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博士生论坛论文集

Doctoral Student Forum Proceedings

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目录 Table of Contents

一. 序言 Message from the Organizer..iv

二. 大會組織 Conference Organization..v

博士生论坛 Doctoral Student Forum

1 Investigating Learning Motivation Transfer in a Computer-Supported Collaborative Learning Environment: A Study in Mathematics Class

Zhizi ZHENG and Daner SUN

6 Investigating In-service Mathematics Teachers' Understanding of Programming-based Mathematical Teaching Practices

Huiyan YE

11 The Impact of Design Thinking-based Computer-supported Collaborative Learning (CSCL) on the Development of Creative Thinking Skills Among Vocational Students

Juan WANG and Daner SUN

17 后疫情背景下在线学习的影响机理研究——基于师生视角的分析

黄禧钰，黄惠娟

24 增强现实环境促进小学生计算思维的教学研究

罗舒澄，林晓凡

30 基于数字游戏学习：对小学生外语焦虑和词汇学习的影响

熊昭洋，吴骏杰

34 指向深度学习的在线同伴反馈学习活动研究

王玉洁

43 Format Effectiveness of a Conversational Chatbot for Learning Abstract Concepts in Biology Courses: A Multicenter, Controlled, Randomized Trial Among Beginners

Junhua Xian and Xin Yong

47 Digital Media and Learning: Exploring the Construction of Media Literacy Among College Students Through Spherical Video-based Virtual Reality Production

Youwen Shi

52 New Takes on Developing Language Learning and Intercultural Competence Using Telecollaboration Project Supported by Generative AI

Wayan Sintawati, Xinyu Wang and Hongquan Bai

57 课堂文本语言行为自动分析系统开发及应用

黄立新，卢卓豪，薛松

一. 序言 Message from the Organizer

GCCCE 2024 博士生论坛为支持计算机教育应用领域中年轻研究人才的成长，向全球华人优秀博士生提供一个与同行交流学术的平台，并在相关研究领域专家小组的引领下深入探讨学术问题。参与者通过展示其博士论文有关要素，进行学术研讨，从而对论文及其研究进行完善、改进以及深化对计算机教育应用的理解。因此，本论坛为参与者提供了一次难得的互动机会，来审思博士论文研究和及时发现值得进一步思索和探究的问题; 本论坛也是一个与学术专家小组和其他博士生对话的平台，参与者可以贡献想法并且接受对他们当前研究的反馈意见和指导；该论坛同时也是一个学术共同体，以支持活跃在计算机教育研究领域的年轻学者。

本论文集收录了 10 篇论文，涵盖了 GCCCE 2024 大会多个主题: 学习科学与计算机支持协作学习，移动、泛在与情境化学习，悦趣化学习、教育游戏与数字玩具，高等教育与成人学习的技术应用、教师专业发展，技术增强语言与人文学科学习，人工智能教育应用及实践、智慧学习环境，学习分析与学习评估，STEM 与创客教育，和教育技术创新、政策与实践。今年的博士生论坛包含三个部分：短演讲、报告与讨论，以及一对一私人指导会议。前两个部份会开放给所有 GCCCE 的与会者，但是第三部分则仅限博士生论坛主席、邀请专家以及博士生论坛论文被接受的学生作者参与。在报告与讨论和一对一私人指导会议, 博士生论坛得到了以下专家小组的全力支持与协助：

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我们同时再次感谢 19 位来自中国大陆、香港、台湾、澳门和新加坡的资深华人学者担任议程委员。

孫丹兒 香港教育大學(香港)

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Investigating Learning Motivation Transfer in a Computer-Supported Collaborative Learning Environment: A Study in Mathematics Class

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Abstract: *The proposal presents a study investigating transfer patterns of motivation in students' learning. There is a lack of studies that focus on the transfer of motivation in the learning process, but it is vital. This study combines quantitative and qualitative research approaches to thoroughly explore students' learning motivations and transformation patterns and identify the underlying reasons for these shifts. The dynamics of learning motivation are better understood as a result of this work. The research proposes possible directions for transforming learning motivation and provides essential exploratory research experience support for subsequent research.*
Keywords: Learning Science, Computer-Supported Collaborative Learning, Learning Motivation Transfer, Learning Attitude; Qualitative Research

1. Introduction

The last century has seen a lot of discussion on student motivation (Vu et al., 2022). The transfer of learning motivation is still relatively new. Therefore, this study puts forward the idea of exploring how students' learning motivation transfers in science learning, and the research mainly focuses on the reasons behind it.

The majority of academic research in the field of education focuses on the role of students' motivation and aims to investigate the potential I mpact of their learning motivation on their learning outcomes (Rafiola et al., 2020; El-Adl & Alkharusi), as well as examining the potential impact of other factors within the learning process on students' motivation (Zheng et al., 2020; Yousef, 2021; Liao et al., 2019). Previous research provides a foundation for understanding the interrelationships and causal links between various factors involved in the learning process. However, the development of learning motivation and the relationships with learning outcomes is not characterized by linear progression but is challenging and complicated. Considering the constrain of theory content and methods of students' motivation transfer, the present study aims to use qualitative research methods to provide new perspectives in understanding students' motivations (Fossey, 2002). Investigating students' learning motivation transfer in computer-supported collaborative learning in mathematics class provides a new understanding of learning motivation, from the status to the sequence.

2. Literature Review

In an online learning context, motivation is more important, which is closely related to self-regulation and management of students (Sansone et al., 2011). Research found that students' motivation was significantly associated with their participation and engagement (Järvelä et al., 2011; Renninger et al., 2011). However, considering the complexity and multi-dimensionality of motivation, especially in the context of computer-supported collaborative learning, there is limited understanding of how motivation transfers and evolves. The study mainly focuses on the transfer process of these elements in mathematics learning and tries to discover their inner relations.

The method of investigating students' learning motivation is limited. A survey commonly used in previous research to represent the internal psychological status of students. In the former research scales, the Echelle de Motivation en Education (EME) developed by Vallerand and colleagues (1992) and the Student Motivation Scale (Martin, 2001) are frequently used in the field of educational psychology. In some research, students' learning motivation will be advanced analyzed as an element in a structural equation model (Xiong et al., 2015). The results usually reveal the relations between motivation and learning outcomes, such as engagement, retention, and academic scores, which contribute to understanding how motivation contributes to learning. However, the present study aims to focus on the motivation of students and explore the transfer of students' learning motivation. The process of transfer is a series of statuses with time change and sequence, which is impossible to be well described with a single rubric.

Thus, the study adapts the qualitative methods to gain insights into how students' learning motivation transfers under the computer-supported collaborative learning context.

The present study proposes the following research questions:

RQ1: How is students' learning motivation before and after the course?

RQ2: How are students' participation behaviors with the online mathematics platform?

RQ3: How is high school students' learning motivation transferred in the computer-supported collaborative mathematics class? (Qualitative research question)

3. Research Design and Methods

3.1. participants and Procedures

The participants in the study will be 40 to 50 students, around the average number of students per class, from a high school in the south of China. The study will be conducted in a mathematics course, in semester two of year one high school study, under computer-supported collaborative learning lasting one week. The course lecturer will be an experienced mathematics teacher familiar with students' weaknesses in math learning and already has one semester of experience giving classes to the same class. The study will be conducted under ethics and respect the will of all the participants, and they have the right to quit the study at any time.

The math course will last seven lessons and 40 minutes per lesson, in all 280 minutes. Students will be divided into groups, including four to five students. An online mathematics platform, which is integrated with target-related literacy and video materials, test questions, and an open discussion forum, will be provided to students.

The learning and teaching process is shown in **Figure 1**. The lecturer will introduce the learning goals of the lessons and give a lecture on the knowledge needed for collaborative learning. Then, the teacher will take students into the knowledge problem-based learning context of the present difficulties. Students will discuss in groups and present the learning questions from their perspectives. The teacher will give group feedback on their study questions and post it to the class. Accompanying the learning questions and learning goals, students will have a chance to learn and discuss in groups and finally solve the problem. The teacher will supervise the whole process and provide students with effective instruction. Finally, students will be asked to present the learning outcomes, and the teacher will give them feedback and assessment.

3.2. Data collection and analysis

Students' learning motivation will be collected by questionnaire before and after the course. The study utilized the Mathematics Motivation Questionnaire, adapted firstly by Fiorella and colleagues (2021), to measure students' learning motivation in math learning. The instruments include six aspects, including intrinsic motivation (three items, as "I enjoy learning math"), self-regulation (four items, as "I use strategies that ensure I learn math well"), utility value (four items, as "I think about how I will use math I learn"), self-efficacy (four items, as "I am confident I will do well on math tests"), and test anxiety (five items, reverse question, as "I worry about failing math tests") (Fiorella et al., 2021, p. 7). In the study, the questionnaire will be adapted to the Chinese context. Thus, the CFA (confirmatory factors analysis) will be conducted, and the index, including Chi-square value, degree of free, SRMR, RMSEA, CFI, and TLI, will be used to examine the validation of the instruments. Meanwhile, the study will use Cronbach's alpha value to examine the reliability of the questionnaire.

The study will also use the data from the platform, which records students' learning participation, including time students spend on specific areas, discussion content, and materials view times. The frequency of the participation data will be presented in the statistical analysis to understand their learning engagement.

3.2. Qualitative Research Design and the Conceptual Framework

In the study, qualitative research methods will mainly be used to investigate how students' learning motivation transfer in a CSCL class and the possible influencing factors, for instance, their background and personalities. Several students will receive a short interview after every class, and their discourse in the class will be recorded, including interaction with teachers and peer students and their learning traits.

The conceptual framework is shown in **Figure 2**. At first, the study was based on social cognitive and self-determination theories (Saeed & Zyngier, 2012). After that, the study aimed to investigate students' learning motivation transfer, which needs to know the background of the motivation and the context. The concept of motivation is from learning attitude (Ebata, 2008). The study will be in a computer-supported collaborative learning environment mathematics class. The students are from high school. Their background information is vital, which contributes to the motivation. Possible factors include personal, social, and environmental factors (Bénabou & Tirole, 2005). Internal and external motivations are included (Bénabou & Tirole, 2003). This study focuses on exploring the direct relationship between the transfer pattern and its causes.

Sub-questions: Question 3.1: How is students' motivation from the background information? Question 3.2: How do students' learning motivation improve in this process? Furthermore, what causes the improvement? Question 3.3: How do students' learning motivation fade in this process? Furthermore, what causes the fade? Question 3.4: What makes the transfer students' learning motivation?

From question 3.1, students' basic information will be revealed, including their family composition, community identity, and cultural background. The background may have already influenced their behaviors and the form of their personality. In this case, the question will provide the researcher with a preview of the general motivation of the students. Questions 3.2 and 3.3 are proposed to discover the different changes in students' learning motivation in the learning process and to explore more details of what causes the changes. Questions 3.2 and 3.3 make predictions about possible evolutionary directions. However, the focus is on exploring the causes of change. The research will delve into the reasons behind the shift. Question 3.4 mainly hopes to explore the causes of changes in student motivation. Are changes in students' learning motivation related to corresponding events? Are students' motivational shifts correlated with time? These questions are included in question 3.4. The research hopes to obtain corresponding answers to this question and establish a reliable theoretical transformation model. In order to explore the causes behind the changes in motivation, we can better understand students' motivation changes during the learning process and provide inspiration for future studies and practices.

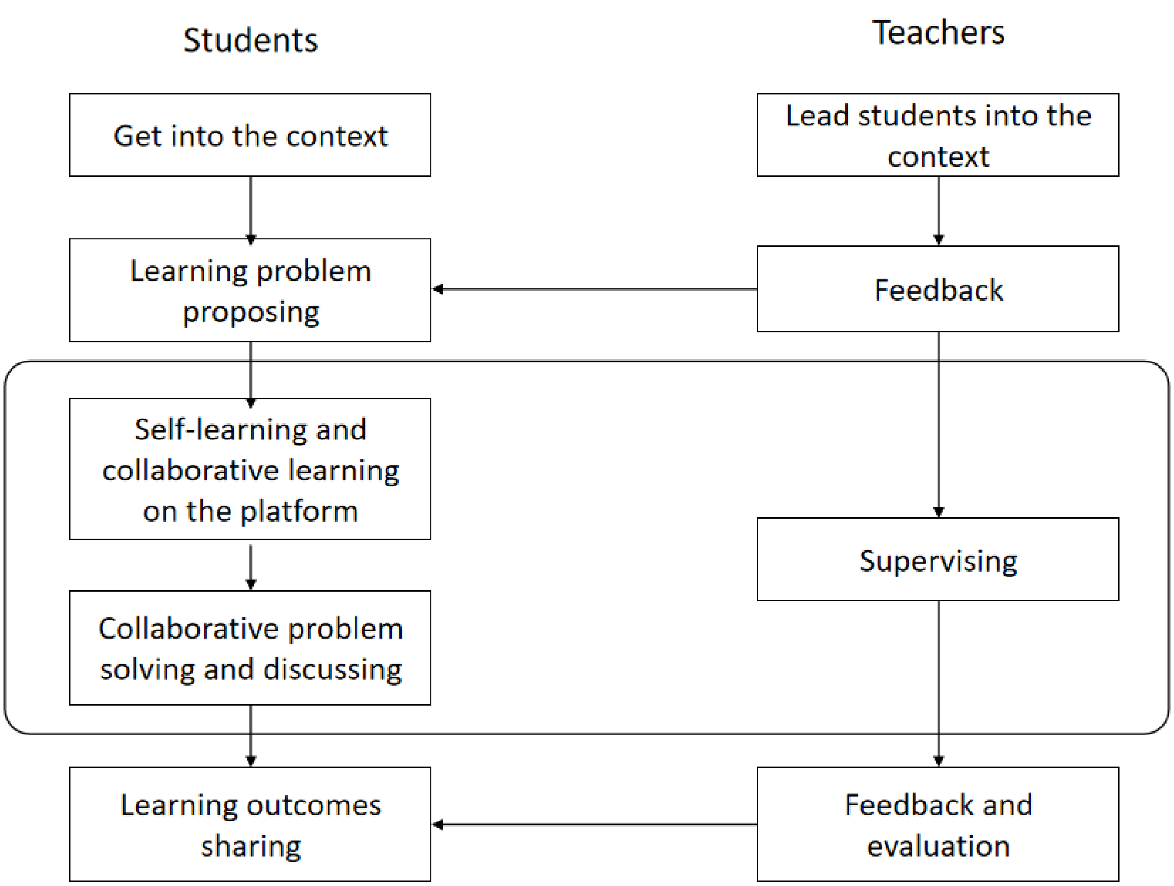

*Figure 1.*The learning process of mathematics computer-supported collaborative learning

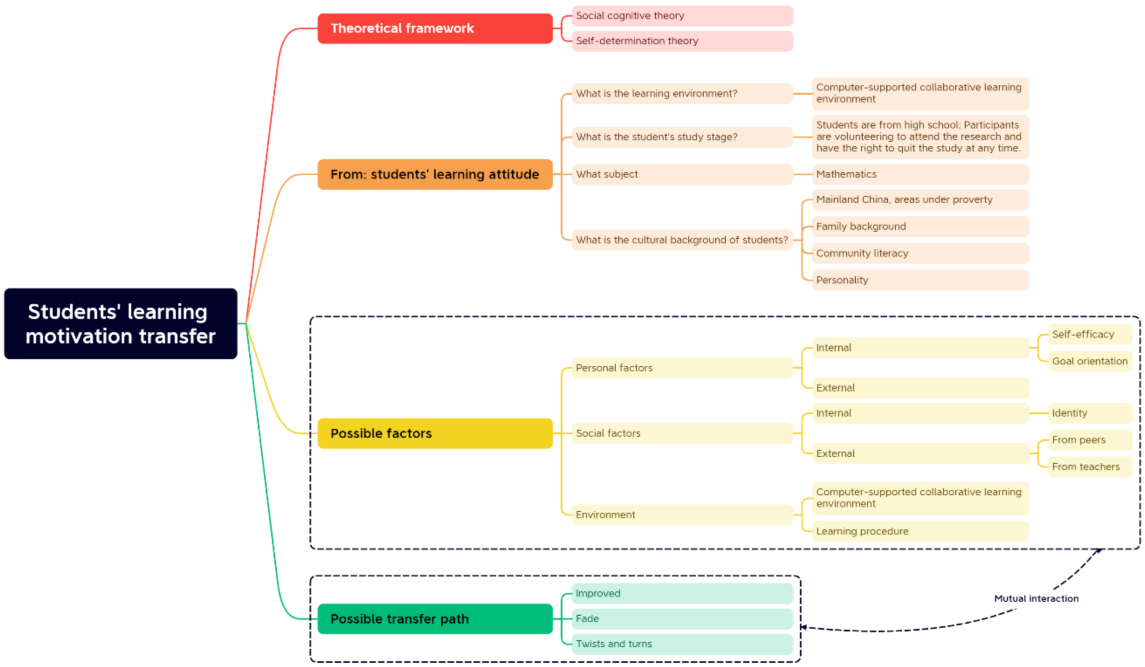

Figure 2. The framework of the learning motivation transfer

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Investigating In-service Mathematics Teachers' Understanding of Programming-based Mathematical Teaching Practices

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Abstract: *Existing empirical studies have evidenced that programming-based mathematical problem-solving could facilitate students' development of mathematical thinking and computational thinking. However, little being known about how to facilitate in-service mathematics teachers' (MTs) acquisition of the knowledge and competence to implement such interdisciplinary teaching. Adopting the instructional approach of vignette activity sequence, this study aims to examine in-service MTs' understanding of programming-based mathematical teaching practices and evaluate the effectiveness of vignette activity sequence to facilitate MTs' professional development.*
Keywords: Programming, Programming-based mathematical teaching practices, Mathematics teacher development

1. Introduction

Computational thinking (CT), as a form of problem-solving thinking closely related to programming (Wing, 2008), has attracted the growing interest of mathematics educators in introducing CT into mathematics education (e.g., Miller, 2019). Existing empirical studies have evidenced that programming-based mathematical problem-solving could facilitate students' development of mathematical thinking (MT) and CT (See a review in Ye, Liang, et al., 2023), which offers opportunities to bring programming and CT into the mathematics classroom to support students understand mathematics in new ways (Feurzeig et al., 2011). However, as programming-based mathematics teaching is an interdisciplinary pedagogical practice which requires a relatively high level of competence and knowledge different from traditional mathematics classroom teaching (Huang et al., 2022), mathematics teachers (MTs) expressed concerns about their readiness to carry out programming-based mathematical instruction (Vinnervik, 2022). Furthermore, most of the existing research on programming-based mathematical instruction is small case studies or researcher-led classroom practices, which results in little being known about how to facilitate in-service mathematics teachers' acquisition of the knowledge and competence to implement such interdisciplinary teaching.

Regarding effective mathematics teaching, MTs are expected to acquire knowledge that entails mathematical content knowledge, mathematical pedagogical content knowledge, and other domain-specific knowledge (Ball et al., 2009; Shulman, 1986) especially in a technology-integrated classroom (Koehler & Mishra, 2009). One of the significant ways to prepare MTs for technology-enhanced mathematics teaching is to support them in identifying "teaching practices in which the proficient enactment by a teacher is likely to lead to comparatively large advances in student learning" (Ball et al., 2009, p. 460). Research has evidenced the benefits that instructional vignettes can contribute to teachers' preparation for effective teaching practices (Stecher et al., 2006). Thus, adopting the instructional approach of vignette activity sequence (Wilkerson et al., 2018), this study aims to examine in-service MTs' understanding of programming-based mathematical teaching practices (P-MTPs) and evaluate the effectiveness of vignette activity sequence to facilitate MTs' professional development in programming-based mathematical teaching from the perspective of technological pedagogical content knowledge (Koehler & Mishra, 2009). To this end, we will address the following research questions:

(1) What kinds of programming-based mathematical practices (P-MPs) and teaching practices (P-MTPs) do the MTs identify?

(2) How do in-service MTs evaluate the professional development activities based on the vignette activity sequence from the perspective of developing their programming-based mathematics pedagogical competence?

2. Theoretical Background

2.1 Technological Pedagogical Content Knowledge (TPACK)

In the 1980s, Shulman (1986) proposed a theory of teacher knowledge (PCK: Pedagogical Content Knowledge) from the perspective of what teachers should know about teaching. As time progressed, the use of technology in teaching came into focus. Instead of using only blackboards and textbooks as in traditional teaching, teachers have begun to integrate technology into their teaching. Therefore, Koehler and Mishra (2009) added the dimension of technological knowledge to the teacher knowledge structure and proposed the framework of Technological Pedagogical Content Knowledge (TPACK; Figure 1). Mishra and Koehler (2009) argue that technological pedagogical content knowledge (TPACK) is the most essential knowledge for teachers to conduct high-quality instruction that integrates technology, and this kind of knowledge is not simply the sum of content knowledge, pedagogical knowledge, and technological knowledge, but requires teachers to integrate all three core kinds of knowledge creatively and flexibly, which is different from subject-specific content knowledge or technologist knowledge, or general pedagogical knowledge shared by teachers across disciplines. Thus, technological pedagogical content knowledge (TPACK) requires teachers to fully understand the linkages between the three to develop appropriate and content-specific pedagogical strategies. For example, understanding how to use technology to demonstrate concepts; how to use pedagogical techniques in conjunction with technology to teach content in a constructive manner; and knowing what makes concepts difficult or easy to learn and how to use technology to help students solve learning difficulties. Therefore, MTs' development of TPACK is the focus of attention in this study, which will be used to assess the effect of the professional development activity on MTs' understanding of programming-based mathematics teaching practices.

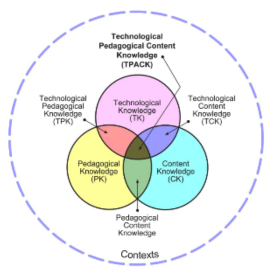

Figure 1. The TPACK framework and its knowledge components (Koehler & Mishra, 2009)

2.2 Programming-based Mathematical Teaching Practices

By conducting a comparative case study of professional education in three different professions, Grossman et al. (2009) have identified three key concepts for understanding the pedagogies of practices in professional education: representations, decomposition, and approximations of practices. Specifically, representations of practice include the different ways in which practice is represented in professional education and what these different representations can show novices. Decomposition of practice refers to the breaking down of practice into its component parts for pedagogical purposes. Approximations of practices involve opportunities to engage in more or less proximity to professional practice (Grossman et al., 2009). Connecting the framework for teaching practice developed by Grossman et al. (2009) and harnessing the benefits of educational vignettes, Wilkerson et al. (2018) proposed a vignette activity sequence (Figure 2) used to support teachers' mathematical knowledge for teaching by identifying mathematical practices and mathematical teaching practices. However, there is a lack of research on investigating mathematical teaching practices in programming settings, so in this study, we will adapt the vignette activity sequence accordingly, that is, instead of assessing teachers' competence in identifying teaching practices based on a well-established framework, we will provide open discursive space for MTs to discuss their own observed teaching practices based on the review of the vignette. Upon this, we will summarize the programming-based mathematical teaching practices through open coding. We will detail the research design in the Method section.

Figure 2. Mathematical Practice and Mathematical Teaching Practices vignette activity sequence (Wilkerson et al., 2018)

3. Method

3.1 Participants and Context

As part of a larger research project, the main objective of this study is to identify programming-based mathematical teaching practices by investigating mathematics teachers' understanding of programming-based mathematical instruction, so as to provide empirical experience for teacher professional development programmes related to programming-based mathematical teaching. Therefore, this study will recruit six in-service secondary school mathematics teachers in Hong Kong as participants. The criteria for participant recruitment are those who possess basic programming skills and have experience in programming-based problem-solving but have never implemented programming-based mathematical teaching in their mathematics classroom.

3.2 Research Design

In this study, we will adapt the vignette activity sequence (Figure 3) proposed by Wilkerson et al. (2018) to support MTs' TPACK knowledge for programming-based mathematical teaching by identifying programming-based mathematical teaching practices (MTP). We will detail each step in the following section.

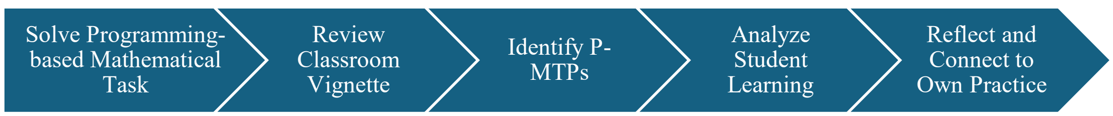

Figure 3. Vignette Activity Sequence for understanding programming-based mathematical teaching practices.

Step I: Solve Programming-based Mathematical Task

In-service mathematics teachers (MTs) are assigned to work on a programming-based mathematical task before peer discussion. This step aims to familiarize MTs with the tasks so that they can better understand the instructional approach and students' problem-solving processes shown in the vignette. As such, MTs will also be asked to write down what they think students might struggle with. Then, all MTs will engage in a discussion about the programming-based mathematical task described in the vignette and their problem-solving methods before reviewing the classroom vignette.

Step II: Review Vignette of Classroom Teaching and Student Learning

After peer discussion about their problem-solving strategies, MTs will review vignettes of classroom teaching and student learning in the form of videos and written descriptions provided by researchers. The vignettes used in this study are taken from a large research project undertaken by the researcher's team, which developed a series of programming-based mathematical tasks for classroom teaching and learning. Instructional materials as well as videos of classroom instruction and student learning collected during the research period will be used as learning materials for MTs aiming to investigate their understanding of programming-based mathematics teaching practices and student learning. Specifically, the process of vignette selection is as follows:

(a) Lesson instructor (LI) write down the highlights of the lesson.

(b) Researchers select vignettes in consideration of the purpose of the study and LI's lesson design intention.

(c) Researchers invite the LI to write down his/her intention of instructional design as well as teaching reflection regarding the researchers' chosen classroom episode.

(d) Researchers reconsider the chosen vignette based on LI's reflection on each episode and choose the final vignette.

Thus, each selected teaching vignette will be attached with the LI's lesson design intentions and teaching reflections, as well as the researchers' reasons for the vignette selection. Regarding the vignette material provided to the MTs, in addition to the video material, a written document describing LI's lesson design intention, teaching practices and students' learning process will be supplied to the MTs. Then, MTs will be asked to record their attention without any prompts as they review the vignette materials.

Step III: Identify Programming-based Mathematics Teaching Practices

When the MTs have completed the first round of vignette review and written down their self-initiated observations, the researcher will provide a worksheet with guiding questions (Table 1) for the MTs to review the vignette materials again from the perspective of P-MTPs (Part 1) fill in the form individually.

Table 1. Worksheet for MTs

Part 1: Programming-based Mathematical Teaching Practices (P-MPT)

• Identify any Programming-based Mathematical Teaching Practices practiced by the teacher that is illustrated in the vignette. • Provide evidence from the vignette to justify the Programming-based Mathematical Teaching Practices you selected. • Please connect your evidence to the material/discussions/research discussed in class.
Part 2: Programming-based Mathematical Practices (PMP) • Identify any Programming-based Mathematical Practices practiced by the students illustrated in the vignette. • Provide evidence from the vignette to justify the Programming-based Mathematical Practices you selected. • Please connect your evidence to the material/discussions/research discussed in class.
Part 3: Reflect and Connect to Own Practice • How does reflecting on this vignette inform your own teaching practices? • What will you take away from this vignette, or what connections can you make to your own teaching of future teaching?

Step IV: Analyze Student Learning

Research has shown that teachers can learn from student thinking for their professional development (Liang, 2023). Therefore, one of the important steps in the vignette activity sequence is for MTs to understand student thinking by analysing the programming-based mathematical learning processes that students engaged in. Similar to the step of identifying P-MTPs, MTs will be asked to complete worksheets with specific questions in Step IV (Table 1, Part 2), which elicited MTs to think about the relationship between P-MTPs and P-MPs to deepen their understanding of P-MTPs.

Step V: Reflect and Connect to Own Practice

As a step towards Approximations of practices advocated by Grossman et al (2009), after MTs have completed the vignette reviewing and identified P-MTPs and P-MPs, they will design their own lesson plan based on their understanding of programming-based mathematical teaching practices. Specifically, MTs will be asked to mark the P-MTPs used and the pre-defined student P-MPs in their lesson plans. Thereafter, following the perspective of TPACK, the researcher will conduct one-on-one interviews based on the MTs' individual lesson plans to gain insights into their understanding of programming-based mathematical teaching practices.

3.3 Data Collection and Analysis

The whole process of the research will be video recorded, so all the discourses and behaviours of MTs in this study will be transformed into video and text data. Besides that, worksheets and lesson plans completed by MTs and interviews between the researcher and MTs based on their individual lesson plans are also key sources of data. Therefore, as shown in Figure 4, the data for this study included: video-recordings of self-problem-solving and peer discussion; worksheets; lesson plans and lesson-plan-based interviews.

Regarding data analysis, we will focus on MTs' discourse and their written documentation. As the purpose of this study is to identify different kinds of programming-based mathematical teaching practices, we will adopt the method of thematic analysis to identify, analyse and report patterns of data (Braun & Clarke, 2006). Thematic analysis is suitable for this study for it identifies not only similarities but also differences, as well as yielding unforeseen insights and summarizing key features of a large data set.

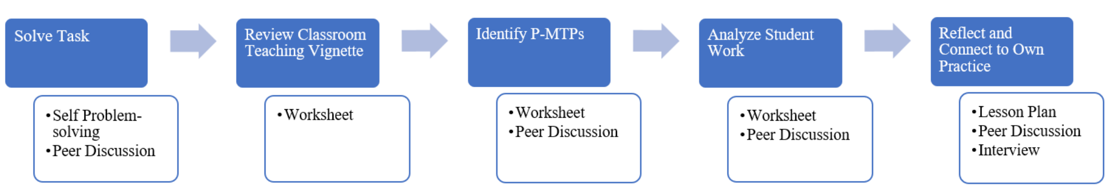

Figure 4. Data collection for each step.

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The impact of design thinking-based computer-supported collaborative learning (CSCL) on the development of creative thinking skills among vocational students

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Abstract: *Creative thinking is a crucial skill in the 21st century, particularly for vocational students, as it plays a pivotal role in adapting to future career field changes. However, conventional teaching methods pose challenges in fostering creative thinking skills. Therefore, this study employs the design thinking approach to devise computer-supported collaborative learning tasks encompassing diverse themes for creative problem-solving. By employing correlation analysis and epistemic network analysis, we investigate the development and evolution of vocational students' creative thinking skills during the process. Consequently, we construct a teaching design utilizing design thinking methods to enhance creative thinking within CSCL.*
Keywords: design thinking, computer-supported collaborative learning(CSCL), creative thinking, epistemic network analysis

1. Introduction

In the era of rapid global economic and information technology advancements, innovation has emerged as an indispensable cornerstone for national and regional development, with innovative talents playing a pivotal role in driving this progress (Siburian et al., 2019; Nurkhin & Pramusinto, 2020). In the face of fierce international competition, innovation, as the main source of economic development, is particularly important as the first driving force for development (Schmiele,2012). "Mass innovation" has also become the core competition model of current social and economic growth (Chen et al., 2018). Recognizing vocational education's significance as a vital foundation for both economic and societal development, the General Office of the State Council issued the 'Decision on the Development of Vocational Education' in 2005, in which emphasized vocational colleges' responsibility to cultivate innovative skilled talents. Creative thinking skills are an indispensable skill for contemporary vocational students in the era of globalization and it is recognized as a 21st-century competency together with critical thinking, communication skills and collaboration skills (Nazarethet al.,2019; Henriksen et al.,2017). Creative thinking skills refer to the capacity to generate unique solutions and approach problems from diverse creative perspectives (Bosman & Eom, 2019), as a fundamental skill that play an integral role in supporting a comprehensive educational philosophy within higher education. Moreover, the 21st century defined as the era of Industry 4.0 was characterized by information technology and intelligence, where the transformations occurring across various industries have raised higher demands for vocational education as well (Nurmi
et al.,2002). Vocational education is regarded as work-related education with its primary objective being learning and developing work-related skills (Nurmi et al., 2002). This has prompted educators to reassess the relationship between vocational education and skills development due to the rapid obsolescence of traditional vocational skills in a rapidly changing environment. Brown &Lauder (2006) emphasized that creative thinking is key in navigating future career changes while helping students better adjust to evolving professional fields. However, it is evident that traditional knowledge-based teaching approaches are no longer adequate for cultivating creative thinking among vocational students (Heong et al.,2011). Therefore, addressing how to effectively promote the development of creative thinking among vocational students has become an urgent issue demanding resolution, which plays a crucial role in promoting students' all-round development. Design thinking (DT) is an innovative pedagogical approach that fosters creative thinking by focusing on individuals (Anderson,2012). Furthermore, design thinking is regarded as a creative methodology encompassing intricate skills and processes, and it is also acknowledged by scholars as a means of cultivating essential capabilities for the 21st century (Martin, 2019; Lin et al., 2020). Design thinking is a crucial educational concept that primarily emphasizes the process of creative problem- solving (Johansson-Sköldberg et a.,2013). Design thinking comprises several distinct stages, each with specific activities, providing educators with a

flexible, comprehensible, and innovative framework to support teaching implementation and learning (Sándorová et al., 2020). Moreover, design thinking offers opportunities for fostering creative thinking and motivating its development among students. Educators

can utilize this approach to instill creativity in their students' minds (Balakrishnan, 2022). Additionally, design thinking" as a novel pedagogy used in the context of computer supported collaborative learning (CSCL) have gained significant attention due to their close relationship in enhancing creative thinking skills(Lin &Hong, 2019; Tsai & Wang, 2021). Especially, in the context of vocational colleges, design thinking methods aid in nurturing students' practical problem-solving skills and creative thinking capabilities so that they can effectively adapt to future work changes (Henriksen et al., 2017). By focusing on gaining profound insights into user needs and problem nature itself, design thinking enables vocational education students to better comprehend challenges within real work scenarios while stimulating their ability to propose innovative solutions. This study employs a design thinking approach to devise collaborative learning activities of creative problem-solving with different themes in computer-supported collaborative learning, thereby investigating the progression and transformations of vocational students' creative thinking skills throughout the process.

2. Literature review

2.1 Cultivating creative thinking in vocational education

Over the past decade, there has been a consistent increase in research papers focusing on fostering innovative thinking in vocational education, highlighting the growing significance of innovative education. Currently, research on cultivating students' innovative thinking in vocational education primarily revolves around analyzing practical tasks, promoting student participation and assessing their innovative thinking abilities, as well as exploring innovative educational models. Boss and Krauss (2017) proposed that practical project-based learning facilitates the stimulation of students' innovative thinking. Samani et al. (2019) suggested that contextually-driven project-based learning (CPjBL) can generally enhance vocational students' critical thinking, creativity, and problem-solving abilities. Dewanto et al. (2018) highlighted in their study that vocational students must possess practical skills, with creative thinking ability being one of the crucial competencies supporting them to become skilled talents. This aspect of research also reflects the dearth of innovative thinking among contemporary vocational students. For instance, Gao (2022) contends that there is insufficient awareness of innovation among current vocational students. And vocational students lack the capacity for creative problem-solving (Samani et al., 2019). Li et al. (2022) argue that present-day vocational education lacks opportunities for nurturing diverse thinking among students due to traditional teacher-centered teaching methods restricting their creative thinking abilities and diminishing their interest in learning; thus, higher vocational colleges need to diligently address this predicament through different teaching methods or models. Although these studies have discussed the development of innovative thinking ability of vocational students, the evaluation of innovative ability focuses more on result evaluation rather than process evaluation.

2.2 Design thinking

Design thinking, as a human-centered innovative methodology, entails comprehending individuals' needs and leveraging interdisciplinary knowledge to devise groundbreaking solutions (Goldman et al.,2016). Brown (2008) proposed that design thinking is a human-centric innovation methodology that encompasses the consideration of individuals' needs and behaviors, as well as the technological feasibility. Martin (2009) characterizes design thinking as the primary approach for generating novel ideas and creatively addressing problems. In addition to facilitating a structured process that fosters the enhancement of innovative capabilities, design thinking also offers a valuable framework for students' participatory experiences aimed at enhancing their creative problem-solving skills (Grau &Rockett, 2022). Design thinking cultivates their adaptability in various work environments and industries while promoting the generation of innovative solutions through collaborative efforts (Guaman-Quintanilla et al., 2022). In vocational education, this approach facilitates students' comprehension of challenges in authentic work scenarios and fosters their capacity to generate innovative solutions (Harth&Panke,2019). With the widespread adoption of design thinking in the field of education, numerous design thinking models for teaching have been proposed by researchers. Among these models, the most renowned one is the Stanford d.school's design thinking model (Zhu et al., 2023;Plattner,2013). The Stanford model encompasses five stages of design thinking: empathy, definition, ideation, prototype development, and testing (Figure 1). The title of the paper or poster should appear on the top edge of the first page of the document. Type the title in uppercase and lowercase letters, centered between the left and right margins and in Times 14-point, boldface type. Capitalize the first letter of nouns, pronouns, verbs, adjectives, and adverbs; do not capitalize articles, coordinate conjunctions, or prepositions, unless the title begins with such a word. In case the title is two or more lines, double-space between the lines. Insert a blank single-spaced line after the title.

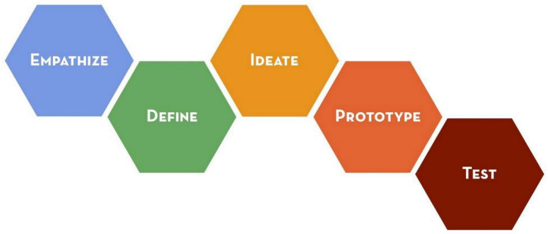

Figure 1. Stanford design thinking process(d,school,2011)

3. Research questions

RQ1: Does integrating design thinking into computer-supported collaborative learning have an impact on the creative thinking skills of vocational students?

RQ2: How does creative thinking skills develop in different stages of design thinking?

RQ3: What is the focus of the development of creative thinking ability at each stage?

4. Method

4.1 Participants

A total of 40 participants, including 20 girls and 20 boys, were recruited from a vocational and technical college in Guizhou known for its emphasis on cultivating skilled talents across various industries. The students, aged between 19 and20, possessed basic computer knowledge and prior experience with collaborative learning but had not received any formal training or courses in innovative thinking. To ensure data integrity, the researcher randomly assigned the 40 students into four groups consisting of ten members each. Within their respective groups, students collaboratively completed the required plan design task. The study was conducted by the author himself who possesses over seven years of teaching experience.

4.2 Research design

This research was conducted in the Innovation and Entrepreneurship Course, which aims to cultivate students' innovative spirit and entrepreneurial ability, and stimulate students' innovative thinking and entrepreneurial awareness. The course includes 10different sections, with a total of 18 weeks (one class per week). This study intends to use design-based research as the research guidance paradigm, which includes four main research links: preparation, design, execution, and evaluation (Dede, 2005). The specific process is shown in the figure2.

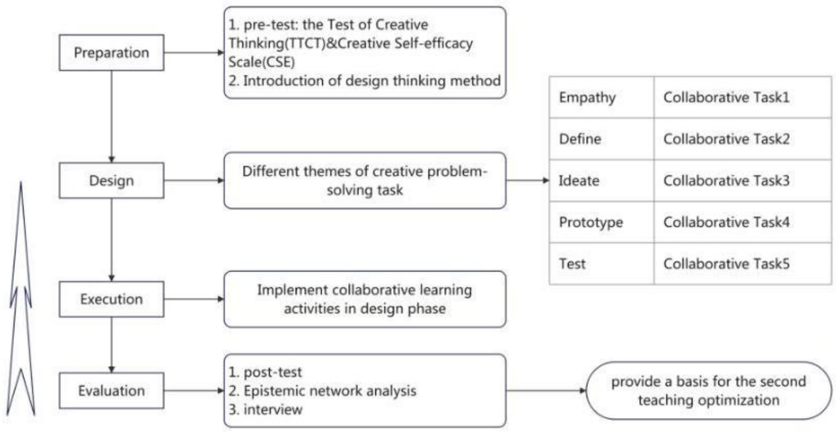

Figure 2. Design thinking-based collaborative learning activities design

4.3 Computer-supported collaborative learning environment

In this study, the social media platform WeChat will be utilized to design a computer-supported collaborative learning environment. WeChat serves as a pivotal tool for facilitating online collaborative learning by providing an interactive platform for communication and collaboration, encompassing features such as information sharing, note-taking, group formation, discussions, and task allocation. As a versatile mobile application, WeChat integrates audiovisual capabilities with text-based chat functionality and document sharing options into one cohesive platform while supporting real-time multilingual interaction (Liu & Shi, 2016). Henceforth, WeChat was chosen as the implementation medium for computer-supported collaborative learning in this research endeavor. The study comprised of 40 participants who were randomly divided into five groups of eight members each to ensure data integrity. A dedicated WeChat learning group chat was established for each study group—thus forming five distinct WeChat learning groups. At the commencement of the tasks assigned, the instructor introduced fundamental functions within WeChat enabling file transfer along with audio and video exchange capabilities while also encouraging students to supplement their queries and ideas through symbols, expressions, and images. All stages of collaborative tasks designed based on the principles of design thinking in this study were conducted exclusively within these respective WeChat learning groups including inter-group and intra-group discussions alongside work display and feedback.

5. Data collection and analysis

The data sources primarily encompass WeChat learning groups and survey data obtained from questionnaires. The WeChat data collected will be utilized to analyze the changes and development of students' creative thinking skills, with a specific focus on process analysis. At the end of each week, data in the WeChat learning group of each group will be collected and sorted out. The data types include discourse data (text and audio) and image resources. Audio files and image resources will be converted into text and sorted out. On the other hand, the questionnaire-based data mainly compare the overall enhancement of creative thinking skills before and after engaging in activities. In summary, while the survey data predominantly investigates whether there is an impact, the WeChat data delves into how this impact occurs. The data analysis will involve the utilization of descriptive statistics, correlation analysis, and ENA network analysis. Descriptive statistics and correlation analysis will primarily be employed to examine the changes in innovative thinking ability and innovative self-efficacy before and after the integration of design thinking, as assessed by the innovative thinking test and the innovative self-efficacy scale. The ENA network analysis will predominantly focus on analyzing discourse data and image data shared by middle school students within the WeChat learning group across five stages of design thinking. Epistemic network analysis, rooted in the theory of cognitive frameworks, is frequently employed to model the interconnections among cognitive elements - the patterns of relationships between knowledge, skills, values and other components (Shaffer, 2016). The structure of connections between these elements reflects their strength and development over time (Shaffer et al., 2016). Therefore, this analysis method can better answer research questions 2 and 3.

6. Current research stage and future work

The initial instructional phase has been concluded, encompassing pre-teaching creativity tests and creative self-efficacy assessments, as well as the collection of discourse data from the WeChat learning group following the first teaching session. Subsequently, interviews will be conducted to gain insights into any existing issues within the teaching process, enabling further adjustments to be made in accordance with post-instruction test results.

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后疫情背景下在线学习的影响机理研究——基于师生视角的分析

The Mechanisms of Online Learning's Impact in the Post-Pandemic Context: An Analysis from the Perspectives of Teachers and Students

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【摘要】 后疫情时期，在线学习方式成为教育教学的新常态，但当前的在线学习的理论框架，缺少教师和学生视角相比较的研究。本研究在分析教师和学生在在线学习认知信念结构和特点、在线学习概念分类、学习环境感知作用的基础上，提出各因素间的影响机理假设。通过问卷调查数据的统计分析，验证在线学习师生影响机理的假设。结论表明教师、学生的在线学习认知信念、在线学习概念、网络学习环境感知之间均存在明显的相关性。研究的结论将丰富和完善在线学习影响机理理论，为后疫情时代在线学习的实施提供有益参考。

【关键词】 在线学习；影响机理；在线学习认知信念；在线学习概念；网络学习环境感知

Abstract: *In the post-epidemic period, the online learning has become the new norm, but the current theoretical framework of online learning lacks research that contrasts teachers' and students' perspectives. Based on the analysis of the structure and characteristics of teachers' and students' cognitive beliefs about online learning, conceptions of online learning, and perceptions of the learning environment, a hypothesis of the influence mechanism was proposed. The statistical analysis of the questionnaire data was conducted to verify the hypothesis. The conclusions indicate that significant correlations exist between teachers' and students' cognitive beliefs about online learning, online learning concepts, and perceptions of the online learning environment. The findings of this study enrich the theory and provide useful references for the online learning implementation.*

Keywords**:** Online learning, Influence mechanism, Epistemic belief in online learning, Conceptions of online learning, Perceptions of online learning environment

1. 研究背景

随着信息技术、移动设备、互联网技术的发展，在线学习已经成为现今学习者最常用的学习手段之一。当前新冠变异病毒在全球持续蔓延，使得在线学习必须成为学校教育的新常态。

以往的研究表明，教师和学生对在线学习的观点存在明显的差距，这可能会导致课程枯燥和学生学习体验不佳。例如，研究者试图调查学生和教师对移动学习的偏好，为开发有效的学习环境提供帮助，研究发现高中教师和学生移动学习环境偏好存在差距：教师更关心技术问题，而学生则更关注学习材料的丰富性和有用性(Lai 等人, 2016)。在语言类课堂中，教师和学生认知风格的差异可能会增加学生学习中的焦虑感，甚至会引起对教师和课堂的厌恶(Oxford & Lavine, 1992)。在后疫情背景下，尽管教师和学生处于相同的在线学习环境中，由于认知风格水平、利用环境的能力、个人经验和习惯等的不同，他们对学习环境的认识也有很大不同。已有学者在研究中指出，影响学习主体的并不是具体的学习环境本身，而是他们对学习环境的感知。因此，理解师生的学习环境感知能够帮助设计更符合师生特点的学习环境，提升他们的在线学习体验感。

同时，表征个体对在线学习认知和看法的因素也受到了很多研究者的关注。有研究者指出，学习者的认知信念与学习过程、理解力和学业成就密切相关(Ferguson & Bråten, 2013)；认知信念可能影响学习者的学习策略选择和他们在学习中的参与(Hofe & Pintrich, 1997)；且认知信念具有领域特定性和语境敏感性，个体对学习环境的感知与他们的认知信念有关(Tsai, 2000)。学习概念被看作是学习主体感知和解释学习意义的视角，会影响学习主体的行为和对学习环境的反应方式；有研究者指出，不同的学习环境可能会导致学生采用不同层次的学习概念。在传统科学课堂中，复杂的认知信念与更高层次的学习概念（即将学习概念化为增加知识、应用和获得深入理解）呈显著的正相关关系。

尽管研究者已在传统课堂学习背景下证明了认知信念、学习概念、学习环境感知两两之间的作用路径（表 1），但由于后疫情背景下学习环境、学习方式和师生认知已经产生了较大的变化，本研究希望在后疫情背景下，对以上影响因素的作用机理进行进一步的探究和阐释。

表 1 在线学习影响因素作用路径

作用路径	依据	解决问题
学习概念 **|** **学习环境感知**	学习概念与环境感知各个维度之间既存在正相关、也存在负相关。(Sadi & Lee, 2022)	从对学习的概念认识提升上解决如何利用环境获得积极的学习体验、有效的问题解决途径和主动的知识建构方式的问题。
认知信念 **|** **学习环境感知**	认知信念具有领域特定性和语境敏感性，认知信念可能影响了学生对学习环境的认知。(Tsai, 2000)	从对知识本质和知识获取方式的认知上解决如何利用环境深入理解知识、搭建相关联的知识体系的问题。
认知信念 **|** **学习概念**	在传统背景的科学学习中，复杂的认知信念与更高层次的学习概念呈现正相关关系。(Chiu 等人, 2013)	从对知识发展性、确定性、来源、关联的认识提升上解决如何有效应用、迁移知识以解决现实困难的问题。

研究以建构主义学习理论为基础。建构主义的学习过程包括两方面的建构，一方面，学习者需要通过自己的经验理解新知识，并将其纳入自身的知识体系中，另一方面，从记忆系统中提取的知识本身也需要进行建构，而不是独立地被提取。在当前的学习观中，建构主义具有核心地位。学习被视为解释和构建个人知识表示的一个积极过程。学生必须积极地处理信息，并通过经验构建知识。后疫情时代的在线学习中需关注教师和学生的主体作用，在线学习中的在线学习认知信念、学习概念、学习环境感知等不易察觉的个体内部因素之间存在着一定的相关关系，这些因素的相互影响对于个体的认知建构有着重要作用。

本研究将关注点放在后疫情背景下的在线学习环境中，提出在线学习影响机理概要模型假设，对教师与学生的在线学习认知信念、在线学习概念和网络学习环境感知等三个影响因素进行整合、关联和逻辑建构，从师生主动建构的角度对在线学习影响做出解释。

根据教师和学生的在线学习影响因素和以上分析，具体的研究假设有：

H1：假设教师在线学习认知信念对网络学习环境感知有正向预测作用

H2：假设教师在线学习认知信念对在线学习概念有正向预测作用

H3：假设教师在线学习概念对网络学习环境感知有正向预测作用

H4：假设学生在线学习认知信念对网络学习环境感知有正向预测作用

H5：假设学生在线学习认知信念对在线学习概念有正向预测作用

H6：假设学生在线学习概念对网络学习环境感知有正向预测作用

基于以上假设，研究分别发放教师和学生问卷收集数据，将得到的数据进行统计分析。从而为理解和分析师生在在线学习环境下的差异、解决在线学习现有问题提供理论支撑和解释依据。

2. 研究目的

本研究探究师生视角下在线学习的影响机理，能够为更好地解释教师和学生在在线学习中的状况差异，设计更符合二者认知的在线学习环境，应对后疫情背景下的在线学习提供理论支撑，推动在线学习的高质量纵深发展。因此，本研究在厘清前人对认知信念、学习概念、学习环境感知结构和作用研究的基础上，提出在线学习影响机理假设，以探究三者的逻辑关系和互动机理，对在线学习的策略选择、环境支持服务设计和技术应用具有重要的引导和支撑作用。

3. 研究设计

3.1. 研究方法

在后疫情时代的背景下，本研究通过文献调查法总结梳理后疫情时代在线学习存在的困难和挑战，归纳前人对在线学习影响因素的研究。因此，本研究通过文献梳理归纳，提出以“认知信念”、“学习概念”、“学习环境感知”三个内在因素为切入点，提出教师、学生在线学习影响机理假设。通过问卷调查法收集教师和学生的观点和想法，采用相关分析、结构方程模型等数据分析方法验证影响机理假设的合理性。

3.2. 研究工具

本研究采用问卷收集教师和学生关于在线学习认知信念、网络学习环境感知、在线学习概念问卷的观点和想法。

本研究采用翻译成中文的互联网特定认知问卷（Bråten 等人，2005）来调查受访者的在线学习认知信念。ISEQ 的 36 个项目分别用于评估认知信念的四个维度。本研究将在线学习认知信念问卷修订为知识来源（Source）、知识确定性（Certainty）、知识发展（Development）、网络搜寻与探究（Justification）等四个一级维度。调查学习环境感知问卷维度来源于 Kember 等人（2004）所提出的跨领域学习策略分析架构，用于区分网络学习环境感知的内涵。共分为四个维度，包括：深层动机（Deep Motive）、深层策略（Deep Strategy）、表面动机（Surface Motive）以及表面策略（Surface Strategy），其中深层动机和深层策略被归为“深度方法”、表面动机和表面策略被归为“表面方法”。用于确定学生在线学习概念的问卷维度参考由 Lee 等人（2008）开发的“学习科学概念（CLOS）”量表。该量表由 35 个项目和 6 个维度组成，即记忆（5 项目）、考试（6 项目）、计算与练习（5 项目）、增长知识（5 项目）、应用（4 项目）、以新的方式理解和看待（6 项目）。本研究将问卷修订为记忆、考试、计算与练习、增长知识、应用所需信息、理解、探求新的方法等七个一级维度。

4. 数据分析与结果

4.1. 学生问卷分析

本研究共收集了 509 份有效的学生问卷，调查对象集中在初一至高二年级，年龄在 13~17 岁之间，其中男生 319 人，占总问卷数的 62.7%，女生 190 人，占总问卷数的 37.2%。

通过相关分析发现，大学生在线学习认知信念（知识来源、知识确定性、知识发展、网络搜寻与探究）和在线学习概念的七个维度（记忆、考试、计算与练习、增长知识、应用所需信息、理解、探求新的方法），与在线学习环境感知的四个维度（深层动机、深层策略、表面动机、表面

策略）彼此间大都有显著的正相关关系；仅有在线学习认知信念中的“知识来源”、在线学习概念中的“增长知识”与网络学习环境感知的四个维度大部分无显著相关关系或有显著的负相关关系（除“增长知识”与“表面动机”有显著的负相关关系）。从网络学习环境感知的四个维度上看，“表面策略”与在线学习认知信念、在线学习概念的各个维度大都呈现显著的负相关关系。

表 2 学生在线学习认知信念、在线学习概念与网络学习环境感知相关分析

维度	深层动机	深层策略	表面动机	表面策略
知识来源	-.048	.031	.027	-.008
知识确定性	.217**	.358**	.195**	-.293**
知识发展	.247**	.361**	.119*	-.226**
网络搜寻与探究	.160**	.131*	.140**	-.090
记忆	.212**	.082	.148**	-.205**
考试	.124*	.176**	.087	-.182**
计算与练习	.181**	.219**	.118*	-.163**
增长知识	-.027	.008	-.124*	.007
应用所需信息	.180**	.359**	.427**	-.174**
理解	.359**	.229**	.229**	-.174**
探求新的方法	.190**	.322**	.207**	-.299**

** p <0.01. * p <0.05.

本研究经由结构方程模型分析发现，学生的在线学习概念、在线学习认知信念对于网络学习环境感知有正向的影响，由表 3 可知其关系模型的整体拟合度达到 0.890，显示模型的拟合度在可接受的范围内。

表 3 结构方程模型拟合度

拟合指数	结构方程模型	推荐值
χ^2/DF	6.337	≤5
RMSEA	0.102	<0.08
RMR	0.075	<0.05
GFI	0.890	>0.90
AGFI	0.848	>0.90
NFI	0.613	>0.90
CFI	0.648	>0.90
IFI	0.653	>0.90

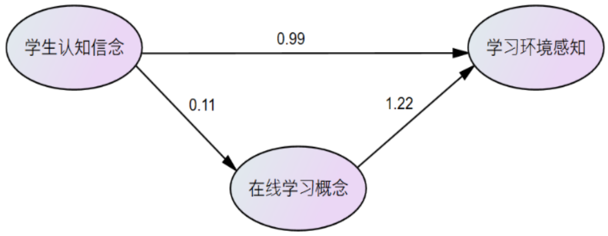

图 1 学生在线学习影响机理结构方程模型

4.2. 教师问卷分析

本研究共收集了 741 份有效的教师问卷，调查对象中包括男教师 226 人，占问卷总数的 30.5%，女教师 521 人，占问卷总数的 69.5%。

教师的网络学习环境感知中的“深层策略”、“表面策略”、“深层动机”、“表层动机”与在线学习认知信念的四个维度（知识来源、知识确定性、知识发展、网络搜寻与探究）与在线学习概念的七个维度（记忆、考试、计算与练习、增长知识、应用所需信息、理解、探求新的方法）均有显著的正相关关系（如表 4）。

表 4 在线学习认知信念、在线学习概念和网络学习环境感知的相关分析

维度	深层动机	深层策略	表面动机	表面策略
知识来源	.868**	.823**	.812**	.792**
知识确定性	.930**	.869**	.853**	.766**
知识发展	.935**	.887**	.870**	.790**
网络搜寻与探究	.870**	.838**	.800**	.807**
记忆	.840**	.882**	.828**	.714**
考试	.838**	.875**	.817**	.707**
计算与练习	.731**	.767**	.801**	.738**
增长知识	.824**	.858**	.808**	.711**
应用所需信息	.827**	.860**	.810**	.737**
理解	.835**	.872**	.813**	.758**
探求新的方法	.819**	.877**	.819**	.713**

** p <0.01.

本研究经由结构方程模型分析发现，教师的在线学习概念、在线学习认知信念对于网络学习环境感知有正向的影响，由表 5 可知其关系模型的整体拟合度达到 0.816，显示模型的拟合度在可接受的范围内。

表 5 结构方程模型拟合度

拟合指数	结构方程模型	推荐值
χ^2/DF	13.96	≤5
RMSEA	0.132	<0.08

RMR	0.240	＜0.05
GFI	0.816	＞0.90
AGFI	0.746	＞0.90
NFI	0.941	＞0.90
CFI	0.945	＞0.90
IFI	0.945	＞0.90

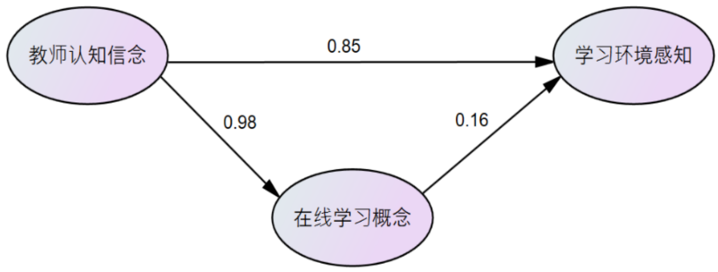

图 2 教师在线学习影响机理结构方程模型

整体而言，经过结构方程模型验证可以得出，模型标准化回归系数（β 值）、标准误（S.E.）、临界比（C.R.）及显著性水平（P 值）和研究假设检验结果如表 6。

表 6 模型参数检验值及研究假设验证

假设内容	β 值	S.E.	C.R.	P 值	是否成立
H1：教师在线学习认知信念➞网络学习环境感知	0.983	0.025	39.474	***	是
H2：教师在线学习认知信念➞在线学习概念	0.852	0.035	24.242	***	是
H3：教师在线学习概念➞网络学习环境感知	0.158	0.028	5.585	***	是
H4：学生在线学习认知信念➞网络学习环境感知	0.107	0.150	0.709	0.478	否
H5：学生在线学习认知信念➞在线学习概念	0.989	0.185	5.357	***	是
H6：学生在线学习概念➞网络学习环境感知	1.223	2.384	0.513	0.608	否

*** $p<0.001$.

通过比较师生数据相关分析的结果发现，师生在线学习影响机理既表现出相似之处，也表现出相异之处。其中相似之处表现在教师与学生在线学习认知信念、在线学习概念、网络学习环境感知之间的大部分维度均存在显著的相关关系；相异之处表现在学生与教师在学习认知信念中的“知识来源”维度和在线学习概念中的“增长知识”维度对网络学习环境感知中四个维度的影响上有明显不同；学生与教师在在线学习认知信念、在线学习概念的各个维度对网络学习环境感知中的“表面策略”的影响上有明显不同。这可能说明教师更关注在线学习环境当中的等级评定、形式鼓励等设计，而学生对此类设计的认同度不明显，两者的认知差异可能导致学生在在线学习环境中因此类设计而产生焦虑感和对在线学习课堂的厌恶。

5. 下一步将展开的研究工作

在以上分析的基础上，本研究希望在在线学习中更多地关注到教师、学生对于在线学习本身或在线学习环境的认识。通过培养更复杂的在线学习认知信念、更高层次的在线学习概念提高教师和学生的网络学习环境感知，从而促进他们有效地利用环境辅助学习。基于以上结果，本研究将以建构主义理论为基础，从在线学习环境支持服务、教学方法策略选择、在

线学习技术应用的角度，进行在线学习环境的提升策略设计，并开展实验研究，验证策略的应用效果。

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增强现实环境促进小学生计算思维的教学研究

Augmented Reality to Promote the Teaching and Learning of Computational Thinking to Elementary School Students

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【摘要】 近年来，学生的计算思维培养受到广泛的关注，研究发现现有的计算思维培养存在的挑战：学生在理解计算思维抽象概念或复杂问题时因缺乏情境化的有效指导致使学习效果不佳。因此，本文构建了基于增强现实（AR）环境的计算思维教学策略，对其效果在广州市某小学六年级开展准实验研究，发现该策略能提高学生的学习绩效以及计算思维倾向，在 AR 环境下进行计算思维教学能够让学生具有更好的抽象、分解、评价和泛化能力，进而促进了小学生计算思维的培养。
【关键词】 增强现实；计算思维；情境化

Abstract: *In recent years, the cultivation of students' computational thinking has received extensive attention. The existing research has identified a challenge in the development of computational thinking: the lack of contextualized and effective guidance for students to understand abstract concepts or complex problems in computational thinking, leading to poor learning outcomes. Therefore, this paper constructs a computational thinking teaching strategy based on Augmented Reality (AR) environment, and conducts a quasi-experimental study on its effect in the sixth grade of an elementary school in Guangzhou. It was found that the strategy improved students' learning performance as well as their tendency to computational thinking, providing students with better abstraction, decomposition, evaluation, and generalization skills.*
Keywords: augmented reality, computational thinking, contextualization

1. 引言

1.1. 学生的计算思维培养引起广泛关注

近年来，学生的计算思维培养受到广泛的关注，各国政策文件开始强调学生计算思维的培养。在《新媒体联盟地平线报告：2018 高等教育版》中指出，培养计算思维对于学生来说至关重要(兰 & 郭, 2019)。在《义务教育信息科技课程标准（2022 年版）》中也明确指出："创新教学方式，以真实问题或项目驱动，引导学生经历原理运用过程、计算思维过程和数字化工具应用过程，建构知识，提升问题解决能力"。此外，2016 年美国国际教育技术协会(The International Society for Technology in Education，ISTE)在《学生标准》(ISTE Standards for Students)中增加了培养计算思维的要求，包括通过将问题分解、提取关键信息、开发描述性模型来理解复杂系统或促进问题解决等。

1.2. 当前计算思维培养缺乏可视化的情境支持

现有的培养计算思维的传统课程教学中，大多都以编程教育的方式让学生理解计算机科学概念，但缺少可视化的情境帮助学生理解抽象的概念或复杂的问题情境。有学者指出通过学习编程反复灌输计算机科学的基本概念和原理需要复杂的思维能力，初学者可能会发现编程的困难和复杂(Noh & Lee, 2020)。Gardeli 等(2020)指出当前正规教育环境的资源有限，缺乏合适的设备和基础设施来实施计算思维教育。这表明了利用有效的可视化技术支持计算思维的培养是一种值得采用的方法。

2. 基于增强现实环境的计算思维教学的研究述评

2.1. 计算思维内涵与定义

我国《义务教育信息科技课程标准（2022 年版）》在课程目标的学科核心素养内涵中提出了计算思维的定义，“个体运用计算机科学领域的思想方法，在问题解决过程中涉及的抽象、分解、建模、算法设计等思维活动。”本研究参考了《义务教育信息科技课程标准（2022 年版）》对计算思维的定义，界定的计算思维聚集于小学生利用计算思维解决问题的思维活动过程。

2.2. 增强现实内涵与定义

增强现实（Augment Reality，简称 AR）是一种将虚拟环境和现实环境结合起来进行即时互动，使用户能够同时看到虚拟世界和现实世界中的物体，给用户带来一种参与感和沉浸感的技术(Azuma, 1997)。本研究探索 AR 环境融入到计算思维的教学中，将计算机处理过的数字信息叠加在真实世界中，创设实际生活的问题情境。

2.3. 国内外研究现状述评

2.3.1. 国内外计算思维策略研究述评

国内学者对于培养计算思维的教学模式和策略做了大量研究。通过 App Inventor 可视化编程工具，将项目问题的逻辑从拆解转为叠加，结合教案和学案实践计算思维的教学，以此有效提升学生在计算概念水平上的计算思维(郁等, 2017)。此外，张立国等(2018)在对计算思维特征分析的基础上，提出了基于可视化理念的计算思维培养的教学策略。

国外学者开展了对于计算思维策略的多维度探索，尝试将计算思维融入到中小学的多学科教学中。通过与语言艺术、技术和数学教师的合作，利用互动新闻将计算思维融入到一中学的标准课程和常规课堂体验中(Wolz 等, 2011)。Swanson 等(2017)将计算思维融入到生物课程中，发现计算丰富的生物课程有助于提高学生识别模型的能力，对学生计算思维实践发展具有积极的影响。

2.3.2. 国内外增强现实环境对计算思维影响研究述评

通过梳理文献发现，我国对 AR 环境下培养小学生计算思维的研究较少。究其原因，可能是因为 AR 在国内的教学应用刚刚兴起，所覆盖的领域有限，所以现阶段符合本研究主题的国内文献较为罕见。

而在国外相关研究中，AR 应用为学生提供可视化的指导，对促进学生计算思维发展具有积极影响。一些研究人员将基于摄像头的 AR 系统与有形的人工制品结合起来，创造出具有视觉反馈的物理编程环境，为儿童引入一种有吸引力和激励性的合作方式，并帮助他们学习计算思维的抽象概念(Gardeli & Vosinakis, 2020)。Abdul Hanid 等(2022)将 AR 应用程序与计算思维集成到几何主题中，研究表明，该教学方法在提高计算思维、视觉技能和几何主题成就方面具有积极的作用。

2.3.3. 国内外研究现状总结

已有研究对于计算思维的教学缺少一套经过验证的可迁移应用的规范性教法。此外，学生在理解计算思维抽象概念或复杂问题时因缺乏情境化的有效指导致使学习效果不佳，目前国内也需要更多的实证研究验证 AR 环境对于小学生计算思维培养的影响以及探索有效的教学干预方法。

因此，创设一个合适的学习环境帮助小学生学习计算思维十分重要。AR 的存在感、实体感和情境可视化，能够帮助学生与先前所学的知识建立更深的联系。AR 环境带给使用者的沉浸感与互动性适合应用于教学中，且与情景教学和建构主义教育思想相匹配，利用

AR 技术，学习者可以进行移动学习，实现自主及个性化学习。并且 AR 环境更加能够与传统意义上的教学环境相融合(杨等, 2017)。

3. 策略构建与实验设计

3.1. 基于增强现实环境的计算思维教学策略构建

本研究利用 AR 设备建立合适的计算思维学习环境，以教学系统设计理论、情境学习理论以及建构主义理论为指导，分析小学信息科技课堂与学习者的特征，提出了基于 AR 环境的计算思维教学策略，分为“情境模拟——抽象特征——设计算法——迁移应用”四个阶段。情境模拟阶段通过 AR 模型创设问题情境，呈现可视化的真实情境，引导学生从多方面思考问题；抽象特征阶段通过 AR 情境找出问题关键点，小组合作讨论抽象出问题的一般原理；设计算法阶段利用 AR 资源帮助学生探究，引导学生思考不同问题之间的关系，根据问题原理设计解决问题的算法，找出问题的有效解决方案，并将问题解决过程一步步地列出来；迁移应用阶段通过 AR 情境进行迁移学习，应用所学知识与经验方法解决真实问题。

3.2. 实验情况

本研究为探究基于 AR 环境的计算思维教学策略的应用效果，以广州市某小学六年级学生为实验样本，从学习成绩和计算思维倾向两个维度开展了准实验研究。其中实验组采用基于 AR 环境的计算思维教学策略，控制组采用以传统信息技术为手段的计算思维教学。提出的研究假设为：运用基于 AR 环境的计算思维教学策略的学生，比采用传统信息技术手段的计算思维教学的学生取得较好的学习绩效，并有更高的计算思维倾向。

对六年级学生选用 Arduino 器材制作《智能交通信号灯》主题，了解交通信号灯的变换规则，了解 RGB-LED 模块和超声波传感器的工作原理，动手制作智能感应的交通灯。使用基于 AR 环境的计算思维教学策略而设计的 AR 教学资源为学生提供了学习工具，主要作用在于呈现及帮助学生理解问题情境，将学生引入情境，唤醒学生强烈的认知兴趣，以增强学生的学习体验感。参与课程学习的学生共有 98 人，其中实验组和控制组各 49 人，并且课程实验共持续 4 周，在实验开始前一周培训实验组的学生使用 AR 设备。

3.3. 实验流程

控制组主要通过视频、图片、文字等传统的信息化手段，以 PPT 的形式向学生呈现问题情境，要求学生使用无 AR 资源的电子学习手册进行知识的深入了解和学习，课堂设计的活动多为动手操作活动，活动中为学生提供完整的操作流程。

而在教学设计中，本研究为实验组设计了更多 AR 环境下的教学活动，利用导学案和电子学习手册将课堂任务和面对面的课堂活动结合起来。学生在课堂上以小组形式观察 AR 资源，使用 Arduino 元件制作“闪烁交通灯”、“变换交通灯”和“智能交通灯”，在制作过程中通过观察 AR 资源，对制作交通信号灯遇到的问题进行知识反馈，并在导学案中记录制作过程中遇到的问题，采取了什么方法去解决所遇到的问题，为什么会采用这种方法（多次尝试？同伴建议？教师指导？），最后是否解决了问题等。并且通过编程对制作的交通信号灯进行简单的使用效果测试，比较 AR 资源中的交通信号灯和所制作的“智能交通灯”。

在作品制作完成后，实验组和控制组的学生均以小组成果汇报的方式分享完成情况，在分享过程小学生需要向同学分享制作步骤、所遇到的问题、所使用的方法、最后的结果，其他听讲学生向分享学生提问并进行评价。

3.4. 测量工具

3.4.1. 计算思维测试卷

本研究使用计算思维测试卷测试两个班学生的计算思维的知识应用。试题改编自 Bebras 国际计算思维挑战题，选取最基本的计算思维相关问题，满分为 100 分，学习前测试题和学习后测试题均为四道单项选择题和一道简答题。前测和后测的题型、题数、分数设置以及难度系数是一致的。

3.4.2. 计算思维倾向量表

本研究的计算思维倾向量表改编自 Tsai 等人（2021），总体量表 Cronbach's α 为 0.91，量表各子维度 Cronbach's α 系数在 0.74 到 0.83 之间。本研究的前测和后测问卷均根据计算思维倾向的五个维度进行设计，即"抽象""分解""算法思维""评价""泛化"，前后测问卷分别设计了 19 道问题，做成李克特 5 级量表记分，1-5 级分分别代表"非常不符合""不太符合""一般符合""比较符合""非常符合"。问卷的问题样例主要有"我习惯于从整体角度来思考问题，而不是看细节"、"我通常会考虑如何将一个大问题分成几个小问题"等。在信度检验方面，前测问卷整体的 Cronbach's α 系数为 0.961，后测问卷的整体的 Cronbach's α 系数为 0.954，因此本问卷具有十分好的信度，能够用于测量学生的计算思维倾向。

4. 实证结果分析

4.1. 策略对学生学习成绩的作用

本研究采用单向协方差分析（ANCOVA）来检验基于 AR 环境的计算思维策略对学生学习成绩的影响。数据分析发现实验组学生的平均成绩高于控制组，F 值为 4.791，p 为 0.031，小于 0.05，说明实验组的学习成绩显著高于控制组，这表示与采用传统的信息化手段辅助计算思维教学相比，使用基于 AR 环境的计算思维策略进行教学能够更好地提高学生的学习成绩。

4.2. 策略对学生计算思维倾向的作用

本研究通过分析学生在 AR 环境下学习的抽象、分解、算法思维、评价与泛化能力来揭示该教学策略的应用效果。在实验中，本研究采用 ANCOVA 来分析提出的策略对学生计算思维倾向的作用。结果显示，实验组与控制组学生的算法思维(F=3.709, p=0.057>0.05, η^2=0.041)能力差异不显著，说明两组的结果不受策略的影响。然而实验组学生在计算思维倾向的抽象(F=7.154, p=0.009<0.01, η^2=0.077)、分解(F=11.165, p=0.001<0.01, η^2=0.115)、评价(F=3.972, p=0.049<0.05, η^2=0.044)和泛化(F=8.136, p=0.005<0.01, η^2=0.086)能力均表现出显著性差异，明显高于控制组，因此实验组的计算思维倾向显著高于控制组。这表示，基于 AR 环境的计算思维教学策略能够更好地帮助学生从多方面理解、思考复杂的问题情境以及问题之间的关系，理解抽象概念，寻找问题的关键点，并结合具体的问题情境找出有效的解决方案，提升学生运用所学知识和经验方法解决实际问题并迁移应用的能力，进而提高学生的计算思维倾向。

5. 讨论与总结

本研究的实验结果表明，基于 AR 环境的计算思维教学策略能够更好的提高学生的学习成绩与计算思维倾向。该结论与前人的研究结论在提升学习成绩方面是一致的。Chang 和 Hwang(2018)指出，相比于传统的信息化辅助手段进行教学，通过 AR 教学资源的学习指导，更加有助于提高学生的学习绩效。本研究还发现，与传统的信息化辅助计算思维教学相比，应用基于 AR 环境的计算思维教学策略并不能更加显著地提升学生的算法思维。这与 Lin 等(2021)在关于 AR 应用程序对计算思维技能中算法思维的培养研究结论有相似

之处。其研究表明算法思维主要对应于编程和算法选择技能，尽管 AR 应用程序可以帮助学生理解问题，但并不能够提高学生的算法思维能力。

此外，本研究的调查范围比较小，未能采用大规模的样本为将来的研究提供足够的依据，因此下一步将扩大样本量与年龄段进行实证研究。同时本研究所提出的策略针对的学科主要为信息科技学科，未来研究还需扩大学科范围，探索基于 AR 环境的计算思维教学策略在其他学科领域的应用成效及结合学科特征进行优化设计，使之更有应用推广价值。

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基于数字游戏学习：对小学生外语焦虑和词汇学习的影响

Digital Game-Based Learning: the Impact on Foreign Language Anxiety and Vocabulary Learning

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【摘要】 外语焦虑被认为是影响外语学习的核心情感因素。基于数字游戏的学习通常具有互动和娱乐性，提供相对轻松安全的学习环境，可能有助于减少焦虑。然而尽管潜力巨大，对这一方向的研究依旧较少。为了在一定程度上填补这一空白，本研究旨在调查基于数字游戏的学习对外语焦虑以及词汇学习的影响。设计为期六周的实验研究，通过词汇测试，问卷以及半结构化访谈等方式收集数据。本研究可能有助于提高对游戏学习和教育心理的理解，并为学习者和教育工作者提供指导，以优化学习体验和成果。
【关键词】 基于游戏的学习；技术增强学习；外语焦虑；英语词汇学习；小学生

Abstract: *Foreign language anxiety is considered to be a core affective factor affecting foreign language learning, and game-based learning may help reduce anxiety. Despite the huge potential, there has been little research in this area in the past. To fill this gap, this study aimed to investigate the effects of digital game-based learning on foreign language anxiety as well as vocabulary learning. A six-week experimental study was designed to collect data through vocabulary tests, questionnaires and semi-structured interviews. This research may help improve understanding of the psychology of gaming learning and education, and provide guidance for learners and educators to optimize learning experiences and outcomes.*
Keywords: game-based learning, technology-enhanced learning, foreign language anxiety (FLA), English vocabulary learning, primary school students

1. 研究背景

词汇是语言学习中至关重要的组成部分，对学生的语言能力和学业成功具有重要影响(Nation, 2001; Wei et al., 2018)。随着全球化的进展和跨文化交流的增加，学生需要掌握更丰富的词汇以有效地进行沟通和理解。然而，由于接触有限和缺乏练习，学习者往往难以自然地掌握词汇。此外，传统的学习方法，如机械记忆和简单重复，常常导致学生缺乏学习兴趣和动机，进而为学习英语词汇带来额外的困难(Lee, 2022)。尽管学生花费了大量时间，但他们通常无法获得令人满意的词汇习得效果(Teng, 2022)。因此，研究如何提高学生的词汇量以及影响词汇学习的教学方法变得尤为重要。

焦虑是学习过程中常见的情绪体验，通常与自主神经系统的激活相关，表现为紧张、担忧、恐惧等主观感受 (Spielberger, 1983)。焦虑通常分为特质焦虑，状态焦虑和特定情境焦虑。在外语学习中，焦虑被概念化为与外语学习语境相关的紧张和恐惧，与基于课堂的学习和特定的语言技能如口语、阅读有关等。其中，沟通焦虑、考试焦虑和对负面评价的恐惧是三种具有代表性的焦虑 (Horwitz, 2017)。这种情绪状态对学习动机和学习成果产生重要影响。尽管早期的一些研究认为焦虑可能对学习表现有促进作用(Scovel, 1978)，最近的大量研究表明，焦虑与动机和成就之间总体呈负相关(Teimouri et al., 2019; Zhang,

2019)。因此，了解教学方法对学生焦虑的影响，有助于我们设计更有效的教学策略，提高学生的学习体验和学业成就。

技术的快速发展推动了传统教育的范式的变革，为二语学习开辟了一个充满希望的新领域。其中数字游戏已成为教育领域的重要参考媒介，许多研究致力于探索数字游戏在语言学习中的应用。基于数字游戏的学习被认为能够通过提供丰富的语言输入和有趣的学习环境，增加游戏场景中知识应用的机会，有利于提供沉浸的学习体验，从而减少情绪障碍，促进学习过程 (Chen et al., 2019; Lin et al., 2020)。 此外，数字游戏还鼓励积极参与，自主学习和探索式发现学习(Lai & Chen, 2021; Lee, 2019)。协作互动数字游戏使学习者交换想法和信息，支持共同目标的实现(Zou et al., 2021)。过去的研究表明协作互动数字游戏在提高学习者参与度、加强学习表现等方面的积极影响(Yang et al., 2021)。在学习焦虑方面，虽然有研究表明协作互动数字游戏可以减轻焦虑，但也有一些学习者可能对游戏中的社交压力或竞争感到焦虑(Dondio et al., 2023; Lin & Hou, 2022)。

因此，探索协作互动游戏对于减少小学生外语焦虑，促进词汇学习的有效性至关重要。然而，目前针对协作互动数字游戏对学生词汇量和焦虑的影响的研究还相对有限。基于此，本研究旨在探索三种不同的方法对学生词汇量和焦虑的影响，以在一定程度上填补这一空白。通过准实验设计，比较传统教科书、百词斩学习应用程序和互动、协作数字游戏这三种方法在词汇学习和减轻焦虑方面的表现，以获得关于优化语言学习的有益见解。该研究结果将为教育实践提供指导，并为学校和教师改进教学和学习方法提供建议。最终提高学生的词汇量和学习体验，为语言发展和学习成就做出积极贡献。

2. 研究目的

教科书是传统的教学资源，百词斩是一种在线词汇学习平台，而基于互动协作的数字游戏则提供了一种游戏化的学习环境。本研究通过探究教科书、百词斩和基于互动协作的数字游戏在词汇学习和减轻学习焦虑方面的效果，旨在提供关于最佳学习方法和教育策略的实证支持，从而改善学生的学习成果和学习体验。以下两个研究问题指导本研究。

研究问题：

1.教科书，百词斩和基于互动协作的数字游戏的学习对学生词汇量的影响如何？

2.教科书，百词斩和基于互动协作的数字游戏的学习对学生外语学习焦虑的影响如何？

研究假设：

组别 3（互动合作数字游戏组）的参与者在词汇量增长和焦虑水平降低方面表现最好，其次是组别 2（百词斩组），最后是组别 1（教科书组）。互动合作数字游戏组提供了更加有趣和多样化的学习环境，可以激发学习者的兴趣和动机，有助于提高词汇量和减少焦虑。

3. 研究方法

3.1. 研究对象

本研究将招募来自中国一所学校的 90 名小学三年级学生参与实验。所有参与者以汉语为母语。他们将被随机平均地分为三组: 教科书组，百词斩组和协作数字游戏组。实验将持续六周。实验开始前，我们将向所有参与者分发一份同意书，并由他们的父母签署，以确认他们同意参与本研究。

3.2. 研究设计

前测：在实验开始前，对所有参与者进行一次词汇量测试，并记录焦虑水平。将通过使用标准化的词汇测验（如词汇量测试题）和外语课堂焦虑量表 (Horwitz et al., 1986) 来完成。外语课堂焦虑量表被广泛使用考察学生外语学习焦虑程度，其 Cronbach 's α 值达到了较高的可靠性(Cronbach 's α = .93)。

学习过程：每个实验组的学生将使用指定的教材或平台进行为期四周，每周 40 分钟的英语词汇学习。教科书组学生将使用传统教科书进行词汇学习，将按照教材的指导进行学习和练习。百词斩组学生将使用英语词汇学习软件百词斩进行词汇学习，将通过百词斩平台上的词汇学习模块进行学习和练习。互动协作数字游戏组学生将使用一款互动协作数字游戏进行词汇学习，将以游戏的形式参与词汇学习和练习。

后测：在学习结束后的第四周，对所有参与者进行一次词汇量测试，并记录焦虑水平。使用相同的词汇量测试题和焦虑评价量表进行测量。

延迟后测：在实验结束后的第六周进行一次延迟后测，以评估长期效果。对所有参与者进行词汇量测试，并记录焦虑的水平。

访谈：在第五周，研究者将从三个组中分别随机抽取 5 名学生，邀请他们参与小组访谈。访谈问题将基于文献综述和研究问题，旨在探讨学习焦虑等相关主题。例如，研究者可能会询问学生们对学习焦虑的看法，以及他们是否认为基于游戏的学习对他们的学习焦虑有影响等。访谈将以参与者的第一语言汉语进行，以便学生们自由地表达自己的想法和意见。访谈过程将会被录音，以供后续的数据分析使用。

3.3. 数据分析

研究将采用混合方法，结合定量和定性分析。问卷调查的结果将使用统计分析软件 SPSS 进行定量分析。包括对问卷数据进行描述性统计分析，例如计算均值、标准差、频率和百分比等，以了解样本的特征和分布情况。此外，还将使用方差分析方法比较不同实验组在词汇量和焦虑方面的差异。此外，访谈内容将通过文本挖掘的主题分析进行定性分析，帮助研究者识别和理解学生在英语学习中的观点、体验和态度，深入探索学生对学习焦虑，基于数字游戏学习以及其他相关主题的看法。

4. 现在的研究阶段

到目前为止，这项研究还处于初始阶段。研究者完成了本研究的主要部分：文献综述、概念框架、和实验工具。

5. 下一步将展开的研究工作

本研究接下来的工作包括游戏的开发和英语词汇学习的内容。试点研究，寻求与小学合作，实施为期六周的实验，数据收集和分析，理论框架的完善以及论文的撰写。

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指向深度学习的在线同伴反馈学习活动研究

A Study of Online Peer-Feedback Learning Activities Pointing to Deeper Learning

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【摘要】 在教育改革发展的时代背景下，如何促进学习者由浅层学习向深度学习的转变，是当前一项重要的课题。同伴反馈有助于推动学生认知和元认知的发展，从而潜在地促进深度学习的实现。基于此，本研究首先构建了一个同伴反馈框架；其次，我们以“学前儿童健康教育”课程为例，设计了一系列同伴反馈活动。最后，本研究从深度学习方法、认知水平和情感体验三个维度对在线教学中同伴反馈对深度学习的促进效果进行了研究。本研究表明，同伴反馈活动能够帮助学习者更加积极参与到学习活动中，转变浅表学习方法，提升学习者的认知层次。
【关键词】 同伴反馈；深度学习；协作交互；在线讨论

Abstract: *In the context of the era of education reform and development, how to promote the transformation of learners from shallow learning to deep learning is an important topic at present. And peer feedback helps to promote students' cognitive and metacognitive development, thus potentially facilitating the realisation of deep learning. Based on this, this study firstly constructed a peer feedback framework; secondly, we designed a series of peer feedback activities based on the example of the course "Health Education for Pre-school Children". Finally, this study investigates the effects of peer feedback on deep learning in online teaching from three dimensions: deep learning method, cognitive level and emotional experience. This study shows that peer feedback activities can help learners participate more actively in learning activities, change superficial learning methods, and improve learners' cognitive level.*
Keywords: Peer feedback; deep learning; collaborative interaction; online discussion

1. 前言

随着在线教育的兴起，传统课堂中的浅表互动问题延续到在线活动当中。学生在线讨论中存在大量的浅表学习现象，常常表现为发言提问不积极、交流范围小、在线讨论敷衍、对学习结果无所谓等参与度不高的现象，导致讨论活动常常沦为走过场。目前，学生的浅表互动现象，表明学生对于学习活动的参与度不高，学习动机不强，对于学习内容的思考浮于表面，没有进行深入思考，对于知识的学习停留于机械记忆，没有真正了解学习内容的内涵，进行批判性思考，从而进行迁移与创新。当前学生的学习状况并不符合新时代对于人才培养的要求。那么如何解决目前的在线教学中存在的浅表互动问题，促进学习者深度学习的发生，是本研究重点关注的问题。而同伴反馈成为了解决这一问题的重要手段。黄荣怀等学者认为学习的发生应当满足五个条件：真实问题、学习兴趣、学习活动的体验、分析性思考、指导与反馈（Kollar,2010）。反馈被认为是学生学习过程中的一个基本因素，没有反馈学习者很难学会复杂的、抽象的知识与技能，它是帮助学生发展的脚手架，是促进学生深度学习的重要杠杆。基于此，本研究拟构建在线教学中指向深度学习的同伴反馈框架并进行同伴反馈活动的设计，在此基础上进一步探究在线同伴反馈活动对于学习者的学习方法的转变、认知层次的提升以及情感体验是否具有影响。

2. 框架构建

2.1. 指向深度学习的同伴反馈框架的构建

CIMO-logic 由情境、干预、机制和结果四个要素组成，有助于我们理解特定情境下干预是否会导致某种结果的发生，以及这种结果产生的机制。借助 CIMO-logic，我们构建了一个促进深度学习的同伴反馈框架，旨在指导在混合式教学中如何促进深度学习。在本研究中，CIMO-logic 用于指导我们理解在在线教学环境中，同伴反馈是否会促进深度学习的发生，以及为什么会促进深度学习的发生。

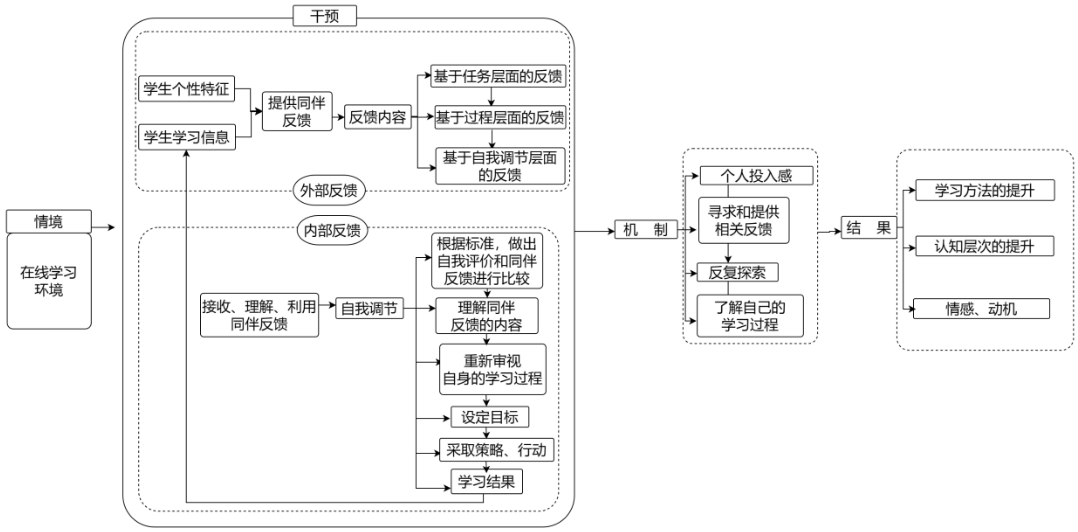

图 1 指向深度学习的在线同伴反馈框架

本研究主要以“CIMO 逻辑”为依托设计指向深度学习的在线同伴反馈框架，充分设计了引发学习者深度学习的在线同伴反馈框架。在干预过程中，分为外部反馈和内部反馈。外部反馈主要来源与同伴、教师对于作业或作品的定量或定性反馈；内部反馈是指学习者自身接收、理解外部反馈，反思自身与目标之间的差距，引发学习者重新审视自身的学习过程，重新采取策略和行动。在此过程中，评价者和被评价者都可以从中学到东西，通过评价同伴的作业，学生可以加深自己的学习，增强学习动机，可以发展更高层次的学习技能，并能评估、监督和调节自己的学习。学生会提升自己的反思能力，进而改进自己的作品。反馈可以使学生学会更多的知识，帮助学生做出更好的评价判断，并发展他们的元认知技能。学生对同伴的想法进行比较和质疑、评价、修改建议、反思、规划，从而调节自己的思维。由于学生在在线学习环境中更容易交流，因此在线同伴反馈比面对面环境中的反馈更能影响学生的学习结果。本研究中使用的同伴反馈策略为反馈培训、反馈量规和反馈方式。

2.2. 深度学习测评方法的设计

研究主要通过学习方法测量、认知层次评估、同伴对话反馈参与度分析以及课程体验反馈调查四个方面来评价同伴对话反馈活动开展的效果。学习方法的测量研究选取 Entwistle 等人（2013）研制的学习方法权威测量问卷 ASSIST（缩减版）调查学生在相应教学阶段达到的学习方法层次情况。该工具主要基于 Marton 和 Saljo（1976a,1997）关于学习方法的理论思想，并在结合 Entwistle 和 Ramsden（1982）以及 Biggs（1979,1987）关于学习方法测量已有研究成果的基础上进一步研制而成，后被广泛用于各个国家高等教育领域学生学习方法的测量。工具包括深度学习方法、策略学习方法、浅表学习方法

三个维度，分别用于测量相应层次学习方法的倾向程度。研究通过对学生进行教学主题相关的主观题测验并对其回答内容进行评分的方式来评估其达到的认知层次水平。测验要求学生对每个问题进行思考后组织自己的语言进行回答。研究主要选取 Burnett（1999）提出的改进型 SOLO 评分框架对学生的回答内容进行评分。研究通过开放问题调查的方式来收集学生的课程体验反馈，内容包括学生认为自己达到的深度学习情况、学习得到（或未得到）深化的原因、同伴对话反馈活动的体验感受、互动平台的使用感受、课程还存在的不足之处以及对课程、活动或平台的改进建议等。

3. 研究设计

3.1. 研究对象

本研究选取华南地区 T 大学学前教育专业 50 名本科生为研究对象。该 50 名学生系统学习过相关的网络课程，熟知网络技术知识，具备良好的在线学习能力、信息素养，以及丰富的在线学习平台的使用和操作经验。在学业上，能够独立自主的完成学习任务，借助在线社交工具向教师和同伴寻求帮助，完成学业目标。在情感上，与班级同学感情深厚，学生们与任课老师和助教老师也在日常交流中产生了融洽的师生关系。

3.2. 课程环境

基于社会建构主义理论以及活动理论的支持，进行设计促进深度学习的在线同伴反馈学习活动。本研究依托在线学习平台《学习通》，在网络技术的支撑下，开展在线同伴反馈学习活动。《学习通》在线学习平台是该师范院校引进的在线学习平台，供校内师生进行免费学习和使用，与其他在线学习平台相比，其在可获得性，灵活性、成本上都具有了很大的优势。该在线学习平台功能齐全，教师端功能：章节内容建设、辅助资料建设、教学准备、课前教学、课堂互动、作业考核、考试考核、课程统计、课程管理等功能。学生端：学习资源、视频、测试、讨论回复或发帖等，学生可以使用《学习通》APP 或者是电脑端进行课程学习。在线同伴反馈的特征是学习者能够进行在线对话式交流互动，助教借助课前教学模块，可进行主题讨论的发布，助教老师在线发布话题讨论后，学生可以对讨论内容进行作答，助教同时也可以给学生进行加分、点赞、回复等操作。学生在线可查看同伴发布的讨论内容后，需要按照笔者设计的在线同伴反馈要求以及主题讨论的反馈标准，进行在线同伴反馈，即以评分和评论的形式进行有效在线反馈。

3.3. 指向深度学习的同伴反馈活动的设计与实施

基于指向深度学习的同伴反馈框架，本研究设计了促进深度学习的同伴反馈活动，主要包括同伴反馈培训、同伴反馈的实施、同伴反馈工具与支架、主题作业的制作与修改、修改后作品的再次反馈。

同伴反馈培训：在同伴反馈活动正式开始之前，需要对学习者进行反馈培训，让学习者了解反馈的意义以及重要性，引起学学习者对于反馈的重视。师生需要共同明确反馈目的、制定反馈标准，教师为学习者提供反馈范本，并开展为期一周的反馈培训，训练反馈技能

同伴反馈实施：在活动正式开始后，为了达到“以评促学”的目的，需要设计评价目标，包括能够理解教学设计各个组成部分的含义；能够运用多种方式设计学前儿童健康教育课程的教学方案；通过课程训练，能够较好地掌握知识与技能、过程与方法以及在情感态度价值观上均得到一定的提升。反馈任务主要为对于同伴的主题作品进行多次反馈。反馈方式包括两个方面，一是互评反馈的主体包括个体反馈和小组反馈，即个体反馈是指学习者对同伴的主题作品做出评价；小组反馈是指将学习者随机分成两人以上的

学习小组，每个小组对其他小组的主题作品进行评价；二是反馈方式包括定性评价和定量等级评价。

同伴反馈工具与支架：同伴反馈工具主要是“学习通”平台，支持学习者开展线上同伴反馈。在反馈的过程中提供相应的反馈表述支架以及问题解决过程支架。

主题作业的制作与修改：学习者根据具体教学要求制作主题作品，完成后上传平台。根据同伴反馈做出相应修改。

修改后作品的再次反馈：针对同伴反馈提出的问题与建议进行修改之后，需要将修改后的主题作品再次上传至平台，同伴将依据教学目标对于修改后的主题作品再次进行反馈。

3.4. 深度学习结果数据收集与编码

学习者学习方法数据的收集。首先，本研究选取 Entwistle（2013）等人研制的学习方法权威测量问卷 ASSIST 缩减版作为学生在六次讨论活动体验前后的学习方法前后测工具，包括深度学习方法、策略学习方法、浅表学习方法三个维度，每个维度包含 6 个条目，分别用于测量相应层次的学习方法倾向程度。其中，深度学习方法维度包含学习过程中会联系观点、会使用证据、对想法和元认知感兴趣、为自己在做的事寻求意义等内容；策略学习方法维度包含注重学习过程中的时间管理、会组织学习、适应评价要求和监督自我学习、追求达到最高成绩等；浅表学习方法维度包含学习过程中会害怕失败、只进行常规记忆、学习局限于课程大纲最低要求、只想以最低限度的付出完成课程等。每个维度所包含的题数及题项样例如表 1 所示，其中，量表每个题目的学生得分均在 1—5 分之间（1=完全不符合；2=有点不符合；3=不确定；4=有点符合；5=非常符合），每种学习方法的总得分最高均为 30 分，最低 6 分，得分越高说明学生在所测量的学习过程中越趋向于该种学习方法。

本研究参与学习方法前后测的有效学生是 50 人，由下表可知该工具的三个学习方法维度在本研究中的前后测信效度均较好。

表 1 学习方法前后测信效度检验结果

学习方法层次	深度学习方法	策略学习方法	浅表学习方法
前测 α 系数	0.69	0.73	0.68
后测 α 系数	0.70	0.71	0.72

学习者认知层次数据的收集。本研究对学生进行了讨论活动对应六周教学主题的主观题前后测，要求学生对每个问题进行思考后组织自己的语言进行回答，其中参与认知层次前测和后测的有效学生为 50 人。回答内容由两位研究人员基于改进型 SOLO 评分框架进行独立编码评分（0=无结构；1=单点结构；2=多点结构；3=关联结构；4=抽象拓展结构），前后测 2 人评分的一致性检验结果均较好（K 前测=0.738；K 后测=0.716），表明结果具有高度一致性。学生回答内容所得平均分（0—4 分）即代表其认知思维达到的深浅层次。

学习者情感水平的数据收集。本研究采用王怀波等人编制的深度学习结果量表的情感态度部分测量学生的情感水平，问卷中情感部分包括积极情感和内在动机两个维度。对问卷进行相关信效度分析，克朗巴哈 α 系数为 0.761，说明内部一致性较好。KMO 检验量为 0.712，Bartlett 检验 P 值为 0.000，差异显著，说明量表效度较高。

同伴反馈对深度学习机制的影响.本研究主要通过访谈法收集数据，来揭示深度学习机制。本研究利用“学习通”平台发布访谈问题，访谈问题为：“在‘学前儿童健康教育’这门课程中，我们通过同伴反馈的方式进行评价，对于这种学习活动你有什么看法？你认为对你的学习过程或结果有一定的影响吗？”本研究利用 Nvivo11 对访谈数据进行编码。

4. 结果分析

4.1. 在线教学中的同伴反馈可以促进学习者由浅表学习方法向深度学习方法的转变

由表 2 可知，促进深度学习的同伴反馈学习活动对学生学习方法深化均有显著促进作用，具体体现在：（1）学生的深度学习方法倾向显著提高（t=4.31，p<0.001）；（2）学生的策略学习方法倾向显著提高（t=6.29，p<0.001）；（3）学生的浅表学习方法倾向显著降低（t=-4.47，p<0.001）。

表 2 学习方法前后测比较

		N	M	SD	df	t	p
深度学习方法	前测	50	21.87	3.32	49	4.31^{***}	0.00
	后测	50	23.49	3.39			
策略学习方法	前测	50	20.19	4.32	49	6.29^{***}	0.00
	后测	50	22.85	3.97			
浅表学习方法	前测	50	17.93	4.09	49	-4.47^{***}	0.00
	后测	50	15.97	4.61			

4.2. 在线教学中的同伴反馈可以促进学习者认知层次的发展

学生的认知层次显著提高（t=12.13，p<0.001），但学生的思维结构主要从一开始的“单一结构”或“低级多元结构”（M=1.69，SD=0.71）提升到了“中级多元结构”和“高级多元结构”（M=3.21，SD=0.84），尚未上升到更高水平的深度学习程度的关联结构和抽象拓展结构。

表 3 认知层次前后测比较

		N	M	SD	df	t	p
认知层次	前测	50	1.69	0.71	49	12.13^{***}	0.00
	后测	50	3.21	0.84			

4.3. 在线教学中同伴反馈对不同学习者学习方法和认知层次的影响

为了探究不同水平学习者的深度学习方法倾向和认知层次水平变化情况，本研究根据 Biggs（1987）研制学习方法测量工具时规定的学习类型识别规则对整体学生进一步分类。具体的分类规则是：一个学生某种学习方法的得分在该方法学生整体得分 8-10 分位数范围的记为“+”，代表“高水平”；得分在 4-7 分位数范围的记为“0”，代表“中等水平”；得分在 1-3 分位数范围的记为“-”，代表“低水平”。在此基础上，Biggs 将每个个体对应三种学习方法可能存在的各种组合最终归类为 6 种类型：即低成就动机者、一般浅表学习者、成就导向的浅表学习者、纯成就导向者、一般深度学习者和成就导向的深度学习者。其中，仅最后两种为深度学习者，前四种均未达到深度学习。

基于上述分类方法，本研究根据被试的学习方法前后测结果对其在实施同伴反馈学习活动前后的学习者类型进行识别，最终得到各类学习者在干预前后的变化情况：（1）干预前，学生群体中有低成就动机者 23 人，一般浅表学习者 7 人，成就导向的浅表学习者 2 人，纯成就导向者 10 人，一般深度学习者 3 人，成就导向的深度学习者 5 人；（2）干预后，低成就动机者减少较多，变为 15 人，一般浅表学习者减少为 5 人，成就导向的浅表学习者依然为 2 人，纯成就导向者增加为 11 人，一般深度学习者减少为 2 人，成就导向的深度学习者增加较多，变为 15 人。

由于学生整体前测的认知层次均未达到深度层次，而学习方法不同层次的人数分布又差距较大，故为了便于进行统计学分析，研究最终按照学习方法分类规则将前四种学生合并为非深度学习者，后两种合并为深度学习者，进而对这两大类学生的学习方法和认知层次前后测进行配对样本 t 检验，结果如表 4 所示。其中：（1）非深度学习者的深度学习方法倾向显著提升（t=5.61，p<0.001），策略学习方法倾向显著提升（t=6.98，p<0.001），浅表学习方法倾向显著降低（t=-4.19，p<0.001），认知水平显著提升（t=12.51，p<0.001）；（2）深度学习者的深度学习方法倾向无显著变化（t=-0.69，p>0.05），策略学习方法倾向也无显著变化（t=0.59，p>0.05），浅表学习方法倾向也无显著变化（t=-1.61，p>0.05），但认知层次显著提升（t=4.70，p<0.01）。

表 4 不同类型学习者的学习方法和认知层次前后测比较

			N	M	SD	df	*t*	*p*
非深度学习者	深度学习方法	前测	42	20.87	2.69	41	5.61***	0.00
		后测	42	22.96	3.11	41		
	策略学习方法	前测	42	19.61	4.12	41	6.98***	0.00
		后测	42	22.64	3.72	41		
	浅表学习方法	前测	42	18.19	3.78	41	-4.19***	0.00
		后测	42	16.11	4.53	41		
	认知层次	前测	42	1.73	0.71	41	12.51***	0.00
		后测	42	3.39	0.84	41		
深度学习者	深度学习方法	前测	8	26.75	1.69	7	-0.69	0.50
		后测	8	25.96	3.91	7		
	策略学习方法	前测	8	23.69	4.46	7	0.59	0.55
		后测	8	24.46	5.11	7		
	浅表学习	前测	8	17.99	5.67	7	-1.61	0.13
		后测	8	15.62	5.49	7		
	认知层次	前测	8	1.82	0.71	7	4.70***	0.001
		后测	8	3.11	0.69	7		

由此可见，在线同伴反馈活动对不同类型学生学习方法和认知层次的深化效果各异：（1）在促进学习方法深化方面，其对非深度学习者的作用大于对深度学习者的作用，这也跟两类学习者原本的学习方法深度水平有关，对于深度学习者而言，学习方法进一步改善的空间必然没有非深度学习者大，但从深度学习者的浅表学习方法倾向下降（M 前测-M 后测=2.37）比非深度学习者下降（M 前测-M 后测=2.08）更多来看，该策略对削弱深度学习者的浅表学习方法倾向依然有帮助（虽未达到显著，但可能跟该类被试数量偏少有关）；（2）在促进认知层次提升方面，该策略对两类学习者的作用都有较明显的作用，但

从非深度学习者的认知层次提升（M 后测-M 前测=1.70）比深度学习者提升（M 后测-M 前测=1.29）更多来看，该策略对非深度学习者的认知改善更有帮助。

4.4. 在线教学中的同伴反馈可以激发学习者的积极情感和内在动机

在在线教学完成之后，本研究利用问卷来分析学习者的情感状态，结果如下表所示。

表 5 深度学习机制内容和维度

维度	题目	Mean	S.D.	N
积极情感	通过同伴反馈活动，我感觉我比以前的学习投入了许多	3.75	0.86	50
	通过同伴反馈活动，我认为课程很有趣	3.51	0.99	50
	我认为这个活动对于我的帮助很大	3.87	0.92	50
内在动机	我会主动搜集和本课程相关的资料	3.76	0.91	50
	我会寻找各种资料来证明自己的观点	3.87	0.87	50

由表 5 可知，在积极情感维度，均值都高于 3.5（最高为 5），表明同伴反馈对深度学习产生了显著的积极影响。通过分析同伴反馈内容发现，学习者与同伴进行互评反馈的兴趣较高，因此推动学习者进行同伴反馈活动的一个重要因素就是兴趣。兴趣能够激发学习者的正向情感，提升学习者对于同伴反馈活动的个人投入，促进深度学习的发生。内在动机维度均值都高于 3.8，表明学习者愿意且主动参与到交流讨论当中，拥有强烈的动机。在在线同伴反馈活动中，动机越强，参与度越高，更容易促进学习者深度学习的发生。

4.5. 在线同伴反馈活动引发深度学习机制

通过对于访谈内容进行编码与分析，本研究发现同伴反馈活动在一定程度上引发了深度学习机制。深度学习机制的内容与维度如表 6 所示。

表 6 深度学习机制的内容与维度

深度学习机制内容	维度
个人投入感	增进熟悉度
	增强动机
	促进积极情感
寻求和提供相关反馈	学习新的观点
	审视自身问题
	多次相互反馈
反复探索	提出深入的问题或建议
	接收、理解、利用反馈
了解自己的学习过程	将自己的观点与同伴的观点比较

首先，提供同伴反馈能够增加学生的个人投入。在学习活动中，学习者能够发现同伴和自己不一样的想法和观点，思想进行碰撞，产生争论，由此提升学习者的参与度，增强学习者的学习动机，激发积极情感，促进深度学习的发生。

其次，在完成同伴反馈任务时，学习者需要接收来自同伴的反馈。同伴从不同的视角对于作品提出问题或建议，促使学习者对于新知识、教学目标、自身作品进行重新思考，批判性地看待自己的想法，这样的反思会促进学习者进行深入思考。

接着，通过对于作品的迭代反馈和修改，在此过程中，学习者和同伴会不断发生思想的碰撞，产生更加频繁的争论，这样的争论有利于学习者深化对于问题的认识，从而促进深度学习的发生。

最后，在整个同伴反馈活动中，学习者承担着两种角色，一个是反馈的发送者，一个是反馈的接收者。反馈的发送者要求学习者表达自己观点，反馈的接收者要求学习者思考、理解、利用同伴提出的问题和建议，两个过程都在促使学习者不断深化对于目标与自身目前状态的认识，从而更好地开展深度学习。

5. 结语

本研究结合当前教育改革的提出的深度学习的要求以及在线学习中存在的浅表互动的问题，利用同伴反馈这个切入点，构建指向深度学习的同伴反馈框架，设计了促进深度学习的同伴反馈活动并提出了具体的实施流程。通过同伴反馈活动，学习者的个人投入大大增加，学习动机增强，同时激发了积极情感，能够促进学习者高效地参与到活动当中，不断与同伴的观点碰撞，引发对于自身学习的深入思考，促进深度学习的发生。本研究发现，通过同伴反馈活动，学习者在学习方法方面，由浅表学习向策略学习和深度学习方法转变；在认知层次方面向更高层次即高级多元结构提升；在情感和动机方面，学习者的学习动机不断增强，积极情感被激发。本研究主要针对在线环境中的同伴反馈活动进行探究，而环境以及学科的不同也会导致结果的不同，未来希望在不同环境、不同学科中继续探索，完善同伴反馈活动，帮助更多的学习者促进深度学习的发生。

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Format Effectiveness of a Conversational Chatbot for Learning Abstract Concepts in Biology Courses: A Multicenter, Controlled, Randomized Trial Among Beginners

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Abstract: *In biological sciences, abstract concepts have always been the focus and difficulty in the teaching and learning process, but in many teaching and learning activities in biological sciences, there is a shortage of appropriate technological tools to assist students in the understanding of abstract concepts. The potential advantages of mobile tools can circumvent this problem and facilitate pedagogical reforms in the educational system. Chatbots may be a useful addition to regular teaching activities, given their ease of scaling to large numbers of people and their great potential. Moreover, the purpose of this study was to evaluate the effectiveness of instructional support interventions through chatbots in smartphones compared to traditional teaching activity practices. In addition, this was a pragmatic, multicenter, controlled and randomized trial involving 10 classes in a secondary school in the Chongqing area. Teachers recruited students aged 18 years or older who attended on-site counseling and received technology-assisted learning, and randomly assigned them to receive either traditional instruction (control group [CG]) or an evidence-based chatbot intervention (intervention group [IG]). The intervention in both groups was based on the 5A principles (i.e., Ask, Advise, Assess, Assist, and Arrange), and a quiz test was administered by a collaborator after 6 months. In assessing the primary outcome, an intention-to-treat analysis was used, with a baseline observation forward for missing data and a logistic regression model with robust estimates.*

Keywords: Biology teaching; chatbot; smartphone; artificial intelligence; time-sensitive intervention

1. Research Background

Biology is the most rapidly developing natural discipline in the 20th century, and it is constantly crossing and penetrating with other disciplines, gradually highlighting the status of the dominant discipline in the study subjects. For beginners, biology has many concepts and fragmented knowledge, especially many concepts are too abstract leading to a decrease in the interest of many beginners in learning biology (An et al., 2022). Specifically manifested as: basic concepts are not clear, ambiguous; abstract concepts are mostly fragmented existence, will not be integrated; knowledge application ability is poor, unable to learn to use (Borsci, 2022). The reason for this is that although the biology students are able to better understand and accept the knowledge taught, but because there is an absence of good aids that available to help them change the status of the present situation.

2. Research Objective

The purpose of this study was to evaluate the effectiveness of learning assistance interventions via chatbots in smartphones compared to traditional teaching practices. The potential advantages of conversational chatbots supported by mobile device technology stand out (Araujo, 2018). It possesses effectiveness, accessibility, portability, privacy, customization, time-sensitive interventions, access to social support, excellent compliance, and great scalability, effectively circumventing such problems as weak foundation, poor ability, and unsatisfactory grades due to unanswered doubts encountered by the students during the learning process, and promoting interest and patience in learning among the beginners of the Biology course (Abdul-Kader & Woods, 2015). Globally, the number of smartphones in use continues to grow. There are an estimated 520 million cell phone subscribers and 8 billion cell phone lines worldwide, more than the world's population (with a penetration rate of 102%), and these numbers are expected to continue to rise (Holmes et al., 2019). Therefore, mobile devices carrying conversational chatbot help struggling students to change their learning status quo in Biology and develop interest and ability to learn, thus helping struggling Biology students to improve their subject literacy and complete their transformation.

3. Research methods

3.1. Trial Design

This was a multicenter, controlled and randomized trial. The study was conducted in 10 beginning classes of the biology program in the Experimental Middle School of the main city of Chongqing (China), with a follow-up period of 6 months. The study followed the CONSORT (Consolidated Standards of Reporting of Trials) guidelines (Badrulhisham et al., 2024). The CONSORT-EHEALTH checklist is intended for authors of randomized trials evaluating web-based and Internet-based applications/interventions, including mobile interventions, electronic games (incl multiplayer games), social media, certain telehealth applications, and other interactive and/or networked electronic applications (Hussain et al., 2019). Some of the items (e.g., all subitems under item 5 - description of the intervention) may also be applicable for other study designs (John et al., 2022).

3.2. Participants

Teachers and students of Chongqing Experimental Secondary School expressed their willingness to participate in the study.8 educators volunteered to be collaborators, were informed of the objectives, design and methodology of the study, and received training on fieldwork, data collection and processing, and good practices (Miao et al., 2024). Of these, 80 students were involved in recruiting participants. Included students had to have never systematically studied concepts related to biological sciences before the previous month, receive the help of a conversational chatbot in the following month, have a smartphone on which an informative application could be installed, confirm that they could be contacted within 6 months after the intervention, and provide informed written consent (Sánchez-Díaz et al., 2018). Exclusion criteria were students with significant communication difficulties or who clearly indicated that they could not persevere to the end of the program. Participants were not assessed for computer or Internet illiteracy.

3.3. Recruitment

The target for each collaborator was a 6-month period to recruit at least 3 students by offering all students with learning difficulties for any reason the opportunity to participate on a continuous basis (Dadkhah et al., 2023). After checking that enrollees met the inclusion criteria, they were informed about the characteristics of the trial and invited to participate (Patients who accepted to participate provided informed consent) and read an information document (Svenningsson & Faraon, 2019).

Data regarding students who refused enrollment were collected (age, gender, and reason for refusal). Participant data were collected in two phases (Figure 1): baseline (T0) and 6 months (T1). In addition, professionals were responsible for the follow-up of students in the control group (CG), which was recorded at each follow-up visit.

3.4. Randomization and Blinding

After informed consent was obtained and baseline information was collected, participants were randomly assigned to the intervention group (IG, chatbot) or CG (usual care) at the baseline visit (T0) by simple randomization software with no other restrictions (Lin et al., 2023). No other method was used to perform the randomization assignment order. The software generates a tagline to indicate to professionals which group the participant has been assigned to and a printable file for IG patients that contains the password to access the chatbot.

Given the nature of the intervention, both participants and professionals were aware of their allocation arrangements (Chaves & Gerosa, 2021). The experimental design was "double-blind" for group assignment.

3.5. Intervention

Intervention strategies for participants in both groups were based on the 5A principles (i.e., ask, advise, assess, assist, and arrange) of the U.S. Clinical Practice Guidelines. During the recruitment phase, all participants who met the inclusion criteria were interviewed face-to-face about their studies and received advice from their teacher about a communicative chatbot to assist their studies, and the teacher also asked the students about their willingness to participate. Students who accepted to try technology-assisted learning in the following month and agreed to participate in the trial were randomly assigned to either the IG or CG group. Students received individual interventions combining behavioral and traditional teaching methods and structured answers over several follow-up visits, either online via chatbot or face-to-face with their assigned teacher.

3.6. Statistical Analysis

All students lost to follow-up were coded for traditional preferences as specified in the previously published protocol for the intention analysis. Regression models (logistic or linear, as appropriate) were used to analyze the effect of the intervention on all outcomes, with robust estimates adjusted for subgroup recruitment of students (Kowald & Bruns, 2020). Missing data were analyzed using the baseline-observation-forward (BOCF) method. The effectiveness of the intervention on primary outcomes was assessed by between-group differences in biochemical validation success rates at T1 and T0, reported as proportions and corresponding 95% Cis (Ramesh et al., 2017).

In addition, variables measuring intensity of use were assessed through between-group differences in mean number of contacts and total interaction time. Subgroup analyses were also conducted based on the intensity of chatbot use or the intensity of contact between students and teachers (Padvi, 2024). Statistical tests for independent samples (Student t-test and chi-square test) were used for between-group comparisons at baseline, and repeated-measures ANOVA for related samples was used to assess within-group differences and changes over time.

4. Research Progress

At present, the biggest bottleneck encountered in the progress of this experimental research is a technical problem. In other words, the development of the software, the communicative chatbot, is still in the stage of constant negotiation. The existing similar apps in the market are based on psychotherapeutic diagnosis. Therefore, it is not very suitable for this experimental design.

5. Arrangement for Follow-up to the Research

The next steps in the schedule include (1) finding or designing a suitable chatbot, (2) finalizing with the schools where the data will be collected, (3) providing professional and systematic training to the participating teachers, and (4) completing the recruitment of participants.

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Digital media and learning: exploring the construction of media literacy among college students through Spherical video-based virtual reality production

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Abstract: *In today's media-saturated society, young people spend a significant amount of time immersed in various forms of media, which greatly impacts their values and social behaviors. As a result, possessing media literacy skills has become essential for young people to navigate and engage with an ever-changing society. This has prompted a paradigm shift in media education, with a focus on the interplay between media education and the utilization of new technologies, garnering global attention from educators. The aim of this research is to investigate how college students develop media literacy skills through the process of authorship within Spherical video-based virtual reality (SVVR) production. The study findings will enrich the current understanding of VR applications in media education, specifically emphasizing the effectiveness of SVVR interventions in enhancing digital media competencies among college students.*
Keywords: SVVR, media literacy, higher education

1. Introduction

Ito et al. (2009) emphasize that in the digital age, young people are acquiring the social and technological skills necessary for active participation in contemporary society through their engagement in online activities driven by friendships and personal interests. Similarly, Lankshear and Knobel (2010) have identified a paradigm shift in the learning culture of adolescents, characterized by a hands-on approach to learning through the creation of texts using digital media. This phenomenon has resulted in today's adolescents assuming dual roles as consumers and producers of their own media texts. They further argue that the traditional boundaries between individuals who consume and produce texts have become increasingly blurred and propose a new role, producer, which encompasses individuals actively utilizing available resources in their literacy practices to generate and disseminate new resources within their network. The pedagogical approach of learning by doing has become the predominant method of engagement for young individuals when they interact with digital media (Lankshear & Knobel, 2003).

In the dynamic realm of contemporary media, immersive media technologies, primarily represented by virtual reality (VR), have gained significant influence as they endeavor to create mediated experiences that closely resemble the authenticity of real life (Kalyanaraman & Bailenson, 2019). Spherical video-based virtual reality (SVVR), a subset of immersive VR (Jong, 2022), is also known as spherical video, panoramic video, 360-degree video (360° video), or omnidirectional video in the literature (Li et al., 2023). 360-degree video technology is a method of capturing the real environment with special cameras that can record the entire surrounding scene either from a static position or from a dynamic movement (Ranieri et al., 2022; Rosendahl & Wagner, 2023). SVVR can be conveniently utilized with a mobile phone and inexpensive cardboard goggles (Jong, 2022). In other words. SVVR has the advantages of being cheap and user-friendly. It is suitable for teachers who may not be "tech-savvy" but want to offer immersive learning experiences with technological support for their students during teaching (Chien et al., 2020; Jong et al., 2020). The integration of SVVR in education has been extensive, demonstrating positive outcomes for student learning (e.g. Chen et al., 2024; Wu et al., 2023; Yang et al., 2022). However, there is a scarcity of research examining how media literacy is impacted by the interaction or production of SVVR. Mikelli and Dawkins (2020) conducted a qualitative pilot study to examine the utilization of SVVR in the context of critical media literacy. The study involved young individuals from disadvantaged backgrounds who were engaged in the production of immersive films. The research yielded empirical evidence that highlighted the potential impact of SVVR in critical media literacy settings, aligning with the principles of media education. Moreover, this approach facilitated the development of youth agency, fostering the formation of self-identities and self-expression. The process of creating and sharing media content was found to enhance the confidence and skills of the young participants. The immersive nature of SVVR provided a unique opportunity to explore and represent the concepts of space and place, which mirror the dynamic and fluid nature of identity. In other words, SVVR, as a powerful tool, enables participants to become experts in articulating their own experiences and offering profound insights through the creation and pursuit of new ideas, while also being recognized by youth workers for its potential to promote empathy and facilitate a deeper understanding of diverse perspectives. However, their research is only a pilot study and therefore lacks a sufficient sample size.

This study aims to explore the construction of media literacy through authorship and perceptions of college students through SVVR production. The findings from this study will contribute to the existing body of knowledge on VR in media education, specifically highlighting the efficacy of SVVR lessons for college students in the digital media field. The research question is as followed:

Are there any changes of students' perceptions on authorship through SVVR production?

2. Related Work

2.1 Definition of media literacy

Different organizations and scholars have provided their own definitions of media literacy, reflecting various perspectives and understandings of the concept. For example, The National Association for Media Literacy Education in USA (NAMLE) provides the comprehensive definitions: Media refers to "all electronic or digital means and print or artistic visuals used to transmit messages. Literacy is the ability to encode and decode symbols and to synthesize and analyze messages. Media literacy is the ability to encode and decode the symbols transmitted via media and synthesize, analyze and produce mediated messages". The Association for Media Literacy in Canada (AML) defines media literacy is "the knowledge and skills necessary to understand and use the codes and conventions of a wide variety of media forms and genres appropriately, healthily, effectively and ethically. Media literacy also aims to provide people with the ability to create and distribute their own media products". The Office of Communications in UK (Ofcom) defines media literacy as "the ability to use, understand and create media and communications in a variety of contexts". In other words, media literacy involves interacting with textual, auditory, visual, video, and social media to comprehend various forms of information, ultimately leading to the development of a distinct skill set in locating, manipulating, and utilizing such information (Chetty et al., 2018). Potter (2022, p.23) defines that media literacy is "a set of perspectives that we actively use to expose ourselves to the mass media to process and interpret the meaning of the messages we encounter". These definitions underscore the definitions of media literacy in terms of analyzing and possessing mediated messages, media production skills, and also highlighting the active engagement of individuals in this process.

Therefore, media literacy in this paper is defined as the competencies needed to decode and encode media symbols, critically analyze and synthesize mediated messages, and ethically produce and distribute media content across various contexts, fostering active engagement in media production. To sum up, media literacy focuses on fostering an informed and discerning comprehension of the mass media, including their techniques and the consequential effects of these techniques. It is an educational endeavor that seeks to enhance students' understanding and appreciation of the functioning, meaning production, organization, and reality construction of media. Besides, media literacy aims to equip students with the skills to produce media content (Duncan, 2006).

2.2 Impact of media production on media literacy

The impact of media production on media literacy has drawn significant attention and discussion among scholars. Between the 1980s and the mid-1990s, creative media production was largely overlooked in media literacy (Kafai & Peppler, 2011). This disregard can be partly attributed to the prioritization of production skills in vocational media courses, which led to a greater emphasis on critical comprehension of new media rather than exploring its expressive and creative potential (Buckingham, 2003). After that, there has been a significant shift in perspective as educators and researchers have come to recognize the significance of production in new media education (Kafai et al., 2019; McDougall & Potamitis, 2010). This shift is driven by various factors, including changing perspectives on the relationship between production and analysis and the increased accessibility and affordability of digital authoring tools (Burn & Durran, 2007). Contemporary technology is characterized by its digital, interactive, hyper-textual, virtual, networked, and simulated nature, collectively referred to as digital media (Lister et al., 2009). What distinguishes digital media is not only the shift in physical properties from analog to digital, but more importantly, the transformative impact this shift has on social practices (Tan & Kim, 2015). With the continuous advancement of technology, digital media has become increasingly prevalent and popular, giving rise to the concept of digital literacy. Simultaneously, digital production platforms have become more accessible and user-friendly, enabling media production to transition from being solely the domain of professionals to something that ordinary individuals can easily engage in. AML claims that although digital literacy refers specifically to "the critical use and consumption of digitally-created and distributed media (e.g., internet, smartphones, social media and video games), it falls under the umbrella of media literacy, and media literacy helps to understand and appreciate it". Digital literacy, in a broader context, encompasses a cognitive approach and can be considered complementary to media education, and even synonymous with media literacy (Varis, 2010). Digital literacy, as a form of media literacy, aims to develop both critical understanding and active participation in media. The goal of digital and media literacy is to cultivate individuals' ability to critically analyze and creatively express themselves. Scholars argue that production is crucial for media literacy as it grants students a deeper understanding of the constructed nature of media, enhancing their ability to analyze media more effectively (Bennett et al., 2020; Buckingham, 2007; Dezuanni, 2021; Potter, 2022). Moreover, production facilitates the social and cultural participation of young individuals within digital environments (Hoechsmann & Poyntz, 2012; Ito, 2010; Poyntz & Hoechsmann, 2011).

3. Method

This experiment will employ a quasi-experimental design and focus on selecting college students as target participants. The decision to target college students aligns with the findings of Luo et al. (2021), who reviewed VR research in education and found that VR is predominantly utilized in higher education settings. Using SVVR lessons necessitates higher levels of learner autonomy and self-regulatory skills, more commonly found in higher education contexts than in secondary or primary education (Bembenutty, 2011). The experiment is expected to last approximately two weeks. During the first week, participants will receive guidance from researchers on learning the filming techniques for SVVR materials and training on the use of SVVR production platforms. In the following week, participants will commence shooting their own SVVR content and create SVVR materials (3-5 minute) in the laboratory. They will also be asked to complete relevant questionnaires and participate in interviews.

4. Future Work

Authorship in the digital realm is marked by a contemporary culture to explore the possibilities offered by available technology, enabling individuals to create new works, share them, and remix existing works in ways that may significantly deviate from the original sources, due to the ability to manipulate and combine diverse forms of original content (Ng, 2009). Data collection for this research will involve questionnaires and semi-structured individual interviews to gather primary data. This study aims to explore the construction of media literacy through identity, engagement, digital media literacy skills through SVVR production. Besides, semi-structured individual interviews will explore the participants' perceptions, experiences, and challenges during SVVR production. NVivo 12, a qualitative data analysis software, will be employed to analyze the collected data. Thematic analysis will be the chosen analytical approach, which involves identifying and organizing patterns, themes, and categories within the data. This analysis will help to uncover commonalities in the students' conceptions and experiences, providing a comprehensive understanding of the impact of SVVR-based learning.

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New Takes on Developing Language Learning and Intercultural Competence Using Telecollaboration Project Supported by Generative AI

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Abstract: *This paper is the ideas and plans for a doctoral dissertation. Since AI+X is a trend and significant content in China's education development strategy, the Telecollaboration system aims to involve AI (Generative AI) in this current research. This Telecollaboration system supported by Generative AI is intended to facilitate language skills (writing and speaking) distantly and intercultural competence in its learning sequences. However, despite its great potential, this direction was hardly investigated in the previous study in this direction. Since few studies have explored the telecollaboration system between Chinese and Indonesian participants in earlier studies, this 14-week experiment tries to fill the gap by investigating 40 undergraduate students from Indonesia and 40 undergraduate students from China. The data will be collected through pre- and post-questionnaires, interviews, reflective reports, and evaluations. This study may contribute to enhancing students' writing skills, speaking skills, and intercultural competence.*
Keywords: telecollaboration, Generative AI, writing skills, speaking skills, intercultural competence

1. Introduction

Online intercultural exchange has become crucial (Sevilla-Pavon, 2018) since many people speaking different languages, representing various cultures, and residing in different countries are becoming "closer" to each other with the help of information technologies (Özdemir, 2017). In the previous studies, language skills and intercultural competence were separately developed. For example, telecollaboration activity only develops writing skills (Ku, 2018; Rokhmah, 2018;), speaking skills (Liu & Yang, 2023; Taskiran, 2020), and intercultural competence (Schenker, 2012; Shadiev et al., 2023). O'Dowd (2012) suggested applying online communication tools to bring together classes of language learners in geographically distant locations to develop their foreign language skills and intercultural competence through collaborative tasks and project work. Distance exchange projects, also called telecollaboration (Belz, 2002), have been motivated by various purposes, including language skills (writing and oral) and intercultural competence (Ware & Hellmich, 2014; Lee, 2020). Through writing, speaking, and interacting with different people from different cultures, learners can engage in language learning and intercultural competence (Shadiev et al., 2020; Shadiev et al., 2021; Shadiev et al., 2023).

Since AI+X is a trend and significant content in China's education development strategy, the telecollaboration system aims to involve AI (Generative AI) in this current research. Generative AI (GenAI) is a group of machine learning algorithms designed to generate new data samples that mimic existing datasets (Chan & Hu, 2023). GenAI models use advanced algorithms to learn patterns and develop new content such as text, images, sounds, videos, and code. Some examples of GenAI tools include ChatGPT, Earnie BOT, Bard, Stable Diffusion, and Dall-E. In this study, we employed ChatGPT (Generative Pre-trained Transformer), the cutting-edge language model developed by OpenAI, which is one of the most exciting advancements in the field of AI that is free to access (OpenAI, 2023). ChatGPT has caught the attention of teaching-learning (Kohnke et al., 2023). Warschauer et al. (2023) identified that ChatGPT promotes comprehensive writing assistance through content development, corpus search, text modification, feedback and questions, response to questions, sentence generation, vocabulary and sentence support, vocabulary or grammar support, and paraphrasing or summary. These features are proposed to develop writing skills by process writing in a telecollaboration project. ChatGPT can be a virtual teaching assistant that gives students immediate feedback (Javaid et al., 2023) and assessment (Zirar, 2023) that can be used as a conversation tool to answer non-understanding words or sentences that cause communication breakdown during interactive oral presentations. These features are proposed to develop speaking skills by negotiating meaning in a telecollaboration project. Finally, GenAI can support revising and editing, such as paraphrasing the reflective report, to ensure they produce immersive and high-quality writing products of reflective reports before sharing them with their peers. These features are proposed to develop intercultural competence in a telecollaboration project.

We design online intercultural exchange among Indonesian and Chinese college students. This learning sequence includes creating (writing), sharing and discussing (speaking), and reflecting (intercultural competence) on the intercultural content supported by Gen AI in the telecollaboration project. In the current study, the social constructivism theory explains the writing process to develop writing skills by engaging in the learning and knowledge construction process through independent and collaborative learning activities. The interaction hypothesis (Long & Robinson, 1998) is developed through face-to-face communication and interaction where a particular type of interaction, namely negotiation of meaning (NoM), the interaction is modified between or among conversational partners to help overcome communication breakdowns (Long, 1983; Long & Porter, 1985; Porters, 1986; Nakahama et al., 2001) to develop speaking skills through feedback and assessment through oral presentation in sharing and discussion activity. Cultural convergence theory (Gudykunst et al., 1988; Kincaid, 1979) means two or more participants reach a mutual understanding of culture and the world culture they live in through communication and information exchange to develop their intercultural competence where the participants produce reflective reports from the activities.

Telecollaboration offers a worthwhile opportunity to create digital environments for language learners to communicate with people from diverse backgrounds (Çiftçi & Savaş, 2018). In foreign language education, 'telecollaboration' refers to applying online communication tools to bring together classes of language learners in geographically distant locations to develop their foreign language skills and intercultural competence through collaborative tasks and project work (O'Dowd, 2012). Taskiran (2020) suggested combining multiple technologies to develop foreign language skills and intercultural competence. In this study, we develop a telecollaboration system supported by GenAI to promote writing (online forum + GenAI), speaking (video conferencing + GenAI), and intercultural competence (online forum + GenAI).

2. Research Objectives

We aim to propose our own model after completing this pilot study. This pilot study seeks to address this significant gap by embarking on a more focused examination of the GenAI support telecollaboration project, particularly emphasizing writing skills, speaking skills, and intercultural competence. To address these research objectives, the following research questions were formulated:

1. To what extent does a telecollaborative project supported by GenAI technology contribute to developing participants' writing skills compared to non-GenAI instruction?
2. To what extent does a telecollaborative project supported by GenAI technology contribute to developing participants' speaking skills compared to non-GenAI instruction?
3. To what extent does a telecollaborative project supported by GenAI technology contribute to developing participants' intercultural competence compared to non-GenAI instruction?
4. What are the participants' perceptions toward the impact of GenAI on their language skills and intercultural competence?

3. Research Methods

3.1. Research Design

This research adopts a quasi-experimental design involving the participants of 80 undergraduate students from China and Indonesia. This study will be divided into two phases. The first phase will involve 20 Chinese students and 20 Indonesian students. They will be randomly and equally assigned to two groups: the control group and the experiment group. The research approach involves collecting, analyzing, and integrating both qualitative and quantitative data within two phases of studies. The data were collected through pre-and post-assessments, interviews, and reflective reports.

3.2. Participants

This study involved the participants of 80 undergraduate students. The Indonesian participants (40 participants) are from one university in Lampung province, Indonesia. All the Chinese participants (40 participants) are from Nanjing Normal University. All participants were between 18-25 years old and voluntarily joined our online intercultural exchange program. In this study, the Indonesian and Chinese participants were undergraduate students, and all were native speakers of Indonesian and Chinese language. Their English proficiency has reached an intermediate level. They have mastered certain vocabulary, grammar, and conversation and can carry out basic dialogue in conversation. After some preparation, they also could carry out complex interactions. All students have experience using GenAI for at least one year to ensure no technical issues while utilizing GenAI in learning activities.

3.3. Research Procedure

The study was conducted to examine the effectiveness of GenAI-assisted writing activity, oral language activity, and intercultural learning activity, and it was granted ethical approval by the Ethics Committee of both universities where the research was conducted. Following this, the course instructors clearly explained the study's purpose and data confidentiality to participants to obtain their consent. The experiment procedure will last for 14 weeks tentatively (refer to Figure 1):

In the first week, all participants were required to complete all pre-questionnaires (writing skills, speaking skills, and intercultural competence).

In the second to fifth week, the participants will complete a one-hour learning task that requires four times each week. These tasks include preparing (one week), drafting (one week), revising (one week), and editing (one week). According to the topic, all participants are required to write the cultural topics scripts. Researchers and instructors give guideline books and learning task forms that participants need to follow and conduct. The experimental group will write the script assisted by GenAI in each step (preparing, drafting, revising, and editing) and transfer the product to Ms. Word. For the control group, they will write manually, assisted by the teacher.

In the sixth week, after finishing the writing task, all participants are required to fill out the post-questionnaires (writing skills and technology acceptance model (TAM) questionnaires)) and evaluation. The teacher will conduct an evaluation to determine the participants' writing development level.

In the seventh to tenth week, the participants will complete a one-hour presentation task each week. For the experiment group, the learning activities include an initial presentation (one week), feedback and assessment from peers, GenAI as assisted-teaching to experience the NoM model (2 weeks), and a final presentation (one week). For the control group, the learning activities include an initial presentation (one week), feedback and assessment from peers and a teacher to experience the NoM model (2 weeks), and a final presentation (one week). The presentation materials are the scripts they have created for the writing task. Researchers and instructors give guideline books and learning task forms that participants need to follow and conduct.

In the eleventh week, after finishing the speaking task, all participants are required to fill out the post-questionnaires (writing skills and TAM questionnaires) and evaluation. The teacher will conduct an evaluation to determine the participants' speaking development level.

In the twelfth to thirteenth weeks, students have two weeks to complete their reflective report about what they have experienced and reflect on it by describing the eight-point reflective report form. Researchers and instructors give guideline books and learning task forms that participants need to follow and conduct. The experiment students first manually write the reflective report, and then they revise and edit it using GenAI. Then, they share their reflective report with their peers. The control group manually writes and shares the result with their partner.

In the fourteenth week, after finishing the speaking task, all participants are required to fill out the post-questionnaires (intercultural competence and TAM questionnaires) and interviews.

Both qualitative and quantitative methods will be employed for the data analysis. The results of the questionnaires will be quantitively analyzed using SPSS. Descriptively, the mean, standard deviation, frequency, and percentage will of the questionnaires will be analyzed. Inferentially, the pair-sample t-test will be conducted to analyze the possible differences between the experimental and the control group in their scores in the questionnaires. The interview transcripts and the reflective reports will be qualitatively analyzed through an open coding system. The evaluation forms were used to classify the level of language learning students reached.

Weeks	Activity	Experimental group (GenAI-assisted)	Control group (traditional)
1	Pre-questionnaires	1. Writing skills (60 items) 2. Speaking skills (38 items) 3. Intercultural competence (45 items)	1. Writing skills (60 items) 2. Speaking skills (38 items) 3. Intercultural competence (45 items
4	Writing task (preparing, drafting, revising, editing)	1. Cultural-technological script 2. Use GenAI in writing, 3. Transform the product of GenAI prompts to Ms. Word	1. Cultural-technological script 2. Non-GenAI-assisted 3. Writing in Ms. Word
1	Post-questionnaires on writing skills, Technology acceptance model (TAM) questionnaires, interviews, and evaluation	1. Writing skills (60 items) 2. TAM questionnaires (29 items) 3. Interviews (58 open-ended questions) 4. Evaluation (10 criteria)	1. Writing skills (60 items) 2. TAM questionnaires (29 items) 3. Interviews (58 open-ended questions) 4. Evaluation (10 criteria)
4	Speaking task (content, structure, delivery manners, and interaction)	1. Initial presentation 2. Feedback from peers and GenAI 3. Final presentation	1. Initial presentation 2. Feedback from peers and teachers 3. Final presentation
1	Post-questionnaires on speaking skills, Technology acceptance model (TAM) questionnaires, interviews, and evaluation	1. Speaking skills (38 items) 2. TAM questionnaires (25 items) 3. Interviews (36 semi-structured interviews) 4. Evaluation (10 criteria)	1. Speaking skills (38 items) 2. TAM questionnaires (25 items) 3. Interviews (36 semi-structured interviews) 4. Evaluation (10 criteria)
2	Intercultural competence task	1. Manually write a reflective report 2. Revising and editing assisted by GenAI 3. Sharing the final report with the partner	1. Manually write a reflective report 2. Revising and editing assisted by teacher 3. Sharing the final report with the partner
1	Post-questionnaires on speaking skills, Technology acceptance model (TAM) questionnaires, interviews, and reflective report	1. Intercultural competence (45 items) 2. TAM questionnaires (25 items) 3. Interviews (29 semi-structured interviews) 4. Reflective report (8 reflective points)	1. Intercultural competence (45 items) 2. TAM questionnaires (25 items) 3. Interviews (29 semi-structured interviews) 4. Reflective report (8 reflective points)

Figure 1. Research procedure

3.4. Potential Limitation

The potential limitation of this current study is in ensuring reliability and validity. All participants will score each item on the questionnaire using a five-point Likert scale anchored to the endpoints "strongly disagree" (1) and "strongly agree" (5). I then checked for the internal consistency of each questionnaire using Cronbach's alpha value. For the interviews, the questions were reviewed for clarity and language by a panel of three experts, comprising one language educator and two specialists in education, to ensure the necessary amendments or not.

4. Current Research Phase and Next Steps

This study tries to develop a telecollaboration project supported by GenAI to develop students' writing skills, speaking skills, and intercultural competence. The qualitative and quantitative findings will be discussed and provided after we complete all the studies. This research is currently in its initial stage. The researcher has completed the four main parts of this research, including the literature review, the conceptual framework, the model of the telecollaboration system, and the instrument of the experiment. This research started by completing the recruitment process for the experiment group from the Indonesian students' side and the recruitment process for Chinese students. The upcoming steps in this study include the preparation step, which involves pre-training students about our research program and training on utilizing the tools. The next step is to start the 14 weeks of the experiment with the experiment group, as well as to collect and analyze data. We then continued the subsequent research on the 14 weeks of activity with the control group, data collection, and analysis. We found no significant problem related to issues on GenAI and student engagement level.

5. Issues that need further discussion in the forum

We are broadly open to any comments and suggestions to improve our research design, specifically whether this design is proper to become a doctorate student dissertation. Thank you.

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课堂文本语言行为自动分析系统开发及应用

Development and Application of Automatic Analysis System for Classroom Textual Language Behavior

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【摘要】从机器学习的视角出发，以课堂语言行为分析理论为基础，基于开发的课堂文本语言行为自动分析系统，选取 100 节课堂和近 30000 句课堂文本形成语言行为标准分数常模，并从“行为、语速、词性”三维度提出课堂语言行为评价体系。随后，选取四名初中信息技术实习教师进行为期 2 个月的语言行为量化分析，通过比较优质课堂发现特点及其差异，并从应用评价体系、学生成绩出发讨论教师教学行为是否得到提升。测试表明，其不仅能提高课堂分析效率，而且对提升实习教师的教学语言行为、专业技能和学生学业水平具有积极影响，尽快帮助教师过渡“新手期”。
【关键词】 机器学习；互动分析；互动分析系统；教师专业成长

Abstract: *From the perspective of machine learning and grounded in classroom language behavior analysis theory, this study developed an automated classroom text language behavior analysis system. Utilizing around 30,000 sentences from 100 classroom sessions, a standard score norm for language behavior was established. The evaluation system proposed examines three dimensions: behavior, speech rate, and parts of speech. Subsequently, four middle school information technology student teachers were selected for a two-month quantitative analysis of their language behavior. By comparing with high-quality classrooms, the characteristics and differences were identified. The discussion extends to whether there has been an improvement in teaching behavior based on the application of the evaluation system and student achievements. Results show that the system not only enhances the efficiency of classroom analysis but also positively impacts the improvement of student teachers' language behavior, professional skills, and students' academic levels. It indicates that the developed system could facilitate a quicker transition for teachers during their novice stages.*
Keywords**:** Machine Learning; Interactive Analysis; Interactive Analysis System; Teacher Professional Growth

1. 前言

对课堂教学进行行为类型的编码与分析是互动分析最重要的目的之一（魏宏聚,2009）。精准分析课堂各阶段情况对教师提升教学、学生深层投入、师生良性互动有显著作用（Kakosimos,2015）、（傅德荣和章慧敏,2001）。现实课堂记录存在多种手段和分析方法，包括 S-T 分析法、传统弗兰德斯互动分析法（FIAS）等，其中以 FIAS 分析法最为主流，传统 FIAS 互动分析法包含教师、学生、沉寂等共 10 种编码类别，每种类别又包含多种交互行为，对行为进行编码并进行数据分析和呈现（魏宏聚,2009）。

现有大部分观察技术和标准的来源均基于弗兰德斯互动分析系统，弗兰德斯教授采用质性方法进行课堂观察及编码，再通过矩阵计算得出结论，该方法大大简化了课堂教学研究过程的复杂性，同时又提高了观察记录的科学性和准确性（张海,2014）。Student-Teacher 分析法简称 S-T 分析法，是一种有效引用于教学过程分析的定量分析方法，能将教学结果以图表形式表示出来，并根据图表所展示的数据进行计算，使教师根据计算结果对教学过程进行分析与讨论。薛新国团队改进传统 S-T 教学分析法，将课堂教学行为划分为教师行为 T、学生行为 S 以及师生互动行为 D 三类，并以此编码课堂教学过程，分析课堂教学模式（薛新国,2019）。黄苗苗团队改进 Flanders 编码，通过课堂观察的形式，标

准化的分析了信息技术优质课堂师生互动行为，获取有效地课堂教学行为信息（黄苗苗,钟媚,潘霞,杨彩香,2021）。

现有团队对 FIAS 的改善主要围绕课堂行为分类、技术记录和矩阵分析维度，以满足现代课堂互动分析需求。但存在局限性：一是课堂现实记录难度高、精度低，容易产生误判或错漏（方海光,高辰柱,陈佳,2012）；二是人工记录耗时、要求高，难以保证一致性和准确性；三是课堂切片颗粒度高，行为转换记录不足(徐丽丽,2020)；四是连续课堂关联度低，缺乏教师成长监督；五是海量课程分析费时，缺乏短时分析手段。基于此，本研究旨在探讨基于文本分类的课堂话语分析工具的开发及应用并提出教师教学行为优化策略研究，帮助教师快速获得专业发展。

本研究的研究问题为：通过开发自动化课堂文本言语行为分析工具，对比、寻找实习教师与优质教师差异并提出教学行为优化策略，观察教师课堂教学行为是否得到优化，专业技能是否获得成长？

2. 课堂文本语言行为分析系统的设计

2.1. 语言行为编码体系确定

教学活动中，师生语言互动行为是主要教学行为，弗兰德斯教授在 20 世纪 60 年代采用质性方法进行课堂观察及编码，并利用矩阵计算得出结论，从而形成弗兰德斯互动分析系统（FIAS），其中课堂语言行为分为 3 大类 10 小类，其中 1-7 为教师语言，8-9 为学生语言，10 为课堂沉默(Flanders, Ned,1963)。虽然弗兰德斯课堂语言互动分析系统解决了研究课堂教学无从着手的境况，但在利用机器学习分析现实课堂的情况下存在弊端，导致课堂语言行为分析准确度的下降，因此本研究在根据人工分析 30 节以上现实课程的基础上，对行为编码体系进行相对应修改。

修改内容如下：（1）教师语言中删去“接纳学生情感”的分类，现实课程中教师较少接纳学生情感，并且利用文本分类时需要介入情感分析，导致其分析结果准确度不高，故删去。（2）将“学生主动发言”分为主动提问和主动发言，现实课程中学生表现较公开课等更为活跃，学生部分语言并非关乎课堂，但是学生能够主动提问说明注意力集中，积极思考并且文本分类对提问和发言的区分度较高，适合作为一个单独分支。（3）将课堂沉默分为有效沉默和混乱或无效沉默，现实课程中较公开课更容易出现混乱或无效沉默，同时有效沉默与混乱或无效沉默的对比也凸显出教师对课堂的掌控度与水平，但 FIAS 编码体系并没有进行划分，应当补全。具体情况如表 1 所示。

表 1 ACTIAS 课堂语言行为编码体系

序号	分类		编码	分类
1	教师语言	间接影响的语言	1	称赞或鼓励
			2	接受或利用学生的想法
			3	教师提问
		直接影响的语言	4	教师讲解
			5	命令或指示
			6	批评学生
2	学生语言		7	回答教师的问题

		8	学生主动提出问题
		9	学生主动发言
3	课堂沉默	10	课堂有效沉默
		11	课堂混乱或无效沉默

2.2. 算法设计与评估

使用计算机文本分类技术可以处理课堂话语并进行分类，但是现有文本分类模型较多，包含常规算法（k 近邻、决策树、贝叶斯算法……）、集成学习算法（随机森林、自增强、lightgbm 算法……），深度学习算法（多分类前馈神经网络，LSTM 神经网络……）。多种分类模型中，面对教师计算机环境需要选择轻量化、精度高、速度快的模型方案，经过对比，随机森林模型在适当时间内（2 分钟左右）达到 80%左右的准确率符合教师计算机环境要求。此外随机森林具有高准确度、可以处理大量输入变量、遗失资料仍可维持准确度、学习过程快速等优点。主要的文本分类处理步骤包括：批量读取文本数据集、中文文本分词、停用词使用、编码器处理文本标签、数值向量转换、建模训练等。随后根据训练得到模型，将课堂话语输入并经过中文文本分词、通用词清洗、数值向量转换后判断话语类型并输出。

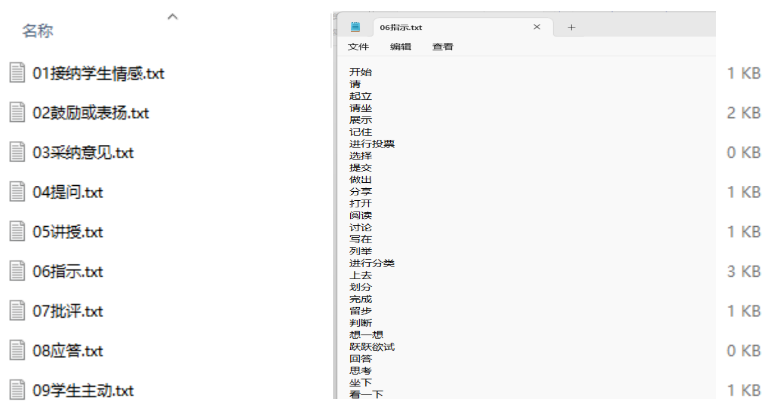

图 1 课堂语言词库示例

2.3.算法有效性验证

为评估基于随机森林—修正算法的性能及有效性，必须进过一系列严格的实验。结合现实世界及人工修改批注的的课程语言行为数据集，其中人工修改批注经过三位熟悉流程且经验丰富的人员进行两轮的批注、对比、修改形成人工批注数据集，最终形成近 30000 句带有批注标识的课堂师生语言行为数据集。随后将数据集经过批量读取文本数据集、中文文本分词、停用词使用、编码器处理文本标签、数值向量转换、建模训练等一系列的数据预处理步骤，以确保数据的质量和一致性。

为了衡量基于随机森林算法的性能，选择了一组合适的评估指标，包含准确率（accuracy）、精确率（precision）、召回率（recall）、F1 分数（F1-score）、支持（support）、宏平均（macro average）和加权平均（weighted average），以对模型进行全面的评价。具体数据如下表 2、表 3。

表 2 学生混淆矩阵报告

	精确率	召回率	F1 分数	支持
0	0.94	0.99	0.96	381
1	0.83	0.28	0.42	36
准确率			0.93	417
平均宏	0.88	0.64	0.69	417
加权平均	0.93	0.93	0.92	417

从表 2 数据分析可知，学生文本分类模型总体的准确率达到 93%，其中类别 0 的准确率为 94%，类别 1 的准确率为 83%，这是由于类别 0 在样本数量上远大于类别 1。然而从宏平均和加权平均的角度进行综合考虑发现，两者的准确率，召回率和 F1 分数都提升到可接受范围，尤其是在加权平均角度下，准确率达到 93%，召回率为 93%，F1 分数为 92%，说明模型在对学生两种类别的识别下表现较好，能够精确区别学生的回答问题和主动说话。

表 3 教师混淆矩阵报告

	精确率	召回率	F1 分数	支持
0	0.75	0.55	0.63	351
1	0.85	0.82	0.84	758
2	0.74	0.84	0.79	886
准确率			0.78	1995
平均宏	0.78	0.74	0.75	1995
加权平均	0.79	0.78	0.78	1995

从表 3 的数据分析可知，教师文本分类模型总体准确率达到 78%，其中类别 0、1、2 的准确率分别为 75%、85%、74%，说明在每项类别的区分上表现较好。从宏平均和加权平均的角度进行综合考虑发现，模型的各项达到 75-80%的水平，说明模型能够在多分类任务的区分上表现尚可，能够区分教师的提问、讲授和指令不同行为。

以上内容全面阐述了实验设计、数据集选择、数据预处理和评估指标的使用，以及基于规则—数据集的修正算法的验证和实验结果分析。通过以上的实验以及结果评估，表明在利用基于随机森林—修正算法对课堂语言行为进行分类后，基本满足现实课堂语言分析对文本预处理、划分师生语言、标识语言行为等需求。

3. 优质课常模生成

常模是指在分析测验结果时，用来确定被试者相对水平的参考系，是衡量个体水平的标准。本研究开发的软件适用于课堂评估、师生互动评价、教学改进等方面，因此制定切实、有效、具有指导作用的常模意义重大。要建立有意义的常模，一是要获取有代表性的常模团体，而是要以常模团体的原始分数为基础，用统计学的方法来到处一种具有特定意义的数据，能反映个体在群体的分布情况和相对位置(方海光,孔新梅,2023)。

美国学者弗兰德斯利用互动矩阵分析法所得到的一系列数据更进一步的分析，提出了 12 项指标以解释该教学行为背后所隐含的意义，并且在统计大量课程数据后得出 12 项指标的常模作为标准，帮助教育者了解自身行为、教育过程中的关键要素、师生建立积极有效的行动、增强学生的参与感和学习动力(Flanders 和 Ned,1963)。

本研究将在借鉴弗兰德斯互动分析常模的基础上，利用自动化分析软件分析大量优质课例数据，为其建立互动分析常模并作为评判标准，突出优秀教师与实习教师在教学行为上的差别。因此通过搜集来源于知网现有文献中优质课例数据以及自主分析优质课数据，共计近 100 节的数量计算平均值，根据标准分数常模规则，并将其作为优质课互动分析常模帮助对比实习教师课堂行为、寻找差别并提出解决意见。

表 4 优质指标常模

行为维度	课程行为比例	优质比例常模	标准差（σ）	理论课比例常模	实践课比例常模
直接角度	教师言语比例	55.9%	13.97	59.27%	52.53%
	学生言语比例	22.10%	5.52	23.93%	20.27%
	有效沉寂	13.0%	3.25	10.58%	15.42%
	无效沉寂	6.10%	1.53	4.1%	8.1%
	沉寂或混乱	19.10%	4.78	14.68%	23.52%
	有效沉寂/无效沉寂	224.21%	28.80	258.05%	190.37%
间接角度	间接影响/直接影响	72.70%	18.20	67.87%	77.53%
	教师反应比例	55.30%	13.83	50.59%	60.01%
	教师发问比例	20.20%	5.05	20.75%	19.65%
	学生自发比例	31.30%	7.83	13.96%	48.64%
	教师实时反应比例	71.10%	17.78	71.33%	70.89%
	教师实时发问比例	55.00%	13.75	45.70%	64.3%
	内容十字区	51.70%	12.93	56.07%	47.33%
	稳定状态区	57.40%	14.35	61.90%	52.9%
	学生稳定状态区	55.90%	18.95	58.68%	53.12%

在借鉴弗兰德斯指标常模的基础上，增加了“有效沉寂”、“无效沉寂”、“有效沉寂/无效沉寂”三个指标，用来细化课堂分析维度，形成表 8 所展示的优质指标常模。但在实际应用的过程中发现各项指标比例是随着课程安排、教学进度、互动频次的不同而浮动的，因此单一的常模缺乏应用价值，为便捷后续数据处理与教师分析，需要定义一些范围进行区分。

4. ACTIAS 的教学应用

4.1. 实验流程设计

研究者在前期文献调查和软件开发的基础上，选定初中代表性课程、制作课程教学设计、录制课堂实录、分析并调整实验方案，从而确定正式实验。选取两名水平相当实习教师形成一组，共两组作为研究对象。两名教师仅进行一次课前备课，并直接进行授课，其中一名利用工具对课堂语言行为进行量化，并结合指导教师意见和优质课例视频进行反思、另一名仅有指导教师意见和优质课例视频进行反思。随后两名教师按照正常教学进度上课，经过历时 2 个月的实验，进行两名教师的成长图对比作为直接依据与班级成绩对比作为辅助依据。实验组教师流程图如图 2 所示。实验对照图如图 3 所示，即对照组缺乏课堂实录分析步骤。

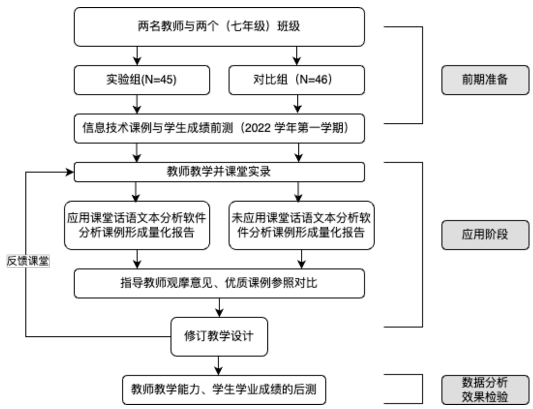

图 2 实验流程图

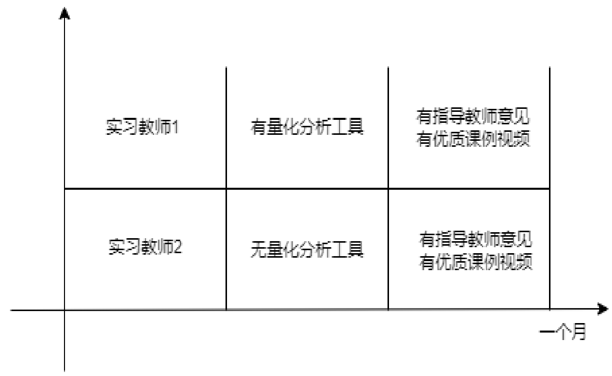

图 3 实验对照图

通过实施两组为期两个月的实验，不断在上课过程中调整策略与方案，来验证在课堂语言量化分析工具的帮助下教师能否获得专业发展上的提升，以及借助教师专业发展综合模式下的学习能否促进教师教学行为上的优化。

4.2. 课程量化数据分析

本研究设计的课堂语言行为分析软件主要从课堂师生行为、语速、词性三维角度进行分析，并基于大量优质课例数据形成优质课例常模，通过评分机制为课堂师生行为、语速进行评分，其中由于词性因人而异且不构成评分依据，因此词性仅作为教师生成报告参考意见的一环。本研究选取两名水平相当实习教师形成一组，共两组作为研究对象。通过录制四名实习教师为期 2 个月、共计 10 节初中信息技术课程，最终对比课程总分、行为分数、语速分数，观察教师是否在软件的辅助下获取更为明显的进步与提升。受制于篇幅限制，当前仅展现一组实验数据作为说明。

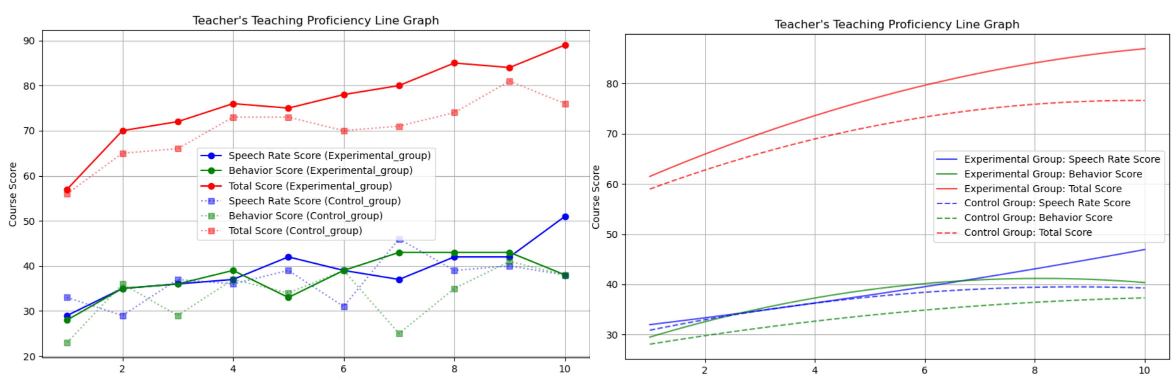

图 4 实验-对照组教师分数变化折线图

通过观察图 4 的课例各项分数变化，实验组别二的教师教学能力各项分数和趋势变化，可以发现实验组教师不论从教学得分、教学能力提升、趋势走向上均比对照组教师表现优异。实验组教师从最初 57 分，利用分析软件经过一系列积极的调整，最终稳步提升至 89 分，虽然中间出现小幅波动，但最终都能够根据意见做出积极调整。而参照组从最

开始 56 分提升至 76 分，虽然教师也得到提升，但是提升幅度明显小于实验组。实验组的语速得分出现较大浮动，说明教师在努力控制自身语速过程中，经历了一段适应期，但经过 4-5 节课的调整，随即能够合理控制自身语速。而参照组的语速在自身范围内上下浮动，未出现显著变化。实验组和参照组在行为得分上均出现稳步提升趋势，但是实验组的得分相对参照组提升更加稳定，波动较小。说明参照实验组意见的教师更够把握课堂师生行为，控制课堂节奏和不同环节的分配。

这些显著的提升可以归因于实验组教师获得了课堂话语文本分析软件提供的详细反馈。通过这种反馈，他们能够清晰地了解自己在课堂细节、具体问题以及提升方向上的不足。因此，他们能够在较短的时间内进行有针对性的纠正和改善。相比之下，对照组教师由于缺乏这种具体的反馈，所获得的信息较为笼统，难以在短时间内实现有效的教学转换与提升。综上所述，课堂话语文本分析软件对教师教学能力的提升具有显著的效果。它为教师提供了精准的反馈信息，帮助他们更好地理解自己的教学情况，并针对性地改进教学方法和技巧，从而提升教学质量和效果。

4.3. 学生练习数据

随着新手教师课堂行为的逐渐规范、合理化，学生的练习成绩将会在一定程度上得到提升。本研究通过每节课后对学生进行课堂知识习题的测试并记录成绩，来辅助说明教师教学行为提升将直接影响学生学习效果。本研究要求教师在每堂课后都对学生进行当堂信息技术知识习题的练习，采取满分 5 分制对学生进行打分并记录。通过为期 2 个月，共计 10 堂课进行前后对比。

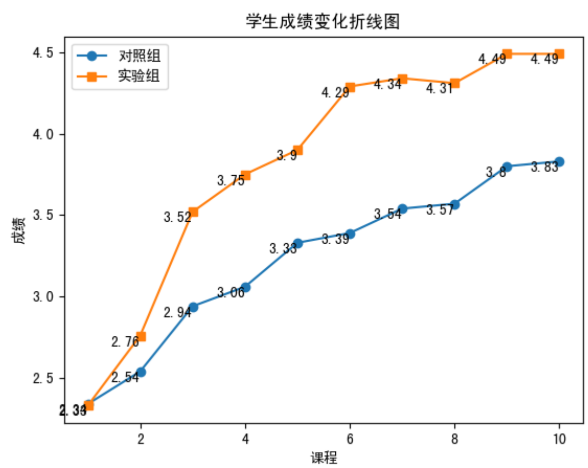

图 5 实验组学生成绩折线图

根据图 5，在编程方面零基础且相同水平的班级均在 10 堂课后获得了不同程度的提升，但是实验组成绩较对照组提升明显。值得关注的是，从第三、四节课之后，随着教师课堂熟练度提升、教学行为合理化、语速趋于稳定，学生更能够积极地参与课堂、高效地接受知识、并能够将所学内容融会贯通。此外，自第六课之后，实验组学生成绩趋于稳定，说明课堂大部分学生已经对编程知识形成基本概念，在编程方面短时工作记忆广度得到了提升，能够灵活提取课堂知识解决实际问题。

实验组学生课堂练习成绩的显著提升及其稳定性，不仅证明了教师在为期两个月的软件应用中在教学行为、语速及教学语言方面取得明显进步，同时也反映出利用课堂话语文

本分析软件（ACTIAS）能够在教师专业成长中起到积极作用。它不仅为教师提供了明确的成长路径，还有效地提升了教师课堂表现与学生学业水平。

5. 结束语

通过实际研究与应用可以发现本研究开发的系统以及分析结果具有一定的真实客观性，它不仅可以像 FIAS 等分析法一样对课堂教学行为进行分析，且其过程解放人力、过程简便、可操作性强、连续性高、颗粒度细。但是现阶段软件还存在分析维度较少、缺乏对师生互动更多维度的分析，这些方面还需要进一步优化改进，并且将其与自动化更加靠近，达到真正的计算机赋能教育，从而更好地服务课堂数字化分析。此外，面对课堂环境的纷繁复杂，仅靠语言文本分析是不够的，之后可以利用计算机视觉介入，分析师生课堂动作、表情等维度，更加精准分析师生状态，为新教师过渡、课堂节奏把控、学生学习效果提升做到更好地推荐，这也将作为下一步深入研究的方向之一。

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