	154	3.8268	.54016						

During the Covid-19 process, a significant difference was observed in the learning participation of the students according to their comfort in the environment in which they attended online lessons ($p < 0.05$). The students who said that I am very comfortable in my environment had higher learning participation than the other groups ($p < 0.05$). The students who said that I am not comfortable in the environment I was in while participating in online lessons, had lower learning participation compared to the other groups ($p < 0.05$).

5 Discussions

Covid-19 has raised the understanding and awareness of online learning. Digital transformation has started to speed its implementation during Covid 19, especially in education. In this respect, higher education institutions chose their education models in terms of online platforms and online pedagogy [18]. Therefore, in Covid 19 period, most of the studies focus on the effectiveness of online education [1], [18]. On the other hand, there is an essential consideration to realize the future of online education and pedagogy in terms of affecting factors for learning and the implementation of online education. This research study revealed the affecting factors of learners' engagement in online learning in Covid-19. This research study sheds a light on the most important variable affecting online learning participation was the evaluation of the internet speed in the place where students live during the Covid-19 pandemic. Results showed that s the access to the internet and internet speed increase, university students' participation in learning increases.

6 Conclusion

Covid-19 has changed the structures of education and makes more apparent the use of online education. The future of online education relies on experiences shared in Covid 19 and will be a stance for future policies. In this respect, this research study gives insights into the factors affecting online learning during Covid-19 to reflect the road map for future practices.

In this research study, it is revealed that in the Covid-19 pandemic process, the most effective factors for learning participation were technological opportunities, in other words, the conditions of access to the internet. It has been observed that students' access to technological opportunities and taking advantage of these opportunities is extremely effective in their online learning participation. While there was no difference in learning participation among the limiting factors in the online learning process, it was observed that the decrease in the limiting factors increased participation in online learning.

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Measuring Students' Acceptance of Using Tencent Conference Application in EFL Learning Based on the Technology Acceptance Model

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Abstract. Due to the rapid development and wide spread of Internet technology, modern information technology has become one of the important trends of educational reform and development. The Outline of the National Plan for Medium - and Long-term Education Reform and Development of China (2010-2020) (the Outline for short) points out that "information technology has a revolutionary impact on the development of education and must be attached great importance". Information technology is gradually infiltrating into the field of education and teaching. Using the Technology Acceptance Model as the theoretical framework, this study investigated students' use and acceptance of Tencent Conference in English as foreign language (EFL) learning among more than 180 college students. The purpose of this study was to analyze the correlation between Technology Acceptance Model variables and students' acceptance of Tencent Conference in language learning. This study found that both learners' self-learning attitude and their perception of technology use had a positive impact on their acceptance of technology, and the frequency of personal use did not affect the acceptance. The significance of this study was to examine learners through video meeting feeling of learning English, to adopt appropriate methods in English teaching activities to improve the acceptance of learning, improve the quality of foreign language teaching, online deepens the study of online foreign language teaching, to colleges and universities how to better use the videoconferencing provides a revelation.

Keywords: CMC · Videoconference · Technology Acceptance Model · EFL Learning

1 Introduction

Universities, secondary schools, and primary schools are all faced with new challenges since the outbreak of the COVID-19. Many Chinese colleges and universities have adopted various forms of online teaching to ensure educational continuity. The two most popular methods of simultaneous online teaching are online live streaming and videoconference. However, due to the lack of face-to-face communication, it is difficult to ensure high quality learning efficiency in the

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absence of supervision.[1] Videoconferencing creates a teaching environment that is more interactive in real time and provides more timely feedback.

According to previous research, the application of videoconferencing in college foreign language teaching is insufficient. It is beneficial to study learners' acceptance of new technology in order to improve the quality of English teaching in China's higher education. The Technology Acceptance Model (TAM) is used in this study for interdisciplinary research, providing a new perspective for foreign language teaching research. There are five factors of technology acceptance in this study including Computer Self-Efficacy, Perceived Usefulness, Perceived Ease of Use, Attitude, and Behavioral Intention, the correlation between each other helps to explore learners' acceptance of videoconference. We are going to analyze the reasons and to enrich the research content of online foreign language teaching. It can be used as a reference and inspiration to improve online English teaching, English teaching strategies, and college information-based teaching in the future.

2 Literature review

2.1 Videoconference in higher education

Scholars have compared synchronous teaching and asynchronous teaching in online education. Skylar studied the influence of online asynchronous teaching and online synchronous video teaching on students' performance and satisfaction, and the results showed that students were more satisfied with synchronous "online" and online "face-to-face" teaching modes. Videoconference is an emergent form of synchronous online learning which allows participants to communicate with each other both visually and audially. Clark et al. showed that students had a stronger sense of "teaching presence" and "social presence" in the simultaneous videoconference scenario. According to the above literature, studies on comparative analysis are relatively sufficient, while those focusing only on synchronous teaching are relatively few.[2] Videoconference teaching has changed the teacher-centered teaching mode in traditional teaching and adopted the student-centered teaching mode constructed by the core elements of education. Educators can form a two-way information feedback chain with classroom learners through videoconference system, and timely adjust communication behavior through feedback, to achieve more effective teaching effect.

2.2 Students' acceptance of technology in higher education

Since the 1970s, acceptance is defined as the first decision to use that technology by users who have had little or no experience with it. User acceptance of new technology is a necessary requirement for the successful implementation of a new technology. The study of student acceptance first appeared in 2001. Students' acceptance of online learning directly determines their learning behavior and learning effect. Because computers cut off communication, teachers can't observe students' learning status, students can't cooperate with their peers, which is bound to affect learning satisfaction. Then. since 2014, the research popularity has gradually increased and reached a research climax from 2019 to 2021. Due to the lack of close supervision by teachers, it is generally believed that students' autonomous learning ability and learning motivation will be weakened in the face of online learning, which has also been confirmed by most current studies.[3] Hind and Hassan found that there is a strong positive correlation between actual use of ZOOM and students' attitudes and behavioral intentions, but how the three factors affect each other and students' learning enthusiasm still needs further exploration. Therefore, it is very important to discuss students' acceptance of online learning.

To sum up, there are few studies on the acceptability of the use of videoconference in education. In China, there is scant research on learner's acceptance of videoconference in foreign language teaching, especially in higher education.

3 Theoretical Framework——Technology Acceptance Model

The theoretical framework related to TAM has been widely recognized by the academic world, and the research heat has shown a rapidly rising trend in recent years. In order to explore and explain the factors that lead individuals to accept, reject or continue to use new technologies, Davis proposed and developed the Technology Acceptance Model (TAM) based on the Theory of Reasoned Action (TRA) model.[4] Its original purpose is to provide an explanation of the widely accepted determinants of computers, and to provide a theoretical text that can explain the relationship between attitude, intention, and behavior. The TAM explains that individuals' performance towards a particular behavior is determined by their Behavioral Intention to perform a task. Two specific variables (Perceived Usefulness and Perceived Ease of Use) are assumed to be the fundamental determinants of user acceptance.

The TAM believes that system use is determined by Behavioral Intention, which is jointly determined by user Attitude and Perceived Usefulness, and user Attitude jointly determined by Perceived Usefulness and Perceived Ease of Use. TAM is developed to predict the probability that individuals or organizations will adopt new technologies, it is mainly composed of five internal variables and external

variables. The internal variables include Perceived Ease of Use, Perceived Usefulness, Attitude, Behavior Intention. Finally, external variables, namely personal influence variables, include Computer Self-Efficacy, which is also the most important personal influence variables of users. The following table provides an explanation of these variables:

Table 1. Technology Acceptance Model variables and definitions (Source: The technology acceptance model (Turner et al. 2010))

Variable		Definition
Personal Influence Variables	Computer Self-Efficacy	The belief in one's ability to successfully complete a task using a computer. (Holden and Rada 2011)
Core Variables	Perceived Usefulness (PU)	The belief that technology enhances job performance (Scherer et al. 2019)
	Perceived Ease of Use (PEU)	The belief that effort will not be required. (Scherer et al. 2019)
	Attitude	A personal evaluation regarding the use of the technology. (Lee and Letho 2013)
Outcome Variables	Behavioral Intention (BI)	An individual's intention to use a piece of technology. (2019)

4 Study design

4.1 Hypothesis

This research adopts the Technology Acceptance Model (TAM) to explore the application of foreign language learners use Tencent Conference of the response and feedback, and to explore and explain individual students to accept, reject, or continue to use the technology factors, and improvement for the future network English teaching, to improve English teaching strategy, teaching reform of university informatization provides a certain reference and enlightenment.[5,6,7] The following research hypothesis are proposed:

Hypothesis1.Computer Self-Efficacy has a positive effect on Perceived Ease of Use.

Hypothesis2.Computer Self-Efficacy has a positive effect on Attitude.

Hypothesis3.Computer Self-Efficacy has a positive effect on Behavioral Intention.

Hypothesis4.Perceived Ease of Use has a positive effect on Perceived Usefulness.

Hypothesis5.Perceived Usefulness has a positive effect on Attitude.

Hypothesis6.Attitude has a positive effect on Behavioral Intention.

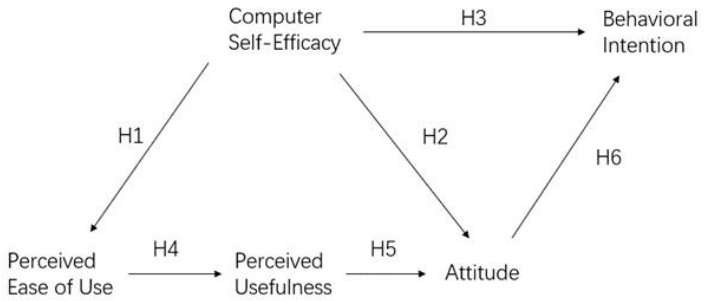

Fig. 1. Research Hypotheses

4.2 Research Participants

One hundred eighty English major undergraduates from a Chinese southern university took part in the study. During the 2020 COVID-19 pandemic, they used Tencent Conference as a platform for English learning. Learners use Tencent Conference once a week to participate in 1.5 hours of an English course, teachers use screen sharing so that all learners can see the courseware, slide, or white board display speech content, and unlock the function of real-time voice so that learners can participate in classroom quizzes and group discussions on time, and use online editing class discussion or chat box. One hundred and eighty students completed a questionnaire expressing their feelings about the use of Tencent Conference in English classes.

4.3 Research methods

The technology research model is used to explore students' use and feedback of Tencent Conference in their English learning. Based on TAM Model (2019) and relevant studies, this study constructed a conceptual framework for the application of Tencent Conference in English learning by taking Computer Self-Efficacy, Perceived Usefulness, Perceived Ease of Use, Attitude, Behavioral Intention as the research objects.

4.4 Research Participants

The tool used in this study is a modification of a questionnaire developed by Yang and Wang (2019), created a new Technology Acceptance Model questionnaire suitable for college foreign language teaching. The questionnaire consists of two main parts, including questions related to the construction items in the research model. In the first part of the questionnaire, respondents recorded their responses on a five-point Likert Scale, indicating how much they agreed on each item. [8]

The Cronbach α coefficient is usually between 0 and 1. If the α coefficient reaches 0.8-0.9, the scale has very good reliability. In this study, SPSS software was used to verify the reliability of the questionnaire by Cronbach Alpha coefficient. The reliability of the questionnaire was 0.845. This indicates that this part of the scale has good reliability and can be used in this study.

Sample size	Cronbach's α
50	0.845

Table 2. Cronbach coefficient of the questionnaire.

5 Research results and discussion

The questionnaire survey results of 180 undergraduates majoring in English in 2018 were collected. The Social Sciences Statistical Software Package (SPSS) version 22.0 was used to analyze the data. Pearson correlation coefficient (R) between Computer Self-Efficacy, Perceived Usefulness, Perceived Ease of Use, Attitude and Behavioral Intention is used. Generally, above 0.7 indicates strong correlation. The correlation between 0.4 and 0.7 is moderate. 0.2~0.4 indicates weak correlation.

To determine the strength of the relationships between the six constructs, a correlation coefficient analysis was performed. Correlation coefficient analysis describes the strength and direction of the linear relationship between two variables, and the degree of correlation indicates the strength of the correlation between them. Plus and minus signs indicate whether there is a positive correlation: as the independent variable increases, the dependent variable also increases; Or negative: as the independent variable increases. Correlation values can be used to determine the influence of independent variables on dependent variables. This criterion is used to understand the strength of the relationship between the five constructs.[9,10]

Hypothesis1. Computer Self-Efficacy has a positive effect on Perceived Ease of Use.

Hypothesis2. Computer Self-Efficacy has a positive effect on Attitude.

Hypothesis3. Computer Self-Efficacy has a positive effect on Behavioral Intention.

Table 3. Correlation between Computer Self-Efficacy and other variables

		Computer Self-Efficacy
Perceived Ease of Use	r	0.625**
	P	0
Attitude	r	0.540**
	P	0
Behavioral Intention	r	0.524**
	P	0

N=180 *p<0.05 **p<0.01

r: correlation coefficient; P: significance value, which describes the probability of something happening; N: Number of samples

As can be seen from the table, Computer Self-Efficacy positively affects Perceived Ease of Use (r>0, P<0.05), Attitude (r>0, P<0.05), Behavioral Intention (r>0, P<0.05). Among those variables, the impact on Perceived Ease of Use is the highest. Behavioral Intention (r>0, P<0.05), which means these three hypotheses are valid, and Computer Self-Efficacy has a positive effect on them. The results of this study show that Computer Self-Efficacy has a high degree of positive correlation with Perceived Ease of Use, Attitude and Behavioral Intention, which improves learning motivation and pleasure.

Hypothesis4. Perceived Ease of Use has a positive effect on Perceived Usefulness.

Table 4. Correlation between Perceived Ease of Use and Perceived Usefulness

		Perceived Usefulness
Perceived Ease of Use	r	0.420**
	P	0

N=180 *p<0.05 **p<0.01

r: correlation coefficient; P: significance value, which describes the probability of something happening; N: Number of samples

The correlation between Perceived Ease of Use and Perceived Usefulness is 0.473 and shows significance at the level of 0.01. This indicates that when learners think the technology is easy to use, they will more subjectively consider the technology useful. It also affects willingness to use to some extent.

Hypothesis5. Perceived Usefulness has a positive effect on Attitude.

Table 5. Correlation between Perceived Usefulness and Attitude

		Attitude
Perceived Usefulness	r	0.420**
	P	0

N=180 *p<0.05 **p<0.01
r: correlation coefficient; P: significance value, which describes the probability of something happening; N: Number of samples

The correlation between Perceived Usefulness and Attitude is 0.497 and shows a significance level of 0.01, indicating that there is a significant positive correlation between Perceived Usefulness and Attitude. Perceived Usefulness directly affects willingness to use. In other words, when the learner thinks the technology is useful, it will greatly promote his positive attitude towards the technology.

Hypothesis6.Attitude has a positive effect on Behavioral Intention.

Table 6. Correlation between Attitude and Behavioral Intention

		Behavioral Intention
Attitude	r	0.716**
	P	0

N=180 *p<0.05 **p<0.01
r: correlation coefficient; P: significance value, which describes the probability of something happening; N: Number of samples

The correlation value between Attitude and Behavioral Intention is 0.716, showing a significance level of 0.01, indicating that there is a very significant positive correlation between Attitude and Behavioral Intention. Therefore, if learners have a positive attitude, they are more likely to continue using Tencent Conference as a learning tool in the future.

6 Conclusion

6.1 Research findings

This study mainly uses questionnaire survey to explore the application of Tencent Conference in English learning based on Technology Acceptance Model (TAM). After all the research, the author came to the following conclusions:

The results of this study show that Computer Self-Efficacy is highly positively correlated with Perceived Ease of Use, Attitude and Behavioral Intention, which can improve learning motivation and pleasure. Learners are trying to adapt to the new environment of online teaching. Through the form of video conference,

learners' learning enthusiasm and authenticity can be improved, learning efficiency can be improved, and learning acceptance can be improved. There was a significant positive correlation between Perceived Usefulness and Perceived Ease of Use. This suggests that when learners think the technology is easy to use, they will view the technology more subjectively as useful. If learners have a positive attitude, they are more likely to continue to use Tencent Conference as a learning tool in the future. From the perspective of the overall relationship mapping, all variables ultimately point to the outcome variable Behavioral Intention. From the data, both Computer Self-Efficacy and core variables have a positive influence on attitude, and Attitude and Behavioral Intention also have an inseparable positive influence relationship, and Computer Self-Efficacy is directly positively correlated with Behavioral Intention. In general, all variables positively affect Behavioral Intention, so learners will continue to use the technology as a learning tool. English teaching in the form of videoconference breaks the traditional concept of physics and time, giving students enough freedom, but at the same time, it may lead to the lack of teachers' monitoring or learning atmosphere, and challenge students' self-discipline. [11,12]

Based on this, the following three implications to teaching practice are put forward:

First, teachers should make proper use of videoconferencing technology to create language learning situation. This study shows that students are very interested in online learning that caters to the trend of The Times, which means that in future teaching activities, teachers can use modern information technology to create language learning situations for students, so as stimulate students' interest in learning. Second, online teaching should give full play to the principal role of students. Try to arouse students' enthusiasm in foreign language learning, let students learn to take the initiative in foreign language learning, and give play to the main role of learners. Third, online English learning different from traditional English learning in the classroom, teachers need to online English teaching, the real -time dynamic focus on students, try your best to enable students to understand teaching contents, keep up with the pace of course. [13,14,15]

6.2 Limitations and Prospects Research methods

There are also some limitations in this study. First, the sample size of this study is small, which may limit the universality of the results. In future studies, appropriately expanding the sample size may improve the accuracy of the model. Second, the participants in this study belong to the same professional and linguistic background. To further verify the research results, students of different majors can be included in the sample, that is, students of science, engineering and arts can be involved. Third, the results of this study are based on the analysis of self-reported data. Observational data can be used in further studies for later verification of results, and defects caused by self-reported data can be avoided as far as possible.

Finally, this study conducted a cross-sectional survey on students' perception of using Tencent Conference, but the perception may change over time. Further research may also consider the overall study of various data sources, which may better capture the use intention.[17,18]

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Perception Model and Intervention Mechanism of Academic Emotions empowered by Artificial Intelligence: A systematic Literature Review

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Abstract. Academic emotion is an important non-intellectual factor affecting learning behavior, learning motivation and academic achievement. In the field of AI-enabled learning, multi-source heterogeneous data such as physiology, psychology and behavior can be used to comprehensively outline the implicit emotional state of learners. This research adopts the meta-analysis method to sort out the expression methods and corresponding indicators of academic emotion and constructed an artificial intelligence perception model including data layer, technology layer, presentation layer and presentation layer. Based on this, according to the Gross emotion regulation process model, this research explored the intervention mechanism of academic emotions at different timings (situation selection, situation modification, attention allocation, cognitive change and response adjustment) and from different levels (the process level, the way level and the tool level) to provide some reference for researchers in related fields.

Keywords: Academic Emotions · Emotion Perception · Intervention Mechanism · Artificial Intelligence

1 Introduction

Academic emotions refer to emotional experiences that are closely related to school learning, classroom teaching and academic achievement [1]. A large number of studies have shown that academic emotions can profoundly affect learners' motivation, academic performance and academic achievement. In the past, the emotional state of learners could only be understood through teacher observation. With the continuous application of artificial intelligence in the education field, more researchers are devoted to track and analysis learner process data and implicit state data, so as to discover potential crises of learners and provide timely intervention.

In the existing academic emotion perception research, researchers mainly focused on identification indicators [2], identification methods [3, 4], analysis methods [5, 6], modal fusion [7] perception models [8, 9], application scene [10] and other aspects to carry out research. In the research on the intervention of

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academic emotions, systematic intervention is the main way. In terms of specific strategies, most of them are cognitive reappraisal and expression suppression.

To sum up, the existing research has provided a rich theoretical basis and practical experience for the perception and intervention of academic emotions. However, there is a lack of a systematic model and indicator system for emotion perception, as well as precise intervention in the generation and development of academic emotions. Therefore, the research question is: in the field of artificial intelligence, how to perceive and intervene in academic emotions?

2 Research Design

This study collects relevant domestic and foreign literature from 2012 to 2022. The search terms are: academic emotion recognition, academic emotion intervention, academic emotion scale.413 literatures were preliminarily retrieved. In order to have a high correlation, the following standards are followed: The learning environment is smart; the research objects are higher education students; speculative and critical literatures are excluded; including both academic emotion recognition methods and scales. According to the criteria, 134 papers remained. The specific process is shown in Figure 1.

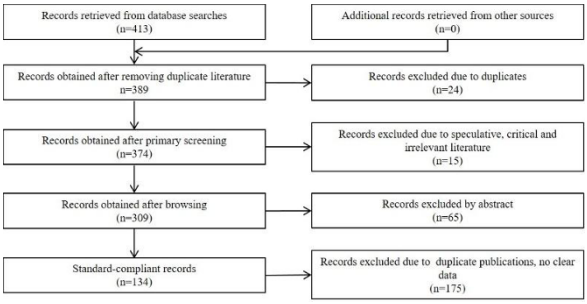

Fig. 1. Literature Screening Flow Chart

3 Perceptual Model of Academic Emotions

3.1 Representation of academic emotions

American scholar D' Mello [11] divided learners' emotions in the learning process into 8 kinds of emotions. Based on this, this study summarizes learners' emotions into eight types: anxiety, boredom, puzzled, fatigue, shame, focus, happy, and depression. Emotions include behavioral expression, subjective experience and

physiological arousal. This study will characterize different emotion types from three aspects: explicit behaviors, subjective experience and physiological signals. Explicit behaviors include facial expressions, body postures, tone of voice, etc. Subjective experience is determined by self-report method through achievement emotion questionnaire. Physiological signals include eye movement, EEG, ECG, EMG, etc.

3.2 Recognition of academic emotions

Each identification index has specific attributes, and selecting appropriate identification techniques and algorithms according to the attributes is the core of emotion identification. According to the learners' facial expressions and body movements, the type of academic emotion can be obtained. The experiment shows that speech recognition accuracy is much lower than facial expressions, and the combination of the two is more accurate [12]. Physiological data need to be obtained by a specific signal collector. D'Mello [13] uses an eye tracker to detect the learner's eye movement pattern, thereby identifying the learner's learning state. The techniques used for physiological signals are more difficult. Emotional experience does not require technical support, and is generally measured through emotional questionnaires.

3.3 Perceptual Models of Academic Emotions

Based on the above, the identification of academic emotions should go through the steps of "data collection - data analysis - data representation - emotional presentation", that is, collect data related to academic emotions through cameras, eye trackers and other equipment. Then, utilize technical means to analyze and process Data signal. Finally, use the representation of different emotions to judge the type of academic emotions. Specifically are as shown in Figure 2.

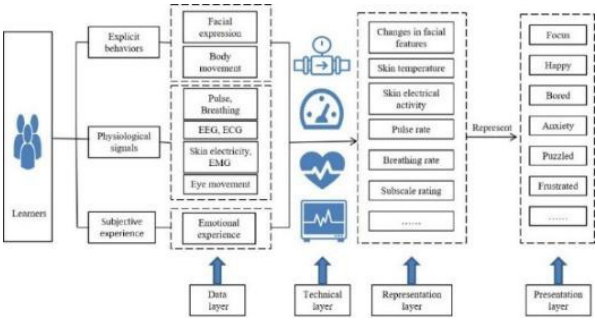

Fig. 2. Perceptual Model of Academic Emotions

Data layer. First of all, in the data collection stage, it is necessary to collect data from three aspects: explicit behaviors, physiological signals, and subjective experience. In explicit behaviors, facial expression is a common indicator for judging emotional state, and can be recorded through the camera. Among physiological signals, some researchers have shown that EEG signals and other signals have complementary roles in emotion classification. Subjective experience main source scale data [14].

Technical layer. The data analysis stage is inseparable from the support of related technologies. The acquisition of explicit behaviors is simple and effective using devices such as cameras and gesture capturers. Physiological signals are difficult to measure accurately, and must be based on EMG acquisition electrodes, eye trackers, heart rate monitors and other instruments. Subjective experience is the least technologically dependent, and existing emotional scales can meet the needs.

Representation layer. The data representation stage is to convert the result of data analysis into a form that can directly correspond to the emotion type according to the representation standard of academic emotion in the previous part. A single signal is inaccurate in identifying emotions. When the body has a strong emotional response, the skin's electrical conductivity increases, but we can't determine the kind of emotion [15]. It is reasonable to combine multiple representations to determine the emotion type.

Presentation layer. Emotion presentation stage directly presents the learners' emotion types on the basis of data representation, which is the final result of academic emotion perception.

4 Intervention Mechanisms of Academic Emotions

Based on Gross emotion regulation process model, this study explored the intervention timing and intervention mechanism of academic emotions according to the typical characteristics of five emotion regulation processes: situation selection, situation modification, attention allocation, cognitive change and response regulation. The specific process is shown in Figure 3.

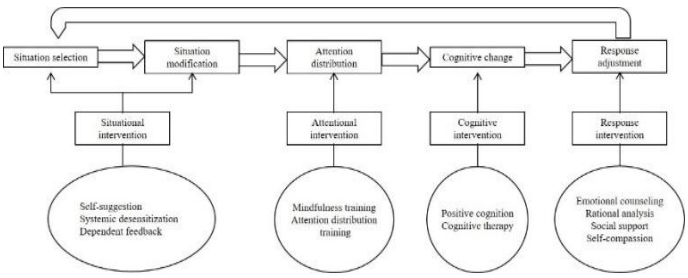

Fig. 3. The Intervention Mechanism of Academic Emotions

Situational Intervention Based on Approach and Avoidance Responses. Situational intervention refers to the intervention of situations that may cause bad academic emotions of learners, which is mainly reflected in the two stages of situational selection and situational modification. Situation selection is the purposeful avoidance or approach to a particular situation or person. Situation modification is to control the situation through one's own efforts and change the situation into a state of adaptation.

Attentional Intervention Based on the Global-local Processing Paradigm. Attentional intervention refers to regulating academic emotions by diverting or changing the learner's attention, which is mainly reflected in the attention distribution stage. The whole-part processing paradigm allows learners to focus more on task-relevant parts rather than other irrelevant information.

Cognitive Intervention Based on Cognitive Behavioral Therapy Paradigm. Cognitive intervention refers to the transformation of learners' cognitive level to achieve the effect of regulating academic emotions. It mainly occurs in the stage of cognitive change, and improves emotional experience by changing the perception of events and emotions themselves. Cognitive-behavioral therapy can change people's automatic thinking and unreasonable beliefs about a thing. Changing the concept is far more important than solving the problem itself. Teachers can modify these cognitive steps or assessments for interventions such as positive cognition and cognitive therapy.

Guidance-based Response Intervention. Response intervention occurs in the last link, which refers to the intervention on the response of the learner, which mainly occurs in the stage of response adjustment, and adjusts the three aspects of physiology, experience and behaviors. At this stage, teachers are required to provide guidance on emotion and behaviors, which is of great significance for the next emotion regulation. Intervention methods include emotional counseling, rational analysis, social support, and self-compassion training.

5 Summary

The perception and measurement of academic emotions is a complex process, which can be carried out from three aspects: explicit behaviors, physiological signals, and subjective experience. This study followed the steps of "data collection -data analysis-data representation-emotion presentation" to build a more systematic perception model, and proposes the intervention mechanism and the intervention strategy model according to the process of emotion regulation. With the advancement of technology and the emergence of various sensors, the measurement methods of academic emotions have increased significantly, but the accuracy and simplicity of operation still need to be improved. Therefore, future research will focus on the multimodal data fusion to achieve accurate identification of academic emotions and use results to intervene in academic emotions.

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Problem-driven Understanding in Augmented Reality: The Effects on Learning Engagement and Writing Achievement

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Abstract. To solve a series of problems arising from the application of augmented reality in writing teaching, this study designed a problem-driven comprehension teaching strategy and used an empirical research method to explore the effects of problem-driven understanding teaching and instructional teaching in an augmented reality environment on elementary school students' learning achievement and learning engagement in Chinese writing, as well as teachers' and students' satisfaction with problem-driven understanding teaching in an augmented reality environment. The study found that problem-driven understanding instruction in augmented reality can alleviate the problem of low student learning engagement caused by the application of augmented reality in teaching to a certain extent; and can promote students' learning achievement in writing, especially in the three dimensions of completeness, correctness.

Keywords: Augmented Reality · Problem-driven Understanding · Writing Learning

1 Introduction

With the popularization and development of education, writing has evolved from a special way of life for a few cultural elites to a new type of socialized and everyday life content and lifestyle. For individuals, writing is a need for survival and development, an intrinsic need for life, a need to master contemporary learning methods, and an important way to improve one's overall quality. For society, writing is a basic requirement for every member of the information society, with the role of inheriting and developing human civilization, promoting social production, and social development. With the development of augmented reality technology, the popularity of mobile devices, and augmented reality educational applications, augmented reality technology has become a hot topic in educational research, and some researchers have tried to introduce augmented reality technology into the writing classroom. Research results show that although augmented reality has great potential to improve writing problems, the integration of technology and teaching has given rise to a series of new problems that create barriers to students' understanding of the writing process. For example,

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inappropriate guidance in teaching leads to malfunction in the use of technology[1], complex task setting leads to increased cognitive load[2], and interesting and rich scenarios lead to distraction[3]. To improve the problems of augmented reality in writing and promote the integration of augmented reality and writing teaching, this study designed an AR experiential learning system and a problem-driven comprehension teaching strategy with the help of AR technology, combined with specific writing topics, and conducted an instructional design and controlled experiments in an attempt to answer the following questions:

- What is the impact of problem-driven understanding instruction on students' engagement in writing compared to instructional teaching in augmented reality?
- What is the effect of problem-driven understanding instruction on students' learning achievement in writing in the augmented reality environment compared with instructional teaching?

2 Literature review

Augmented reality is a new technology that "seamlessly" integrates real-world information and virtual world information, which is a way to apply virtual information to the real world and be perceived by human senses, thus This can achieve a sensory experience beyond reality[4]. In recent years, the popularity of low-cost visual sensors such as cameras has created the basis for AR consumption, the development of environmental perception algorithms such as visual synchronization positioning and mapping has provided key guidance for the integration of virtual information with reality, the progress of optical technology has largely promoted the development of AR displays, and the maturity of multimedia technology has enriched the content and style of augmented reality applications[5]. With the development of augmented reality technology, mobile devices, and the popularity of augmented reality educational applications, augmented reality technology has become a hot topic in educational research. Due to the features of real-time interaction, virtual-reality combination, and 3D presentation, the application of AR in writing teaching can stimulate students' learning motivation[6], enrich students' learning experience[7], improve writing classroom interactivity[8], deeper understanding of learning content[9], and thus improve writing performance. The application of augmented reality in writing can improve the motivation and experience in writing learning to a certain extent. Although augmented reality has great potential to improve writing problems, some studies have shown that there are some challenges in applying augmented reality to writing. One is that the usefulness and ease of use of augmented reality affect the effectiveness of education[10]. Students report that they often encounter technical problems when using AR for learning activities and feel that AR is complicated. If AR applications used in education do not have a user-friendly design interface and

guidance for users, students will encounter great challenges in using AR applications for learning[11]. Second, the complexity of augmented reality tasks can increase the cognitive load of students[12]. Students will acquire a large amount of material and have to complete complex tasks in the process of using AR apps. Third, the fun nature of the augmented reality environment distracts students[13]. In the process of using AR for learning activities, students are attracted by the realistic and interesting scenes of augmented reality and interact and communicate with their peers too much, which is not related to the learning task, making it difficult for them to concentrate on the learning task related to the current topic.

Based on the above-mentioned problems in augmented reality-supported writing learning and related research, this study designs an AR-based experiential writing learning environment to provide students with rich learning scenarios and resources to increase their sense of writing experience; at the same time, it designs a problem-driven comprehension teaching strategy to create a real and interesting and meaningful learning environment for students based on the problem-oriented, body -to-mind immersive learning experience. The problem-driven understanding teaching strategy is designed to create an authentic and meaningful learning environment for students and to develop an immersive learning experience from the body to mind.

3 AR Experience Learning System

Narrative writing is an important style of writing for primary school students in China, which mainly records the experiences of people and the development of things, including time, place, people, cause, process, and result. The AR experiential learning system mainly presents scenes related to the "forest zoo", including animals and plants that are difficult for students to observe up close in their daily lives, including tigers, badger bears, spiders, giraffes, wild boars, squirrels, ginkgo trees, tulips, etc. The system is designed based on the unit writing theme "writing an observation diary" provided by the Ministry of Education's primary language textbook. The scenes include animals and plants that are difficult for students to observe up close in their daily lives, including tigers, badgers and bears, spiders, giraffes, wild boars, squirrels, ginkgo trees, tulips, and a wide variety of other plants and animals. Students can operate their own tablets to observe the scenes, click on their favorite animals and plants and the system will provide explanations about the animals, or they can adjust their views back and forth to observe the appearance of the animals and plants in detail. By observing in the immersive forest scenes, students can not only experience the diversity of forest ecology, but also observe their favorite plants and animals in detail with the narration, which will stimulate students' imagination, desire for expression and

sharing, and provide them with rich materials for the vivid and imaginative narration of the observed objects. The materials used in this study are scenes built into the "AR Forest Zoo" app system, including AR scenes, immersive nature sounds, and audio narration, which provide learning guidance for students to observe and experience. In this way, students can use their tablets to conduct an immersive observation experience in the AR Forest Zoo App. Figure 1 shows the AR system architecture.

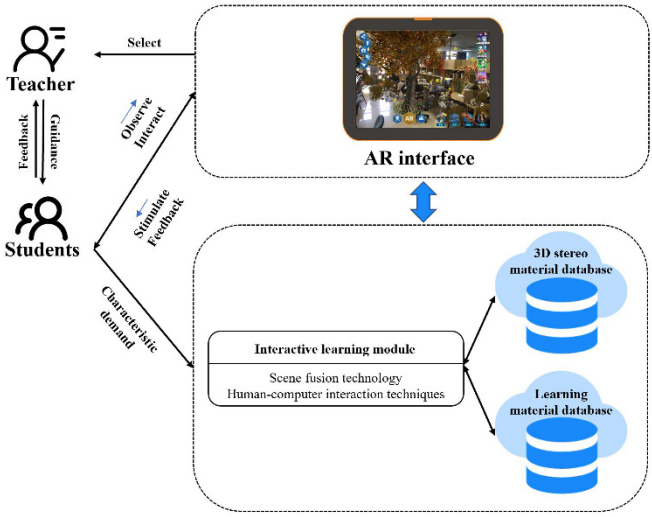

Fig. 1. The structure of the AR experience learning system

4 Research design

4.1 Participants

Eighty students from the fourth grade of an experimental elementary school volunteered to participate in this study. The experimental and control groups were taught by the same teacher, with 40 students in each group. The experimental group carried out problem-driven comprehension instruction with AR technology support, while the control group carried out traditional teacher-centered lecture-based instruction with AR technology support. The teachers who participated in this study had limited knowledge of AR technology and had not used AR to conduct instructional activities, although they were capable of using information technology to conduct instructional activities. Therefore, this research team trained the participating teachers before the experiment began and worked with the participating teachers to determine the teaching process for the experimental group.

After 2 weeks of training and workshops, the teachers involved in the study were proficient in using AR for general teaching activities and problem-driven understanding teaching activities.

4.2 Research procedure

This study used a quasi-experimental design that included a pre-test and post-test control group design. The experiment was conducted over 3 weeks of 3 hours per week during the fall semester of the 2021-2022 academic year. Before conducting this study, the research team introduced the experimental group to the installation and basic use of the AR experiential learning system. The experimental and control groups were administered the Writing Proficiency Test and the Learning Engagement Scale Test before and after the implementation of this study. The maximum time to complete the writing test was mid-45 minutes before and after the test, and the time to complete the learning engagement scale was controlled to be within 5 minutes. The experimental procedure is shown in Figure1.

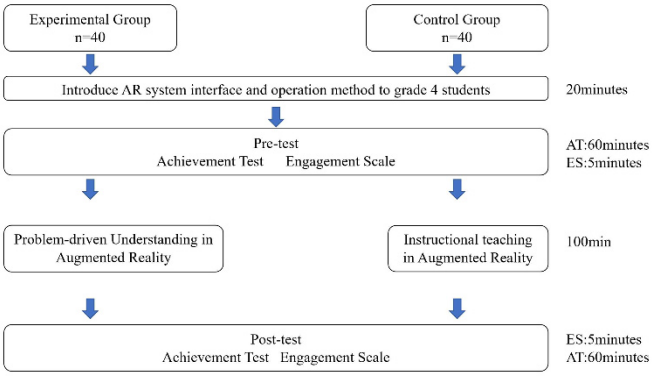

Fig. 2. experimental procedure

4.3 AR-supported teaching and learning process

Before the start of the experiment, students in both the experimental and control groups mastered the use of the AR application, and then the specific procedure of the PBL activity with AR technology was introduced.

Stage 1 "Get students' attention and inform them of the learning objectives": Before the formal class, the teacher described the scene in the "AR Forest Park" app to the students and informed them of the learning task of this composition class, i.e., to choose an animal of their choice in the "AR Forest Park" app. The teacher will tell students the task of this lesson, which is to choose an animal they

like in the "AR Forest Park", observe it carefully through the tablet, and describe the animal they observe with their own pens.

Stage 2: "Prompt students to recall and awaken their prior knowledge": The teacher guides students to recall their previous writing content and writing methods, and invites them to share their own writing experiences. Students recall their writing experiences and recall their knowledge of writing.

Stage 3: "Presenting writing examples to promote students' understanding": The teacher uses "The Cute Turtle" as an example to explain the observation and composition requirements. Through reading, thinking, sharing, and exchanging detailed analysis of the writing case, students accumulate writing materials, master writing methods, and clarify the writing structure, so as to lay a good foundation for the next step of observation and writing transfer application.

Stage 4 "AR immersion observation, deeper investigation into the problem": In this phase, students in the experimental group carried out AR observation activities with the problem as the core, due to the poor self-control of fourth-graders, the observation phase was first 5 minutes for overall observation and then 10 minutes for step-by-step observation around the problem. In the overall observation stage, students were familiar with the scene elements in the "AR Forest Park" and understood the environment of plants and animals in the forest as a whole. In the step-by-step observation stage, the teacher provides students with a problem-solving task sheet, which presents the problems that students need to solve during the AR observation process and helps students record their observations, accumulate writing materials, and form writing ideas. The task sheet is shown in the figure. Question 1 is the guiding question, "If you were asked to make and record an observation of a small animal, which small animal would you choose? Why did you choose it?" The purpose of this question is to help students identify the goal of their observations and lead their thinking. Question 2 is the core question, "How would you like to observe this critter?". Using the core question as to the fulcrum of understanding, we migrate the relevant knowledge explained in the case in the second stage to help students observe the small animal in detail from four dimensions: appearance, movement, observation process, thoughts, and mood. " The purpose of this question is to promote students' deep understanding. After observing the critter in detail, students were guided to review what they had learned about the critter through observation and what they would like to learn about it and were encouraged to write their ideas in the essay and share them with the reader for later written exchange and discussion.

Stage 5: "Solve the problem and write the essay": The task of the students in this stage is to sort through the observations recorded on the task list, review the problem-solving situation, and carry out writing activities.

Through the above five stages, students were able to observe the objects through the AR application in sufficient detail and focus on the writing class without being distracted by the AR software, resulting in low engagement in learning.

5 Research tools

Essay evaluation scale. The composition evaluation scale used in this study was developed on the basis of the composition scale proposed by Cheung, Tse, and Tsang[14], which was revised to form a four-dimensional composition evaluation scale of correctness, completeness, expressiveness, and creativity, and teachers evaluated students' compositions from these four dimensions, and the score of each dimension The proportion of each dimension is 40%, 30%, 20%, and 10%, respectively, out of 100 points. The four dimensions assess whether the students' writing meets the required writing requirements, whether they can use accurate and vivid language to express the content and ideas, whether they conform to the structure of narrative writing, and whether the format is suitable for the writing requirements.

Learning Engagement Scale. The Learning Engagement Scale was developed by researchers to determine the level of engagement of elementary school students in the writing classroom. First, a comprehensive literature review of engagement augmented reality engagement, and engagement scales related to writing learning was conducted. According to the purpose of this study, the Augmented Reality Engagement in Writing Learning Scale, which contains 14 items in three dimensions: behavioral engagement, cognitive engagement, and affective engagement, was formed by adjusting the scale developed by Lee and Lai[15], with an acceptable Cronbach's alpha of 0.864, indicating that the scale is acceptable and emphasizes internal consistency.

6 Data Analysis

- **RQ1: What is the impact of problem-driven understanding instruction on student engagement in writing learning compared to instructional teaching in an augmented reality environment?**

In this study, the independent samples t-test was used to compare the pretest learning engagement levels of the two groups of students, and the results are shown in Table 1. There was no significant difference between the pre-test learning engagement levels of the two groups ($t=-0.569$, $p=0.571>0.05$), which indicates that there was no significant difference in the original learning engagement levels of the students in the experimental and control groups. Then, paired-samples t-tests were used to analyze the post-pre-test learning engagement levels of students in both groups, and the results are shown in Table 2. The mean post-test scores of learning engagement of students in both groups were lower than the mean scores of the pre-test, which indicates that the application of augmented reality technology in

the classroom reduces students' learning engagement. There is no significant difference between the experimental group and the control group, which shows that the problem-driven understanding teaching in augmented reality helps to improve the problem of students' engagement decline in classroom teaching supported by augmented reality technology, because the process of students' understanding of knowledge is a process of deepening their thinking around problems. Under the guidance of problems, students can concentrate on the understanding of knowledge.

Table 1. Independent sample t test of pre-test of students' learning engagement in control group and experimental group.

Group	N	M	SD	F	df	t	p
Experimental group(EG)	40	58.48	8.199	0.020	78	-0.395	0.694
Control group(CG)	40	59.23	8.772				

Table 2. T-test results of post-test paired samples of experimental group and control group.

variable	Group	M		SD		t
		Post-test	Pre-test	Post-test	Pre-test	
Learning	EG	55.13	58.48	9.832	8.199	-1.603
Engagement	CG	54.05	59.23	11.207	8.772	-2.188*
Behavioral	EG	15.40	16.18	2.942	2.707	-1.189
Engagement	CG	15.08	16.40	3.369	2.985	-1.900
Emotional	EG	20.25	21.63	4.271	3.208	-1.599
Engagement	CG	19.80	21.75	4.375	3.484	-2.038*
Cognitive	EG	19.48	20.68	3.679	3.230	-1.443
Engagement	CG	19.18	21.08	4.460	3.482	-2.101*

- **RQ2: What is the impact of problem-driven understanding instruction on student learning achievement in writing compared to instructional teaching in an augmented reality environment?**

Independent samples t-test was used to analyze the writing scores of the students in the experimental and control groups, and the results are shown in Table 3. Overall the students in the experimental and control groups had significant overall performance in composition ($F=0.209$, $p=0.000<0.001$), completeness ($F=0.346$, $p=0.000<0.001$), correctness ($F=0.508$, $p=0.000<0.001$) and expressiveness ($F=0.410$, $p=0.003<0.05$) and the experimental group outperformed the control group. However, there was no significant difference between the two groups on the dimension of innovativeness ($F=0.976$, $p=0.111>0.05$). This shows that the problem-driven understanding teaching in augmented reality environment can significantly promote the completeness, correctness and expressiveness of students'

writing, but it is not obvious in promoting innovation. The clear learning objectives, structured question chains and rich writing materials in the problem-driven understanding teaching in augmented reality environment can improve the completeness, correctness and expressiveness of students' writing. The reason why the effect of writing innovation is not remarkable may be due to a single writing paradigm and a less inspiring AR scene.

Table 3. Independent Sample T Test of Students' Writing Achievements in Two Teaching.

variable	Group	N	M	SD	F	df	t	p
Total score	EG	40	90.65	3.30	0.209	78	3.751	0.000***
	CG	40	88.12	2.70				
integrity	EG	40	90.81	3.60	0.346	78	3.675	0.000***
	CG	40	87.81	3.73				
correctness	EG	40	90.94	3.33	0.508	78	3.918	0.000***
	CG	40	88.40	2.39				
Expressiveness	EG	40	90.51	3.58	0.410	78	3.125	0.003**
	CG	40	88.15	3.17				
novelty	EG	40	89.36	2.95	0.976	78	1.611	0.111
	CG	40	88.20	3.48				

7 Conclusion

In this study, a quasi-experimental study was designed to improve the problem of students' comprehension barriers caused by the application of augmented reality in writing instruction, with problem-driven comprehension instruction in an augmented reality environment as the experimental group and lecture-based instruction in an augmented reality environment as the control group, to explore the effectiveness of problem-driven comprehension instruction in an augmented reality environment in promoting students' learning engagement and writing learning achievement. The results of the study found that problem-driven comprehension instruction in an augmented reality environment can alleviate the problem of low student learning engagement caused by the application of augmented reality technology in teaching to a certain extent; and can promote students' writing learning achievement, especially in the three dimensions of completeness, correctness, and expressiveness; and both teachers and students have higher satisfaction with comprehension instruction in augmented reality environment. However, due to the variability of the study sample, the limitations of the AR learning context, and the complexity of instruction, the application of problem-driven comprehension instruction in the augmented reality environment, in reality, needs to be flexible and adaptable. Frontline teachers can draw on the experience of

this study and apply the comprehension teaching model in an augmented reality environment to writing instruction by combining the actual teaching environment and resources to solve the difficulties in writing instruction.

In the future, the use of multimodal perception technology, cognitive network analysis, and intelligent human-computer interaction for the analysis of students' writing learning effectiveness in an augmented reality environment will help further reveal the internal mechanism of students' writing learning effectiveness enhancement.

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Research on Ethical Issues of Artificial Intelligence in Education

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Abstract. The application of artificial intelligence technology in the field of education is becoming more and more extensive, and the ethical issues that come with it are common. The development of responsible and trustworthy artificial intelligence has become a global consensus, but if we want to explore the philosophical problems behind technology, we must have a systematic understanding of the epistemological aspects of technology. Therefore, by analyzing the research results of scholars, this paper wants to try to clarify the problems that are not yet clear. So, this paper wants to (1) define the concept of the ethics of artificial intelligence in education; (2) clarify the ethical issues of artificial intelligence in education include: the ethics of people, the ethics of technology itself, and the ethics of education; (3) put the ethics of artificial intelligence in education into the category of Technical Application Ethics of Social Education (TAESE); and (4) obey the principles of people-oriented, accountability, ethical constraints, transparency, fairness and justice during constructing standards that how to apply AI ethically in the field of education. Artificial intelligence can better empower each other with education, to realize "education for artificial intelligence, not artificial intelligence for education".
Keywords: Artificial Intelligenc・Education・Ethics・Avoidance

1 Introduction

In 1956, experts at the Dartmouth Conference of the Ivy League in the United States identified the term of Artificial Intelligence (AI), and artificial intelligence began to be popular in various fields. The application of artificial intelligence in the field of education has also prospered.

There is no doubt that the application of artificial intelligence in the field of education surely has produced positive effects, for example: Topal et al. [1] took 41 fifth-grade students as the research object, and through experimental control, found that not only students think chatbots are interesting and useful, but also the application of chatbots has a positive impact on students' learning experience. Artificial intelligence became more effective at personalizing for differences in students' self-regulated learning – their ability to make good choices during

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learning that enhance their learning outcomes and efficiency.[2] Besides, intelligent tutoring systems have been able to identify a student who is bored, frustrated, or gaming the system (trying to find strategies to complete materials without needing to learn) and reengage them productively.[3]

While there is good reason for optimism about the technological dimension of AI in education, care must be taken that the introduction of AI into the classroom is not driven by the technology as much as by genuine human need [4]. Due to the strong data integration and analysis capabilities of artificial intelligence [5], some data privacy and security ethical issues have become increasingly clear. WEF [6] pointed out that ethical issues in artificial intelligence and educational applications include: inequality, artificial stupidity, security etc. As a result, there is a kind of concern in society that robots will replace people or where people will go etc. Although there are some critical voices, technology should not be understood and criticized blindly. "Around the world, almost no research has been conducted, no guidelines have been provided, no policies have been developed, and no regulations have been put in place to address the specific ethical issues raised by the use of AI in education," Holmes said [7]. Therefore, it is necessary to regulate the application of artificial intelligence in education. This paper wants to make a more comprehensive understanding to the ethics of artificial intelligence in education from the epistemological level. Because only after a deeper understanding of the epistemological level of technology can the social critique of technology have space to exist.[8]

In summary, the application of artificial intelligence in the field of education is two-sided. In order to make artificial intelligence play a better role in education, it is important to avoid the existing ethical risk problems. Only after the ethical issues are avoided can artificial intelligence technology better serve education and empower education. However, when looking through the relevant literature, the author found that the research on the ethical issues of artificial intelligence education is not very mature at present, for example, there is no unified conclusion on the concept of artificial intelligence education ethics; there is still no unity in following the principles; and there is no unified generalization in the category to which it belongs.

In order to clarify the ethical issues of artificial intelligence in education, it is necessary to clarify its conceptual definition, category, principles, classification and other issues. Therefore, the research questions in this paper have the following four points:

(1)What is the concept definition of the ethics of artificial intelligence in education?

(2)What is the category of the ethics of artificial intelligence in education?

(3)What are the kinds of the ethics of artificial intelligence in education?

(4)What principles should be followed in constructing the ethical norms of artificial intelligence in education?

2 The definition of ethical of artificial intelligence in education

In China, the word ethics first appeared in the Book of Rites and Music: "Those who are all heard are also born in the hearts of the people; those who are musicians, those who understand ethics are also". Ethics is the principle of human ethics and morality, which refers to "various moral codes of conduct for people to get along with each other". [9] In the West, The Cambridge Dictionary of Philosophy points out that the term "Ethics," broadly referred to as "morality," is often used narrowly to represent the moral principles of a certain tradition, group, or individual. It can be seen that both China and the West have given the meaning of moral codes to groups or individuals for ethics. Ethics can be defined as the moral principles

governing the behaviors or actions of an individual or a group of individuals [10]. Educational ethics has emerged since the birth of education, and in today's situation where digital technology is sweeping the world, the ethical issues of education brought by technology have attracted more and more attention. Educational ethics refers to the code of ethical conduct that groups or individuals should follow in educational activities.

Scholars have many views and forms of expression on the concept of ethics of artificial intelligence in education. For example, Selin Akgun et al. [11] pointed out that the ethics problems of artificial intelligence in education include privacy, surveillance, autonomy, bias, and discrimination. Keng Siau et.al [12] pointed out that the ethics of AI specifies the moral obligations and duties of an AI and its creators, the ethics of AI include robot ethics and machine ethics. Jason Borenstein et al. [13] believe that the ethical issues of artificial intelligence education refer to privacy erosion and trust in Ai technology.

From the relevant results, it can be seen that scholars are starting from the concept of "ethics", deeply analyzing the connotation of "ethics", and then analyzing the concept of "education ethics", because the concept of "artificial intelligence" has formed a unified consensus in the academic community, so the combination of "AI + education ethics" can clarify the connotation of artificial intelligence education ethics.

On the basis of synthesizing the above concepts, this paper summarizes the proper meaning and keywords of the ethical concept of artificial intelligence in education, namely: people, technology, education, application, guidelines, ethics, etc. Therefore, this paper believes that the ethics of artificial intelligence in education refers to a series of moral codes and codes of conduct that should be followed between groups and individuals and technology when artificial intelligence is applied to the field of education.

3 The division to the category of the ethics of artificial intelligence in education

Although AI ethics is now recognized as a full-fledged branch of applied ethics along with bioethics, animal ethics, or environmental ethics - and its body of work is in the process of consolidation, there is still no consensus on the essential components that an adequate and comprehensive training in AI ethics should include [14]. Li Xiaoyan et al. [15] pointed out that the ethics of artificial intelligence in education application should belong to the research category of educational ethics, because its research process is based on the perspective of people, to regulate people's behavior in the process of applying artificial intelligence, rather than focusing on the behavior of artificial intelligence itself. Li Ziyun [16] believes that in addition to the category of general social ethics, the ethics of artificial intelligence in education also belongs to the category of technical ethics, and its construction process can refer to the paradigm of scientific and technological ethics.

On the whole, the ethics categories of AI in education include three categories: social ethics, technology ethics and educational ethics. This paper believes the ethics of artificial intelligence in education should be the sum of all these, which could be named Technical Ethics of Social Education (TESE)

Besides, ethics is a separate discipline that includes three smaller disciplines [17]:

(1)Metaethics: mainly studies the meaning of ethical concepts, the existence of ethical entities (ontology) and the possibility of ethical knowledge (epistemology).

(2)Normative ethics: involves the actual means of determining a morally (or ethically correct) course of action.

(3)Applied ethics: involves what a moral subject (defined as a person who is able to judge right and wrong and be held accountable) is obligated or allowed to do in a particular situation or in a particular area of action.

(4)According to this division, this paper believes that the ethics of artificial intelligence education belongs to the subfield of applied ethics, and its main concern is some ethical issues that arise in the application of artificial intelligence in the field of education.

In summary, this paper believes that the ethics of artificial intelligence in education belongs to the category of Technical Application Ethics of Social Education (TAESE)

4 Types of the ethics of artificial intelligence in education

Research types on the ethics of artificial intelligence in education can help to have a clearer understanding of the ethics of artificial intelligence in education. At present, scholars divide the types of AI ethics in education according to different classification standards. Zhang LiGuo et al. [18] divide artificial intelligence

education ethics into strong artificial intelligence education ethics and weak artificial intelligence education ethics according to the ethical problems caused by the application of artificial intelligence technology in education, and also point out in their articles that the educational ethics problems of humanoids (where humanoids refer to both individuals and groups) mainly include data ethics and algorithmic ethics. Deng Guoming et al. [19] divided the ethical issues faced by artificial intelligence in education into stakeholder ethics, technology ethics and social ethics. Sun Tian Linzi [20] pointed out that most of the ethical irregularities about the application of artificial intelligence in education are concentrated on technical problems, subject problems and education problems. Selin Akgun et al. [21] point out the potential ethical and social risks associated with the application of AI in education as privacy, surveillance, autonomy, prejudice, and discrimination.

It can be seen that the types of the ethics of artificial intelligence in education are actually the relationship between "subject - artificial intelligence technology - education", technology as an "intermediary variable", if it is biased towards either side of the subject or education, it will produce related ethical problems. So based on this, the paper divides the ethical issues of artificial intelligence in education into three parts:

(1)The ethical issues on people. Including teachers, students, education administrators and stakeholders. Not only these subjects' roles are reversed and unclear, but also the problem of "who is the master" about the status of man and machine is uncertain and ambiguous.

(2)The ethical issues on technology itself. Including algorithmic ethics, data ethics and the extended issues by algorithmic ethics and data ethics.

(3)The ethics issues on education. Including educational equity caused by disequilibrium educational resources, whether educational evaluation will be "data-only", whether educational value orientation will be shifted, and so on.

So, the process of applying artificial intelligence in the field of education should pay attention to the fact that education is for artificial intelligence, not artificial intelligence for education. [22] No matter which field artificial intelligence technology is applied, it should be kept in mind that it is only a means and a way, only to better enable the whole society and the whole world to achieve intelligent processes through the collaboration of human and machine.

5 Principles for the construction of ethical norms in artificial intelligence education

Looking through the literature and relevant reports at home and abroad, it can be found that there are many studies on the ethical principles of artificial intelligence. For example, the *Ethical Recommendations on Artificial Intelligence* [23] issued by UNESCO in Paris, France, clarifies the 10 principles and 10 policy action areas that

regulate artificial intelligence technology. *The IEEE Code of Ethics for AI Design* [24], released by the IEEE, states that the design of AI should follow five principles, namely: human rights, well-being, accountability, transparency, and prudence. *The Draft Ethical Guidelines for Trusted AI* [25] issued by the European Union point out that AI should meet seven principles in the future, including guaranteeing full human autonomy, technological stability and security, data security and privacy, transparency and interpretability of models and algorithms, fairness and non-discrimination, sustainability and accountability of natural ecology and social well-being.

In addition to the relevant reports and policy documents, many literatures have put forward their own views. Dawson et al. [26] pointed out that the ethics of artificial intelligent in education include, generates net-benefits, regulatory and legal compliance, fairness, contestability, do no harm, privacy protection, transparency and explain ability, accountability. Hagendorff [27] highlights that the requirements for accountability, privacy, and fairness can be found in 80% of the 22 guidelines he analyzed. Kimon Kieslich et al. [28] concluded that the ethical principles include explainability, fairness, security, accountability, accuracy, privacy, and machine autonomy.

This paper believes that when artificial intelligence is applied to the field of education, the most important thing to grasp is people, focusing on using artificial intelligence to teach, rather than teaching artificial intelligence. As Holmes et al. [29] point out, the ethics of AI in education applications needs to clarify four issues, which are the purpose of learning (for example, to prepare students for exams or help them achieve self-actualization); the choice of pedagogy (adopting a common approach, i.e., educationalism, which is questioned by the learning science community); the role of technology on teachers (to replace or enhance human functioning), and the opportunity for accepting education (often viewed by communities through the ethical dimension of fairness and equality). The application of emerging technologies in the field of education is for better serving education and promote the realization of educational equity and lifelong learning. So, when building an ethical system for artificial intelligence in education, it should be fully considered what role artificial intelligence should play in the field of education, what limits should have, and what principles should be followed. Only in this way can technology and education better empower each other.

Based on the formulation of ethical principles by the above scholars, by analyzing key elements, this paper concludes that the principles that should be followed in the construction of the ethical normative system of artificial intelligence in education are:

(1)People-oriented. The application of artificial intelligence technology in the field of education is ultimately to better cultivate people, and it can be seen from the ethical problems of people that the construction of the normative system should put this principle at the core and priority position.

(2)Accountability. In the process of building a normative system, a strict accountability system should be established so that "behavior" can be followed and regulated.

(3)Moral constraints. In addition to a clear accountability system, the normative system should also have moral constraints, so as to gradually make it a norm that is conventional and people are willing to obey.

(4)Transparency. The normative system should state that all resources related to data and algorithms should be transparent. On the basis of transparency, data privacy protection can be increased.

(5)Fairness and justice. Artificial intelligence is applied in the field of education in order to achieve educational equity. So, in the formulating of ethical norms should achieve social fairness and justice through educational equity.

6 Conclusion

The incorporation of AI applications in educational institutions is likely to bring with it benefits, but also significant risks [30]. This paper aims to have a clearer understanding of the epistemological aspects of the ethics of artificial intelligence in education. There is fully promise for using artificial intelligence to solve some of the major challenges, which is faced by education today, revolute teaching practices and ultimately achieve the progress of Sustainable Development Goals.

The concept of people-oriented will always be the main theme of the development of the times. So, in the applying process of artificial intelligence in education, it should be kept in mind that technology should be use to serve people. The application of artificial intelligence in the field of education will undoubtedly become the trend of future education, although it will be accompanied by many ethical issues.

From a certain point of view, the problem of ethical risk is indeed insoluble, so in the future, countries and regions need to formulate corresponding ethical norms to avoid this problem and promote the high-quality development of artificial intelligence in the field of education.

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Research on the impact of virtual reality environment on primary school students' classroom interaction behavior from the perspective of double-cycle theory

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Abstract. There are lack of problems in traditional writing teaching for real context experience and perception, and the virtual reality (VR) to support students support students' participation in enthusiasm and writing literacy. Therefore, the article has passed the use of quasi-experimental research, incorporates the double-cycle teaching concept, and randomly distributes 97 primary school students as experimental groups and control groups, in VR, PPT learning environment, and uses the lag sequence analysis method. Differences in the Interactive Effect of Classroom Teachers and Students in Different Learning Environments. The research results show that the VR-based writing learning environment can promote students' class interaction; the integration of dual cycle teaching concept has promoted VR in writing classroom applications, making teaching models and teaching technologies.

Keywords: VR · Double Cycle Teaching · Writing Learning · Lag Sequence Analysis

1 Introduction

With the development of artificial intelligence technology, some researchers find that immersion interactive technology such as virtual reality can effectively solve the problem of writing learning, such as writing [1]. It is possible to create a cultivation of the active and writing literacy of the students to support students [2]; virtual reality technology can also promote literary creation through the generation and replication of human experience [3] [4]. Most of these researches are rarely mentioned from the perspective of technical perspectives, and the combination of teaching methods and virtual reality technology is rarely mentioned.

Therefore, based on the problems and related studies in the above teaching, this study provides students with contextual resources, show visual clues, constructing visualization clues by designing a virtual reality environment in the perspective of dual cyclic theory, showing visualization clues, building a space, and enhancing its writing The sense of experience in learning. In-depth discussion on the following issues: Degree, promote teachers and students interaction; Under the support of

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virtual reality, the double cycle teaching model can enhance the interaction between teachers and students.

2 Theory

2.1 Writing Learning Based on Spherical Video Virtual Reality Technology

Virtual reality is a comprehensive information technology that fused digital image technology, multimedia technology, and computer simulation technology, one of integrated information technology, which can construct an immersive three-dimensional simulation environment of human-computer interaction and multi-perceptible characteristics. The environment can stimulate learners 'writing interest by mobilizing learners' sensory sex (such as visual, auditory, etc.) experience [5]. This technique is the extension and expansion of information technology, with a low cost, convenient, immersion, interactivity, and conception. There are more researchers to find virtual reality technology to effectively improve students' writing learning performance, such as Huang et al. To high school language writing, found that the technology can stimulate the innovation of student writing content and self-efficacy [6]. And the experience in VR supports helps to promote students' emotional participation and reading accumulation to write capacity and realize the improvement of writing learning effects [7]. Virtual reality technology can effectively enhance the interactive experience of students and learning environments, emphasizing the active construction of students' ability to participate in and knowledge, can change the shortcomings of traditional division of writing, enhance students' learning, deepen students' cognition Ability [2].

2.2 Double Cycle Teaching

Double cyclic teaching stems from cognitive feedback, can stimulate students to reflect on the process and results of the problem, with a view to more accurate, psychological model is more perfect [8]. Its focus is not to find out and correct errors, but to cultivate learners to learn to reflect, notice invalid behavior, and try to handle the same learning tasks after reviewing related materials and adjust learning strategies, including learners basic strategies , Psychological models, attitudes, and related guidelines, double cycle teaching can be effectively realized. Some researchers have found that dual cycle teaching can effectively improve students' ability to master knowledge, such as Jennifer Greenwood, believe that in dual cycling learning middle school students can reflect on learning objectives and

norms, and link the knowledge of classroom learning with the knowledge structure Improve [9].

This study proposed a two-cycle teaching model. As shown in Figure 1, the model is based on the "double-ring learning" theory proposed by Algies (1991), and the learning model based on context-based computer games proposed by Huang (2016) is carried out. Improvement [10]. "Single cycle teaching" means students who have repeatedly try to handle the same problem or the same task, not to find a better way or learn more about learning methods, and "Double Cycling Teaching" emphasizes students through reflection through the process. Use additional learning phases to get more knowledge or find better solutions, and teachers can help students find better solutions to solve problems, lectures, explain new knowledge or present new skills.

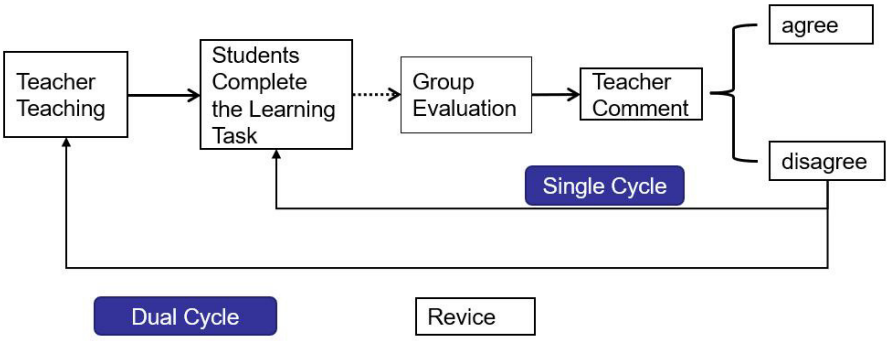

Fig. 1. Dual cycle teaching model

3 Research Design

In response to the previous research issues, this study chose primary school language composition classroom as a research situation, and chooses the study tasks of Hong Kong-Zhuhai-Macao Bridge as a virtual experiment. The experimental group completed the learning task in the spherical video virtual reality experiment, and the control group completed the learning task in an aspherical video virtual reality experiment, and the two groups used two cycle teaching modes for teaching. The experiment aimed at the effect of measuring the effect of spherical video virtual reality experiments on the interaction of the classroom in the elementary school essay class.

3.1 Research object

The research object of this experiment selected 97 students in a primary school as a subject, participated in the study course research, and randomly assigned to the experimental group and control group. Students in the experiment group student under the VR writing study environment, while the control group student learned in the PPT writing study environment.

3.2 Coding

The coding table used by this study is a W-ITIAS coding table that is re-prepared after the ITIAS classroom observation meter, and the classroom number record, and the classroom teaching video data sample is coming from the class of five grades in a primary school. Elementary School Writing Class "Port - Macao Bridge" as an analytical sample. According to the needs of the research, the number of the number of codes is reset, the encoding content is increased, "thinking" and "doing exercises" in the original coding classification "Thinking" and "doing practice" are divided into students, "helpless teaching" Confusion "is divided into other behaviors, and the rest is not modified. Finally, the teacher's behavior is 6, and the student behavior is 6, the technology uses 3 types, and the quiet behavior is 3.

TABLE.1. W-ITIAS

Classification		Coding	Contents
Teacher's behaviors	Teacher reply	T1	Forward feedback
		T2	Negative feedback
	Teacher initiat	T3	Closed questions
		T4	Open question
	Teacher present	T5	Teaching
		T6	Instruction
Technology		TT	Teacher operates technology
		ST	Students operate technology
		TS	Technical role in students
Students's behaviors	Students reply	S1	Take the initiative to answer
		S2	Passive answer
	Students initiat	S3	Take the initiative to question
		S4	Passive question
	Students present	S5	Positive evaluation
		S6	Negative comment
Quiet		01	Silence or confusion
		02	Thinking question
		03	Student practice

3.3 Procedure

In order to verify the research issues proposed in the previous article, the experimental process for this study is divided into three phases: the first stage, the writing test, selecting two classes equivalent to the writing level as experimental group and control group; second At the stage, the research team and primary and secondary school teachers jointly explore the layout of VR learning scenarios, design and improve the teaching plan and the interactive coding scale of teachers and students in the classroom; the third stage, first let the experimental groups are familiar with the VR-based learning environment interface and basic How to use, and interview with the writing learning of the experimental group and the control group student. The first-line teachers then studied two groups of students with the "Hong Kong-Zhuhai-Macao Bridge" and recorded the classroom video. Recycling and organizing related materials, randomly interviewing the experimental group student after the course, and further analyzing the data.

4 Analysis

Learning behavior analysis is rich in connotation, including behavioral frequency analysis, behavioral sequence analysis, behavioral relationship analysis, and its potential influencing factors. Among them, teachers and students 'interactive behavioral frequency analysis is the most simples, and it is possible to reflect different environmental learners' learning behavior differences. Based on the initial analysis of behavioral generation of behavioral differences, the basis for learning behavior sequences is made to analyze the behavior sequence analysis. Therefore, before the analysis of the teacher-student interaction behavior, the behavior conversion frequency table made by GSEQ software is used.

TABLE II. EXPERIMENTAL GROUP BEHAVIOR CONVERSION FREQUENCY TABLE

Given:	T1	T2	T3	T4	T5	T6	S1	S2	S3	S4	S5	S6	TT	ST	TS	O1	O2	O3	Totals
T1	47	0	4	9	5	7	14	0	1	0	4	0	1	0	0	0	0	0	92
T2	0	0	0	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	5
T3	0	0	8	0	0	1	9	0	0	0	0	0	0	0	0	1	1	0	20
T4	1	1	0	19	0	0	21	1	0	0	1	2	0	0	0	6	0	0	52
T5	1	0	3	6	156	3	1	1	0	1	0	0	0	1	0	0	0	0	173
T6	1	0	0	2	2	51	2	3	0	2	1	0	0	3	0	5	0	2	74
S1	29	3	5	9	2	0	155	0	0	0	0	0	3	0	0	1	0	0	207
S2	0	1	0	1	2	0	0	26	0	0	0	0	1	0	0	0	0	0	31
S3	2	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	5
S4	1	0	0	0	0	4	0	0	0	192	0	0	0	0	0	0	0	0	197
S5	8	0	0	0	0	0	0	0	0	0	53	0	0	0	0	0	0	0	61
S6	1	0	0	1	0	0	0	0	0	0	0	7	0	0	0	0	0	0	9
TT	0	0	0	2	2	0	0	0	0	0	0	0	1	0	0	1	0	0	6

ST	0	0	0	0	0	4	0	0	0	0	0	0	0	373	0	0	0	0	377
TS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O1	0	0	0	0	3	4	2	0	1	2	2	0	0	0	0	12	0	0	26
O2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
O3	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	88	90
Totals	92	5	20	52	172	75	207	31	5	197	61	9	6	377	0	26	1	90	1426

TABLE IV. EXPERIMENTAL GROUP BEHAVIOR CONVERSION FREQUENCY TABLE

Given:	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**TT**	**ST**	**TS**	**O1**	**O2**	**O3**	**Totals**
T1	38	0	4	14	7	3	2	2	0	1	0	0	3	0	0	0	0	0	74
T2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T3	0	0	2	1	0	0	9	4	0	0	0	0	0	0	1	1	0	0	18
T4	3	0	0	29	1	0	31	2	1	0	1	2	0	0	0	7	2	2	81
T5	1	0	2	10	112	3	0	1	0	0	0	0	1	0	0	2	0	1	133
T6	0	0	0	1	2	7	1	6	0	2	1	0	1	0	0	0	1	2	24
S1	21	0	5	16	4	2	134	0	2	0	0	0	1	0	0	0	0	0	185
S2	3	0	2	4	6	1	0	47	0	0	1	0	0	0	0	0	0	0	64
S3	1	0	0	0	0	0	2	0	3	0	0	0	0	0	0	0	0	0	6
S4	0	0	0	1	0	2	0	0	0	197	0	0	0	0	0	0	0	0	200
S5	3	0	0	0	0	1	0	1	0	0	13	0	0	0	0	0	0	0	18
S6	1	0	0	1	0	0	0	0	0	0	0	6	0	0	0	0	0	0	8
TT	2	0	2	1	0	0	0	0	0	0	0	0	4	0	1	0	0	0	10
ST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TS	0	0	0	1	0	0	0	0	0	0	0	0	0	0	266	0	0	0	267
O1	0	0	0	2	1	0	5	1	0	0	2	0	0	0	0	9	0	0	20
O2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	5
O3	1	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	252	258
Totals	74	0	18	81	133	23	185	64	6	200	18	8	10	0	268	20	5	258	1371

From the perspective of overall statistics, teachers and students in the two teaching environments are similar, and teachers are feedback (T1), teachers' open question (T4), students actively answer (S1), companion discussion (S4), etc. The frequency of behavior is significantly higher than other behaviors, and teachers negative feedback (T2), students take the initiative (S3), students negative evaluation (S6), teacher operation technology (TT), student thinking (O2) and other behavior frequently Low. In the primary and secondary school, the teacher's

feedback is relatively poor in the classroom, and the students 'classroom activity is relatively high, whether or not the VR glasses are used, the students' classroom is relatively high.Highlighting the teacher's question, student question, teacher feedback, student feedback and other behavior. Under the guidance of dual cyclic teaching, teachers have relatively small intervention, students' initiative is enhanced, and the learning task is used in the learning process, and the learning goals are more clearer.

From a macro perspective, VR technical support writing classroom teachers and students have basically higher than the Writing classroom without VR, obviously, the writing class of VR technical support is higher, and the students are more active. More active and positive. Learning motivation is a "lead" triggering learning behavior, and VR technology supports the writing classroom middle school students' learning motivation levels. From a microscopic perspective, VR technical support in writing classrooms for their peer-to-end feedback and the behavioral frequency of thinking problems are significantly lower than those of traditional learning class. It can be seen that in the traditional classroom, since there is no equipment interference, students think the problem is longer, more fully, and more prone to amendments to the writing of companions. VR Technical Supported Writing Class Middle School Students 'Behavior Data Behavior This is much higher than the Writing Classroom without VR, and the behavior data of teachers' operational technology is much higher than the Writing classroom supported by VR technical support. This is the experiment group Related. In addition, the tradition of learning (O3) in traditional writing class is far higher than the writing class of VR technology support, and students have more opportunities for students. If they leave themselves, they have more thinking, they can think more. Reflections on your learning effect.

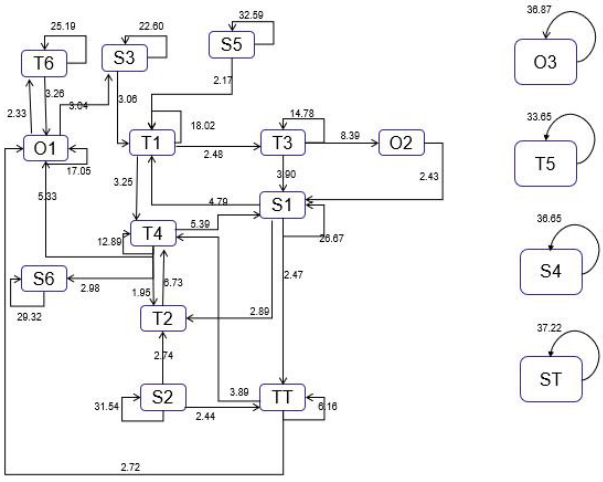

Fig. 2. Experimental Group Behavior Sequence Conversion Diagram

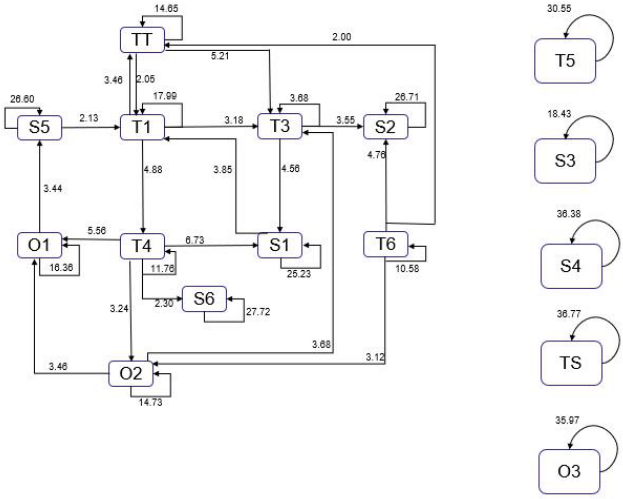

Fig. 3. Control Group Behavior Sequence Conversion Diagram

5 Discussion

In the primary school writing class of VR, the interaction of VR supported by the two cycle teaching philosophy. There are a variety of forms and functions. By studying the interaction of teachers and students in the classroom supported by VR technology from the perspective of behavioral sequences, research reflects teachers and students Interactive behavioral sequence, including teachers 'teachings and demonstrations, students' discussion and exercises, question and answer interactions between teachers and students, and many types of interactions such as technical support, and can also reflect the structure of teachers and students, help understand Teacher - student interaction.

(1) Through research and analysis, VR technology can effectively improve the interaction of teachers and students, promote students 'feedback, effectively improve the classroom input of students' writing learning. This study compared to the analysis of classroom interactions and teachers and students in different writing environments. The results show that in the VR learning environment, the behavioral sequence Z value of the experimental group students is significantly higher than the behavioral sequence Z value of the control group student, especially Students are more prominent about the actions of companions' writing results, whether they are free discussions with companions, exchange view behavior (S5) or the amendments to the companion writing (S6) have a certain increase (Experimental Group z value respectively For 32.59 and 29.32, the corresponding Z values of the control group are 26.60 and 27.72 respectively), and it is obvious

that students are more likely to trigger students' feedback on their peers in a dynamic virtual environment, and improve the investment in classroom learning.

(2) With the support of VR, the dual cyclic teaching model can effectively improve the interaction between teachers and students. Through the experimental group and control group video analysis, it can be found that from the perspective of a significant behavior, the teacher puts forward open problems, give students appropriate thinking After the time, students can not only answer questions, but also through inspiration and guidance, students can further think about it, take the initiative to make problems, free to express their own opinions and insights, which is conducive to the cultivation of students' thinking ability. The behavioral sequence that student actively questioned triggered, and teachers can recognize students' active questions and give feedback in time. Therefore, the double cycle teaching model can play a positive role in the classroom, promote the interaction of teachers and students, to achieve regulatory function, fully reflect the technical and teaching mode for teaching services.

In summary, this study integrates VR technology and dual cycle teaching mode into writing learning education, hoping to promote writing learning from two aspects of technology and education model, building "immersive" learning scenarios, create and virtual Scene is more suitable for education methods, VR technology can get a more wide innovative application in the field of education, especially writing teaching, fully empower new curriculum resources, teaching paradigms, teaching relationships, organizational morphology, etc. Educational system elements, etc. Promote the overall changes in class writing teaching under the intelligent era.

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Research on Knowledge Graph Construction for Python Programming Language

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Abstract. As the core and foundation of artificial intelligence, knowledge graph provides new power to smart education. With the popularization and low age of learning programming languages, building knowledge graphs for them is especially crucial for learning this programming language. Therefore, the paper takes Python programming language as an example, designs the schema layer and data layer of this knowledge graph, and constructs the knowledge graph of Python programming language through five steps: ontology construction, data analysis, entity extraction, relationship extraction, and knowledge storage. Finally, the application of this knowledge graph is explained, which helps learners understand the global knowledge, detect the knowledge level and recommend learning paths, effectively build a cognitive framework and promote personalized learning.

Keywords: Knowledge Graph · Python Programming Language · Graph Construction

1 Introduction

With the in-depth application of technologies such as big data, machine learning and artificial intelligence in the field of education, building knowledge graphs has become an important research topic in the development of intelligent education. The knowledge graph is a large-scale semantic network, that is a knowledge base with a directed graph structure, which is a semantic representation of the objective world and aims to describe various entities or concepts that exist in the real world [1]. The application of knowledge graph in education forms the concept of educational knowledge graph, which can effectively form the knowledge system of various disciplines and improve learners' cognitive level. Meanwhile, with the increasing popularity of programming languages, their knowledge graphs are especially important for learning programming languages. In view of this, the paper constructs a Python programming language knowledge graphs and illustrates the application of this knowledge graph, which has some inspiring implications for promoting personalization, intelligence and informatization in education.

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2 Literature Review

The existing research on educational knowledge graph mainly includes three aspects, such as model construction, creation techniques and innovative applications. In terms of model creation, the educational knowledge graph model is divided into the knowledge graph layer, the problem graph layer and the ability graph layer, aiming at students' thinking development [2]. In terms of construction technology, it is mainly divided into composition technology and support technology. The current methods of constructing knowledge ontology in education field are: manual method, automatic method and semi-automatic method; the supporting technologies of knowledge graph are: knowledge extraction technology, semantic linking technology and visualization technology, etc. The knowledge graphs are mainly constructed automatically through syntactic analyzer and latent semantic analysis method [3], and multi-modal knowledge graphs containing knowledge entities and their hierarchical relationships are constructed based on courses [4]. In terms of its innovative applications, educational knowledge graphs can be applied to different educational scenarios, such as knowledge base construction, adaptive learning, virtual learning assistants, etc.

3 Knowledge Graph Design for Python Programming Language

3.1 Pattern Layer Design

The paper uses the Python programming language as a specific knowledge content, including basic theoretical knowledge and practical knowledge. Based on this, the Python programming language ontology design is carried out. First, ontology knowledge and categories are identified, important concepts are listed and knowledge structures are established, then concept hierarchies are established and properties and relationships of classes are defined, and finally ontology instantiation is performed [5].

3.2 Data Layer Design

In the data layer, the paper uses the Neo4j to save the knowledge graph into the graph database for structured presentation. The design of the graph database mainly includes (1) transforming classes in the ontology into Label in the graph database; (2) transforming relational properties of classes into edges of the graph; (3)

transforming entities into Nodes of the graph, each node has its own Property, which is connected to other nodes by inheriting the properties of classes; (4) transforming entity properties into node properties. As shown in Figure 1.

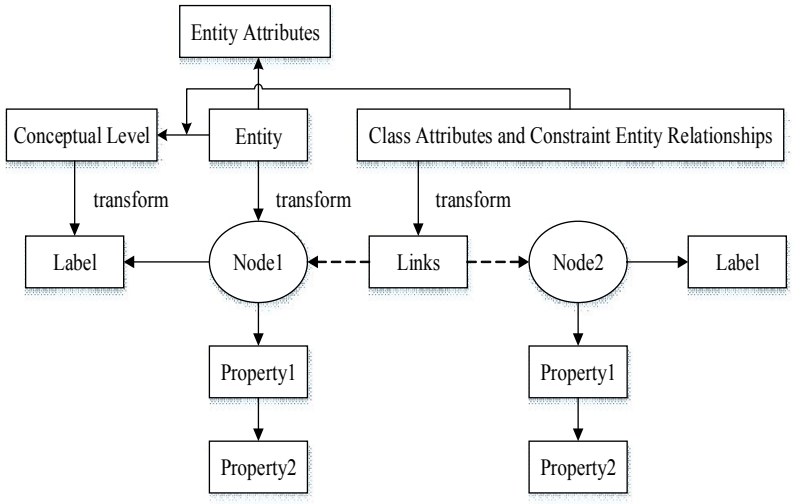

Fig. 1. O ntology and Graph Database Conversion

4 Python Programming Language Knowledge Graph Construction

4.1 Python Programming Language Ontology Construction

The paper is based on Python programming language and determines the ontology content from top down, mainly including environment building, basic programming and application development. The environment building part is to enable learners to learn to configure the environment; in basic programming, master the basic syntax, statements, operators and expressions of the language; basic applications refer to database, website construction, artificial intelligence and so on. After establishing the conceptual hierarchy of the Python programming language, the ontology building tool Protégé is used to set it up. The results are shown in Figure 2.

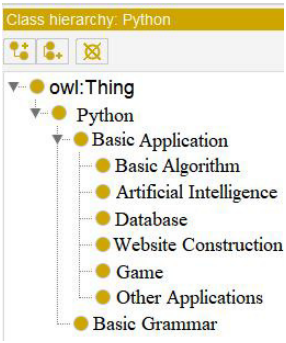

Fig. 2. Python Ontology Class Hierarchy

By analyzing the knowledge of Python programming language, three class relations are created: "isPartof", "isParallelof" and "relates_to". Among them, "isPartof" indicates the inclusion relationship between classes, "isParallelof" indicates the sibling relationship (parallel relationship) between classes, and "relates_to" indicates that classes are related. Figure 3 shows the semantic relations defined in Protégé.

Fig. 3. Semantic Relationships of Classes

After creating the semantic relationship of the class, set the relationship attribute and the data attribute of the class. Set the Domain attribute for "isPartof", which means which class the attribute belongs to, and set the Ranges attribute to constrain the scope of the object's attributes; then define two data attributes, title (describing the title of the knowledge point) and content (indicating the specific knowledge content), and define the Ranges constraint for them as well, mainly of types "int", "short", "long", "string" and other types. Since the title and content of Python programming language knowledge are text, the Ranges constraint is set to "string" type. Therefore, the ontology model is constructed as shown in Figure 4 (the solid blue line indicates the "isPartof" relationship, the dashed orange line indicates the "isParallelof" relationship, and the dashed yellow line indicates the "relates_to" relationship).

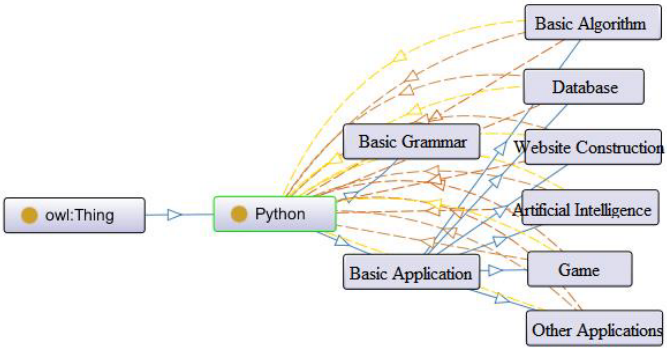

Fig. 4. Python Programming Language Ontology Model

4.2 Data Acquisition and Data Processing

The paper mainly obtain data from web pages such as electronic textbooks, Wikipedia, and CNKI. These are mainly divided into encyclopedia pages and general pages. Encyclopedia pages contain a lot of structured data that can be extracted using page templates. While general web pages such as e-textbook sites and tutorial sites contain a lot of redundant, erroneous and incomplete information, which needs to be manually evaluated for the mined information. After getting the Python programming language data, cleaning, filling, and deleting are performed. Using tools such as SPSS and EXCEL, the redundant data are manually filled in using methods such as mean, minimum, maximum or probability estimation according to the context; the erroneous data are identified by deviation analysis; and the duplicate data are combined by judging whether the attribute values of the data are equal. After processing, the extracted data meet the data requirements of the Python programming language knowledge graph.

4.3 Python Programming Language Terminology Extraction

The paper is based on the extraction method of the encyclopedia site or vertical site, mainly by sequence annotation of a sentence, extracting the subsistence features, prefix and suffix features, and word itself features. First, to determine the quantity of Python programming language terms, by consulting teaching materials, syllabus, lesson plans and other teaching contents, manually determine whether the keyword is the knowledge content that needs to be learned, that is, whether the keyword is the table of contents, chapter, syllabus title or common knowledge point of the textbook, etc. If so, the keyword is selected. Second, determine the quality of Python programming language terms, which is divided into two parts, the first part

is to determine the quality of individual keywords, and the second part is to compare the quality between keywords. The first part is mainly to determine the validity of the keywords by comparing the teaching contents of the programming language textbook, syllabus and lesson plan, that is to check whether the keywords are in line with the programming language knowledge; in the second part, also based on the teaching contents mentioned above, by determining whether the keywords are core key knowledge (with many connections to other knowledge points), antecedent knowledge (you have to learn the knowledge point before you can learn the next knowledge), associated knowledge (knowledge that can be learned together), etc., to determine the relationship and degree of influence between the keywords. In this process, the teaching experts need to negotiate the extraction specification and evaluation method to achieve more than 90% consistency, and finally determine the Python programming language terms. Finally, the extracted terms are classified in Excel for subsequent construction of the knowledge graph.

4.4 Python Programming Language Semantic Relations Determination

Based on lexical features, syntactic features and semantic features, a rule-based relationship extraction method was used. Through the construction of the Python programming language ontology, four semantic relations for the Python programming language, namely "contain (containment relation)", "isFirst (antecedent relation)", "isNext (successor relation)", and " isParallelof (sibling/parallel relationship)".

4.5 Knowledge Storage Based on Neo4j

The paper uses py2neo to implement knowledge storage, and its partial visualization in the graph database Neo4j is shown in Figure 5

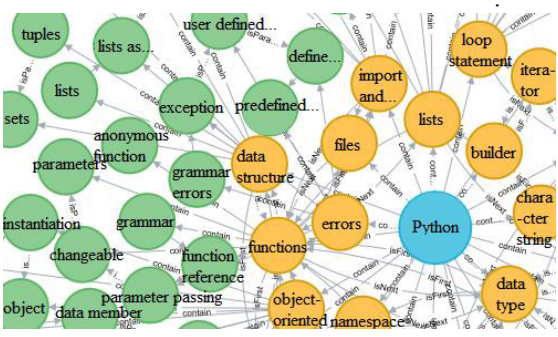

Fig. 5. Partial Display of the Python Language Knowledge Graph

5 Application of Knowledge Graph for Python Programming Language

5.1 Understanding the Overall Knowledge of the Python Programming Language Knowledge

Through the application of knowledge graph of Python programming language, learners can effectively understand the overall knowledge of the Python programming language, which is of great help to the whole learning process. At the early stage of learning, learners have a general understanding of the Python programming language, including which aspects of knowledge they need to understand and master, and the order of knowledge learning, etc. In the middle stage of learning, it helps learners understand their own learning situation, target the learning of primary and secondary knowledge, and improve their learning efficiency. In the later stage of learning, the knowledge graph allows learners to summarize and review the content of the knowledge and learn from it.

5.2 Test Learners' Knowledge Level

Because the Python programming language knowledge graph is built in a top-down manner, each knowledge point can be queried layer by layer. Learners and teachers can test each knowledge point one by one, starting from chapter knowledge, to section knowledge, and then to subsection knowledge, so as to know each learner's existing knowledge level and learning progress, and record the testing process to form learning status report data, which can provide a reliable basis for subsequent learning, check the gaps, and formulate reasonable learning strategies.

5.3 Recommend Learning Paths for Learners

Based on the learners' personality characteristics (including knowledge level, cognitive ability, learning style and interests), based on the Python programming language knowledge graph, a personalized learning recommendation system can be designed and developed to recommend the most optimized learning path for each learner for the knowledge point, and also recommend the learning resources corresponding to the knowledge point for the learner, and then recommend the learning resource path. On this basis, the learning activities of learners can also be arranged and combined, thus forming a sequence of learning activities and

recommending learning steps and strategies to learners to realize personalized learning. In addition, future research can build on the foundation of the paper and consider the comprehensive adoption of automated methods to construct multidimensional and multi-level knowledge maps to achieve the integration of knowledge concepts, cognitive schemas, and learning resources to further achieve accuracy and comprehensiveness.

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Research on PBL-based Maker Teaching Mode Supported by AI Algorithm Platform——Take the teaching of "Face Recognition Access Control System" as an example

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Abstract. This study takes the classroom teaching of the "Face Recognition Access Control System" carried out by the Artificial Intelligence Education Base in Linping District as an example. Through the real situation, supported by the AI algorithm platform, in the program design process of "clarification of problems - analysis of problems - design scheme - communication and demonstration - scheme optimization" and in the production experience of "model design - material collection - model construction - function realization - sharing and communication", PBL-based artificial intelligence maker teaching activities are carried out to help students actively explore the knowledge of face recognition technology from real situations, build the concept of face recognition technology, and gradually cultivate students' Engineering thinking, Creative thinking, Collaborative ability and Complex problem-solving ability, and promote the development of students' artificial intelligence literacy. The research summary proposes a PBL-based maker teaching model supported by the AI algorithm platform, in order to provide reference and reference for front-line teachers to carry out similar research.

Keywords: AI Algorithm Platform · Project-based Learning · Artificial Intelligence Maker Teaching Activities · Teaching Mode

1 Introduction

The future is a world full of unknowns, with too many uncertainties and challenges. In the face of future uncertainty, it is necessary to cultivate talents with problem-solving ability and innovative quality. Maker education is one of the important ways to cultivate innovative talents with innovative awareness, innovative thinking and innovative ability [1]. It combines elements from the philosophy of experiential education (learning from doing), project-based learning (task-focused), innovative education (aiming to develop students' innovative qualities), and DIY (Do It Yourself) [2]. Domestically, the term "maker" can be traced back to Premier Li

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Keqiang's speech during his inspection of the Shenzhen Firewood Space. Since its development, the "maker education" derived from it has been widely practiced in primary and secondary schools. However, with the continuous progress of society and the development of new technologies, human beings have entered the era of intelligence, and social development has put forward higher requirements for the needs of talents. New technologies have begun to "force" the transformation of education, and artificial intelligence education has become a compulsory course for the "digital indigenous" generation [3]. At present, artificial intelligence education for primary and secondary schools is currently in its infancy and exploration at home and abroad [4]. Therefore, this study provides a preliminary exploration of how to carry out PBL-based AI maker teaching practices with the support of AI algorithm platforms. By building an AI algorithm platform to support the PBL-based maker teaching model, we aim to improve the comprehensive quality of students and promote the development of students' artificial intelligence literacy, so as to cope with the uncertainty of the future.

2 The PBL-based Maker Teaching Mode Supported by AI Algorithm Platform

The factors affecting teaching mainly include teaching objectives, teaching environment, teachers, students, teaching resources, teaching activities, teaching evaluation and other aspects [5]. This study believes that the teaching model consists of six elements, including the guiding ideology, teaching objectives, teachers and students, realization conditions, teaching process and teaching evaluation. Based on constructivist learning theory and pragmatic learning theory, and with the "AI algorithm platform" as the main supporting environment, this study constructs a PBL-based maker teaching model supported by the AI algorithm platform (Fig. 1).

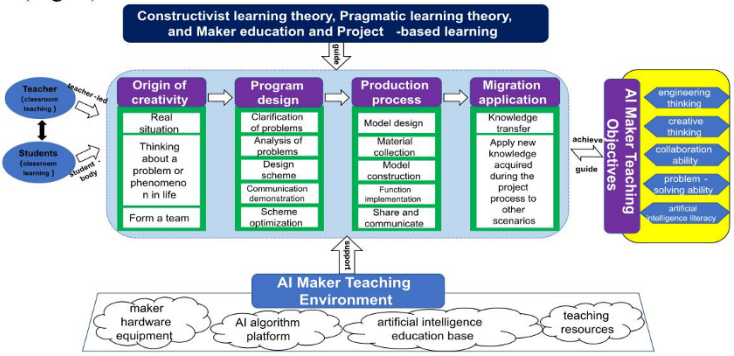

Fig.1. The PBL-based maker teaching model supported by the AI algorithm platform

As can be seen from Figure 1, the guiding ideology of this model is mainly constructivist learning theory, pragmatic learning theory, and maker education and project-based learning related theories. The teaching objectives are mainly around the cultivation of students' artificial intelligence literacy, which is embodied in students' engineering thinking, creative thinking, collaboration ability and problem-solving ability. The implementation conditions of teaching and the teaching environment of artificial intelligence makers mainly include maker hardware equipment, AI algorithm platform, artificial intelligence education base and corresponding teaching resources. The teaching process is mainly based on the origin of creativity, using real situations, going through the program design process of "clear problem - analysis of problems - design scheme - communication demonstration - scheme optimization", "model design - material collection - model construction - function realization - sharing and communication" and the transfer and application of knowledge. The evaluation of teaching effectiveness is mainly to measure and evaluate the teaching practice of teachers using this teaching mode to carry out artificial intelligence maker courses, and the changes shown by students in terms of engineering thinking, creative thinking, collaboration ability and problem-solving ability.

2.1 AI algorithm platform

The AI algorithm platform (Genius Brain) in this study is a platform for learning artificial intelligence [6], on this platform some implementation of artificial intelligence algorithms can be carried out. For example, face recognition, human body key point detection, gesture recognition, emotion detection, text classification, etc. Its functions mainly include: AI algorithm interface call, AI algorithm experimental testing and AI algorithm principle learning, as shown in Fig. 2. The platform provides functions such as function fitting, face detection and recognition, human body key point detection, sentiment analysis, image analysis, etc., and also provides online tools for students and teachers to train their own classifiers and regression analysis models, providing a training ground for teachers and students to practice artificial intelligence education.

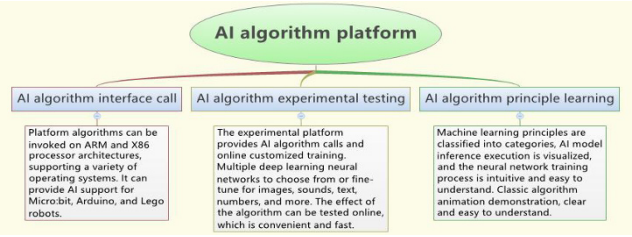

Fig. 2. Main functional modules of the AI algorithm platform

2.2 Project-based teaching process

The origin of the idea. The origin of creativity is generally a certain idea that has never been formed in the brain of human beings through deep thinking about a certain phenomenon or a certain problem encountered in life. In this part, it is necessary to provide real situations.

Program design. *Clarify the problem.* To clarify the problem, that is, to determine the process of problem, the learner needs to analyze the situation, extract the phenomenon or problem encountered in life, and ask a clear question.

Analyze the problem. Analyzing the problem, that is, in order to split the problem raised, the learner needs to contact his own knowledge system, split the problem, and finally achieve the purpose of breaking through his own efforts or teamwork.

Design scheme. Design scheme, that is, the process of generating strategies, learners through independent learning, collaborative learning to build new knowledge, in the process of building new knowledge to analyze a large number of relevant information and materials, generate strategies, put forward hypotheses, the formation of paper preliminary design schemes.

Communication and argumentation. Communicating arguments, that is, the process of discussing the feasibility of the plan, learners share their ideas with others, solicit the opinions of others, and determine whether the design plan is feasible.

Program optimization. Program optimization, that is, in order to adjust the optimization plan for smooth implementation, the learners according to the suggestions of others (teachers, professionals, elders), once again improve their own design plan, forming a final executable plan.

Production process. *Model design.* Model design, that is, for learners to use tools (computer graphics software) to design creative intelligent product models, including specific product structure, appearance renderings.

Material collection. Material collection, that is, to obtain relevant materials, to provide material support for the model to form a "shape", to ensure that the program can be smoothly implemented.

Model construction. Model building, that is, the process of "forming" the model, the learner needs to transform the designed model into a visible and tangible thing, and needs to assemble each part of the model.

Function implementation. Functional realization, that is, the process of turning the initial idea into reality, the learner needs to connect the model with the relevant hardware, and then through programming implementation, project debugging and modification, and finally realize their own creativity, output creative intelligent works.

Share and communicate. Sharing and communication, that is, in the process of displaying the results, learners share their experiences in the process of creative and

intelligent manufacturing, and introduce their creative and intelligent works to the outside world.

Migration application. Migration application, that is, the transfer and application of knowledge, learners apply the new knowledge learned in the process of creative and intelligent manufacturing to other scenarios. Knowledge transfer is not only a means of testing the understanding of knowledge, but also an important way to deepen the understanding and consolidation of knowledge; it is both a guide to practice and at the same time to be tested by practice.

3 An example of maker teaching based on PBL supported by AI algorithm platform - "Face Recognition Access Control System"

3.1 Interpretation of teaching content

"Face Recognition Access Control System" is the content of the smart home module in the series of "smart" courses developed by the Artificial Intelligence Education Base in Linping District. The learning objectives of this content are to understand the basic concepts of face recognition, familiar with the important parts of the access control system; know what the face recognition algorithm is, and be able to illustrate the application of the face recognition algorithm in life; master the use of the face recognition function of the Genius Brain platform; learn to use Mind+ graphical programming to control the steering wheel rotation; master the recognition of the face through the camera module. Control the rotation of the steering gear, simulate the method of face recognition access control system; initial understanding of AI technology, generate interest in AI technology learning. The course schedule for this content is a total of 8 lessons, each lesson is 30 minutes, and the lesson schedule is shown in Table 1.

Table 1. Lesson Schedule.

Main content	Class schedule
Project start	0.5 lessons
Artificial intelligence related concepts	1 lesson
Genius Brain face recognition feature learning	1 lesson
Use The Mind+ programming controls the steering gear to rotate	1 lesson
Camera module assembly	0.5 lessons
Feature implementation: Program logic in Mind+	1 lesson
Project Production: Design an application scenario and complete the production	2 lessons
Project works are shared and displayed	1 lesson

3.2 Teaching process

The origin of creativity – real situations, stimulating interest. By introducing the problems encountered in daily life, explain the problem situation: Hanghang's grandfather likes to play chess with the "little friends" in the park, but as Grandpa gets older, his memory is getting worse and worse, and he always forgets to bring the key when he goes out, and recently there have been several times when Hanghang returned home from *school* to see Grandpa sitting on the steps at the door waiting for Hanghang or his parents to come back and open the door. Put forward the problems that need to be solved in this course project: help Grandpa Hanghang solve the problem of forgetting to bring the key into the house. Through life situations, arouse students' interest in learning, and assign group tasks:

- Determine the name of the course project
- Form a project team

Table 2. "XXX" division of labour.

name	role	Main tasks
	designer	Mainly responsible for the design of product shape and function.
	engineer	Mainly responsible for the construction of the project.
	programmer	Mainly responsible for the design and writing of programs.
	Promoter	Mainly responsible for publicity speeches, display products.

- Draw up a schedule for the promotion of experimental projects

Table 3. "XXX" project implementation plan.

Matters	detail	Finish date	remark
Origin of the project	Determine the project name according to the problem you want to solve in your life, form a project team, and draw up a project schedule		
Scheme design	Work together as a group to complete the project implementation plan		
Production process	Build models according to the design and debug functions		
Aggregated analysis	Summarize and share		

Program design - analysis and discussion, program conception. *Clarify the problem.* Around the problem of "helping Grandpa Hanghang solve the difficulty of forgetting to bring the key into the house", the students consulted the relevant materials and discussed, and the teacher summarized. In today's continuous development of AI technology, especially face recognition technology, the above problems are finally further clarified as: How to use AI technology to solve the problem of forgetting to bring a key into the house?

Analyze the problem. Guide students to further analyze the clear problems, and ask students to think: What aspects need to be considered if you want to realize the opening and closing of the face recognition control door? Decompose the explicit

problem into four sub-questions: First, what is the principle of face recognition? Second, what props are used for self-made face recognition? Third, can the accuracy of face recognition be guaranteed? Fourth, if you encounter a bad person who wants to enter the door, is there an alarm measure?

Design scheme. According to the results of the problem analysis, guide students to consult a large number of relevant information and materials, put forward hypotheses: face collection can be carried out with the help of cameras, face comparison can be carried out using the Genius Brain platform; and the mega2560 motherboard is used for steering gear control to achieve door opening and closing.

①Self-directed learning: Present students with facial recognition technology and content used on the Genius Brain platform through knowledge links. to help students better understand artificial intelligence.

②Collaborative learning: Students collaborate with each other to complete the training of face models using the Genius Brain platform. Students log on to the AI algorithm platform (platform URL: https://lab.qingsteam.cn/) to find the face recognition algorithm function to create a project, after entering the project, according to the "project introduction - preparation data - training data - test data - project application" for face model training. The detailed steps are shown in Fig. 3.

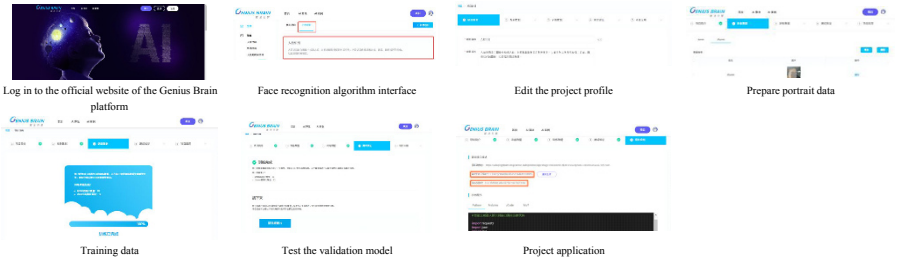

Fig. 3. Face recognition model training process

③ Autonomous Inquiry: Understanding the Steering Gear. Guide students to carefully observe the structure of the steering gear. Teacher's summary: The steering gear is a position (angle) servo drive for those control systems that require constant changes in angle and can be maintained.

④Hands-on: Connect the motherboard. After knowing the servo, guide students to refer to the wiring diagram between the servo and the motherboard (Fig. 4) to connect the motherboard, the red line (positive pole) and the black line (negative pole) must not be reversed, otherwise the servo will be burned, and the yellow line (signal) corresponds to the number in the program.

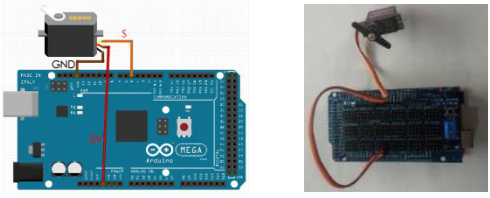

Fig. 4. The servo is connected to the motherboard

④ Hands-on: Program controls the rotation of the steering gear. Question: How to use the program to control the rotation of the steering gear? Guide students to think about ways to control the rotation of the steering gear using Mind+ graphical programming. The teacher summarizes the following reference steps of the process:

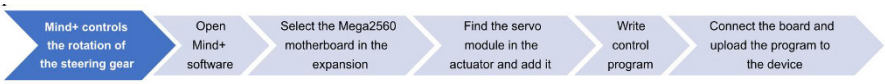

Fig. 5. Mind+ controls the steering gear rotation step

Assign the task of making explanatory documents: Group discussions are required to jointly complete the projects of the group to produce explanatory documents to form a preliminary design plan. The production instructions should include: the origin of the idea, the design concept, the implementation function and the bill of materials, etc.

Communication and argumentation. Out-of-group communication: After each group completes the initial design plan formed in the group, it communicates its own design with "others". In the classroom, "others" refers to students other than this group and the teachers of this lesson, listening to their suggestions; outside the classroom, "other people" can be parents, professional teachers, small partners, etc. outside the course, such as: You can show your parents, get the support of parents, you can also show the school's friends to exchange ideas, but also communicate with the school's teachers, seek more professional guidance from school teachers, and ensure the feasibility of the plan.

Program optimization. Layout optimization and promotion tasks: Organize each team to modify and optimize the designed plan according to the deficiencies found in the communication and demonstration process, and form the final implementation plan.

Production process - model building, implementation of functions. *Model design.* Assign model design tasks: Organize students to design the model appearance structure according to the sketch of the project works in the design plan. In this process, teachers need to fully consider the learning situation, let students combine the situation of the group to practice, and complete the design of the model. The model floor plan can be drawn with the help of computer software tools, or it can be cropped instead of cardboard or carton boxes. Fig. 6 shows the floor plan of the smart access control project model, and the appearance effect of the work is clearly visible.

Material collection. According to the design of the program, students are prepared to collect the materials needed to produce the works of this group of projects. Teachers should try their best to provide students with material support within their capabilities to help the production process of the project. Fig. 7 shows

the materials required for the smart access control project. Material collection can be carried out simultaneously with model design.

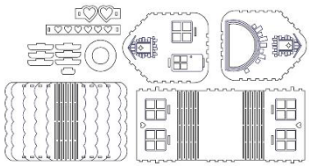

Fig. 6. Intelligent Access Control System Model

Fig. 7. Main hardware equipment

Model construction. ①Model cutting. Import the designed project model diagram into the cutting software and set the laser cutting data to perform laser cutting. Fig. 8 shows the smart access control model imported into the LaserMaker software interface.

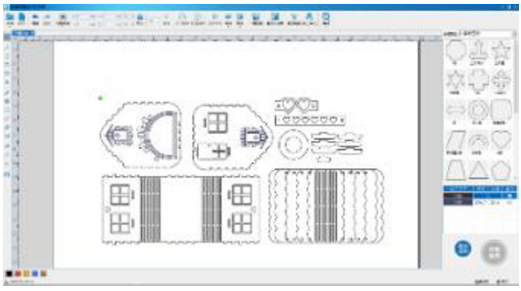

Fig. 8. Smart Access Control LaserMaker software interface

②Structure construction. Students assemble and stitch the cut model structure to complete the structure construction. The assembled smart access control model is shown in Fig. 9 (the unplaced hardware is not yet completely enclosed).

③Servo installation. Organize students to use a hot melt glue gun to secure the steering gear to the door (Fig. 10).

Fig. 9. Intelligent access control structure construction

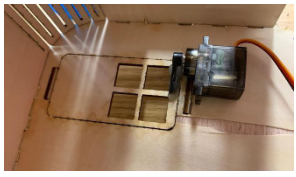

Fig. 10. Schematic diagram of the installation of the steering gear

Function implementation. Organize students to discuss and form specific ideas for the functional realization of project works within the group based on the assumptions and learning effects previously proposed. The intelligent access

control project function is implemented by uploading the owner's photo to the AI algorithm platform for data training (see "Face model training using the Genius Brain platform"). When a person comes to the door, the camera detects the face of the person, determines whether it is a resident, and if so, opens the door and does not open it.

① Hardware connection. Task Challenge: Correctly connect the hardware involved according to the functional characteristics of each hardware. The connection diagram of the smart access control project is shown in Figure 11.

② Program writing. According to the analysis of the functional implementation ideas of the project works of this group, the flow chart is drawn (Figure 12), and the programming practice is carried out.

Fig. 11. Hardware connection

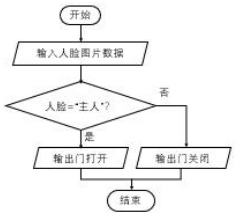

Fig. 12. Intelligent access control flowchart

After connecting the hardware and drawing the flow chart, the students use the blue USB cable to connect the motherboard to the computer and start the Mind+ software for programming. In this process, the teacher should take care of all students, let the students program the practice according to the situation of the group project, and carry out inspection guidance. The smart access control program is shown in Fig. 13. The program logic in Mind+ is shown in Fig. 14.

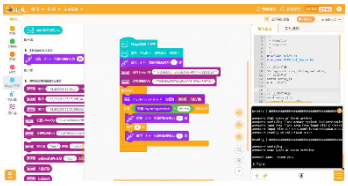

Fig. 13. Programming

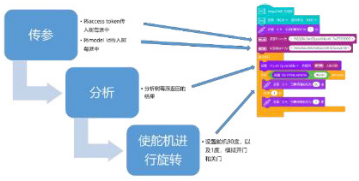

Fig. 14. Intelligent access control system control program logic

③ Project debugging. After the student compiles the program, the project debugging, clicks connect the device to connect, then uploads the control program to the device, clicks Upload to the device, and waits for the upload to be completed before starting debugging, to see if the programs they design can make the functions of the project works of this group realize. In this process, teachers need to conduct classroom tour counseling and explain common problems, such as: the photos collected by the camera in real time are not clear, there are spaces in the Token and ID strings, and the pin number does not match the location of the hardware connection. Strive to make it possible for every student to experience

success. Students analyze and solve problems again, optimize programs to implement functions, and finally combine all the hardware with the model. The final effect of the smart access control project is shown in Fig. 15.

Share and communicate. Organize each group to display project works and share their experiences in the process of creative and intelligent manufacturing. Students are required to summarize the process of project production in this lesson, including writing the project production documentation of the group, making a presentation to share, etc., in order to better Introduce your creative creations to others.

Migration Applications—Knowledge transfer, project applications. Assign the Expansion Challenge Task: Guide students to complete the production of the face recognition access control system project, and then apply the knowledge they have learned to other scenarios. Inspire students to think further and teach them to apply knowledge transfer to other projects and solve new problems. Figure 16 is the student's application of face recognition access control migration to the "Qingbei School Bus" project.

Fig. 15. Renderings of smart access control projects

Fig. 16. Student work

In the above teaching process, projects run through the entire teaching activities. In the project-based learning activities, teachers use the AI algorithm platform to carry out PBL-based artificial intelligence maker teaching through real situations. Students "build new knowledge - use new knowledge - solve problems" in the production process of "clear problem - analysis problem - design plan - communication demonstration - solution optimization" and "model design - material collection - model construction - function realization - sharing and communication". In the whole project-based learning process, students can master the knowledge of face recognition technology and the methods of using maker software and hardware equipment It can cultivate the spirit of independent inquiry, and can also gradually cultivate their engineering thinking, innovative thinking, collaboration ability, and problem-solving ability, and promote the development of their own artificial intelligence literacy.

3.3 Project evaluation

After the project is over, teachers and students evaluate the project works and the project practice process, reflect on the shortcomings, and summarize the gains. The project evaluation table is shown in Table 4, and the project evaluation content is

both summary and process indicators, and also includes individual evaluation, group evaluation and teacher evaluation. It better reflects the diversification of evaluation content and methods emphasized in the new curriculum reform.

Table 4. Project evaluation table.

Evaluate the content	Personal evaluation	Panel evaluation	Teacher evaluation
The aesthetics of the work	□ excellent □ good □ average	□ excellent □ good □ average	□ excellent □ good □ average
The solidity of the work	□ excellent □ good □ average	□ excellent □ good □ average	□ excellent □ good □ average
The functionality of the work	□ excellent □ good □ average	□ excellent □ good □ average	□ excellent □ good □ average
The innovativeness of the work	□ excellent □ good □ average	□ excellent □ good □ average	□ excellent □ good □ average
Degree of group member cooperation	□ excellent □ good □ average	□ excellent □ good □ average	□ excellent □ good □ average
Learned about the concept of AI face recognition	□ excellent □ good □ average	□ excellent □ good □ average	□ excellent □ good □ average
Master the steps of face recognition model training	□ excellent □ good □ average	□ excellent □ good □ average	□ excellent □ good □ average
Master the method of controlling the rotation of the steering gear through a single-chip microcomputer	□ excellent □ good □ average	□ excellent □ good □ average	□ excellent □ good □ average
Learned to design and build a simple smart access control model	□ excellent □ good □ average	□ excellent □ good □ average	□ excellent □ good □ average
Mastered the basic methods of programming with Mind+ software and the method of programming control doors using the steering gear module	□ excellent □ good □ average	□ excellent □ good □ average	□ excellent □ good □ average
Master the general flow of project practice	□ excellent □ good □ average	□ excellent □ good □ average	□ excellent □ good □ average

4 Summary and Outlook

In this study, a PBL-based maker teaching model is constructed with the support of ai algorithm platform, and the teaching of "Face Recognition Access Control System" is used as an example to illustrate how this mode can be applied to teaching practice. Subsequently, this study will further analyze the application effect of the PBL-based maker teaching model supported by the AI algorithm platform. Using the "ECCC Scale" (Engineering thinking, Creative thinking, Collaboration, complex problem-solving) developed by the research team collects changes in students' "engineering thinking", "innovative thinking", "collaborative ability", "problem solving ability" and so on. Distribute the "PBL-based Maker Learning Questionnaire supported by the A I algorithm platform" to collect student data, further analyze the learning effect of students and the teaching process of teachers, and continuously optimize the teaching mode of this research PBL-based artificial intelligence maker education teaching practice.

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Research on the Influence of Co-construction Concept Map on Students' Classroom Learning Effect in AR Environment

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Abstract: Building a high-quality learning classroom has become one of the important contents and directions of primary school teaching reform in China at this stage, which is crucial for students' thinking cultivation and knowledge building. Based on the existing problems in AR classroom in primary and secondary schools, this study theoretically discusses the importance of concept map teaching strategy, and introduces it into classroom teaching activities to verify the influence of co-construction concept map teaching strategy on classroom learning. This study focuses on three aspects of classroom atmosphere, learning attitude and learning effect in classroom learning effect, discusses from the aspects of learning engagement, classroom interaction and changes in writing achievement, analyzes the influence of co-construction concept map on students' classroom learning effect in AR environment, and provides reliable experience for the selection of techniques and strategies in high-quality classroom.

Keywords: AR Environment · Co-construction Concept Map · Learning Engagement · Classroom Learning Effect

1 Introduction

With the advent of the intelligent era, the new generation of information technology has been widely used in all walks of life, especially in the innovation and development of education. At present, Augmented Reality (AR) is popular among teachers and students because of its advantages such as timely simulation of learning objects, simple and easy manipulation of models, and real-time integration of reality and virtual reality. Through investigation, it is found that AR classroom teaching generally lacks organization, purpose and guidance. Teachers need to internalize technology and apply it to teaching activities in combination with appropriate teaching strategies or methods. Therefore, co-construction concept map is selected as a teaching strategy and applied to classroom teaching.

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According to research, in collaborative inquiry learning environment, concept map can positively influence consensus building activities and learning, and visualize the relationship between concepts[1]. In this study, two kinds of concept maps are applied to the classroom as teaching strategies to make up for the deficiency of single technology in the classroom. This study focuses on three aspects of classroom learning effect: learning attitude, classroom atmosphere and learning effect, and studies from the following three issues: (1) whether co-construction concept map teaching strategy can stimulate students' intrinsic learning motivation and improve their learning engagement; (2) How the co-construction concept map teaching strategy affects students' classroom interaction; (3) Under the concept map teaching mode, what are the effects of self -construction concept map and co-construction concept map on students' writing achievement with different participation?

2 Literature Review

2.1 Co-construction concept map

Co-construction concept map, also known as collaborative concept mapping[2], refers to group learners' collaborative construction of concept map in a shared learning space. Co-construction concept map helps students to keep their attention in the process of group interaction, improve the cognitive structure of the group (van Boxtel et al., 2002)[3] , and helps students to improve their group learning motivation, promote their learning emotional experience and reduce the anxiety of participants in the process of collaborative learning (Czerniak et al., 1998)[4]. Integrating the co-construction concept map into the learning situation is conducive to improving learners' behavior in the learning process (Janssen et al., 2012), and can promote deeper and more effective interaction (Sizmur et al., 1997)[5], and realize the meaning construction together.

2.2 Learning engagement

The theory of learning engagement was first put forward by American scholar Astin. He believes that learning engagement refers to the sum of students' mental and physical efforts in learning activities[6], which is a quantifiable indicator that can be measured and evaluated. It covers a series of institutional practices and student behaviors related to students' satisfaction and achievement, including task time, social and academic integration, and teaching practice. Among them, the concept of task time was put forward by Tyler. He thinks that Sorinola and others

verify that learning engagement is an important factor to support learning and plays a key role in achieving students' learning goals[7].

3 Research design

3.1 Participants

The subjects of the study are the students in the fourth grade of a primary school. Their ages are between 9 and 10 years old. There are 42 students in the experimental class (24 boys and 18 girls) and 38 students in the control class (18 boys and 20 girls).

3.2 Instruments

Questionnaire on Learning Engagement. In this study, the three-dimensional scale proposed by Sun[9] was selected as the learning engagement questionnaire, and the level of students' learning participation was tested from three dimensions: behavioral participation, emotional participation and cognitive participation. The scale adopts Likert's five-point scoring method, and its Cronbach coefficient is 0.95, which indicates that the scale has outstanding internal consistency. The scale consists of "very consistent", "consistent", "uncertain", "non-consistent" and "very inconsistent", and the options are respectively assigned 5, 4, 3, 2 and 1 points. The higher the students' scores, the higher their learning engagement.

Lag earning behavior analysis and measurement table Through the research and analysis of students' interactive behaviors in classroom videos, combined with relevant research literature[10], 10 types of classroom interactive behaviors such as lecture, question and answer, sharing, asking for help, observing, recording, discussing, connecting, operating and other behaviors were designed, and they were summarized into four dimensions: teacher-student interaction, student-student interaction, human-computer interaction and other behaviors, which were used as indicators of behavior sequence analysis. Table 1 presents the first-level dimension names, second-level dimension names, research codes and behavior descriptions of 10 programming behaviors.

Table 1. Coding and description of students' classroom interaction behavior

Primary dimension	Secondary dimension	encode	describe
Teacher-student interaction	Teach	TT	Teachers teach knowledge unilaterally and students listen.
	Questions and Answers	TQ	Teachers ask questions, and students raise their hands to answer questions and share their views.
	Share	TS	After completing the task list, the group sent representatives to share the results.
	Appeal	TA	In the process of learning, students raise their hands to ask for help from teachers.
Student-student interaction	Observe	SO	Members of the group observed and studied the tablet resources.
	Record	SR	Fill in the task list during or after the observation.
	Discuss	SD	Members of the group exchange views and interact with each other on the contents of observation or task list.
Man-machine interaction	Connect	MC	Switch on and off the machine and connect the external equipment.
	Operate	MO	Operate the software interface during observation.
Other behaviors other behaviors		OB	Chatting, irrelevant content, or teachers maintaining classroom order.

3.3 Experimental Procedure

First of all, through the actual teaching investigation, taking the students' latest composition score as the pre-test analysis, two classes with the same writing level from eight classes in the fourth grade were selected as experimental objects, marked as experimental class and control class, and the pre-test of learning engagement was conducted. Next, both the experimental group and the control group carry out writing learning activities for 5 weeks. Before class, the teacher will simply explain the operation of resource software and the completion of task list of concept map. The classroom is supported by AR technology. The experimental class adopts the co-construction concept map for learning, while the control class adopts the heterogeneous concept map for learning. Students are required to complete the writing task in class.

4 Experimental results

4.1 Compare and analyze whether the students' learning engagement in the experimental class and the control class has changed significantly horizontally and vertically

Table 2. Paired sample T test results of learning engagement

variable	group					
	experimental class			Control class		
	Pre-test mean	Post-test mean	*p*	Pre-test mean	Post-test mean	*p*
Behavioral engagement	16.76	17.93	.010**	16.61	16.97	.209
Emotional engagement	21.93	22.76	.084	21.61	21.89	.549
Cognitive engagement	21.45	22.69	.013*	20.87	21.97	.016*

** $p<0.05$,** $p<0.01$.*

By analyzing the pre-test and post-test mean values of the two groups of students' learning engagement, it is found that there are significant differences in the mean values of the two classes' learning engagement in the post-test behavioral engagement ($p=0.043<0.05$).

The paired sample T-test is adopted to test the respective learning engagement levels of the two classes. The data results show that (as shown in Table 2): the post-test average of the two groups is improved compared with the pre-test average. There is a significant difference in the behavior engagement of the experimental class ($P = 0.044 < 0.05$), but there is no significant difference in the behavior engagement of the control class ($p=0.746>0.05$). There are significant differences in cognitive engagement between the two classes ($P = 0.013 < 0.05$, $P = 0.016 < 0.05$). However, there is no significant difference between the two classes' emotional engagement and the pre-test ($p=0.084>0.05$, $p=0.549>0.05$).

4.2 This paper analyzes what kind of classroom interaction behaviors will be produced by different types of concept map teaching strategies in AR writing class

In this study, the lag sequence analysis method was used to analyze the classroom learning behavior videos of the experimental class and the control class, respectively. According to the behavior coding data, the two groups (in pairs) of researchers showed high consistency ($ICC = 0.808 > 0.8$), and the GSEQ software was used to make the behavior switching frequency table, and the values in the table represented the behavior switching frequency. As shown in Table 3, The

frequency of teacher-student interaction between the two groups is similar, but the frequency of student-student interaction and human-computer interaction in the experimental class is significantly higher than that in the control class.

Table 3. Behavior Analysis Conversion Frequency Table

group	Teacher-student interaction				Student-student interaction			Man-computer interaction		Other behaviors	total
	TT	TQ	TS	TA	SO	SR	SD	MC	MO		
experimental class	7	7	3	1	49	11	20	4	20	7	129
Control class	8	6	4	2	16	10	1	3	15	4	69

Input the behavior sequence into the software tool according to the time sequence to generate the adjusted residual table. According to the theory of lag sequence analysis, Z-score > 1.96 indicates that this behavior sequence is significant [11]. Finally, according to the adjusted residual table, draw a significant behavior sequence transformation diagram, as shown in Figure 1 and Figure 2. The arrow points to the accompanying behavior, and the connected value represents the residual parameter of the behavior sequence. The larger the Z value, the higher the significance level of the behavior sequence.

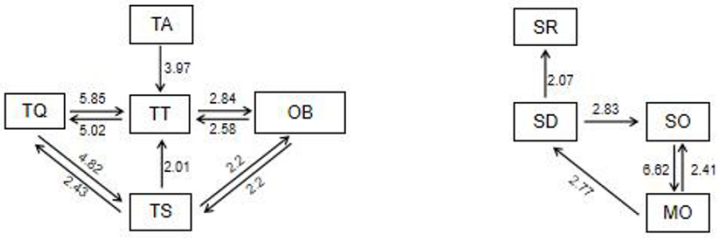

Fig. 1. Sequence diagram of classroom behavior in experimental class

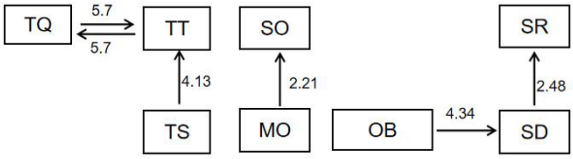

Fig.2. sequence diagram of classroom behavior in control class

The experimental class's behavioral activities are concentrated As can be seen from Fig1,the learning behavior in the experimental class has the following characteristics: ① The "lecturing" behavior is the center of the interaction between

teachers and students, and there is a significant correlation between lecturing, asking for help, sharing and other behaviors. Around the teacher's teaching behavior, there is a closed-loop structure of question and answer → sharing → teaching in the teacher-student interaction stage. Students tend to answer questions and share group views after the teacher's lecture, and at the same time, help-seeking and other behaviors will occur. ② Interaction between students. For closer connection, a closed-loop structure of observation → operation → discussion is formed. After observing, students will discuss with their peers and record the observed contents. During the discussion, they will constantly operate the software interface to make adjustments, forming a continuous sequence of actions.

The activities of the control class are scattered By observing Fig 2, learning behavior in the control class has the following characteristics: ① Teacher-student interaction mainly focuses on lectures and questions and answers. After listening to the teacher's lecture, students are willing to answer the questions raised by the teacher and share their achievements. ② Observe and discuss step by step. Students are accompanied by operational behaviors in the process of observing, and this step is completed independently without interaction with other students. When taking notes, there will be a little communication with peers, but at the same time there will be other behaviors such as chatting.

4.3 Analyze whether concept map teaching strategies and learning engagement have interactive effects on students' writing achievement

This study designed a 2*2 two-factor experiment to analyze whether two concept map teaching strategies and different levels of learning engagement have interactive effects on writing achievement. The results of ANOVA show that different teaching strategies and learning engagement of concept map have no significant interactive influence on students' writing achievement ($p=0.915>0.05$), which shows that teaching strategies and learning engagement will not affect students' writing achievement together.

Table 4. T-test of independent samples of teaching strategies and learning engagement

independent variables		N	Pre-test results	Post-test results	F	*p*
Learning strategy	Co-construction conceptual diagram	42	81.48	83.83	.225	.762
	Self-construction conceptual diagram	38	82.00	84.32		
Learning engagement	High-level	45	81.98	85.78	.004	.013*
	Low-level	35	81.40	81.86		

*$p<0.05$.

One-way ANOVA was carried out on two independent variables: teaching strategies and learning engagement. The results showed that: from the perspective of learning strategies, there was no significant difference in the post-test scores ($p=0.762>0.05$), but they were improved by about 2 points compared with the pre-test scores; From the perspective of learning engagement, there is a significant difference between the two groups of students' post-test scores ($P=0.013<0.05$), and the scores of students with high level of learning engagement have been improved by 4 points on average, but the scores of students with low level of participation have not changed significantly.

5 Analysis and discussion

5.1 Co-construction concept map teaching strategy is more helpful to build students' positive learning attitude

The application of concept map teaching strategy in AR classroom has a positive effect on students' learning engagement, which is mainly reflected in two aspects: behavioral engagement and cognitive engagement. Compared with the control class, the experimental class has a more ideal change in learning engagement. This shows that students have a positive learning attitude towards writing class under the co-construction concept map teaching strategy.

The learning situation created by AR has a strong human-computer interaction learning experience, which can give full play to students' learning initiative and improve students' learning participation to a certain extent. On this basis, the concept map is assigned to classroom learning as a task. The co-construction concept map teaching strategy is to intentionally cultivate students' ability of exploring problems and cooperative learning. Through interaction and cooperation, they can gain experience and improve skills, attract students to take the initiative to participate, have a positive and serious attitude in the face of learning, trigger active exploration, and make learning really happen.

5.2 Co-construction concept map teaching strategy can enrich classroom interaction behavior and enliven classroom learning atmosphere

Comparing the classroom interaction between the two teaching strategies, it is found that the experimental class has richer interactive behaviors, and there is a

close connection between the behavior groups, forming an interactive closed loop. It shows that the co-construction concept map teaching strategy can promote the interaction between teachers and students, enrich the forms of peer interaction, closely combine student-student interaction with human-computer interaction, and promote knowledge construction.

Co-construction concept map puts forward higher requirements for cooperation among peers, and realizes communication, interaction and co-construction in the learning process, so as to realize effective classroom interaction. Students' enthusiasm and enthusiasm stimulated drive their brains to think, share knowledge purposefully, and the classroom learning atmosphere is strong, which greatly improves the efficiency of knowledge transfer in class.

5.3 Concept map teaching strategy can improve writing achievement, and high level of learning engagement can promote further learning effect

It is obviously improved, but there is no significant difference, which shows that the significance construction of concept map teaching strategy has a positive impact on students' learning results. It is found that a high level of learning participation has a further impact on students' academic performance. In the writing class, the concept map is constructed by peers, so that students can actively communicate with other students in the process of construction, and encourage them to continuously construct a perfect cognitive structure during their discussion. At the same time, they can also increase students' learning input, cultivate their awareness of autonomous learning, and then adjust their learning strategies, improve students' problem-solving ability, and realize meaningful learning.

6 Summary and suggestions

Learning engagement is the product of the interaction between students' learning motivation and active learning. The occurrence of learning engagement means that students' learning motivation and active learning have crossed each other, and both of them influence each other closely . The higher students' study commitment and enthusiasm, the stronger their motivation. When students turn their external learning motivation into internal learning motivation, they tend to seek learning opportunities on their own to realize their own value. Therefore, in the process of classroom learning, we should fully stimulate students' learning motivation, improve students' participation in autonomous learning, and achieve the transformation from passive learning to active learning. For example, by giving students a variety of situational learning tasks and solving situational problems,

students can fully link what they have learned in class with their real life, construct flexible rather than inert knowledge, and find the fun and significance of learning.

A good learning environment and atmosphere will give students a positive driving force for learning, and gradually stimulate their potential learning ability and enthusiasm. Under the guidance of cooperative learning and teachers, knowledge construction can help learners realize conceptual change and improve their problem-solving ability. For example, in the writing class, drawing concept maps around the writing theme together, and exchanging views and experiences with each other in the process, so as to structure and describe one's own composition more comprehensively, can break through the writing barriers and improve writing ability.

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Research Status and Application Case Analysis of International Learning Space——Literature Analysis Based on Web Of Science Core Database from 1990 to 2021

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Abstract. As a teaching and learning environment supported by technical support, learning space has advantages in meeting students ' learning needs. In this study, the visualization analysis software Cite Space is used to present the development process of foreign learning space through mapping, to analyze the development trend of foreign learning space research. At the same time, representative cases are selected for analysis, to put forward reference suggestions for the study of domestic learning space. The study found that the study of learning space abroad showed an overall upward trend; the research hotspots include the construction of learning space, the application of intelligent technology, the development and research of education and teaching activities in learning space. The future development of learning space will be more and more in line with learners ' learning needs, and will receive more and more attention.

Keyword: Learning Space · Visual Analysis · Case Analysis · Cite Space

1 Introduction

Any teaching activities must be carried out under certain time and space conditions, which is the specific learning environment of tangible and intangible.[1] The construction of learning environment is the basis for the transformation of learning and teaching methods, and has always been a research hotspot in the field of education.[2] Learning space usually refers to the learning environment of the whole school. It mainly focuses on how to transform the school environment in order to adapt to students ' learning needs under the environment of rich technology.

International research on learning space began in 2006, EDUCAUSE in 2006 published the Learning Space masterpiece,[3] is the earliest representative of the study of learning space. The American Journal of Learning Space in 2011 defined learning space as a place designed to support, promote, stimulate, or enhance learning and teaching.[4] The Horizon Report of the New Media Alliance in 2017

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points out that redesigning learning spaces is a medium-term development trend and will be widely used in higher education in the next 3-5 years.[5]

Learning space as a technical support under the education teaching environment, related research gradually from higher education learning space design extends to the primary and secondary school learning space design. In order to better understand the research hotspots and research directions of learning space. Based on Cite Space software, this study combs the English literature of Web of Science database in the past three decades, analyzes the research status and typical cases of foreign learning space, and provides reference suggestions for future research on learning space.

2 Research data and tools

a) Sample source

The data of this study comes from the Web of Science core collection database. The papers published in the past 30 years (1990.1.1-2021.12.31) are selected for fuzzy retrieval by keywords ' Teaching Space ' or ' Learning Space ' or ' E-learning Space ' or ' Smart Learning Space '. A total of 834 literature data were obtained after removing invalid records such as award-winning display, advertisement, and conference notice.

b) Research tools and methods

In this study, the visualization tool Cite Space is used to analyze the original data, such as author cooperation network analysis, institutional cooperation network analysis, learning space paper volume analysis, keyword analysis and keyword mutation analysis. Through dynamic identification of key nodes and research hotspots, the frontier hotspots of the development of a discipline are displayed, and the knowledge kinship context is explored. On this basis, some typical literatures are read, typical cases are analyzed in depth, and the research hotspots and development trends of learning space are sorted out.

3 Data analysis and discussion

3.1 Development of Learning Space Research

Analysis of Learning Space Volume. This paper makes a statistical analysis of the data of core journal papers about learning space in the past 30 years, and the annual

number of papers is shown in Figure 1.

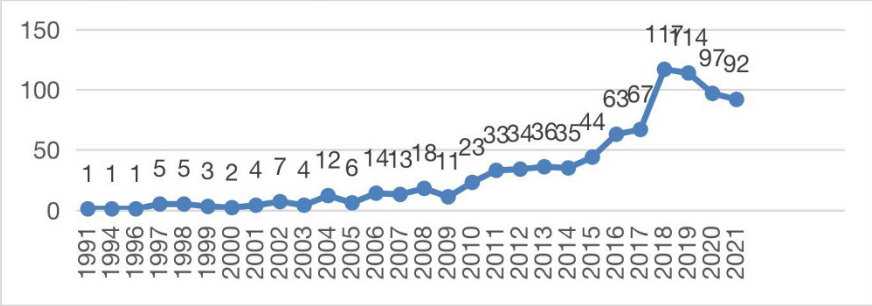

Fig. 1. Annual publication of journal articles on learning space

The overall trend of foreign articles on learning space shows an upward trend, which indicates that the study of learning space has been more and more widely concerned. Although it shows a downward trend after 2019, it is speculated that it may be related to the impact of global epidemics and the impact of research literature retrieval conditions.

The Development Stage of Learning Space Research. Based on the comprehensive analysis of the results of the analysis chart of the number of articles and salience words, this paper divides the development trend of learning space into four stages:

*Germination stage (1990 – 2008).*This stage of research mainly focuses on the classroom. At this stage, many research projects have emerged, such as the Apple Classroom of Tomorrow (ACOT) project, which started in 1985. The goal is to study how teachers and students change teaching and learning using technology, creatively combine the constructivist learning theory with the classroom supported by technical support, put forward a series of effective teaching models, and provide valuable experience for teachers' professional development. The research on Active Learning Classrooms (ALCs) started at the University of Minnesota in 2007.[6]

*Rise phase (2008-2015).*With the introduction of the concept of IBM Smart Earth in 2008, the Internet of Things, cloud computing and so on have become the focus of development strategies in developed countries. Since 2009, the United States, the European Union, Japan, and South Korea have launched their own development strategies related to Internet of Things and cloud computing. In 2008, the Apple Classroom of Tomorrow-Today (ACOT2) project was launched. In addition to following the successful experience of ACOT, ACOT2 is mainly used to help middle schools create a learning environment they need and want. The basic design principles include: skills in the 21st century, applied courses, interactive evaluation methods, social and emotional connection, innovative cultural atmosphere, and ubiquitous technical environment.[7]

*Development stage (2015-2018).*The study of learning space at this stage is in the development stage. The beginning of the fourth industrial revolution has its historical necessity to lead the reform of higher education. Education plays an important role during the previous industrial revolution. The challenges to higher education posed by the Fourth Industrial Revolution, led by a series of innovations such as artificial intelligence, life science, the Internet of Things, robots, new energy, and intelligent manufacturing, also show the possibility and reality of a new round of higher education reform.

*Transition phase (2018 - present).*The Horizon Report (2018 Higher Education Edition) pointed out that one of the trends of higher education reform in the next five years is to redesign learning space.[8] This phase has begun to focus in depth on space transformation projects such as library transformation.[9] The Global Vision Report issued by the International Library Federation Congress in 2018 clearly states that libraries must seize the opportunities offered by digital innovation in the transition process to ensure that they have the right tools, infrastructure, funds and skills.[10]

3.2 Dynamic Analysis of Learning Space Research

Dynamic Analysis of Topic Development in Learning Space Research. Through the analysis of keyword collinear network analysis map of Cite Space software, the current research focus and research focus of learning space researchers can be obtained to a certain extent.[11] As shown in Figure 2, a total of 430 nodes (keywords) and 847 lines (links between keywords) are obtained. The overall structure of foreign research is relatively close.

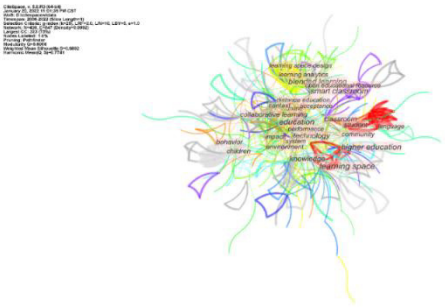

Fig. 2. Analysis map of WOS keyword co-occurrence network

Table 1 lists the top 20 high-frequency keywords in the field of foreign learning space, which can get the keywords with high frequency are higher education, smart classroom, blended learning and so on.

Table 1. Statistics of high frequency keywords

Serial number	frequency	centricity	year	keywords
1	71	0.15	2008	higher education
2	69	0.22	2012	learning space
3	57	0.16	2010	education
4	47	0.12	2008	smart classroom
5	42	0.11	2015	student
6	31	0.14	2012	technology
7	21	0.1	2008	blended learning
8	20	0.03	2015	flipped classroom

Hotspot Analysis of Learning Space Research. Based on Cite Space for keyword clustering map analysis can be drawn as shown in Figure3, according to the network structure and clustering clarity, provides the clustering module value (Q value) and clustering average contour value (S value) two indicators, it can be used as a basis for our evaluation map rendering effect. In general, the clustering module value (Q value) is 0.6908, generally Q > 0.3 means that the community structure is obvious; clustering average contour value (S value) is 0.8802, generally S > 0.7 that clustering is convincing.

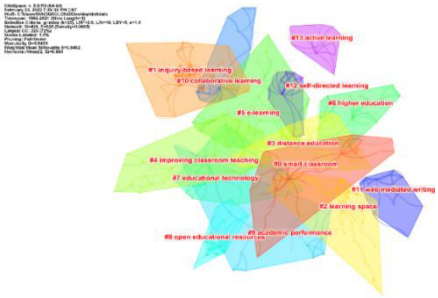

Fig. 3. Cluster Map of Foreign Keywords

Based on the analysis of keyword clustering map, this study combines similar concepts and focuses on four research hotspots, as follows:

Smart learning space. With the rapid development of intelligent information technologies such as the Internet, artificial intelligence and big data, the integration of technology and teaching has been strengthened.[12] New concepts such as ' smart classroom ', ' smart learning space ' and ' smart learning environment ' have been introduced.[13] Some scholars have proposed that the establishment of smart learning space should fully consider the needs of personnel training and the cultivation of students various abilities.[14] Through diversified spatial layout and flexible combination of tables and chairs, we can create a variety of learning spaces such as universality, topicality and research, and create a simple, fashionable, practical, relaxed and friendly learning environment.[15] In addition, the advanced technologies of mobile Internet, Internet of Things, cloud computing and big data provide strong technical support for the establishment of intelligent learning space. Teachers can use touch interaction and screen display to flexibly present learning

resources; students can choose visual interactive system, wireless screen projection and other facilities to increase interaction, scientific research and collaborative learning; in order to meet the needs of distance education, the remote interactive system is used to realize multi-user global remote real-time interaction and remote conference discussion, and share high-quality educational resources.[16] Collect complete objective data by establishing a digital model; build location network to provide location-based services. Key equipment can be monitored, passive intelligent tags can be used for asset management; and provide all-space video network and face recognition open services.

Informal learning space. Learning space refers to all places where learning activities occur, including formal or informal, physical, or virtual dimensions, and available resource services. Extend the concept of learning space to informal learning.[17]

Library as an important informal learning space has been widely concerned in recent years. Some scholars put forward the concept of modern library, arguing that library should be a place where people can communicate with each other, conduct academic discussions, and enjoy entertainment and other services.[18] Including lecture hall, multimedia exhibition room, bookstore, etc., reflects the comprehensive library.[19] As an important informal learning space, university libraries have a lot of experience in providing and developing different learning spaces, as well as evaluation skills and professional knowledge. As a starting place for the application of new technologies, libraries can develop specialized training centers for employees and students. Students in libraries have access to rich historical, cultural, and artistic collections of schools, and enhance campus learning experience.[20] In addition, the library integrates the exchange, processing, dissemination, and accumulation of modern knowledge into a dynamic academic center, gradually developing and transforming into a future learning space.[21]

Higher education. In recent years, the higher education system has undergone various changes. Traditional higher education is designed as an industry-oriented system, which regards students as an assembly line, like a learning factory.[22] Today's higher education institutions should prepare young people for tomorrow ' s knowledge economy and 21st century skills. Modern students should be autonomous learners, responsible for their own learning process, learn how to establish and use networks, work with others, and use information and communication technology (ICT) to find appropriate information. New learning objectives, the increasing application of information and communication technology in education, and the change of teaching methods emphasized by psychology and educational theory are considered as new ways of learning.

People expect that new learning methods need to change the physical environment. More and more people realize that learning occurs in all corners of the campus, not just in classrooms and laboratories. Modern information and communication technology facilities support new learning methods, so that students can learn anytime and anywhere. The information transmission part of the traditional face-to-face lectures was removed from the classroom time. Now

research shows that more and more activities take place outside traditional classrooms. Higher education institutions should provide attractive informal learning space with high-quality interior design. So as to adapt to the impact of network learning, provide better learning experience for learners.

Inquiry-based learning. As a learning method with the rise of the study of learning space, inquiry learning is focused on. The purpose is to cultivate learners' curiosity and motivation, help learners develop their critical thinking negligence, and better adapt to the complex work and unpredictable environment in the future. Inquiry learning connects school science teaching with informal learning and phenomena in daily life, and various typical technologies in learning space provide learners with opportunities to participate in a wider range of inquiry learning, which can provide more personalized and autonomous seamless experience for cross-learning environment, so as to better guarantee the development of inquiry and learning.

4 Case study

Bruno Sevi, a famous Italian architect, once said in his ' architectural space theory: Although we can ignore space, space affects us and controls our spiritual activities. In the field of education, the impact of space is more pronounced, ' Learning Space ' published by the American Association for Higher Education Informatization (EDUCAUSE) in 2006 pointed out that different learning spaces shape different teaching and learning behaviors, and specific learning spaces stimulate and promote specific learning activities.

Since the 1990 s, with the development of learning theory, scientific and technological progress, labor upgrading and other factors, the transformation and reconstruction of traditional classrooms and other teaching places have set off a wave of boom in the world. This study sorts out several typical cases of learning space construction.

4.1 TILE

In August 2009, the University of Iowa launched the TILE project, investing USD 15.5 million to build 6-10 *active learning classrooms*. The design concept of these classrooms is TILE.TILE (Transform, Interact, Learn, Engage) refers to transforming the role of teachers and students, promoting interaction in teaching activities, promoting students ' active learning and promoting students ' participation. The characteristics of the classroom include: each classroom has six round tables, each round table can accommodate up to nine students, and there is an LCD display screen around the classroom. Each group (three people in one group)

is equipped with a laptop, and the room is covered with a wireless network. The signal of the teacher' s laptop is projected to two screens in different directions for students to watch from different angles. The teacher' s worktable is in the middle of the classroom, and the teacher can automatically turn on the lights, power supply, laptops, and projections through the startup key on the worktable, and both teachers and students can control the display content of the LCD screen through the switch.

4.2 TEAL

TEAL (Technology Enabled Active Learning) project was proposed by Massachusetts Institute of Technology in 2000. The purpose of the project is to establish an interactive learning environment for students to be highly cooperative, hands-on and computer-supported. The purpose is to study the teaching environment and curriculum materials that can promote students to better understand physics. Educational theory, subject content and educational technology are the three basic elements that TEAL project team mainly considers when designing and developing learning space. TEAL classroom layout is based on a group of three students, one laptop in each group, and 13 cameras record the activities of each table. There are multiple projection screens on the four walls to ensure that students sitting anywhere can see the projection clearly. The middle of the screen is an electronic whiteboard. The teacher' s desk is in the center of the classroom. Such spatial layout is helpful for teachers and assistants to walk around in the classroom and communicate fully with each group of students. Such classrooms can not only do virtual physical experiments, but also do real physical experiments.

4.3 RULS

The Retrofitting University Learning Spaces (RULS) project is initiated by the *Australian Teaching Committee (ALTC)*. The goal is to support active learning, collaborative learning, and peer teaching through the transformation of the original space. The project focuses on the transformation of formal learning space and informal learning space. At present, many research results with academic value have been obtained.

From the perspective of spatial planning, Dickin University has reformed the traditional classroom. Compared with the traditional classroom, the biggest change in the reformed learning space is not the horseshoe table and chair layout, the table used by students, and the teacher' s worktable, but the reformed learning space provides a separate rest area and media area for teachers and students.

5 Conclusion

This study uses Cite Space software to visualize and analyze the literature data of learning space in the core database of Web of Science in recent 30 years. It is found that the development of learning space will be more and more in line with learners ' learning needs, and will receive more and more extensive attention. Closer cooperation among researchers in learning space ; most of the research institutions are normal universities, and the cooperation between the institutions should continue to strengthen ; the construction of learning space is the inevitable trend of school education in the future, and its standards are worthy of further study.

From the case study and practical analysis of learning space, it can be seen that with the continuous development and progress of technology. The beneficial experience of foreign learning space construction provides important reference and enlightenment for us to construct learning space.

First, in the construction of learning space should pay attention to the unity of individual and public learning space. Public learning space can not only serve learners, provide them with intelligent learning environment, and achieve adaptive and personalized learning, but also provide reference for schools, education-related institutions and education departments.

Second, in the construction of learning space to consider the development of technology and students ' personalized learning needs. Augmented reality technology, sensor technology, learning analysis technology and other technologies provide the possibility to construct the learning space of physical and virtual fusion. The construction of learning space should consider the characteristics of the new generation of digital indigenous group learning, create an environment that can support students to collaborate with each other, facilitate access to the network, and promote real learning. At the same time, we should respect the personalized needs of students, and promote adaptive and personalized learning.

Third, the application of teaching methods should be considered in the design of learning space. Different teaching methods have different requirements for learning space. The purpose of learning space construction is to create a seamless integration environment between virtual and reality for learners. It is necessary to flexibly adjust and change the learning space according to different teaching methods so that learners can easily, efficiently and devote themselves to formal and informal learning.

Fourth, it provides users with diversified learning space. The design and construction of learning spaces such as Copenhagen University, Arab University, Edinburgh University and Tel Aviv University can meet the needs of learners in different situations. University libraries set up some special learning spaces from the perspective of user needs. For example, the family learning space of the University of Toronto Library meets the needs of parents for both learning and parenting. The design of some libraries is to meet the needs of users in professional learning and skills training. For example, the library of Munich University of

Technology has set up a speaker corner. Users can use equipment to practice, and understand their own speech effect through playback video. In general, the subdivision types of social learning space are more abundant.

Fifth, focus on the details between space and services. In the independent learning space, we can often see some services that help users to consult literature and facilitate users ' continuous learning. For example, the University of Edinburgh Library provides sponge book holder and wrapping steel chain. The former is used to support books, and the latter is used to fix pages. It is an excellent auxiliary tool for browsing most of the classics. In social learning space, you can find some design that helps you relax and enhance team cohesion. For example, the Library of Delft University of Technology has a number of massage chairs in the corner of the hall. Users can interact and communicate during rest and relaxation. Such space and service details fully reflect the library ' s attention and care for users.

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Scratch Gamification Instruction Design Oriented by Design Thinking for Higher-Order Cognitive

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Abstract. Domestic youth programming education began late, and there are issues with Scratch programming instruction in primary and secondary schools, such as a lack of experience and randomness. And it has always been a difficult part of IT curriculum, while gamification is a great help to motivate students to learn. Design thinking is naturally contextual, structural and humanistic, and is an effective way to develop higher-order thinking. In order to enhance students' learning experience and stimulate their interest in programming, this article deconstructs the concept of design thinking into the five core competencies of "exploring the problem, gaining insight, creative design, prototype presentation, and analyze and iterative optimization" based on the analysis of design thinking. The design thinking is integrated into the Scratch gamification learning environment, and proposes a Scratch gamification instruction design framework oriented by design thinking. It provides a path in the new era with the goal of cultivating talents with higher-order thinking and provide reference for the new path of smart education development.

Keywords: Design Thinking · Scratch Gamification Instruction · Higher-Order Thinking · Smart Education Environment

1 Introduction

Intelligent computers have increasingly taken over professions in conventional lower-order knowledge domains in recent years. The study of programming instructional design to improve students' higher-order cognition is gaining popularity. Sixteen European countries have included programming education in their primary and secondary school curricula. The State Council of China announced a "new generation of artificial intelligence development plan" that outlined the following goals: establish artificial intelligence-related courses in schools, and gradually boost programming instruction [1]. Gamification is entertaining and encourages creativity, which aligns with the goals of Scratch programming classes. Front-line teachers are gradually recognizing Scratch gamification teaching. However, issues remain, such as the context being disconnected from students' actual life experiences and the lack of a regular and methodical path to achieving the goal

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Design Thinking is a set of methodological systems for innovative solutions to complex problems, and its mapping of educational concepts is consistent with core literacy, providing a new direction for the cultivation of students' core literacy. It is especially important to actively explore the path of two-way coupling between design thinking and Scratch gamification teaching practice, and to condense a teaching model suitable for the cultivation of higher-order thinking skills and analyze their development.

2 Core Concepts

2.1 Overview of Design Thinking

Design thinking is the theorization of the thinking process of designers involved in creativity, and its idea can be traced back to the book "Artificial Science" published by Simon [2]. There are three different connotations: first, it is an analytical, creative process, such as Norman's view that design thinking is a creative process that includes defining a problem, proposing and producing a solution, and evaluating the results [3]; second, it is a system of innovative problem -solving methodologies, and Razzouk and Shute argue that design thinking is a set of heuristic rules, a series of steps or strategies that guide people to solve complex or "difficult" problems and produce innovative products [4]; third, it is a complex thinking ability of designers. A mental process they go through when designing objects, services, or systems, rather than the results they design, such as elegant, useful products [5].

There are many classical design thinking models, such as the IDEO design thinking model, which consists of five key elements: Discover, Explain, Envision, Experiment, and Improve [6]. And the most widely used model, the EDIPT model developed by the Stanford Design Institute, which consists of five steps: Empathize, Define, Ideate, Prototype, and Test [7]. It is important to note that the five stages of this thinking model are non-linear, and users can repeat the whole process or certain specific stages at any time, which is more suitable for the development of design thinking model. The design thinking model is in line with the philosophy and teaching process of developing higher-order thinking.

The structural nature of design thinking is fully expressed in the theory of design thinking process under the concept of three major spaces. The three spaces proposed by Professor Martin include: exploring the puzzle, i.e., facing a macroscopic realistic problem in which the elements involved in the problem intermingle; gaining insight, i.e., focusing on the problem to a manageable extent, extracting the main elements of the puzzle based on experience and exploring the correlation between them, describing them clearly in words to simplify the puzzle;

and forming a program, obtaining a fixed pattern for solving the puzzle. These three spaces are called the "knowledge funnel", which filters out irrelevant elements from top to bottom and finally derives a fixed pattern of key elements to solve the problem. This is shown in Figure 1 below.

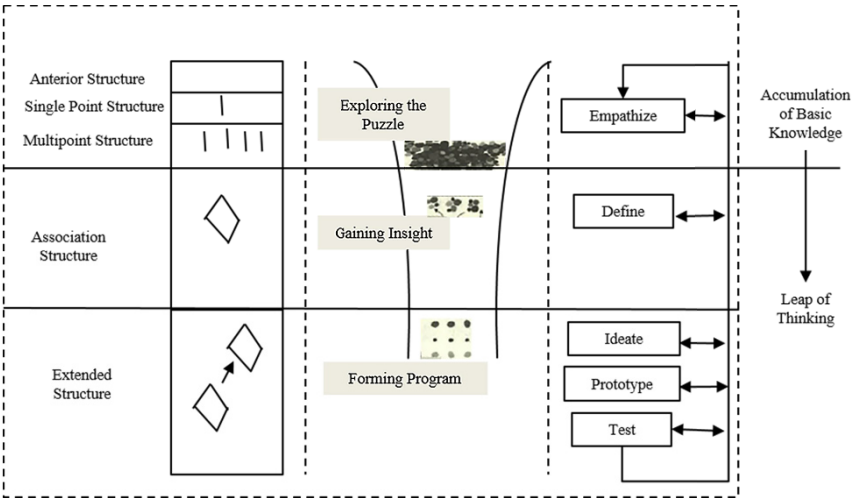

Fig. 1. Framework of design thinking

In summary, we describe these three understandings as three aspects of design thinking, that is, design thinking is the process by which people are able to synthesize their existing knowledge and skills when encountering complex real-world problems, and through the interdependence and promotion of design and thinking, learners' deep thinking can occur and continuously iterate to generate problem-solving strategies and then creatively form ideas and solutions to problems.

2.2 Gamified Learning and Scratch Gamification Instruction

Gamified learning is a kind of instructional design combined with game design strategies, which enables learners to complete the learning content in a playful and relaxed environment. It helps to cultivate learners' initiative, creativity and collaboration [8]. Researchers agree that gamified learning can assist learners strengthen their cognitive and affective abilities while also stimulating their interest and motivation. According to J. J. Vogel et al., using games in the classroom can greatly improve learners' cognition and higher-order thinking, as well as their learning attitudes [9]. Scratch is a graphical programming software. Scratch gamification instruction integrates the idea of game-based learning, allowing students to study while having fun.

2.3 Scratch Gamification Teaching and Design Thinking Integration

Scratch gamification teaching emphasizes the pedagogical rule of continuous iterative improvement of programming to stimulate students' interest. Design thinking is also an iterative cycle that facilitates the output of learning artifacts, and design thinking focuses on the process by which thinking occurs. In a large body of existing research, the space, process, and activities of design thinking (including empathy, crazy ideas, etc.) are viewed as a methodology for innovative problem solving, which involves iterative thinking, visual thinking, rapid prototyping, and out-of-the-box rethinking. So it can be used to guide people through the design process to solve real-world problems in the Scratch gamification classes. Besides, Design thinking is conducive to the cultivation of higher-order thinking such as innovative thinking, and Scratch programming modules in information technology courses are conducive to improving students' creativity such as adventure, imagination, curiosity and challenge [10]. Design artifacts are refined in this iterative process, and the richness of intrinsic human qualities evolves in this iterative process. Setbacks in the problem solving process are considered normal and accepted positively, and when failure is reached quickly, the reasons for failure are recalled downward, new strategies are abstracted upward, and a new iteration is designed as soon as possible to produce the best design product.

3 Construction Of Scratch Gamification Instruction Design Framework Based On Design Thinking

The process of design thinking can reveal a complex and rich structure, so that higher-order thinking of learners can occur.

In view of the above analysis of the conceptual content of design thinking and the structure of design thinking, this study deconstructs it into five core competencies and teaching procedures that are more explicitly operationalized in design thinking-oriented Scratch gamification teaching activities based on the EDIPT model in table 1.

Table 1. Teaching procedures.

EDIPT Model	Procedures	Definition	Higher-Order Objective	Tools
Empathize	Exploring the Problem	Initially Exploring the Problem Idea or Framework	Imagination/ Cooperation	Cognition
Define	Gaining Insight	Determine the Initial Solution for Modeling	Deduction/ Communication	Mind Map
Ideate	Creative Design	Stimulate Innovative	Innovation/	Various Search

		Solutions	Application	Engines
Prototype	Prototype Presentation	Selecting the Best Solution and Made It into a Prototype	Communication/Scratch Cooperation	
Test	Analyze and Iterative Optimization	Evaluation , Reflection, and Iterative Optimization	Critical Reflection	QQ/Wechat / Communication Means

According to above analysis, this study offers such five procedures of Scratch gamification teaching, with the goal of making the process procedural and transparent. Students learn and comprehend programming knowledge and internalize it into higher-order thinking and systematic problem-solving skills. Figure 2 depicts the basic design framework as well as the relationships between the elements according to the aforementioned core concepts.

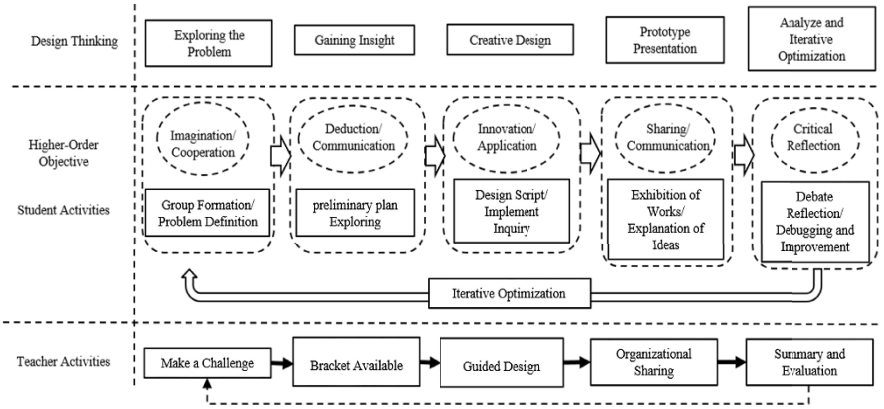

Fig. 2. Framework of Scratch gamification instruction design framework based on design thinking

In terms of teacher activities, teachers mainly play the role of instructor, organizer, supporter and evaluator in the teaching process. At the beginning of teaching, teacher presents the challenges to be completed and team requirements, describe the challenges in detail, provide students with learning supports and timely support, so as to guide the development of the design process. When the design is completed, teacher organizes students to share their works, and evaluate the design products through mutual comments of students and teachers. And encourage students to reflect on their own work and iterative improvement.

In terms of student activities, students mainly play the role of explorers, designers, practitioners and reflectors in the teaching process. After understanding the challenge and defining the task, students explore in a group, brainstorm the design plan, discuss and communicate with each other, carry out the practice of prototyping after the relatively perfect scheme. And then test the prototype works

and optimize and improve the prototype work. Finally, the students reflect on the whole design process, combine the improvement suggestions of teachers or others, and act again, so that the work is constantly improved in the iterative and improvement cycle.

4 Application of The Instruction Design

In this study, 16 students in the senior class of X Middle School in Kunming, Yunnan Province were selected as the subjects who acquire the fundamentals of Scratch software and information technology. It was done in the guise of an 8-hour "Scratch Programming" interest extension class. The following are the specific objectives of this activity: becoming familiar with the basic process of completing game projects with Scratch software; learning to review and optimize game solutions through group cooperation; practicing the spirit of cooperation and sharing; and improving problem awareness and higher-order thinking. The following is the procedure for implementing teaching and learning.

4.1 Exploring the Problem

In the setting of the game "Age of Sail," the teacher explains the task's essential criteria to the students. Following that, under the leadership of the teacher, four groups (dubbed A, B, C, and D groups) were created, each of which investigated the problem situation and the game design job in depth based on their own interests. Problem selection is carried out in the form of teacher-student consultation, which determines the scope of the problem, basic objectives and content, required tools and resources.

4.2 Gaining Insight

After intense discussions and brainstorming, the themes were "Geographic Explorer," "Beijing Opera Culture," "Immunization Battle," and "Deciphering the Water Cycle". Each group presents an initial problem idea or framework to the class in a democratic and focused manner, including: problem objective, basic content, rough scale, and a preliminary idea of a solution. And they required knowledge from a variety of disciplines as well as life experience to create real and complex problem situations, with Group C being particularly relevant to current epidemic control knowledge.

4.3 Creative Design

The teacher conducts a game script and software design analysis, then advises students on how to combine knowledge content with game concepts and develop scripts. The teaching scaffolding is gradually decreased to focus on procedural and strategic features in order to provide students ample room to expand their higher-order talents and obtain enough expertise in handling complicated circumstances. For example, Group C established three levels for the mechanism of action of the immune system's three lines of protection against various infections. After much deliberation, they concluded that they might combine their knowledge of epidemic prevention and control with their understanding of the human immune system's mechanism of action to improve prevention awareness. As illustrated in Figure 2, they created a logic block diagram for the game script.

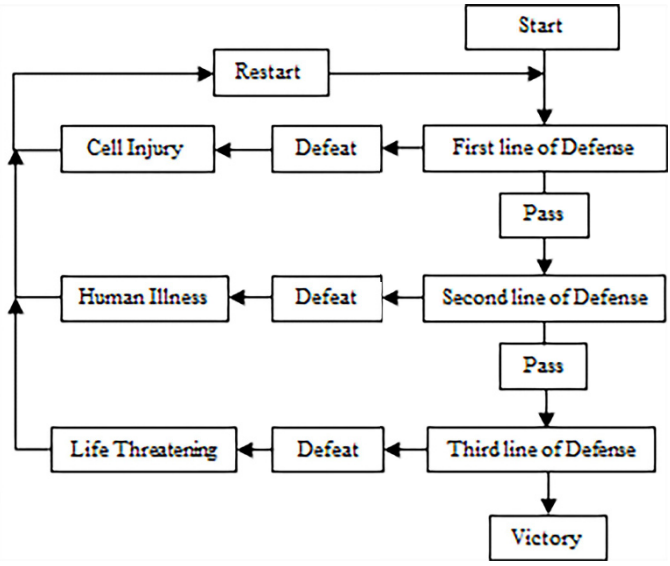

Fig. 2. Game script logic diagram of group C

In the process of communication, students further focus, revise and refine the problem, modify the plan, and teacher comments on them again. In this way, the initial plan of problem modeling and solution – game script are finally determined after several rounds.

4.4 Prototype Presentation

The teacher allows plenty of time for the kids to construct the game, and each group utilizes the Scratch programming software to display the game through the process of continuously improving the script design. When all the groups have

finished programming the game, teacher leads a sharing session in which each group reports on their work's design goal, task division, implemented functionalities, and experience gains. Throughout the process, students' confidence and skill developed.

4.5 Analyze and Iterative Optimization

Each group merged the suggestions of others with the game's own procedural issues, adjusting the first three steps of reflection and programming in the critical thinking process on a constant basis. Finally, each group came up with a more comprehensive screenplay and game. For example, group C's immune cells were unable to attack pathogens due to the incorrect location and number of appearances of immune cells lysozyme, white blood cells, and phagocytes set in the second line of defense programming language. After continuous iterative optimization, the program and work were optimized, and the final prototype work of this part is shown in Figure 3.

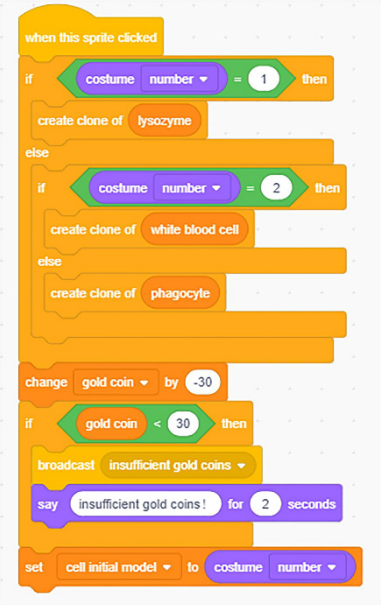

Fig. 3. Game programming procedure of group C

To sum up, Scratch gamification teaching emphasizes students' autonomy in solving problems, bold creativity in game design, effective teamwork, experiences the true joy of "learning by doing," and realizes the transformation from "passive acceptance" to "active investigation". Some students expressed optimism and determination in post-class interviews, saying, "There are always more ways than

problems, and there are better ways than the present ones". In the whole process of Scratch gamification learning, guided by the development of higher-order thinking through design thinking, students' understanding of knowledge is gradually promoted and deepened in the process of problem solving, and students' exploration ability, complex problem solving ability, teamwork ability and interdisciplinary thinking ability are developed.

5 Conclusion

In this study, design thinking is utilized to lead Scratch gamification instruction, which is a specific attempt to carry out wisdom education practice. It serves as a resource for resolving problems such as a lack of depth of experience and unclear objectives in the Scratch programming instruction. It also offers a practical technique to investigate how to develop innovative talents who can utilize their heads and hands, collaborate and resist irritation, criticize and create for the future high-tech period.

It's worth noting that the current study is still in its early stages, with only a few participants and a single theme. Although design thinking is beneficial to gamifying Scratch teaching to improve students' higher-order thinking, we should not expect this method to carry the entire content of programming education. Instead, we should expect more subject teachers to have a deeper understanding of gamification teaching, analysis and assessment of higher-order ability development, and master the method of systematic application so that they can consciously integrate them into their subject-specific teaching practices.

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Study on the Intervention of Promoting Secondary Students' OSRL Skills: A Latent Profile Analysis

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Abstract. Online self-regulated learning (OSRL) ability has been widely noted as a factor affecting the quality of online learning. However, the OSRL ability of secondary school students hasn't received the attention it deserves. Therefore, we applied latent profile analysis to identify subgroups of students. The research sample consisted of 139 eighth-graders. We identified three different self-regulated learning (SRL) profiles, ranging from low to high OSRL skills. In addition, we explored the differences between the three OSRL skills profiles. Based on these findings, the study proposes appropriate intervention strategies for subgroups with different OSRL abilities, as well as suggestions to designers of online learning environments.

Keywords: OSRL · Intervention · Online Learning · Metacognition

1 Introduction

As the COVID-19 pandemic sweeps across the globe, online learning has gained more attention [1]. However, in the global online education practice, education researchers gradually realized that learners in the online learning environment are not performing well. They are faced with an unprecedented number of complex learning tasks as well as learning resources [2]. The lack of high-quality teachers, peers, and platform support in the learning process makes the situation worse. The inescapable difficulties of online education also included deficient interaction between peers and teachers, which is an important way to get help and support [3].

It's proved that self-regulated learning ability has a certain impact on learning effectiveness [4]. It's crucial in the online learning environment as well [5]. To some extent, the success of online learning depends on learners' online self-regulated learning (OSRL) ability [6,7]. The lack of OSRL ability is counted as a reason for students' low performance and satisfaction [8]. Thus, cultivating learners' OSRL ability should be the goal to achieve, for its great necessity.

Up to now, studies have proposed intervention measures and implementation suggestions for improving OSRL ability [9,10], which can be divided into the following categories: external tools, platform intervention or path recommendation, study groups. However, they were conducted mainly in universities, while few of them were related to K-12 [11]. Although online learning effectiveness is shown to

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be associated with the OSRL ability of middle school students, this group has not received enough attention yet, and the research of OSRL still needs to be expanded and deepened. Thus, in order to investigate and improve the OSRL ability of the target group: secondary school students, the questions we address in the current study are as follows:

RQ1: What are the latent profiles of OSRL skills among secondary students?

RQ2: What are the differences between the different OSRL skills profiles?

RQ3: What are the implications of differences in OSRL ability among learners of different profiles for the design of online learning interventions?

To this end, we investigated the OSRL ability of students in a local secondary school. After that, preliminary processing and latent profile analysis were performed on the data collected. Then, according to the general situation of OSRL ability and learning needs of secondary school students, operational intervention strategies for promoting OSRL ability are put forward. This study is expected to provide a certain reference for the design of online learning platforms and materials, so as to make contributions to the high-quality development of online learning.

2 Literature Review: OSRL Interventions

OSRL is the new embodiment of self-regulated learning (SRL) skills in an online learning environment. Research on SRL has been very mature, including theoretical studies on its factors, structural models, and measurement, as well as a large number of empirical studies.

Some researchers will give students self-regulated learning guidance specially, which has a certain effect [12]. But in most studies, intervention is not part of the learning process [13]. With the development of online learning, the feasibility of embedding interventions in the learning process and learning environment has further improved. In Fitriyana's study [14], video conferencing and gaming interventions in chemistry teaching were proved to be effective. Mou [15] pointed out that a structured weekly diary helps students with goal setting, time management, self-monitoring, and self-assessment.

Compared to learners in traditional face-to-face classrooms, online learners receive limited support from teachers. While understanding learners' behavior helps researchers gain insight into the right types of interventions that can be offered to online learners. So making use of the various online learning data is valuable to determine the appropriate technology of Educational Data Mining (EDM). Araka identified the most appropriate algorithm to use EDM [16]. In [17], a digital concept map was used to support self-evaluation as an intervention, found that although students only perceived the effects at two levels: goal setting and task strategy. In addition, it turns out that beyond the result, environment structuring and time management have improved as well.

In conclusion, with the increasing focus on informatization in recent years, the trend of intervention methods has also changed under the background of intelligent education: mainly changed from enhanced interaction and gamification integration based on Motivation Theory, to goal setting and task strategy based on Item Response Theory (IRT) and Cognitive Diagnosis Model (CDM). Accordingly, self-evaluation has shifted from self-evaluation without evidence to self-evaluation supported by learning analysis.

3 Method

3.1 Participants

A convenience sample of secondary students was drawn from grade eight in a public school located in Zhejiang, China, where there are ten classes in this grade. In this study, as representative samples by cluster sampling, a total of 139 adolescents aged 13-15 from two classes were selected. This group of students has a basic knowledge of computer operations and networks.

When asked about previous online learning experiences, 95% (n = 124) indicated they knew about and had participated in online learning in the past, 5.7% (n = 8) indicated that they had taken an online course in the past, but only once. Also, 5% (n = 7) indicated they had never taken an online course before and were excluded from the data analysis. After excluding invalid data, demographic statistics show that there are 73 female students (55.3%) and 59 male students (44.7%) in this sample.

3.2 Instruments

In this study, the Online self-regulated Learning Questionnaire [18] (OSLQ) to investigate students' OSRL ability. OSLQ consists of 24 items that measure online learners' OSRL ability and strategies on six dimensions. This instrument is comprised of 24 items, each measured on a five-point Likert type scale and have values ranging from strongly agree (5) to strongly disagree (1). The average of all subscales provides a measure of overall OSRL, with higher scores indicating higher levels of self-regulation. It has shown satisfactory psychometric characteristics in samples of learners in past online and mixed learning environments.

As the study focuses on secondary school students who are not able to read in English fluently, the items in the scale are translated into Chinese in this study. At the same time, appropriate adjustments to several ambiguous or untargeted items are made. After modification, this scale includes 21 items and 6 dimensions. In this

study, Cronbach's alpha coefficient of the questionnaire is 0.95, Cronbach's alpha coefficients of each subscale are as follows: goal setting (.867), environment structure (.781), task strategy (.863), time management (.87), help-seeking (.78) and self-evaluation (.855).

3.3 Data collection and processing

First of all, we explained the concepts and announcements related to filling in the questionnaire to the students, to help them participate in the survey smoothly. Then they will have 10-20 minutes to complete the questionnaire.

After preliminary screening, we collected 132 valid questionnaires totally. In the next step, SPSS26.0 was used in this study for data management and descriptive statistics. Then, Mplus5.0 software was used to conduct latent profile analysis[19] on the data of each indicator of learners' OSRL strategy level, to determine the classification of heterogeneity of their OSRL strategy level.

4 Results

4.1 Descriptive statistics

Descriptive statistics on the purposes of online learning were calculated to report frequencies and percentages for categorical variables, which are shown in Table 1. Also, taking individual cases as a unit, the frequency of different purposes of online learning is presented in Fig. 1. Table 2 presents the descriptive statistics of the self-report questionnaires' scales of OSRL and motivation.

As presented in table 1, it can be concluded that most of the students in this group have online learning experiences different purposes. Thereinto, online learning for after-school tutoring for school courses takes up the highest proportion, accounting for 68.9%. After-school tutoring for school courses is the main purpose of online learning for middle school students in this area. More than half of the students studied online for the expansion and improvement of knowledge and skills, which is a way to expand their knowledge and boost their competitiveness. There are many possible reasons for the low proportion of online learning for cultivation and development of hobbies, such as students are under great academic pressure, or the quality of offline courses of interest is higher than that of online courses, et al. There is a large variance in students' OSRL behavior as presented in Table 2, because the standard deviations for each questionnaire scales are rather high (especially for Task-Strategy and Time Management, which might be on account of the curriculum design from teachers).

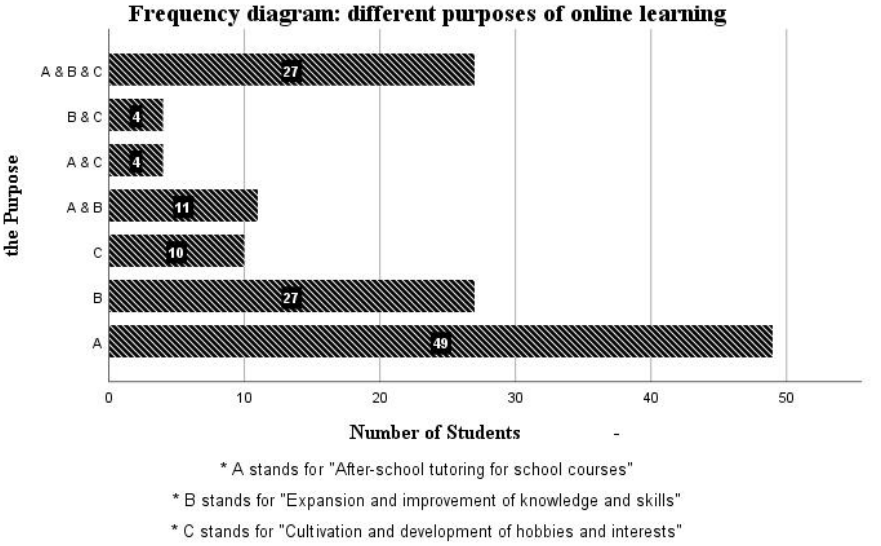

Fig. 1. Frequency diagram: different purposes of online learning

Table 1. The frequency and valid percentage of the purpose of online learning

The purpose of online learning	Frequency	Valid Percentage
After-school tutoring for school courses	49	37.1%
Expansion and improvement of skills	27	20.5%
Cultivation and development of hobbies	10	7.6%
After-school tutoring & Improvement of skills	11	8.3%
After-school tutoring & Cultivation of hobbies	4	3.0%
Improvement of skills & Cultivation of hobbies	4	3.0%
All three purposes	27	20.5%
In total	132	100.0%

Table2. Descriptive statistics for each questionnaire scale (1–6) of OSRL: mean and standard deviation, Cronbach's α, and Pearson correlation coefficients (1–6).

Scales	items	M	SD	α	2.	3.	4.	5.	6.
1. Goal Setting	4	3.58	.96	.87	.69**	.72**	.62**	.64**	.70**
2. Environment Structuring	3	3.90	1.00	.78	-	.61**	.49**	.58**	.59**
3. Task-Strategy	3	3.31	1.14	.86		-	.78**	.67**	.67**
4. Time Management	3	3.35	1.13	.87			-	.64**	.60**
5. Help-Seeking	4	3.10	1.08	.78				-	.70**
6. Self-evaluation	4	3.40	1.05	.86					-

Note. **p < .001 (two-tailed), the correlation was significant.

4.2 the Latent Profile of Online Self-regulated Learning

Selection of the number of clusters. Table 3 contains eight different model fit statistics that were used to evaluate which LPA model fits the data best. It can be concluded that model 7 was the best model fit to the data based on the lower log-likelihood, AIC, BIC, and aBIC values, the higher entropy value, and the nonsignificant LMR test. The log-likelihood, AIC, BIC, and aBIC values showed relatively large decreases in the comparison between model 1 and 2, 2 and 3, until the difference between models 4, 5, 6, 7, and 8. Entropy was best (i.e., >0.80) in models 3, 5, 6 and 8. The results of the LMR test indicate that model 7 was a better fit than model 6, and that model 8 was not a better fit than model 7.

Table 3. Latent profile analysis model fit summary for differ
ent models with a number of clusters 1-8

No.	AIC	BIC	aBIC	Log-likelihood	Entropy	LMR p and meaning	
1	2357.36	2391.95	2354.00	-1166.680	-	-	-
2	2026.20	2080.97	2020.88	-1166.680	0.898	0.0010	2>1
3	1919.99	1994.94	1912.70	-994.100	0.920	0.1208	3<2
4	1873.36	1968.49	1864.11	-933.993	0.883	0.5359	4<3
5	1838.08	1953.39	1826.87	-903.679	0.926	0.3398	5<4
6	1806.11	1941.60	1792.94	-879.039	0.944	0.2697	6<5
7	1784.42	1940.09	1769.29	-856.053	0.923	0.0322	7>6
8	1771.62	1947.47	1754.53	-838.209	0.934	0.8772	8<7

Note. n = 132; The LMR test compares the current model with a model with k - 1 profiles. AIC = Akaike's Information Criterion; BIC = Bayesian Information Criterion; aBIC = Sample-Adjusted BIC; LMR = Lo-Mendell Ruben Likelihood Ratio Test.

In practical application, the evaluation indicators are not consistent, and different information indexes may indicate different models that fit the data best. In this case, the final classification number should be determined by combining the practical significance of classification and the number of samples contained in the classification [20]. Therefore, this study adopts the steep slope diagram test similar to that used in EFA to determine the number of factors, the result is shown in fig. 2. As presented in fig. 2, There is a clear inflection point at 2 and 3, so it is appropriate to select 2-3 categories.

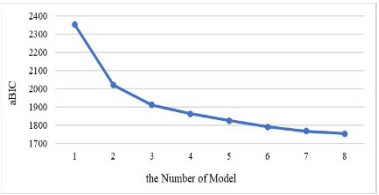

Fig. 2. Steep slope value diagram of aBIC

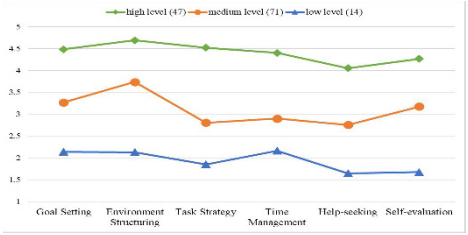

Fig. 3. Comparison of OSRL profile (n) online SRL on different scales.

Therefore, the available models are 2,3,7. However, it is found that the members of the smallest profile were less than 5% in model 7, which could indicate that it's a

statistically spurious profile. This might be relevant to the limited number of samples in this study (n=132). Therefore, after model 7 is excluded, model 3 is finally considered as the appropriate OSRL profile according to the analysis needs of this study. Overall, it can be concluded that model 3 indicating three different SRL profiles fits the data best.

Description and analysis of the self-regulated learning profiles. According to the information presented in Table 3 and Fig. 3, about half of the group of the students (n=71, 53.8%) have OSRL ability that fit medium level, about one-third of them (n=47, 35.6%) are still at low level OSRL ability, and only about one-tenth of them (n=14, 10.6%) reach high level OSRL ability. The result indicated that students at this stage have preliminary OSRL ability, but the overall level is not high. The overall distribution of students' ability levels was spindle-shaped, i.e. more in the middle and less at the top and bottom. Most of them were in the middle and low levels, and only a few of them had average scores of more than 4 in all subscales. More analysis and interpretation will be explained in RQ2 and RQ3.

To answer the second research question, we contrast the main differences between the three profiles in these interpretative labels. First of all, the three profiles can reasonably divide the group of students according to the difference in OSRL abilities, including low, medium, and high levels. There are marked differences between these three types of students both in level and potential in OSRL ability. Therefore, it is necessary to provide tools or strategies to meet the needs of high level students, as well as online learning environment intervention for low and medium level students.

According to the differences between the three profiles, we can put forward corresponding suggestions on the direction and methods of short-term improvement for them. As presented in Table 3 and Fig. 3, The best-developed sub -ability of OSRL in this group of students is time management. The biggest difference between middle level and low level is reflected in environment structuring and self-evaluation, which is closely related to metacognitive ability. It is obvious that evaluating and adjusting their environment and themselves have great significance. To make the leap from medium to high level, more attention should be paid to task strategy and time management strategy. Therefore, it is helpful to provide clear information about the learning task, including content, difficulty, amount of work, and so on. In addition, helping students become more sensitive to the passing and planning of time should also be effective.

Table 4. Descriptive statistic(mean) of the three profiles for OSRL

Scales of OSLQ	**Scores**		
	High level OSRL (n=14,10.6%)	Medium level OSRL (n=71,53.8%)	Low level OSRL (n=47,35.6%)
goal setting	4.485	3.266	2.138
Environment Structuring	4.690	3.735	2.131
Task-Strategy	4.522	2.804	1.851
Time Management	4.402	2.897	2.163
Help-Seeking	4.051	2.753	1.647
Self-evaluation	4.264	3.173	1.673

5 Discussion

To answer the third research question, the study will carry out the discussion based on the literature review and Result section. Developing OSRL should be a way of learning as opposed to a time-limited intervention practice [21]. In the above, the OSRL interventions have been classified by features in this study. Based on the classification of OSRL ability of middle school students: low level, medium level, and high level, the third question can be analyzed as follows.

As presented in Fig. 3., All students are deficient in the ability of help-seeking. Therefore, creating an online learning environment for students that supports communication and discussion can be valuable. Such interaction can be between students [22], teachers and students [23], or even student-computer interaction [24].

For students with high level OSRL, it's sufficient to provide adequate and appropriate OSRL support. They need immediate and enough feedback on their learning, to adjust the learning methods and strategies according to the learning effect and experience. Specific cases are graphical cues like concept map [25], e-portfolio [26], learning analytics dashboard [27], et al. All of them are proved to be effective. For students with medium level OSRL, continuous encouragement and achievement motivation is the key point. As we can see in Fig. 3., their task strategy and time management are weak. So tools to develop their sense of time might be helpful. Furthermore, prioritizing tasks according to their content and difficulty would allow them to structure their knowledge more scientifically. For students with low level OSRL, direct skills teaching is one step that can be taken [28]. In addition to that, clear tool guidance and concise usage instructions can be of great help.

For OSRL intervention designers, it is the most effective way to prepare tools and offer strategies tailored to the learners' characteristics and needs. Therefore, rather than providing a generic template, this study proposes corresponding intervention strategies according to different OSRL levels of student groups individually as well as integrally.

6 Conclusion

OSRL ability is critical to the improvement of online learning effectiveness and experience, and it is also one of the abilities that affect the lifelong learning quality of learners. By reviewing existing research on interventions for OSRL, this study enumerates and classifies the interventions mentioned and be studied. The trend in the development of the OSRL intervention is pointed out as well. Then, the OSRL

ability of 139 eighth-graders in a local secondary school was investigated, a cluster sampling method was adopted in the procedure. According to the general situation of OSRL ability and learning needs of middle school students, the intervention strategies to improve OSRL ability are put forward, which included individual and integrally suggestions.

It is expected to provide a reference for online learning environment designers and teachers to improve students' OSRL levels by improving the design of learning platforms. Theoretically, this study can provide empirical evidence that, from the perspective of intervention design, there should be a different scheme for different OSRL levels of students. In addition, it can promote understanding of OSRL, which should be considered as skills that facilitate learning and a healthy learning style and attitude.

Additionally, the latent analysis may involve other situations where it is difficult to draw firm conclusions because of the diversity of learners, which requires more elaborate research. Also, in this study, intervention strategies are suggested, rather than a plan of action. This deficiency needs to be made up by developing the middle school students' learning platform and applying the practice in the later stage. In conclusion, this study only conducted a horizontal profile analysis on the student population, without a follow-up study. It is necessary to conduct some longitudinal studies on OSRL (supported by [29]).

Based on the results of this study, future studies will develop corresponding learning platforms with OSRL interventions. After that, we will conduct subsequent studies based on this platform. It is hoped to supply more sufficient results which will support the evidence gathered so far.

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The Application of Barrage Technology in College English Classroom Interaction

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Abstract. In recent years, there has been a gradual increase in information-based teaching in domestic university classrooms. However, there is scant research on the use of barrage technology in higher education. This study conducts a comparative experiment in two universities English classes of students majoring in preventive medicine and pharmacy in a university in southeastern China. It aims to investigate the application of barrage technology in college English classes. By comparing the application of barrage technology in two classes, we try to address two questions: What is the overall teaching effectiveness of the application of barrage technology in two college English classes? What are the differences in the number and content of barrages between the anonymous and non-anonymous classes? The results of the study show that the use of barrage in university EFL classrooms has positive effects. It not only helps to promote learners' motivation, stimulate their interest in learning and deepen classroom interaction but also provides data support for teachers to monitor the learning process, track learning behavior, and improve teaching efficiency. This study has a reference value for the in-depth integration of smart teaching tools and foreign language teaching.

Keywords: Barrage · College English Classroom · Interaction

1 Introduction

1.1 Research Background

"Barrage" first appeared on the Japanese barrage video sharing site Nico Nico anime, and then appeared in China on the AcFun (Station A) and BiliBili (Station B). Initially, the barrage was limited to young people and the ACG (Animation, Comic, and Game) community and was not widely used. It was not until 2014 that this particular mode of commentary began to appear on a large scale in traditional media, such as cinema, television, and mobile apps, and research on barrage began to receive increasingly widespread attention from many scholars.[1]

The application of barrage technology in education in other countries is earlier than that in China. For example, Aida Suraya et al. studied the effects of using

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barrage webcasting technology for lectures in college teaching.[2] L, Suh A et al. conducted an empirical study on the behavior of users using barrage for interaction.[3] Hamerly. D. W et al. studied the interaction of barrage in online learning websites.[4] A search of the studies of barrage technology in education in the Chinese knowledge resource database reveals that there is scant research on the use of barrage technology in higher education. As the application of barrage technology becomes more and more widespread, more attention should be paid to the use of barrage technology in different majors in higher education. There is currently more information-based teaching in foreign language teaching. For example, among the studies on teaching platforms (such as Chao Xing, MOODLE, and other platforms), Ge et al. built an English teaching platform based on a corpus and researched related teaching models.[6] Zhou built a university English teaching platform based on humanism and constructivism in 2010. Ge et al. also based on a bilingual parallel corpus of translation teaching platforms and researched teaching models.[7] There are also studies on other online resources such as MOOCs. Chen conducted a study on MOOCs and foreign language teaching in the era of big data in 2015. Jiang et al. conducted a study on the integration of flipped classrooms and MOOCs in 2015, and Zhang et al. conducted an experiment on a flipped classroom -teaching model based on Moocs in 2015. In contrast, there is little research on the application of barrages in higher education, and there are certain research gaps.

1.2 Structuring Your Paper

The classroom is the main setting for the transmission of knowledge. In this particular setting, the teaching subjects interact with each other with the help of words, physical or gestures, and teaching tools. Good classroom interaction not only provides powerful support for classroom teaching but also enables teachers to keep track of students learning dynamics and effectiveness and to adjust the teaching schedule in time. However, as far as the current situation of classroom interaction in universities is concerned, there are still many problems. For example, Meng et al. proposed that the current classroom interaction in colleges and universities lacks autonomy and enthusiasm, there is unfairness in classroom interaction, and the content of classroom interaction is relatively single.[8] Some scholars have also pointed out the problems in the new teacher-student interaction in their research. For example, Fan pointed out in her research that the lack of teacher-student emotional interaction is reflected in the serious imbalance between cognitive and emotional goals, in the lack of interactive feedback between teachers and students as well as the weakened or substituted role and function of teachers.[9]

The introduction of barrage technology into classroom interaction has provided more possibilities for the reform of face-to-face teaching methods, and it is conducive to enhancing students' learning initiative. In the era of “Internet+”, based

on the development of the current video interaction technology-barrage, a new idea of “barrage technology-assisted teaching interaction” has emerged. The researcher conducts a study based on the new classroom interaction method of the barrage, hoping to explore the effectiveness of barrage technology in college EFL classrooms. This study may provide evidence of the usefulness of a new mode of classroom interaction and provide further thinking for educational development.

2 Literature Review

While traditional classroom teaching is still the main form of teaching in China, barrage technology has been used in the US, Japan, and some universities in China. The use of barrage technology has increased the frequency of interaction between teachers and students in the classroom and has provided more opportunities for students who want to speak but are too shy to do so for various reasons to express their ideas, improving the atmosphere of the classroom to a certain extent.

2.1 The Classification of the Barrage

In the research on the application of barrage technology, scholars have classified the barrage data in their research. Li classified barrage data into Positive acceptance and recognition (extension, recognition), Negative taunt, and sarcasm (restraining, querying).[10] Zhang et al classified barrage data into Positive emotion barrage and Positive emotion barrage.[11] Meng et al. classified barrage data into Barrage of students asking questions, Barrage of students answering questions, Barrage During the break, and Barrage about quiz answers.[8]

Based on the classification of barrage data by previous scholars, this study takes into account the requirements of classroom activities and the characteristics of barrages, rather than classifying them simply by nature (positive or negative), and then classifies them into the following five more comprehensive and objective categories: question and answer, group discussion, polling, divergent questioning, and peer review.

2.2 The Studies of Barrage Technology in Education at Home and Abroad

According to previous research, studies of barrage technology in classroom interaction can be divided into two categories: Barrage technology in traditional classroom studies and online classroom studies.

Research by foreign scholars has focused on the use of barrage technology in online video teaching or online live teaching. For example, Aida Suraya et al. studied the effect of using barrage webcasting technology in university teaching, through several sets of comparative experiments, observed the responses of teachers and students, and concluded that barrage technology interactive live teaching can effectively improve the teaching effect. Hamerly. D. W et al. studied the interactive effects of barrage technology on online learning websites and proved their effectiveness in promoting teaching and learning. [4]

The application of barrage technology to teaching in China is later than abroad. The relevant research in China started later than abroad, both in traditional classroom studies and in online classroom studies. In June 2015, Wang Yanjuan, a teacher at Zhejiang University of Technology, first applied barrage technology to classroom teaching. In May 2016, Professor Zhang Xiaoqiang of Chongqing University introduced barrage-assisted teaching; subsequently, Sichuan University, East China Normal University, and other universities have adopted the new classroom-teaching mode of "interactive teaching with barrage technology".

In terms of classroom interactivity, several scholars have done research on the impact of barrage on college classroom interactivity and found that the use of barrage technology has achieved instant communication and interaction between teachers and students with full participation, increased the motivation of student interaction, effectively promoted classroom interaction, and achieved better interactive effects.[5,8,12,13] In terms of student classroom participation and motivation, several scholars have also found through empirical studies that barrage technology has a positive impact in terms of enlivening the classroom atmosphere and increasing students' motivation and classroom participation.[14,15,16,17] In addition, some researchers have found that barrage language can enhance the infectiousness, relevance, and attractiveness of classroom discourse and improve college students' attention and engagement.[18] "Barrage" assisted teaching increased students' behavioral and emotional engagement and positively contributed to students' learning cognition.[19] Barrage technology helped to improve the efficiency and quality of students' classroom learning and teachers' classroom teaching quality, and helped to establish a new type of teacher-student relationship.[20] Dai and Chen list four obvious advantages of the integration of barrage technology into teaching.[15]

(1)Improving students' learning motivation;

(2)Facilitating timely communication between teachers and students, and establishing a new type of teacher-student relationship;

(3)Facilitating the development of students' personalities;

(4)Improving the efficiency and quality of students' classroom learning.

When studying the use of barrage technology in online education, Zhang et al. analyzed the learning interaction of barrage technology videos and found that barrage technology helped to promote emotional communication between teachers and students to a certain extent, enhance learners' sense of social presence and

reduce their loneliness in the online learning process.[11] Lu and Wu did sentiment analysis of online classroom barrage comments, to provide effective data support for the development and modification of teaching plans through sentiment analysis of barrage technology texts. Wang et al. discussed the timeliness of barrage technology in the online classroom.[21] They argued that "barrage technology" is helpful to learners in terms of knowledge memory, but insufficient in terms of course application promotion and learning facilitation, and should be enhanced in the teaching process. The level of intelligence should be enhanced.

However, there is still little research on the application of barrage technology in foreign language teaching, especially on the characteristics and functions of barrage language. We need to conduct related empirical studies to fill this gap and help promote the wider application of barrage technology.

3 Methodology

3.1 Research Methodology

This study will use a mixed research approach, using elements of both qualitative and quantitative research methods, including participant observation, personal interviews, and questionnaires, to collect, analyze data, integrate findings and draw inferences to expand the breadth and depth of understanding and substantiation.

3.2 Research Subjects

The subjects of this study were the control group composed of two administrative classes of 2021students majoring in Preventive Medicine and Pharmacy from the School of Medicine in Hangzhou Normal University, Zhejiang Province. One of the classes is a non-anonymous class, which is labeled as Class A, and the other class is an anonymous class, which is labeled as Class B. Class A consists of 37 students and Class B consists of 36 students.

3.3 Research Tools

This study used a Lenovo desktop computer, an interactive multimedia display platform, a Haodanmu software platform, and a Wenjuanxing platform. After integrating barrage into English classroom interaction, we use a questionnaire to know about students' feedback and evaluation of this technology. There are

twenty-four questions in the questionnaire of this research, which mainly involve two categories: basic information of students, students' attitudes towards using barrage technology to interact in class. In addition, the student personal interview consists of four questions, which mainly focus on the frequency and method of students participating in English classroom interaction, their attitude towards the application of barrage technology in college English classroom interaction, and their evaluation and suggestions on the application of barrage technology in college English classroom interaction. Four students participated in personal interviews.

4 Data Analysis and Discussion

This study analyzed the data of the use of barrage based on our three research questions.

(1) What is the overall teaching effectiveness of the application of barrage technology in two colleges English classes?

(2) What are the differences in the number and content of barrages between the anonymous and non-anonymous classes?

4.1 Questionnaire Results and Analysis

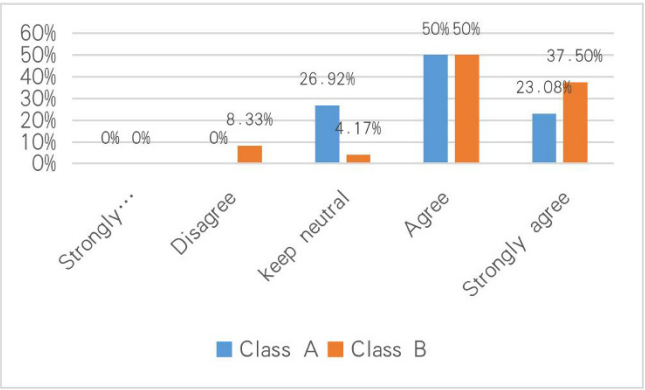

Fig. 1. Students' attitude to use barrage to interact with others in the class

Regarding question 1, the table above shows that a total of 19 students in Class A showed positive attitudes (73.08%), with 23.08% of them considering themselves to be "very positive" in sending barrages and 50% of them considering themselves to be "positive" in sending barrages. A total of 21 students in Class

B showed positive attitudes (87.5%), with 37.5% of students considering themselves to be “very active” in sending barrages and 50% of students considering themselves to be “active” in sending barrages.

In the traditional classroom, students are asked questions and are allowed to answer them, with little opportunity to express their views and the frequency of interaction between students is low. With barrage interaction, there are many opportunities for students to interact with the teacher and with each other, and students are motivated to express themselves. The above data also clearly indicates that the majority of students are actively willing to participate in class discussions in the form of barrage interactions, which has the effect of enhancing the learning atmosphere.

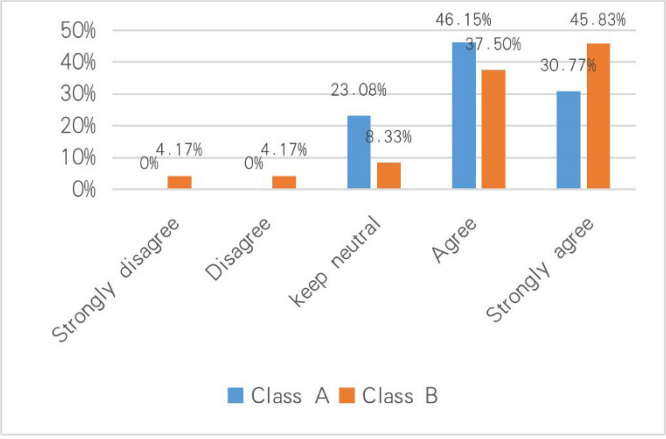

Fig. 2. The effectiveness of barrage in classroom interaction compared with traditional classrooms

In question 2, 20 students (76.92%) in class A thought that barrage interaction was better than traditional classroom interaction, with 8 students strongly agreeing and 12 agreeing, 30.77% and 46.15% respectively. In Class B, 20 students (83.33%) thought the barrage interaction method was better than the traditional classroom interaction method, with 45.83% strongly agreeing and 37.5% agreeing. 2 students were neutral, 1 disagreed, and 1 strongly disagreed.

Through the one-semester experiment, a high percentage of students in both Classes A and B thought that the barrage interaction method was better than the traditional classroom, proving that the majority of students recognized the barrage interaction method.

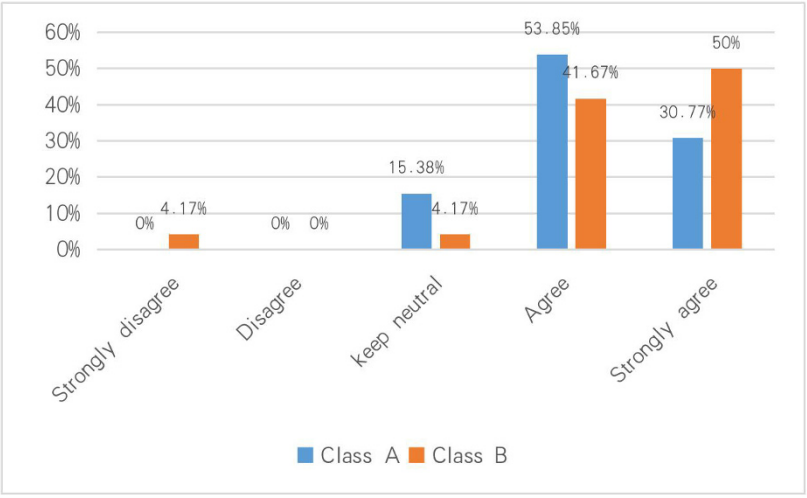

Fig. 3. Students' willingness to use barrage in classroom interaction

Regarding question 3, the above data indicated that after exposure to the barrage interaction format in classes A and B, twenty-two students in class A, or 84.62%, supported the interaction format; four students were not sure if they agreed with the interaction format. Twenty-two students in class B, or 91.67% of all participants, said they are satisfied with the barrage interaction format in college English classes.

According to the above data, 65.38% of the students in class A believe that the interactive method of classroom barrage help to improve the teaching effect of the teacher, and the corresponding proportion of the students in class B is 79.17%. It indicates that more than two-thirds of the students in both classes believed that the interaction of the bullet screen was helpful to improve the teaching effect.

According to the above data analysis, it can be known that in the minds of students in class A and class B, the interactive way of bullet screen can improve their sense of participation in the classroom, and improve their enthusiasm for speaking in class. In some respects, the way of bullet screen interaction does have better effects than traditional classroom interaction, especially in today's Internet age, the way of bullet screen interaction is more favored by college students.

4.2 Barrage Content Analysis

For the use of barrage technology in university EFL classrooms, we analyzed the number of barrages sent by students in both classes and the specific word frequency.

Tab. 1. Polling 1 Class A and Class B

Polling	Choice		
A thinker, doer, or social person?	Thinker	Social person	Doer
Number (Class A)	17	11	9
Proportion	45.95%	29.73%	24.32%
Number (Class B)	29	6	1
Proportion	80.56%	16.7%	2.7%

As you can see from the above voting results, 37 students in Class A and 36 students in Class B participated in the voting. All students in classes A and B participated in the voting, indicating that students were actively involved in the barrage interactive process in class.

Tab. 2. Polling 2 Class A and Class B

Polling	Choice	
Should college students do part-time work?	Yes	No
Number (Class A)	34	2
Proportion	94.44%	5.56%
Number (Class B)	35	1
Proportion	97.2%	2.8%

The above data shows that 36 students in Class A voted, and one student is on leave. 36 students in Class B voted. The results were similar, with students actively participating in the interactive voting sessions.

Tab. 3. Polling 3 Class A

Polling	Choice		
Do you like the current online + offline hybrid teaching model?	Thinker	I do not care.	No.
Number (Class A)	23	10	1
Proportion	67.65%	29.41%	2.94%
Number (Class B)	27	6	3
Proportion	75%	16.7%	8.3%

Similar to the results of the two polls above, thirty-four students in Class A voted, while two other students were absent and one student did not participate in the voting. 36 students in Class B voted and no students were absent, indicating that students in both Classes A and B were very active in the voting category barrage sessions.

Regarding the question and answer type of barrage, the question asked by the teacher at that time was what is your favorite pastime? 43 barrages were collected in Class A, of which three were invalid; 42 valid barrages were collected in Class B. The above data shows that anonymity does not have a significant impact on the sending of this type of barrages. In terms of content, there was no significant comparison between the two classes in terms of the content of the barrages sent by students in both classes.

Regarding the dispersed question type of barrages, Class A collected 21 valid barrages and Class B collected 40 barrages, including one invalid one. In terms of the number of this type of barrages, Class B sent twice as many as Class A, suggesting that students are more willing to send barrages when they are anonymous, whereas in non-anonymous situations students may be more apprehensive and less motivated in class. In such barrages, many different responses appeared in both classes, with Class A having the highest frequency of responses in the categories of bleeping, not memorizing words, and knowing, while Class B had the highest frequency of responses in bleeping, You Dao, and hundred words. The wide variety of responses is also in line with the characteristics of the loose question barrages, as the content of students' responses in both classes reflects their loose thinking process.

For the peer review category, students worked in groups to introduce one type of cybercrime, and other students in their seats sent barrages to comment on the group presentation. Class A collected 109 active barrages and Class B collected 258 active barrages, with Class A and Class B sending the most barrages in this category. Class A had 52 compliments type of barrages, 15 cheers type of barrages, and 42 funny types of barrages. Class B had 155 compliments type of barrages, 42 cheers type of barrages, and 61 funny types of barrages. However, with equal numbers of people in Class A and Class B, Class B sent twice as many barrages as Class A. This is good evidence that students are more willing to express their emotional views in anonymous situations, especially in peer interaction sessions. In addition to the vocabulary barrages collated above, the more frequent content of these barrages was a variety of emoji, many of which were encouraging, and the classroom atmosphere reached a high point as the students on stage were encouraged by the content of the barrages to show their confidence and enthusiasm.

5 Conclusion and Insights

Barrage technology offers a new direction for teaching and learning. It offers more possibilities for integration as the EFL classrooms in higher education are closely linked to multimedia teaching. The experimental results show that the use of barrages in teaching English classes in colleges is very effective. It not only plays a great role in promoting learners' motivation but also brings convenience to teachers in monitoring the learning process, collecting learning data, and improving

teaching efficiency. The effectiveness of barrage interaction in college English classroom interaction is mainly reflected in the following points.

Firstly, instant interaction increases student engagement and motivation. Through barrage technology, students' questions or ideas will be displayed on the multimedia screen in the real-time barrage, without conflicting with the teacher's teaching process. Therefore, the immediacy of barrage interaction can stimulate students' motivation and increase their interest in learning, as well as greatly increase their engagement.

Secondly, it can deepen interaction between teachers and students by allowing teachers to ask specific questions or expand on the content by targeting teaching priorities, and students can participate in discussions by answering or asking questions through the content listed on the screen. In addition, it can deepen peer-to -peer interaction. Firstly, students can briefly express their views on the answer-type questions on a barrage screen. At the same time, groups of students can discuss a particular point in real-time and send the results of the group's discussion via a barrage.

Thirdly, due to the fragmented and concise nature of barrage language, the interactive approach of barrages facilitates the participation of students with low language proficiency. On the one hand, it can help to provide comprehensible input. In traditional video instruction, students are unable to concentrate if they encounter difficulties. However, when videos include the ability to send barrages, they can get help in time to overcome their difficulties and continue learning. On the other hand, for some learning tasks, it is difficult to have adequate discussions relative to some students with low language skills. However, by using barrages, teachers can encourage them to send simplified barrage content and then slowly build up their confidence as they continue to participate, eventually improving their language skills.

Fourthly, barrage interaction helps teachers to monitor the learning process of students. Teachers can learn about students' comments in class through the Haodanmu platform and can export the data for analysis after class so that they can keep track of their student's learning. Through barrages, teachers can keep track of not only individual students' learning status but also the learning status of the whole class and help them adjust by giving tips, suggestions, and guidance.

6 Limitations

The present study has some limitations. We have not addressed the problems hidden in barrage use in classroom interactions. The interactive barrage still has some potential negative effects on classroom teaching.

Firstly, the amount of barrage sent during a certain period can cause the screen to be full of barrages, and even the phenomenon of barrage covering each other,

interfering with normal teaching activities. The long scrolling time or fast scrolling speed of the barrage is likely to cause visual fatigue, and the small font size or small line spacing of the barrage is not conducive to the presentation of the content of the barrage, which affects the teacher's screening of the information of the barrage and does not give students sufficient time to read, understand and think.

Secondly, although there are five categories of barrages that are more comprehensive and objective, the behavior of students is subjective and difficult to control, and it cannot be ruled out that individual students send barrages that are not related to the course content, which makes classroom management difficult. In the case of anonymity, teachers are unable to know who is sending the barrages, so they cannot assess the learning process for a particular student.

Thirdly, the use of mobile phones and the time is taken by students to compose the content of the barrage can be a distraction. According to classroom observations, some students continued to use their mobile phones for long periods after the interactive barrage session and did not listen carefully to the lecture, which inevitably compromised the effectiveness of the lesson and thus defeated the purpose of using barrage to improve students' learning.

In future studies, more attention can be paid to uneven quality of barrages, the mutual blocking of barrages, and the distraction of students' attention by editing barrages.

In conclusion, as a new educational technology, barrage technology has changed the traditional teaching structure, which not only helps to promote learners' motivation but also facilitates teachers to monitor the learning process, collect learning data and improve teaching efficiency.

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The Determination of Students' Opinions on Museum Activities Integrated with Virtual Environments

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Abstract. Within the scope of this research, it is aimed to determine the effectiveness of museum educational activities supported by virtual environments on students' opinions. The research was carried out with a case study design, which is one of the qualitative methods. The students of university (n=35) participated to the study. The data of the research was collected by semi-structured interview form. And also, the views were examined with content analysis. Museum training activities on the works of art at the British Museum, The Hermitage Museum and the Louvre museum were held using virtual environments (Edpuzzle) and google arts and culture platforms for four weeks. Among the findings of the study, it was determined that the students' knowledge and motivation levels regarding virtual museum activities were not sufficient before the application. After the application, it was determined that the students found the museum education applications supported by virtual applications extremely effective.

Keywords: Edpuzzle · Google Arts & Culture · Museum Education · Museum Educational Activities Supported byVirtual Applications · The Students' Opinions

1 Introduction

Museums, which had only archiving and exhibition functions in the past, have become educational environments in which students perform active learning since the 20th century [1,2]. Museums are original sources for both formal and informal learning. It also develops students' higher-order thinking skills. Through the teaching activities carried out in the museum, students can have the skills of questioning, analyzing, critical thinking, observing, creative and critical thinking [3,4,5]. In this context, it is believed that the inclusion of museums in the educational processes will make significant contributions to the learning skills of students. At this point, the effectiveness of virtual museum applications in the dissemination of museums as a teaching environment is an important issue that

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needs to be addressed [1],[3]. Virtual applications can be very beneficial for museum teaching under conditions where access to museums is difficult and travel opportunities are insufficient. Virtual museums, where museum collections are transferred to digital media, can provide unlimited service to students with 360-degree panoramic views via technology [6]. Students can make observations and research on the art works. Thus, they can gain cognitive, affective and psychomotor skills [2]. In addition, with virtual museum applications, students can easily access detailed information about museum collections [7]. In the light of the information given, it is revealed that virtual museum applications add variety to teaching and offer students the opportunity to learn by doing and experiencing. When the relevant literature is examined, it is understood that researches for students are generally prepared on the determination of opinions and perceptions about the use of virtual museums. In addition, there were no researches in which applied activities were carried out for classroom teacher students. And also it has been determined that the researches carried out on this subject are generally prepared for social studies teacher students. In a very limited number of studies, it has been found that classroom teacher students are included in the research [1,2], [5,6,7,8]. In the literature review, no museum research was found in which Web 2.0 tools and virtual platforms were used for students. From this point of view, it is thought that the research to be carried out can eliminate this deficiency in the literature. It is also thought that the inclusion of Web 2.0 tools and google arts & culture platform in the museum teaching process will make virtual museum applications more active. In this way, it is believed that the knowledge level of the students about museum education can be improved and their motivation can be provided.

2 The Purpose of The Research

In this research, it is aimed to determine and evaluate the effectiveness of museum educational activities supported by virtual environments on students' opinions before and after implementation. Accordingly, answers to the following questions were sought in the research.

- What are the student opinions on museum educational activities supported by virtual environments prior to the implementation?
- What are the student opinions regarding museum educational activities supported by virtual environments after the application?

3 Methodolgy

3.1 The Model of Research

The research was carried out with a case study design, which is one of the qualitative methods. The aim of the case study is to examine any event or

phenomenon in detail. [9, 10]. In this research, students' views on museum education practices supported by virtual environments were examined in depth and the selected situation was limited to the sample (volunteer students) determined by the researcher.

3.2 Participants

The sample group of the research consists of university students (n=35) who studied in the classroom teaching department and took the course on museum education practices. The participants of the study were determined by using an easily accessible pattern from the purposeful sampling methods. Determining the participants with this research method limits the treatment of the research findings within the scope of the generalizability principle. This constitutes the limitation of the research.

3.3 Data Collection & Instrument

In this research, the effectiveness of museum educational activities supported by virtual environments was determined. As part of the research, museum educational activities related to works at the British Museum, Hermitage Museum and Louvre Museum were designed via using virtual application and google arts and culture platform. In addition, the effectiveness of the students' opinions was evaluated. In this context, student opinions on the effectiveness of the application were analyzed with a semi-structured interview form.

Semi-Structured Interview Form Developed for Museum Educational Activities Supported by Virtual Environments. The semi-structured interview form was developed by the researcher. In the creation of the questions to be included in the interview form, literature was reviewed for the use of virtual environments in museum education applications. Afterwards, it was revealed that the virtual environments where students can conduct museum educational activities with equality. Thus, the questions are determined in draft form.

In the next stage, necessary arrangements were made by applying to the expert opinion (n=5) in order to ensure the scope validity of the form. The final form was created after being reviewed by linguists (n=2) and measurement experts (n=1).

In the interview form, question as “What are your opinions on museum educational activities supported by virtual environments” were posed students.

Research Process. The research was started primarily by conducting a literature review on virtual environments and their applications in museums. As a result, there was no research evaluating museum educational activities where edpuzzle and google arts & culture applications were used together. Based on this finding, it

was decided to carry out the research and to create a work plan. Prior to the application, students' views on museum activities supported by virtual environments were identified by interview questions created through google forms. After this stage, museums have been designated to use google arts & culture and edpuzzle applications. When the identification of museums, it was noted that museum examples containing rich collections were selected. Accordingly, the British Museum, the Hermitage Museum and the Louvre Museum were selected. The activities are planned by the researcher in accordance with the contents of the art works owned by the museums. In addition, the stages of the applications have been revised in line with the opinions of the experts and redesigned in line with the recommendations. The applications lasted four weeks. During this process, link shares and access to edpuzzle videos were provided through the *Moodle* platform. Students participated in activities through this platform and shared the necessary applications. In the first phase of the applications, "Museum Hunt" activities were carried out through the Google Arts & Culture platform. In this way, it is aimed to improve the research, critical and analytical thinking skills of the students. Working papers with questions about the art works and activities was developed by the researcher for the museum hunting activity (See **Fig. 1**). In the report created for the museum hunting activity; Questions like ‘what is the name of the work?”, ‘What is the date of the work?’, ‘What purpose is it used for?’, ‘What purpose is it used today?’, ‘What are the different aspects of the present works?’.

Fig. 1. The sample of working paper (Source: Prepared by researcher)

In the first phase of the application, firstly students logged into the Google Arts & Culture platform. Afterwards, they reached the art work on the papers through the 3D environments of these museums (See **Fig. 2**). Thus, they answered the questions by conducting examinations on the works. This event was designed and applied to different art works (sculpture, painting, embossing, vase samples) in three museums.

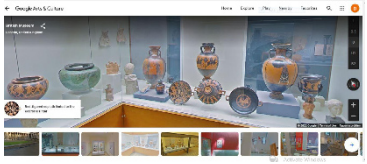

Fig. 2. The platform of Google Arts & culture (Source: The video image was get obtained from Google Arts & Culture.)

Students shared their responses through assignment links which was created through *moodle* platform (See **Fig. 3**).

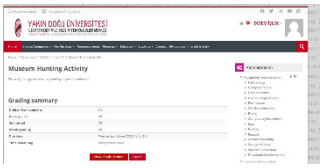

Fig. 3. The sharing of assignment on Moodle Platform (Source: prepared by researcher)

In the second phase of the applications, virtual videos of the Louvre Museum and Hermitage Museum are interactive with the edpuzzle application. Audio recordings and quiz questions (See **Fig. 4**) have been added to the videos. Thus, general information about the works to be examined in museum environments was given by making voiceovers. At this point, the animation technique of the drama method was used. Sample voiceovers include "*Hi I'm an oil painting on display at the Hermitage Museum. I was painted by Leanorda Da Vinci, the famous master of the Renaissance. I'm portrayed on the subject of Mary and Jesus*."

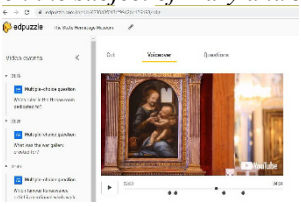

Fig. 4. Edpuzzle Practice at the Museum of Hermitage about voice recording and adding quiz (Source: The video image was get obtained from Edpuzzle)

Among the sample quiz questions added; "*Which famous Renaissance artist mentioned who's work in the Museum?*" In the applications, teaching activities were carried out on "using virtual teaching environments", "setting and answering questions about the art work exhibited in the virtual museum environment", "designing and implementing museum hunting activities using the virtual museum environment". These activities are aimed at improving students' knowledge of the characteristics, purposes of construction and historical development of works, as well as increasing their ability to establish a cause-and-effect relationship.

3.4 Data Analysis

Content analysis method was used to analyze the qualitative data of the research. In the content analysis stage, first of all, the data obtained from the interviews were documented and examined by an expert. In the second stage, the data were coded separately, taking into account the word groups expressed by the participants. Considering the similarities between the codes, the data were collected in categories, thus themes were formed. In the analysis, students were given a code number. In the third stage, the themes previously determined by the researchers were compared by museum education experts (n=2), education programs experts (n=2) and educational technology experts (n=2). Thus, it was

confirmed whether the determined codes represented conceptual themes. At this stage, the codes with "Agreement" and "Disagreement" were determined. Reliability calculation of qualitative data was carried out using Miles and Huberman's (1994) formula [Percent of Agreement = Consensus / (Agreement + Disagreement) x 100]. As a result of this research, 14 of the 18 codes determined by the researchers were approved, and a consensus was reached at the rate of 81.8% on the suitability of the codes. A consensus of 80% indicates that the reliability of the coding is high [11]. Thus, it is aimed to ensure the reliability of the coding processes and themes of the data by taking expert opinions during the interpretation of qualitative data.

4 Findings

In this part of the study, the findings obtained in line with the sub-objectives are included. The findings are presented in two subheadings.

4.1 Student Opinions on Museum Education Activities Supported by Virtual Environments Before the Implementation

The students' opinions on museum education activities supported by virtual environments before the application are given in Table 1. As seen in Table 1, the students' opinions about the pre-application were categorized under the theme of "Functionality of Virtual Applications on Museum Educational Activities".

Table 1. Students' opinions on museum education activities supported by virtual environments before the application

Theme	The Views of Students	f
The Functionality of Virtual Applications on Museum Educational Activities	The lack of knowledge about the integration of virtual applications into museum events	16
	The challenge of integrating virtual applications into museum events	9
	The lack of knowledge about virtual application types	6
	The lack of motivation to use virtual environments	4

Under this theme, the majority of the students stated that their level of knowledge on how to integrate virtual applications into museum activities is not sufficient. Among the sample comments, "*I do not know how to establish the relationship and integration between museum educational activities and virtual applications. (S13)"*. It was also revealed that the majority of the students found the integration of virtual applications to museum activities challenging. Among the exemplary opinions are "*It is quite challenging to implement museum education*

activities and virtual applications at the same time. (S7)". In addition, it has been revealed that the students do not have knowledge about which virtual applications are. Examples of opinions include "*What kind of virtual applications can museum education activities be carried out? I am not knowledgeable about this*. (S19)". Some of the students also stated that they lack motivation to use virtual environments. Among the exemplary opinions are "*The fact that I do not have enough equipment about virtual environments affects my motivation to implement museum activities*. (S26)". As it can be understood from the data obtained, students do not have sufficient knowledge and motivation level to support and integrate virtual environments with museum educational activities before the application. On the other hand, students found the integration of museum educational activities and virtual environments challenging.

4.2 Student Opinions on Museum Education Activities Supported by Virtual Environments After the Implementation

The students' views on museum education activities supported by virtual environments after the application are presented in Tables 2 and 3. Obtained student opinions were gathered under two sub-themes. In the first theme, the students expressed their opinions on "the effects of museum activities supported by virtual applications on the learning-teaching process".

Table 2. Student opinions determined within the scope of the first theme

Theme	The Views of Students	f
The effect of museum activities supported by virtual applications in the learning-teaching process	Ensuring effective learning by making use of technological applications	14
	Development of research skills	10
	Learning by having fun with virtual applications	6
	Easy access to information through virtual environments	3
	Making abstract concepts concrete	2

In this direction, the majority of students stated that technological applications have positive effects on museum education activities. Among the sample opinions, "*I think that actively performing museum education activities by using technology in the learning and teaching process provides very effective learning*. (S2)". Again, the majority of the students stated that virtual applications also improved their research skills. Among the sample views, "*We started to research and explore while implementing museum education activities supported in virtual environments.*. (S22)". In addition, students also mentioned what they learned by gamifying museum education activities with virtual applications. Among the exemplary opinions are "*The animating of the* features *of the works in the videos with the drama technique via Edpuzzle application, we carry out the museum hunt activities made the processes playful and entertaining*. (S11)". And also students

stated that information can be accessed more easily through virtual environments. Among the exemplary opinions are "*There is sometimes a loss of information in the lessons held in the classroom environment. Because the course is not added to the moodle system. However, it has been very easy for us to access virtual environments and museum education activities both through moodle and edpuzzle application*. (S32)". Finally, the students indicated that the visuals used in virtual applications and short-answer questions were effective in concretizing abstract concepts. Among the exemplary opinions are "*Both the rich visuals of the works in the google & culture application and the quiz questions created through edpuzzle embody the concepts that we thought abstractly*. (S27)". The findings revealed that after the application, the students found the museum activities supported by virtual applications educational, effective and easy to implement. On the other hand, the students' views on the second theme are presented in Table 3. Accordingly, the students expressed their views on "creating an active learning environment" within the scope of the second theme.

Table 3. Student opinions determined within the scope of the second theme

Theme	The Views of Students	f
Creating the Active Learning Environment	Ensuring active and permanent learning through virtual applications	11
	Ability to learn effectively with motivation-enhancing activities	11
	Ability to observe	7
	Providing a peer learning environment	4
	Ensuring that the art works in the museum collection can be learned in detail	2

The majority of the students pointed out that they found museum activities supported by virtual applications effective in permanent learning. And also they emphasized that their motivation were very high while they were doing these activites. Among the sample comments, "*Answering questions one-on-one with the Edpuzzle application* has *increased my motivation level. In addition, carrying out the museum hunt event with the google arts & culture platform enabled me to learn permanently* (S19)." Again, the majority of the students also mentioned that the activities increased their observation skills. Among the exemplary opinions, "*We made in-depth examinations and observations on the works with the Google arts & culture application.* (S32)". In addition, the students expressed their views on providing a peer learning environment and learning the works in the museum collections in detail. Among the sample comments, "*We were in constant communication with our peers while implementing the activities. We got help from each other when we were in a difficulty. We were also able to learn detailed information about the artifacts in the museum with virtual applications. It was an awesome experience*. (S20)." It is understood from the findings that the students find museum education activities supported by virtual applications effective in creating active learning environments.

5 Conclusion & Discussion

The results obtained from the research revealed that the students did not have knowledge about integrating virtual applications into museum education activities before the application and they found these applications quite difficult. In parallel with these findings, it is emphasized in the literature that students' perception and awareness levels about virtual museum applications are weak [1]. As can be seen, the result obtained is in line with the findings in the literature. At this point, it is thought that activities supported by virtual applications are significant in increasing the knowledge and motivation levels of students about museum education activities [8]. In this context, in the 21st century education process, where technological developments are integrated into education, it can be said that the use of virtual learning environments as well as real learning environments of students is effective in making it easier for students to learn. In parallel with this view in the literature, it is also mentioned that the use of digital resources and media in which the technology is integrated can be achieved effective results in learning [12]. However, in addition to learning by living in the real museum environment, it is also thought that students can be more easily attracted to their attention with virtual museum applications so that information can be learned more effectively [13, 14]. In this context, while organizing museum education activities, using both virtual environments and real learning environments will assist students to reinforce their learning.The results obtained after the application carried out within the scope of the research also support this view. After the application, the students expressed positive opinions about the museum education activities supported by Edpuzzle and google arts & culture applications. The students expressed their opinions within the scope of the first theme titled "*The effect of museum activities supported by virtual applications on the learning-teaching process*". Among the opinions; providing effective learning, development of research skills, concretization of learning, fun teaching environment and ease of access. In this context, it is stated in the related literature that museum activities that take place in virtual environments increase the instructional level in learning, make learning more enjoyable, and access is easier [6]. In addition, it is emphasized in the literature that through these activities, students' research skills can be developed and abstract learning can be embodied [1], [15]. On the other hand, after the application, the students also indicated their opinions within the scope of the second theme on *"Creating an Active Learning Environment*". Examples of comments include; providing active and permanent learning, conducting motivation-enhancing activities, developing observation skills, providing a peer learning environment, and examining the art works in detail. Parallel to these results, it is mentioned that virtual museum applications can be effective in the formation of learning environments by doing, in effective and permanent learning, in increasing observation skills and knowledge levels, and in providing motivation [2],[7]. In addition, it is also pointed out in the literature that the activities carried out in museum education have positive effects on the creation of peer learning environments [16]. As can be understood from the results obtained, students' views on virtual museum applications have changed positively after the applications carried out within the scope of the research.

6 Recommendation

Based on the results of the research, it is suggested that museum activities using different virtual environments, technological applications and Web 2.0 tools should be carried out practically within the scope of future studies. It is also thought that the application of these applications to different student groups as a sample group may be effective in developing and disseminating awareness levels regarding virtual museum applications. In addition, it is recommended to determine the training needs of teachers on virtual applications and to develop and implement training programs related to this. On the other hand, it is believed that it is important to increase the validity and reliability of the researches to be carried out using both qualitative and quantitative methods using a mixed model.

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The Framework and Implementation of a Highly Immersive Learning Environment for China Science and Technology Museum

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Abstract. The China Science and Technology Museum exerts significant influence over knowledge dissemination, but its traditional learning and dissemination methods cannot fulfill the diversified and digital demands of visitors. With development of computer graphics, it has increased the viability of applying immersive learning supported by Virtual Reality (VR) to educational exhibits. According to the Gibson's theory of perceptual learning, this study proposes a technical framework for China Science and Technology Museum to construct an immersive learning environment. Force feedback technology was used in both physics exhibit and mathematical exhibit to enhance the haptic perception and to create more scene dynamism and immersion. Through user experience assessment, it showed that this virtual environment enabled students to obtain a good sense of presence and engagement, and participants reported a satisfying experience in the virtual immersive learning system.

Keywords: Immersive Learning · Virtual Reality · Virtual Museum

1 Introduction

Science museums traditionally is to provide visitors with the opportunity to experience exhibits closely [1]. Such visiting means is constrained by time and space. And more importantly, a single learning mode could no longer satisfy learners' needs for knowledge learning. Immersive learning is a situative, cognitive and associative learning method that aims to provide learners a realistic and well controlled learning environment, which is supported by modern technologies such as Virtual Reality (VR) and so on, and to promote learning experience through natural or embodied interactions with the learning environment [2]. Since the application of VR environments as learning contexts, researchers have been questioning the impact of presence and immersion in learning activities. It has been proved in previous research that immersion is significantly beneficial to students' understanding of dynamic three-dimensional processes [3].

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There is a huge potential for practicing immersive learning with VR in China Science and Technology Museum. In the actual exhibits on the themes of "The Law of Motion" about physics and "The Charm of Mathematics" about mathematics. Limited by the high cost of VR equipment, prolonged construction period, lagged behind content updates and lack of explanations, VR based immersive learning environment is still in the developmental stage. And how to design a systematic, highly immersive and flexibly interactive learning environment is rarely discussed in previous research. Thus, a systematic and effective immersive learning environment design is significant for science and technology museums which plan to adopt VR technology to improve the efficiency of scientific knowledge dissemination.

2 Related Work

VR based immersive learning environment could provide people with a highly immersive and flexibly interactive virtual environment, which has been previously used in science museum exhibitions to improve visitors' experience and further enhance their knowledge acquisition [4,5,6,7]. In Italy, the Milan Museum of Science and Technology has been experimenting with different types of virtual visits to museum and explored different paradigms for providing interactive experiences while visiting virtual museums [8]. HMD assisted onsite learning experience is also available in the British Museum designed with some theme topics related to difference field of studies such as history and biology. These applications of VR technology in foreign science museum immersive learning have been proved to be effective in promoting visitors' interest and communicating knowledge. However, there are few science museums in China that apply VR based immersive learning.

Besides, with the interdisciplinary development of pedagogy and computer science, several studies investigated the effectiveness of VR for learning. Thisgaard and Makransky' work [9] showed that the virtual learning simulation significantly improved students' learning compared with the traditional lecture-based instruction. Similar studies have shown better cognitive learning through highly immersive VR. Webster' work [10] revealed that students could use immersive VR to train so that gained increased knowledge. Immersive environments offer learners rich and complex content-based learning while also help learners hone their technical, creative and problem-solving skills [11]. Sensory immersions are considered to be one of the major factors affecting users' immersion [12], but force -sensing interaction was less discussed in previous studies on virtual immersive learning environments [13]. Recently, Cui and Mousas [14] evaluated the tactile feedback patterns during a virtual reality fighting game, which showed that having tactile feedback enhanced presence and body tactile sensation in immersive environments. Therefore, the present study aims to investigate the effectiveness of

constructing framework and applying force feedback technology to enhance users' experience in virtual immersive learning.

3 Development

3.1 User Requirements Analysis

First, since our virtual environment will be used for education, it is necessary to ensure that the principles and knowledge contained therein are scientific, and are universal truths today. Secondly, as for the system performance, most users require a fluent and immersive experience in a realistic scene. Finally, in terms of system usability, they require to interact as naturally as possible. It not only requires the designed interaction to be as authentic as possible, but also expect the interaction to be simpler and more convenient.

3.2 Design of Immersive Learning Environment

According to the user requirements, a physical and mathematics immersive learning environment of China Science and Technology Museum was built, which used 3DsMax and Blender modeling software to build 3D models and design animations, and used Unity3D engine to build a virtual scene.

Exhibit Design. The virtual scenes of the physical exhibits are as shown in Fig. 1 (a) and (b). In the 'law of inertia' exhibit, when the train passes the gate, the ball is thrown out and gets back to the original place in the afterwards. In the 'action force and reaction force' exhibit, the cannon will exert a forward firing force on the projectile and retreat due to the opposite reaction force with the same magnitude, pushing the hanging pointer to rotate accordingly. And the virtual scene of the mathematical exhibition in this study is as shown in Fig. 1 (c) and (d). The 'Mobius strip track' exhibit's center is a Mobius ring, with only one face and one side, so the car can return to the origin from any point on the ring. In the 'pushing down a building by a finger' exhibit, as long as the users lightly push down the first domino with the force feedback device, they can witness the whole process of knocking down the huge domino.

Interaction Design. Sensory stimuli including visual, auditory and haptic stimuli are included in this environment to improve the users' interactive experience(Fig. 2). Visitors will see the virtual learning environment wearing the HTC Vive head-mounted display, listen the pre-recorded teaching audio through headset and

interact by holding the controllers. Finally, the Geomagic Touch is used to realize force feedback to complete an immersive haptic interaction. Users interact with the force bar of force-feedback device, feeling like touching the virtual object in real.

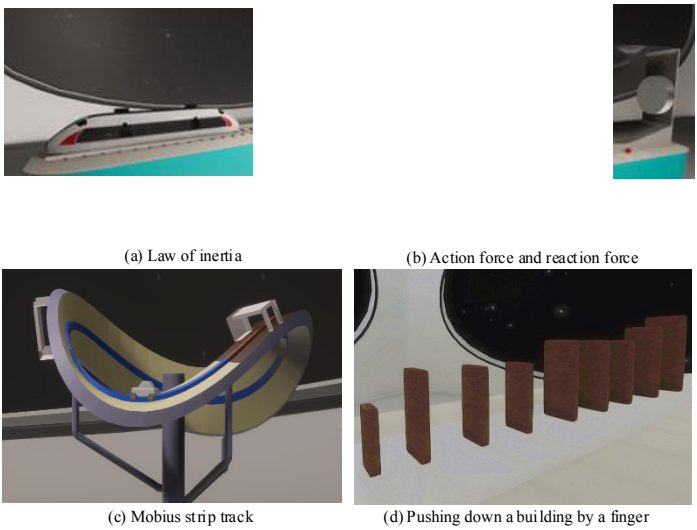

Fig. 1. Virtual scenes of science exhibits

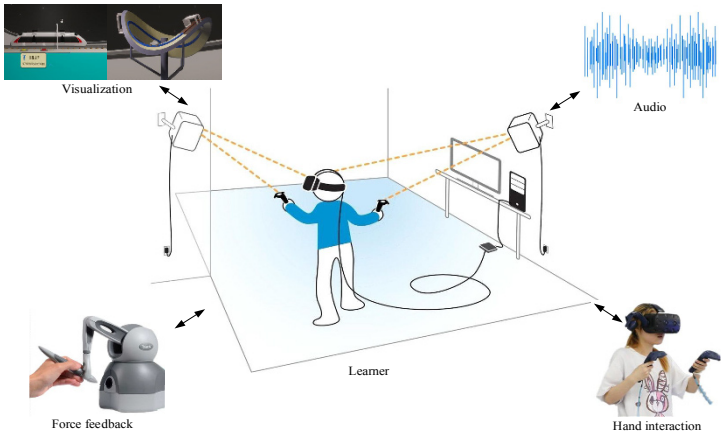

Fig. 2. Setting of the immersive learning environment

Overall Technical Framework. This paper proposes a technical framework for building an immersive learning environment for China Science and Technology Museum, as shown in Fig. 3. The device level is the physical hardware to build a virtual environment, mainly including servers, display terminals and 3D interactive devices. The data level includes all the data needed by the system and those

collected during the running process, which includes model and scene data, multimedia data and user data collected by device sensors. The processing level includes data collection, tracking of user behavior, data visualization, and immersive interaction. The application level realizes the main functions in the virtual environment, including immersive learning, learning guidance, learning assessment, etc.

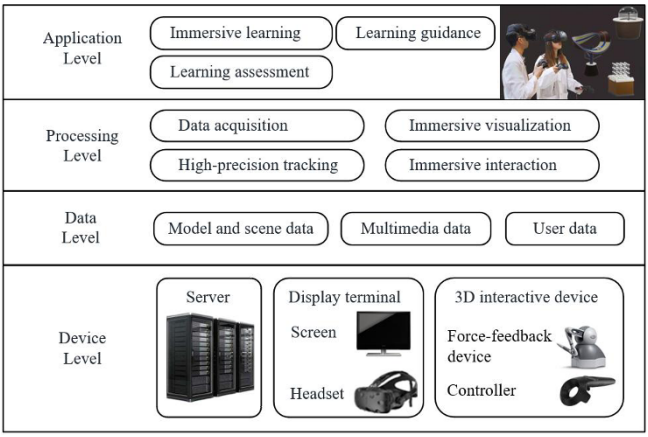

Fig. 3. The four-level technical framework for building an immersive learning environment

4 Experiment Design

Tcha-Tokey K et al. [15] have proposed and validated a unified questionnaire on user experience (UX) in Immersive Virtual Environments (IVE), especially for an edutainment IVE. We conducted experiment with our system and used the UX in IVE questionnaire to measure the UX for two categories of participants: the experienced and the non-experienced students in VR devices.

4.1 Participants

Thirty participants (10 females and 20 males) aged 16-17 years (M = 16.4, SD = 0.5) participated in the study. With regard to their prior experience with VR devices, 37% participants reported never used VR devices before the experiment, while 63% participants had some prior VR experience. The statistical result of the basic information survey is as shown in Table 1.

4.2 Procedure

The experiment had three steps: First, we installed the participants in the experiment room and asked them to complete a "basic information survey", including demographic information in terms of previous experience with VR devices. Then, we introduced the whole system and its exhibits to the participants. Participants were randomly divided into 6 groups of 5-6 participants. The operation of the HTC Vive controllers and Touch force-feedback device was displayed by researchers to each group. Each person independently participated in immersive learning for around 8 minutes in two virtual exhibits about physics. Lasty, the participants completed the UX questionnaire. Each participant spent between 15 to 30 minutes in the experiment room.

Table 1. Demographic information.

Variable	Options	Frequency	Percentage
Gender	female	10	33%
	male	20	67%
Age	16	17	57%
	17	13	43%
Prior VR experience	never	11	37%
	occasionally	19	63%

4.3 Questionnaire Design

The UX questionnaire for IVE developed by Tcha-Tokey K et al. [15] were based on nine other existing questionnaires, and a large number of questionnaires had been proven valid and reliable. In order to achieve the goal of our experiment design, according to the features of this system, questionnaire has been adapted. Irrelevant items were eliminated, and twenty-one important items were retained from the original questionnaire and a 5-point Likert scale was used to measure students' sense of experience (1 = Not at all agree, 5 = Completely agree).

The UX questionnaire for IVE measures users' experience from seven dimensions including presence, engagement, immersion, usability, emotion, experience consequence and technology adoption. Presence is divided into two types: physical presence in virtual environments and social presence in collective or collaborative virtual environments, which refers to the degree to which the virtual environment overwhelms perception [16]. Engagement refers to the relationship between people and activities in the learning process [17], determining the individual's sense of existence and participation in the virtual world. Immersion is a psychological state characterized by the perception that one is enveloped by, included in and interacting with an environment that provides a continuous stream

of stimuli and experiences [18], which determines the degree of personal participation and concentration. Usability is a component defined as the ease of learning (learnability and memorizing) and the ease of using (efficiency, effectiveness and satisfaction) the system [19]. Emotion refers to the users' achievement feelings, such as enjoyment of learning, pride, anger, anxiety, shame, less ness, etc. generated by the user in the virtual environment [20]. Experience consequence refers to the symptoms that the user may experience in the virtual environment, such as cyber sickness, nervousness, dizziness, headache and so on [21]. Technology adoption is a component defined as the actions and decisions taken by the user for a future use or intention to use of the system [22].

5 Results

The experiment result for the participation of high school students are as follows. A Mann-Whitney U test was run to determine if there were differences between students with or without VR experience about their experience with the developed immersive learning environment. Distributions of the experience scores for students with or without VR experience were similar, as assessed by visual inspection. Mean experience score for students with VR experience (3.862) and students without VR experience (3.961) was not statistically significantly different, U = 91, Z = -0.582, p = 0.582, using an exact sampling distribution for U (Table 2).

Table 2. Non-parametric analysis.

GroupID	Mean	Standard deviations	Variance	Z-value	p-value
Without prior VR experience	3.961	0.405	0.164	-0.582	0.582
With prior VR experience	3.862	0.413	0.171		

Means scores for each survey question were also calculated as shown in Fig. 4, with the highest mean score as 4.63 in question 5 for presence and the lowest score as 3.20 in question 15 for usability.

Fig. 4. Summary of the survey questions

To know how the designed immersive learning environment affects users' VR experience, questions in the survey were grouped together according to the subscale, and the average scores for each subscale are shown in Table 3, where technology adoption got the highest score as 4.067 and usability got the lowest score as 3.400

Table 3. Mean and standard deviation of scale scores.

Subscales	Mean	Standard deviations	Variance
Presence	4.000	0.456	0.208
Engagement	4.001	0.543	0.295
Immersion	3.689	0.560	0.314
Usability	3.400	0.865	0.748
Emotion	3.933	0.716	0.513
Experience consequence	3.983	0.793	0.629
Technology adoption	4.067	0.568	0.323

6 Discussion

The non-parametric analysis result shows that the students' experience in the immersive learning environment is not significantly different by the previous virtual reality experience. It can be explained by that there were no statistically significant differences about user experience between students with or without prior VR experience in each dimension. It indicated that the virtual environment is very friendly to experience for beginners and the task for students is easy to finish. The average of all items has a positive average score (greater than 3 points), of which 7 items (33.3%) are higher than 4 points. Among them, items 2, 4, 5, 6, 10, 16, and 21 get higher scores, which shows that students can easily achieve multi-angle and detailed observation of virtual exhibits, which are attractive to students in terms of visual and roaming ways. And students are able to correctly identify the sound source in the virtual environment. Overall, students reported that the interaction ways were interesting, while they emotionally enjoyed the experience in this virtual environment.

However, the average scores for items 3, 11, 15, 18, and 19 are lower, which may be due to the fact that the students were unable to put the ball into the hole smoothly when they used the Touch force-feedback device to experience the "action force and reaction force" exhibit. At the same time, some students also reported that the resolution of the HTC HMD was not high enough. It may be the reason for the low scores of these items. Moreover, students reported that the interaction way was a bit cumbersome and difficult, and they were not fully immersed in the learning process.

On the one hand, in the designed virtual immersive learning environment, the interaction devices and vivid virtual scene effectively attracted the attention of students, providing enough freedom for students to move around and interact with the virtual exhibits, which enhanced students' feeling of engagement. This is in agreement with the results of Parong et al. [23], who found that students in the high-immersive VR group gained high levels of motivation, interest, and engagement. On the other hand, the main reason why students have less immersion than expected can be explained by the lower usability scores of interaction devices in the survey. In the immersion subscale, the device used plays an important role, Carbonell-Carrera et al. [24] had similar results. If the VR devices and haptic devices could be full use of, and design natural interaction ways for them, the immersion sensation would increase.

7 Conclusion

This study realizes the construction of a highly immersive learning environment with force-feedback technology for the China Science and Technology Museum, and proposes a technical framework based on this. Firstly, according to the user requirements analysis, this paper developed the virtual learning environment and then proposes the overall technical framework of the immersive learning environment. The experiment results show that the immersive virtual learning environment designed in this paper has good comprehensive performance in many aspects. By analyzing the results, it is pointed out that this virtual environment enabled users to obtain a good sense of presence and engagement.

At the same time, this study still has some limitations. The promotion and dissemination of VR environments to other science museums is still limited. Considering the cost of VR environment setup and the use of HTC Vive and Touch devices, it is difficult to extend this research to some common science museums. Future research will suggest finding more affordable and commonly used devices for immersive learning environment design. In addition, there is a lack of objective and professional indicators in the assessment process, such as students' EEG data and experts' scores on the system. More metrics can be added in the future to assess the effectiveness of the system. In the future, it is expected to combine immersive popular science projects with 5G technology to build popular science exhibition items with cloud experience.

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The Research on the Application of Artificial Intelligence in Education in China：A Systematic Review

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Abstract. The rapid development of artificial intelligence and other emerging technologies has affected all fields of society. The combination of artificial intelligence and education has also received unprecedented attention. Under the promotion of policies, the application of artificial intelligence in education in China has also been greatly developed. This research follows the literature review research method proposed by Lawrence and Brenda, and reviews the domestic literature on the application of artificial intelligence in education. The main findings are as follows: 1) the typical technologies of the application of artificial intelligence in education include machine learning, knowledge map, natural language processing, robot and intelligent control, etc. At the same time, researchers also pay attention to the combination of artificial intelligence and virtual reality technology, big data, 5G and other emerging technologies; 2) The application of artificial intelligence in education can promote teachers' precision teaching and students' personalized learning; 3) The application of artificial intelligence in education not only brings benefits to teaching and learning, but also produces some ethical and safety issues.

Keywords: artificial intelligence in education · AIED · application of AIED

1 Introduction

With the development of intelligent technology and the promotion of policies, artificial intelligence in education (AIED) has gradually penetrated into the whole process of education, and the application of AIED has gradually deepened. In order to sort out the development of the application of AIED in China, describe the development trend and shortcomings, and provide valuable reference information for the follow-up research of the application of AIED. Based on the relevant literature on CNKI, this paper analyzes the current research status and trends in China, including the application of AIED typical technology, AIED promoting teachers' teaching, AIED promoting students' learning, and AIED ethics and safety issues.

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Therefore, the research focuses on the following three issues.

Q1. What are the typical technologies of the application of AIED?

Q2. How does the application of AIED promote teachers' teaching and students' learning?

Q3. What ethical and safety issues will arise from the application of AIED?

2 Background

There is no uniform definition of what AI is in academia, but there is a certain consensus in various fields. As an emerging field, artificial intelligence generally refers to the generation and expansion of human intelligence through computer simulation [1]. Artificial intelligence is divided into weak artificial intelligence and strong artificial intelligence. We are still in the stage of weak artificial intelligence. The research on strong artificial intelligence still stays in the conceptual stage and is still at the primary level. The emergence of emerging technologies is bound to affect all areas of society, and the field of education is no exception. The application of artificial intelligence in the field of education, that is, the application of AIED. Gao Tingting and Guo Jiong define it as a macro dynamic system. It is not a simple combination of education subsystem and artificial intelligence subsystem, but the product of the deep integration of artificial intelligence and education. It is characterized by the scene of the application of AIED. Its goal is to improve educational performance, and realize the optimization of Education [2].

However, the research on the application of AIED only stays at the technical level, and the discussion is not comprehensive and specific enough. This paper tries to make a comprehensive analysis and brief comment on the literature on the application of AIED retrieved from the Internet of Chinese journals, in order to find the research trend, reflect on the problems existing in the research and inspire future research.

3 Methods

3.1 Search Strategy

The search is executed in databases CNKI. the keyword " application of artificial intelligence in education " was used for subject retrieval, and a total of 660 results were searched.

3.2 Study Selection

The selection process consisted of two stages. The first stage mainly focused on whether the title and abstract conformed to the theme. Stage 2 develops screening criteria based on research questions (see Table 1).

Table 1. Inclusion and Exclusion Criteria.

Inclusion criteria	Exclusion Criteria
The theme is AIED.	Articles that are not related to the topic(such as AI Education, AI technologies, etc).
Articles of application of AIED.	Articles that not focused on the application or not related to application of AIED.
Articles in the field of education.	Articles that study non-educational fields or are not related to educational teaching.
Articles that provide results.	Articles that don't offer results of a study.
Articles that in the core journals.	Articles that not in the core journals(dissertation, conference papers, etc).

3.3 Data analysis

The search terms in the databases generated 660 articles. The screening in Stage 1 excluded 412 articles and 248 articles entered Stage 2. The application of inclusion and exclusion criteria leaving 28 eligible studies finally.

4 Results

4.1 Typical Technology of the Application of AIED

Lu Yu and others pointed out that at present, the key technologies of artificial intelligence in the field of education mainly include machine learning, knowledge map, natural language processing, robot and intelligent control [3]. Machine learning and deep learning, as the core field of AI research, are part of the underlying research of AI, providing algorithm guarantee for other technologies. The research on speech recognition, image recognition, natural language processing and other technologies has laid a technical foundation for the application scenarios of AIED. For example, the speech recognition technology is applied to oral evaluation, and the image recognition technology is applied to recognize objects in photos.

From the retrieved literature, not only these technologies, researchers also pay attention to the combination of artificial intelligence and emerging technologies

such as virtual reality technology, big data, 5G. Virtual reality technology, that is, VR, the integration of VR and AI, is very suitable for educational scene application under the condition of distributed virtual simulation. It can realize intelligent interaction in virtual classroom, virtual experiment and virtual training scene, promote high-level inquiry and adaptive learning [4]. Big data provides data support for the application of AIED and lays a data foundation for improving teaching performance and promoting students' development. Data supported adaptive learning, education evaluation and intelligent teaching decision-making based on educational big data have become the focus of researchers.

4.2 The Application of AIED in Teaching and learning

Technology Promotes Teachers' teaching

The application of big data and artificial intelligence has changed teachers' teaching methods, reduced the burden for teachers and realized precision teaching. Wang Xingwei proposed that data-based teaching decision-making can be divided into three stages: Activity Design for decision-making objectives, human-computer collaborative data processing and data-based teaching design. It has been applied to the course "Fundamentals of computer application" in open education. And it has proved that "data-based" teaching decision-making can effectively intervene teaching activities and understand students' learning styles, and accurately locate students' learning situation and make targeted and accurate teaching decisions to improve teaching effectiveness [5].

The teaching reform based on intelligent technology makes precision teaching possible. At present, the research on Teachers' precision teaching is more focused on how to use the developed artificial intelligence system to support teachers' precision teaching. Most scholars put forward the view that the traditional experience-based teaching decision-making gradually turns to data-based teaching decision-making, which can effectively reduce teachers' burden and make teaching decision-making more scientific and customized.

Technology Promotes Students' learning

AIED not only promotes teachers' precision teaching, but also promotes students' personalized learning. Cai Lianyu and Han Qianqian put forward three scenarios of the application of AIED in schools, in which AI adaptive learning to realize personalized learning is emphasized. AI adaptive learning systems are divided into four categories according to learners' situation and environment, cognitive ability, learning style and emotional state. It is concluded that AI adaptive learning creates a broad implementation platform for personalized learning [6]. Fan Yaqin and Wang Zhihui designed the personalized learning path, and designed the personalized learning implementation process as follows: learner file establishment - learning goal design - task design - role division - resource and tool preparation -

personal learning path design - learning evaluation design - teaching and learning reflection [7].

At present, most of the research on artificial intelligence personalized learning is still macro, and there is less research on the specific aspects involved in personalized learning, such as how to implement it.

4.3 The Ethical and Security Problems of the Application of AIED

In the education field, the application of artificial intelligence has also produced some problems. The most influential is the dispute of safety and ethics.

The description of ethics and risk of the application of AIED includes three aspects: technology level, subject level and education level. The "technical trap" brought by artificial intelligence to education mainly includes the evolution of the rights of artificial intelligence and the educational subject, the alienation of algorithm recommendation and the development of students' personality, the emotional crisis of artificial emotion and interpersonal interaction, the Value Dilemma of intelligent perception and educational data [8]. The ethical dilemma of the application of AIED from the perspective of technology paradox includes three aspects: improper behavior caused by technology abuse, privacy concerns caused by data leakage and identity and right boundary of intelligent teaching machines [9]. The ethical problems at the subject level mainly show in the weakening of the subjectivity of the users by the application of AIED. Artificial intelligence can replace teachers to complete some repetitive or auxiliary work. In the process of using artificial intelligence, teachers may become the appendages of artificial intelligence, which leads to the decline of Teachers' status. At the same time, the application of AIED also has the problem of violating students' freedom. The impact of the application of AIED includes three aspects: increasing educational inequality, suppressing positive value of education, and arrogating educational value of education [10].

From the retrieved literature, at present, the research on the safety and ethics of AIED is gradually increasing. More and more researchers pay attention to ethical issues. The development of credible artificial intelligence has become a consensus.

5 Discussion

Through the reading and analysis of domestic literature on the application of AIED, it is found that the application of AIED in China is mainly promoted by policies. At this stage, the research mainly includes typical technology, teaching application, and ethics, safety problems.

For the application mode of artificial intelligence, Yang Xianmin et.al put forward three educational models: compensation Education (for special groups), alternative education (for conventional business) and adaptive education (service personality development) [11]. However, the current research focuses more on alternative education and adaptive education, while compensation education for special population is less concerned.

At present, more attention is paid to the technology of the application of AIED, and the typical cases of education application are not enough. There are few empirical studies on its typical cases, It is also lack of research on the effect of artificial intelligence application in education.

There are not many typical cases of the application of AIED, and the application scenarios are not clear. In the follow-up, we should strengthen the typical case study of the application of AIED, carry out empirical investigation, experiment and apply artificial intelligence products in the scene, verify its application effect, and effectively improve the teachers' teaching experience and students' learning experience.

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The Smart Education Progress Measurement: can Field Experts' Opinions Help?

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Abstract. The results of a study on the schools' digital transformation process evaluation in the Russian context through the prism of experts' opinions are presented. A smart school is considered a result of the school's digital transformation process. While we use classical quantitative methods for evaluation of the process of transformational changes, these methods fail to capture implicit characteristics of it. The research uses data from expert evaluation collected in the monitoring of the digital transformation of Russian general educational organizations in 2021 linked to ICT (information and communication technology) coordinators' survey indicators of the same schools. We display insignificant correlations between expert evaluation scale scores and indicators of the digital environment. The study shows that the idea of a smart education being a result of a school's digital transformation has not yet received wide recognition among educators. In order to promote the idea of smart education widely, it is necessary to present educators with real examples of a successful transition from a traditional school to a smart school.

Keywords: ICT in Education • Digital Transformation of Education • School Digital Renewal Process • Monitoring of Digital Transformation • Smart Education • Smart School

1 Introduction

The penetration of ICT into the field of general education, which has been going on for almost half a century, has gone through several stages. The attention of teachers was consistently focused on equipping schools with digital technologies, on their development by teachers, and on their implementation in the educational process. In the last decade, the attention of educators has been drawn to the transformation of the school's operation. This is a new stage of a school's digital renewal, which is called the digital transformation of education or the transition from a traditional school to a smart school [1, 2]. The mentioned stages can be considered as different

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stages of the global process of school's digital renewal, which affects all aspects of school work, or as the smart education formation [3].

The authors proceed from the idea that the main result of the digital transformation of education is the transition to a new school model (smart school), which ensures the comprehensive personal development of EVERY student, where each student achieves all the required (established by the standard) personal, subject and meta-subject educational results [4]. The transition from a traditional school to a smart school (digital transformation of education) is a restructuring of schoolwork using new pedagogical technologies that are supported by developing digital technologies. Digital renewal in schools is uneven. Schools change at different rates and may be at different stages of the process. An integrated assessment of the progress of individual schools along the path of digital renewal can be considered the key indicator of the actual development of smart education at the regional or country level. As schools' ICT saturation accelerates and new education methodologies are being developed, the proper measurement of the digital transformation in social life at the system level becomes more and more complicated [5- 7]. Therefore, the question of methods for assessing this indicator is always relevant.

There are two types of indicators to discuss traditional indicators that rely on classical sociological methods and sociological quantification and computational indicators. The last ones rely on intellectual data analysis methods (data mining, visual mining), where data is gained from an integrated digital learning environment. There is just a small number of research where the validity of such indicators and empirical measurements are discussed and the problem of such indicators' validity in smart education remains open. As a result, classical sociological methods dominate in the context of smart education measurement. We would like to highlight two approaches.

1. Internal evaluation relies on traditional social science quantification methods. A school and school community may be assessed in terms of the maturity stages of ICT use [7], or they get a descriptive "portrait" for further study and internal debates [8]. Depending on the purpose, several groups of respondents may be surveyed. Data are obtained by analyzing answers to questions to generate information on ICT use for decision-makers and school administration and educators.

2. External evaluation based on qualitative methods. This approach has limited applicability for large-scale school evaluation [9]. It refers to on-site school visits that include interviews, digital infrastructure audits, and classroom observations. Evaluators might use different checklists to analyze some aspects of ICT use. This method facilitates the acquisition of tacit expert knowledge. Overall judgments and conclusions reveal trends in maturity growth in schools. When combined with quantitative survey data and non-reactive digital data, external evaluation may give a solid foundation for an overall assessment of a school's transition to smart education.

The advantage of expert evaluation is the involvement of tacit expert knowledge in teaching and learning in the smart school environment. Experts use structured tools to evaluate how far the school has progressed along the path of its transformation into a smart school. Because of the variety of techniques to assess of transition to the smart school and the complexity of the process, there is a need for the juxtaposition of diverse approaches and scales. Our research combines assessments of schools conducted by field experts with survey-based evaluation of the smart educational environment in the same schools. We correlate integral evaluation given by experts to indicators of ICT infrastructure [8].

We explore whether, and to what extent, it is possible to recognize transformation steps to smart schools through expert evaluation. We expect it will provide a better understanding of the school's digital transformation measurement for its use in practice.

2 Smart school as a result of digital transformation

Today, experts consider the digital transformation of education as a new stage in the process of digital school renewal, which has been going on for more than a dozen years (computerization, early informatization, mature informatization, digital transformation) [1]. The digital renewal of education is an increasing process of changes that began three decades ago in the organization and methods of implementing the educational process, in all aspects of school work in an evolving digital environment. The stage of computerization is characterized by its focus on the digital infrastructure equipement for students' computer literacy formation. The stage of early informatization is distinguished with the start of ICT use for various subjects. The stage of mature informatization is identified by the wide use of ICT in innovative teaching and learning that is activated with individual learning plans for students. The stage of digital transformation is distinguished by the transition to a smart school where personalized mastery-based learning is delivered to each student.

The goal of digital transformation is a system update:

- the nature of the interaction of the school with the local community (with parents, business representatives, officials, politicians);
- goals and content of training;
- tools, methods, and organizational forms of educational work.

It takes place in an evolving digital environment and is made possible through the use of digital teaching and learning materials, digital tools and services.

Today, experts consider the digital transformation of education as a new stage in the school's digital renewal process, which has been going on for more than a dozen years. Digital renewal is an increasing process of changes in the organization and methodology of the teaching/learning process as well as in all aspects of school

operations. It takes place in an evolving digital environment and is made possible using digital teaching and learning materials, digital tools, and services.

Experts believe that a smart school (SS) is a school that has over a renewal process during its digital transformation. SS functions in a smart educational environment (SEE), implements a personalized mastery-based educational process and, uses the potential of SEE, for the evidence-based development of each student, formation of all the required personal, meta-subject, and subject competencies necessary for the full development and life in the digital economy.

A smart school functions within the framework of a smart educational system (municipal, regional and national), that exists in a smart educational environment (SEE). Smart educational system (SES) systematically guides and supports the functioning of educational organizations, their development, and transformation into SS. SES includes, among other things, educational authorities and legislative bodies directing their work, inspections, and methodological services; institutions for the development of education and training of future teachers; partners, and SEE support and development services.

Smart Educational Environment (SEE) is an evolving ecosystem that includes multi-platform services and digital devices, digital educational and methodological materials, tools and services (virtual component), educational spaces, equipment, materials, tools, and services (physical component) as well as social environment (inside and outside the school). SEE is designed to support the processes of teaching and learning, as well as the successful functioning of schools and the educational system, their digital transformation, and further development.

The authors use the definition of smart education as proposed in the project "Rethinking and Redesigning National Smart Education Strategy", which aims to reshape the educational ecosystems and policies on ICT. «A smart education is an educational process the smart schools provide inside the smart educational systems at the regional/country level using the smart educational environment».

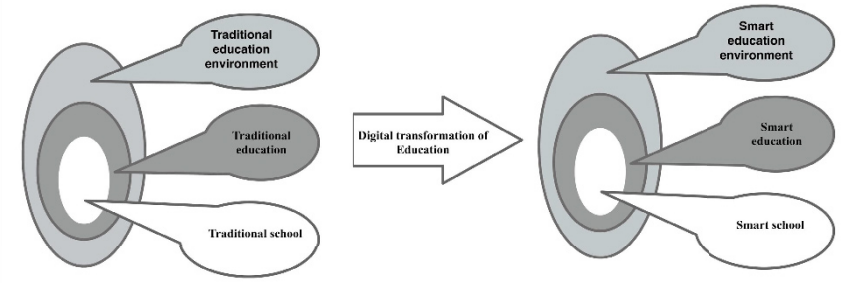

Fig. 1. Digital transformation of education

All modern educational systems include schools that are at different stages of their pass toward a smart school. The composition of schools in the educational system

at the different renewal levels defines the state of smart education at the level of educational system. A smart school is a place where smart education works. Among the dimensions of a smart school is a smart learning environment that contains sophisticated ICT infrastructure, platforms, tools, and other technologies that support teaching and learning (smart education process).

The internal evaluation uses the traditional set of indicators of the smart learning environment development. They include high-speed Internet connection and Wi-Fi that are used for flexible teaching and learning. Conditions for learning in smart schools are shaped by PCs available for the educational process; mobile PCs available and classrooms (rooms) equipped with stationary interactive whiteboards or multimedia projectors, and so on. The indicator of up-date or purchase of computers defines the expansion of ICT infrastructure in the last three years.

3 Data analysis

In order to see the association between field expert's assessment of the school's digital renewal maturity and schools' ICT infrastructure, we use two main data sources:

Data gained from field expert visits in the 2021/22 academic year. Field experts are experienced educators with a rich and practical background in school education. Experts gave a comprehensive onsite schools examination including a set of interviews with school staff, a range of visual examinations of schools' onsite environment, and lesson visits. As a result, experts prepared an overall assessment of maturity for the schools' digital renewal according to the 1-10 scale (Fig 2). The assignment between ordered qualitative scale and numerical assessment has been introduced to the field experts during the workshop given prior to field visits, where the idea of stages of digital renewal was introduced.

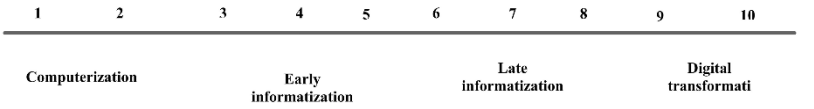

Fig. 2. The Scale for development of school's digital renewal process

Indicators for schools' digital environment development are built upon answers from surveys for schools' ICT coordinators. For the purpose of our analysis, we used the set of indicators shown in table 1. The initial set of indicators was formed according to the framework of monitoring the digital transformation of Russian general educational organizations. We selected 8 indicators of digital infrastructure that mainly provide possibilities for personalized learning models. Their validity

for smart education progress measurement is based on an analytical review of smart education concepts and is confirmed by expert evaluation during the development of monitoring tools.

Table 1. Indicators of infrastructure of smart education

Indicator label	Description	Data source
IN1	School internet connection speed	Surveys of schools' ICT coordinators
IN2	Wi-Fi connection speed at school	Surveys of schools' ICT coordinators and school leaders
IN3	Percentage of students who can work simultaneously while connected to school Wi-Fi	Surveys of schools' ICT coordinators
IN4	Percentage of PCs used for educational purposes at school connected to the Internet	Surveys of schools' ICT coordinators
IN5	Number of mobile PCs (laptops and notebooks) used for educational purposes per 100 students	Surveys of schools' ICT coordinators
IN6	Share of classrooms (rooms) equipped with stationary interactive whiteboards or multimedia projectors	Surveys of schools' ICT coordinators
IN7	PCs used for educational purposes which have access to the Internet, per 100 students	Surveys of schools' ICT coordinators
IN8	Percentage of computers used for educational purposes updated or purchased in the last 3 years	Surveys of schools' ICT coordinators

The total number of schools with complete data obtained from both the survey-based indicators and from field expert assessment constituted the total sample of 147 observations for comparison (fig. 3).

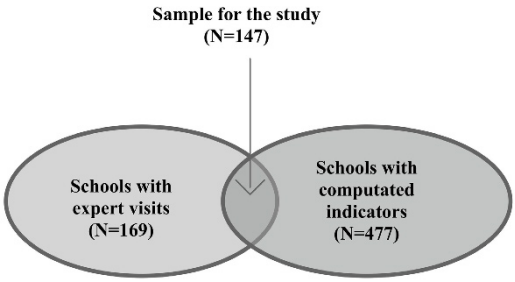

Fig. 3. Samples for survey-based evaluation, field expert assessment and sample for the study

4 Results: expert assessment of schools' digital renewal maturity

The distribution of schools assessed across the digital renewal maturity scale has a tendency to group around early informatization stage (35,37%) and mature informatization (45,58%). A small proportion of schools are situated at computerization stage (10,88%) or at digital transformation stage (8,16%). It means that according to assessment given by field experts, 91,84% of schools need additional resources and efforts to elaborate their work toward smart school. Just 8,16% schools are positioned as schools that are in the process of digital transformation (are going to become smart schools). The fact that the number of potentially smart schools according to expert assessment is relatively small correlates well with early level of smart education diffusion in Russian Federation. It may be explained by lack of well-established **examples** of smart schools' operation in Russia.

Table 2. Distribution of schools according to their level of digital renewal maturity

Level of maturity	Number of schools	%	Cumulative %
1 (Computerization)	16	10,88%	10,88%
2 (Early informatization)	52	35,37%	46,26%
3 (Mature informatization)	67	45,58%	91,84%
4 (Digital transformation)	12	8,16%	100,00%

A series of Pearson's corellation tests were conducted to probe whether there was some association between assessments given by experts and data on the ICT infrastructure of schools on the digital transformation stage (table 3).

Table 3. Correlation analysis between expert assessment and school' ICT infrastructure data

Indicator label	Overall assessment of schools' digital renewal maturity according to the scale (1-10)	Overall level of schools' digital renewal maturity according to the scale (1-4)
IN1	0,012	-0,040
IN2	-0,007	-0,028
IN3	-0,023	0,013
IN4	-0,063	-0,065
IN5	0,047	0,005
IN6	0,130	0,108
IN7	0,050	0,022
IN8	-0,017	0,003

Both assessments examined – by a 10 point scale given by experts and by a digital renewal maturity 4-point qualitative scale – showed negligible correlation with indicators of the ICT infrastructure of schools. It means a very weak association

between the stage of digital renewal and the development of school's ICT infrastructure which shape the smart learning environment.

Comparing the results of correlation analysis with average indicators values distributed by schools' digital renewal maturity levels, we can see that there is no consistent pattern for ICT infrastructure to be more saturated even at stages of mature informatization and digital transformation (table 4).

Table 4. Average indicators values distributed by digital maturity levels

	Overall level of schools' digital renewal maturity according to the scale (1-4)			
Values	1	2	3	4
Avg. of IN1	80,00	75,38	79,40	70,00
Avg. of IN2	65,00	55,00	59,10	55,00
Avg. of IN3	14,74	11,29	15,06	11,41
Avg. of IN4	93,53	77,36	81,24	79,72
Avg. of IN5	8,54	9,61	9,66	8,41
Avg. of IN6	73,66	70,84	74,51	87,69
Avg. of IN7	11,98	11,12	12,97	10,69
Avg. of IN8	61,47	52,62	56,07	59,12

5 Discussion: education expert knowledge as a basis to assess transition to smart school

The presented exploratory study combines schools' digital renewal maturity assessments done by experts with data on schools' digital environment development in a comparable large sample surveyed. We rely not only on structured assessments that experts gave but also on the tacit knowledge that they have. This approach uses statistical methods that handle the association between expert assessments and solid characteristics of a school's ICT infrastructure.

Examining the correlation between expert's assessment and results of a traditional evaluation of schools' digital environment development has shown insignificant correlations between expert evaluation scores and the level of the digital education environment development.

Bearing in mind the outlook of using computational indicators along with classical ones for further measurement of smart education, the issues of validation and mutual validation, including the use of traditional school survey methods, are of great importance for managing the transition to smart schools on the country level.

The fact that, according to expert assessment the number of potentially smart schools is relatively low correlates well with the definitely early level of smart education diffusion in the Russian Federation. It may be explained by the lack of well-established smart school examples in practice.

It can be assumed, that while assessing the overall situation at school experts may have overlooked that the process of transition to the smart school is fragmented even at the education organization level. It means that insufficient ICT infrastructure is distributed between subdivisions of the school according to students' and teachers' readiness to work in the smart learning environment. This is one of the explanations for the insignificant correlations of digital renewal maturity with indicators of ICT infrastructure. There might be internal priorities at schools requiring the use of infrastructure in conditions of limited ICT resources. In terms of personal and mobile computers, the 1:1 model (an inseparable part of the smart school) remains a pipe dream for most schools, and limited Internet and Wi-Fi connections complicate the transition toward smart education at the country level. The case overview of sample schools of the monitoring at each stage showed that schools with 1:1 model potential are equally rare both among schools situated at computerization level and among schools assessed at digital transformation level.

Another explanation for the negligible correlation is that experts tend to assess the educational process in a digital environment by having an idea of the school that uses the rich digital environment effectively. It means that they pay more attention to the use of digital environment and innovative teaching practices as well as to organizational changes rather than to visible, up-to-date digital infrastructure.

Although digital infrastructure development remains a visible and verifiable part of the transition toward digital transformation, the lack of a detailed shared vision of smart schools accompanied by practical examples hinders the sustainable and successful turning of the educational system into smart educational system.

A potential explanation may also lay in the shortage of shared vision of smart school concepts in a school community: ICT coordinators, school leaders, teachers, students, and parents. Weak ICT infrastructure is not the only reason that impedes schools from passing into smart schools. The well-established traditional model of teaching and learning can be an additional barrier to necessary changes. To overcome all these barriers, top-down efforts for smart school model development and dissemination are needed. Sharing successful examples of transition from traditional schools to smart schools can help to overcome these barriers too.

The main conclusion is that multi-dimensional analysis of the change process may help in the exploration of the complex phenomena of transformation to smart education. There is a need for mutual clarification and validation of research instruments, especially from the perspective of traditional and computational indicators.

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Translation of Spanish Text to Mexican Sign Language Glossed Text Using Rules and Deep Learning

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Abstract. People with hearing disabilities face various communication problems in their environment, both social, workplace, and educational. The World Health Organization reports that more than 360 million people worldwide suffer from hearing problems. The number of certified Mexican Sign Language (MSL) interpreters is low, with approximately 40 in Mexico, which has the consequence of not having access to higher education in this community. This article presents an architecture to translate from Spanish to MSL glossed text. This translation architecture obtained results through various models evaluated with the BLEU, WER, and accuracy metrics, confirming the viability with traditional and computational learning models for sign language translation. Translation with traditional techniques was found to perform better than deep learning. In addition, it was possible to build a corpus of ten sentences written in gloss, validated by a member of the deaf community of MSL.

Keywords: Deafness · Mexican Sign Language · Natural Language Processing · Recurrent Neural Network · Knowledge Representation

1 Introduction

In México, there are 5 million people with hearing disabilities, where there are only approximately 40 certified Mexican Sign Language interpreters in all of México, by the National Institute of Statistics and Geography(INEGI).

Sign language is the natural language for the deaf community. Unlike oral language, this is made up of body movements and facial gestures. In México, the Mexican Sign Language (MSL) is used for its deaf community.

Since México is a country where Spanish predominates as the language, MSL is listed as a minority language. This reason has caused the isolation of the deaf community, hindering their personal, professional, and educational development.

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Therefore, the lack of fulfillment of the right to education from the basic to university level has alarmed the community.

The World Health Organization (WHO) reported that more than 360 million people worldwide suffer from a hearing problem. Therefore, the consequence is that many people are limited in communication with others. Additionally, the limitation of communication has detrimental effects on intellectual development by requiring more educational assistance. It denotes high rates of school failure since this assistance is not always available to all students with hearing problems who need it.

In México, according to the last census carried out in 2020 by the INEGI of 20 million people surveyed with some disability, approximately 5 million people will suffer from hearing limitations. In Sonora State, there are an average of about 7,000 people with hearing disabilities, of whom only 7 study at a university level, interpreters are needed so that the community understands that the deaf is intellectually competent.

The main objective of this work was to build a translator from Spanish text to text in MSL glosses, applying two approaches, the first based on rules (automaton) and the second on deep learning (neural networks). With this translation architecture, results were obtained through various models that were evaluated with the BLEU (Bilingual Evaluation Understudy), WER (Word Error Rate), and accuracy metrics, confirming the feasibility with traditional models (rules). The deep learning network allowed laying the foundations for its implementation by making comparisons with different corpus, leaving a wide margin for improvement, mainly in the expansion of the MSL corpus.

1.1 Background

Sign language is the natural language for deaf people and, like all languages, emerges from the need to establish communication between people. Sign language is not universal. Therefore, there are different ways of directing the work of translators and spoken languages.

Most of the published works refer to the translation of the sign into natural language, either in text or voice; among these works are in [1,2,3,4].

In a recent study on the approaches used for the translation of the text into sign language, 38% of the analyzes have been carried out using rule-based machines, and only 6% using neural networks [5]. However, within the studies detailed in this work, none focuses on MSL using deep learning. The most used metrics for evaluating translations are BLEU in first place and WER in the third position.

In [6] the author's presents work for translating numbers into Hindu sign language using 500 images, obtaining better results with the nearest neighbor algorithm. This approach starts from an image classification. Another work from

India is that of [7], where they propose a tool to convert audio or text to Hindu sign language.

Work for the Spanish of Mexico presents an avatar with a vocabulary of 199 words reaching an accuracy of 96% [8]. The authors trained a convolutional network with the movements of each word captured through a Kinect device. In contrast and with a different approach, our work seeks to translate from Spanish to a representation of signs through textual signs (gloss).

A linguistic resource created for machine translation from Spanish to Mexican Sign Language includes sentences from a domestic setting (inside a house) [9]. However, the corpus is not available for use.

Some translators made for the Spanish Sign Language (SSL), are TextoSIGN developed by the Technological Institute of Castilla y León and XUL Social Media Company in 2011. Signslator, developed by the Association for the Normalization of Sign Language (ANICOLS) in collaboration with the communication agency TBWA in Spain, is based on the translation of Spanish sign language. The contributions of our work are a Spanish Text to Glossed Text translator architecture, a comparison between rules and deep learning, applied to three corpora, a corpus of ten sentences written in gloss validated by a member of the MSL deaf community.

2 Material and Method

The structure of sign language is generally established as a language with Subject-Verb-Object (SVO) order [10], even though other authors such as [11] recognize the order Subject-Object-Verb (SOV). However, the claim of an SVO order is mainly based on the systematic analysis of a single sign language, American Sign Language (ASL). Focusing on the Mexican Sign Language and considering that the verb can influence the order it presents, it can be said that the observed order of constituents in grammatical constructions is SVO. Also, we have different variations OSV, VOS, VSO, OVS, and SOV, depending on the verb used and semantic and pragmatic situations [12].

2.1 Module translator of Text in Spanish to Text in gloss of MSL

The architecture that we propose in this work includes three components: the preprocessing block with NLP techniques, the grammatical analysis functionality, and finally, the translation block. Our goal is that the text-to-gloss translator receives a text in Spanish, which is the starting point for natural language processing. Afterward, a well-defined lemmatized structure will be obtained (identifying the root of the word and its grammatical class) of said sentence. Then it

is sent to the grammatical analysis, which in turn, with the help of defined grammatical rules of the MSL, obtains a translation as similar as possible to the original translation. The results in the instance received by the text translator, which through various translation techniques and creating and making use of an MSL Corpus, seeks to perform the precise translation of the MSL glossed text, see Figure 1.

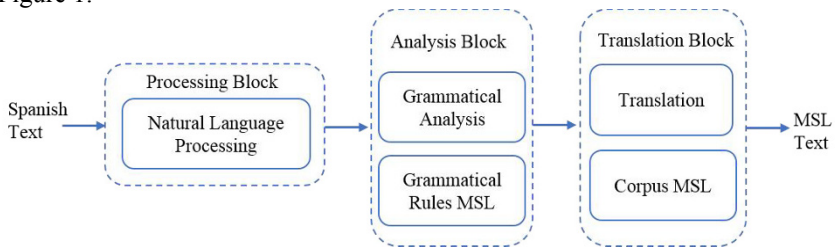

Fig. 1. Spanish Text to MSL Text Translator

2.2 Block 1: Natural Language Processing in Spanish

This stage is based on extracting each of the parts of the text received through a previously developed platform [13]. The platform allows extracting a sentence and lemmatizing it with the help of the FreeLing tool [14]. The recovery of the text to be treated is carried out, and with the help of the FreeLing tool, a labeling process is carried out for each of the words that are recognized in the text. After obtaining the parts of the sentence for each of the sentences, each one being tokenized, the instance that is going to be processed in the next block can be generated. The text obtained from the lemmatization will be displayed in JSON and/or XML format. Each of the sentences in Spanish shows, among various characteristics (lemma and label), corresponding to each of the words recognized by FreeLing.

2.3 Block 2: Grammar analysis for MSL

This block seeks to achieve the approach to the closest grammatical form on the accurate translation, converting the lemmatized text that is generated in the previous functionality and, with the support of the grammatical rules of the MSL [15], to formulate a sentence in MSL gloss.

The lemmatized text initializes the processing within the parsing. Then, with the generated instance, we seek to identify each of the labels of the words that the sentence contains, recognized in the MSL grammar. Subsequently, we seek to obtain a statistical alignment of the tagged lemmas so that it is possible to generate a sentence with the grammatical characteristics of the language to be obtained (in this case, the MSL gloss). The grammar used for the identification and alignment of

lemmas, referring from the use of phonology to the syntax used in the sentences of the MSL, is shown in the work [16].

2.4 Block 3: Translation

A combination of techniques is used in this block. First, an automaton is executed, which searches for the translation with the help of the generated rules (rule-based model). Then, the search for the best combination to display is performed (model based on deep learning). From the set of previously aligned lemmas, the translation is sought in two different models.

The first model seeks to perform a translation by means of an automaton, which consists of a model based on rules obtained from the previous component. The automaton allows the translation to be carried out as close to the grammar that is being worked to get a correct translation. The process carried out by the automaton. First, the aligned lemmas are received, and a lexical analysis process is performed to verify the lemmatization and tokenization, after a syntactic analysis is performed.

In addition, the aim is to translate with deep learning methods, which with the help of a recurrent network and a corpus of MSL can feed and train, and in this way, find the model that best adheres to the grammatical rules and thus carry out the translations. This model is based on a LSTM (Long Short Term Memory) network and the use of Seq2Seq (Encoder-Decoder architecture) of Keras [17] to implement this form of and have a comparison of which model is the one that best performs the expected translation.

Once the translation is generated with the models, a heuristic is sought to make a comparison in the evaluation module and determine which is the text in MSL gloss that obtains the best result and, in the end, send the text in gloss MSL for the educational support platform.

3 Corpus and metrics for translation evaluation

For the experimentation, three different corpora were used. The first is a corpus of Spanish to SSL glossed text [16] that was developed using six different texts with various topics such as student housing, history and war, a day in the life of a dog, population and demographic issues, domestic violence, and a day in the life of a girl. The structure with which the corpus is developed is shown in three different versions described as follows: (A) is a sentence in the Spanish version obtained from the source, (B) is a Spanish SSL translation obtained from sentence A, (C) is a Spanish translation obtained from sentence B. The corpus has 229 sentences written in gloss. An example of this corpus is shown below:

• Sentence A:
This is the solution that students prefer.
• Sentence B:
THAT, RENT APARTMENT LIKE MORE WHO, PERSON + STUDENT +.
• Sentence C:
Students like renting a flat more.

The resources that exist for the work of translation of languages from written languages to Mexican sign language is a research work that is beginning. Therefore, using the techniques of compilation and elaboration of the corpus of Spanish sign language [16], we sought to make an MSL corpus, which will serve for this research and future research. This second corpus is made up of 10 sentences written in gloss with the characteristics shown in Table 1(shaded area). The corpus was validated by a member of the MSL deaf community.

The third is a Spanish-English corpus (30), which contains approximately 125 different languages, all with sentences from a source language to a target language (the target language of all corpora is English) separated by tabs. Although the object of study was the MSL sign language, it was sought to have a comparison with a corpus of different sizes, see Table 1.

Table 1. shows the general information of the SSL corpus.

Corpus	Sentences	Word	sentence length (max)
Spanish-SSL	229	978	52
Spanish Sign Language LSE	229	686	46
Spanish-MSL	10	13	51
Mexican Sign Language MSL	10	18	45
Spanish-English	120,245	44,676	53
English	120,245	22,052	45

3.1 Metrics

The evaluation of the quality of the machine translations generated was made with the BLEU, WER, and accuracy metrics. BLEU (Bilingual Evaluation Understudy) [18], is one of the most used metrics for the automatic evaluation of translation machines. This metric is based on calculating the average precision for each n-gram between the source translation and the target translation, assigning a weight to each n-gram, and being able to compare it with the human translation. An n-gram is a set of elements within a set window, e.g., bigrams. The method has a problem with short sentences, so a penalty factor called BP is incorporated, which avoids giving too much weight to short n-grams. The measurement of the evaluated translation ranges between 0 and 100, where 100 corresponds to a correct translation.

WER (Word Error Rate) [8] is commonly used in voice recognition systems; this metric also allows the evaluation of an automatic translation system. The metric uses a Levenshtein distance that is defined as the number of minimum editing steps between the words of a sentence, considering the insertions, deletions, and substitutions that are applied after obtaining a target translation to be measured as a correct translation. One disadvantage is that it is based on a single valid translation, which allows only one approach to a form of translation evaluation to be observed. The evaluation measurement of this metric is based on the percentage of errors between the total number of words in the translation, which yields a percentage between 0% and 100%. Accuracy is defined as the percentage of instances where the proposed model predicted the correct value; that is, it refers to how close the result of a measurement is to the true value.

4 Experiments

Three experiments were designed under the deep learning approach. The first uses the SSL corpus selecting 85% of the sentences for training and 15% for evaluation. The second experiment uses the MSL corpus; cross-validation was used to obtain the metrics due to its small size. Finally, the Spanish-English corpus was used to have a reference of a larger corpus, using the exact percentages as the first experiment. The experiments were also replicated using an automaton to obtain the glossed translation.

4.1 First Experiment

An accuracy close to 92% is obtained in this training with 1000 iterations performed and a loss of .0297. The sentences obtained in the prediction with the trained model of this experiment turned out to be positive since it makes a prediction with coherence. Even though it is not successful compared to the target sentences of the corpus, a sentence is structured with sense, as we can see in Table 2.

Table 2. Prediction Spanish-LSE corpus*.

Sentence	Correct translation	Prediction
Los domingos papá compra churros.	DOMINGO PAPÁ CHURRO COMPRAR	COMER PREPARAR
Primero suelto a mi perro y después le tiro la pelota.	PRIMERO YO CLI: "desatar al perro", PELOTA TIRAR LEJOS,	PRIMERO PARO DINERO GRAN SUELDO NO.
Mientras que en España el peso de los hijos repercute	ENTONCES, ESPAÑA EN-ESTE-MOMENTO HIJO	ESPAÑA PRIMERO NACIMIENTO MUY
más sobre la mujer no se podrá esperar un aumento de la fecundidad.	RESPONSABLE MÁS QUIÉN-? MUJER+, POSIBLE FUTURO MUJER NACIMIENTO++ CRECER-NO.	POCO MAS O MENOS 115.

* The text is in the original language to kept the grammatical constructions (SVO)

4.2 Second Experiment

Under the same configuration as the first experiment, the results had lower performance. The result observed in Table 3 was generated from the prediction with the trained model of the MSL corpus, which is not accurate in its translation, but a meaningful sentence is obtained.

Table 3. Prediction Spanish-MSL corpus*.

Sentence	Correct translation	Prediction
Mañana tengo que ir al doctor con mi papá.	MAÑANA + PAPÁ + MÍO + YO + DOCTOR + IR.	MAÑAÑANA + DOS + PLATANOS + UNA + PERA + LUIS + COMER.

* The text is in the original language to keep the grammatical constructions (SVO)

4.3 Third Experiment

Using the Spanish-English corpus with 75% of the original corpus and 200 epochs, we obtained an accuracy value of 0.5397. The results of the resulting sentences are presented in Table 4, where you can see the input sentence, the correct output sentence, and the decoded output sentence, which is the result of the prediction, obtained using the trained model.

Table 4. Prediction Spanish-English corpus.

Sentence	Correct translation	Prediction
Olvídate de ella.	*Forget about her.*	*Forget me.*
Puede que vengan.	*They may come.*	*It may do.*
Tom encontró a Mary.	*Tom found Mary.*	*Tom heard Mary.*

We can observe that the predictions are consistent and comply with the structure of what the correct sentence should be.

4.4 Experiments using an automaton

The automaton was designed and built based on the grammatical structure of the MSL gloss with the use of Subject Verb Object in the syntax that is handled in the structure.

With the output obtained from the natural language processing module and the grammatical analysis module that leave us with a structure similar to the one sought in this translation, we seek to make the necessary adjustments to be able to obtain the sentence in MSL gloss. The structure that is handled is simple, and both the lexicon and the syntax are reviewed in the modules prior to entering the automaton, for which the most exhaustive revision by the automaton is carried out in terms of semantics. A disadvantage of using rules is their robustness using the Subject Verb Object rule. Table 5 shows the concentrated results, including the BLEU and WER metrics.

The comparison made was obtained with the gloss sentence of the manual test taken as a reference and by using each of the translations as possible hypotheses. The results were compared and obtained can determine that the best translation obtained is that of the automaton with an accuracy of 0.70 and an error of 0.25 in the translation.

Table 5. Results: Deep-net vs. Automaton.

Model	Corpus	Accuracy	BLEU	WER
Deep-Net	Spanish-SSL	**0.9179**	0.0	1.0
	Spanish-MSL	0.8394	0.5946	1.0
	Spanish-English	0.5397	0.51	0.66
Automaton	Spanish-SSL	-	**0.7071**	**0.25**
	Spanish-MSL	-	0.5623	0.6

The results obtained indicate that rules are still effective, even in small corpora. However, deep networks could help to carry out learning with greater coverage; the result demonstrates this with the Spanish-MSL corpus, which with 229 sentences reaches a value of 0.8394 of accuracy, and 0.5946 of BLEU metric, although the rate of error is very high. One possible reason for the high error rate is that the model is over-trained. The lack of a corpus with a greater number of elements is a limitation, but we believe that deep networks will increase the performance of the BLEU and WER metrics in the future.

5 Conclusions

In this work, a translator proposal was presented that allows obtaining an MSL glossed text from any text in Spanish that is entered. The development of the translator made it possible to implement and compare the traditional methods of text translation with the use of the deep learning approach in the translation task. Significant results were obtained that will help in the future for its application in the area of text processing for sign language.

The techniques applied for the translation of the text allowed us to compare the traditional methods, which was the implementation of an automaton, with the current artificial intelligence technology. The implementation of a recurrent network helped in the generation of a model capable of predicting the gloss of MSL from the learning of sentences that are part of a corpus.

The results that were shown helped us to obtain the first results of a corpus of MSL. In addition, the experiments generated did not allow us to verify that feeding the deep network with many data sets, it obtains better results.

At the beginning of the research, it was decided to limit the work to textual structures that are part of the structure belonging to sign language. In future work, we consider the possibility of implementing a module that works on body movements and, in the same way, another component that works on facial gestures, thus achieving the ability to cover the complete structure of sign language. Finally, it is expected in the future to increase the number of MSL sentences, this will help improve the performance of deep learning algorithms.

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