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Theoretical Retrospectives for Developing a Constructivist Learning Environment Model to Enhance Metacognitive Regulation in Authentic Writing

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ABSTRACT

This study aims to conduct a theoretical retrospective on the development of a Constructivist Learning Environment (CLE) model. An innovative Constructivist Learning Environment (CLE) model will be developed based on the theoretical traceability to improve high school students' metacognitive regulation in authentic writing tasks. Following Richey and Klein's model research framework, the study is currently in the design and development phase, where a CLE is being systematically created and refined. The model integrates six theoretical foundations—psychological, pedagogical, cognitive, metacognitive, media, and technology principles—and is built around seven interconnected components: a Problem Base and Learning Mission, a Learning Resource Center, a Cognitive Tool Center, a Collaboration Center, an Enhanced Metacognitive Regulation Center, a Scaffolding Center, and a Coaching Center. Each component is designed to engage students in real-world authentic writing, providing tools and structured support to develop self-regulation, reflective thinking, and effective writing strategies. Expert input from content, media design, instructional model design, and educational evaluation informs each phase of development, ensuring the model's rigor and relevance. Although implementation has not yet begun, the CLE model represents a pioneering approach in secondary education, bridging the gap between theoretical understanding and practical application, and equipping students with essential skills for lifelong learning and effective communication in real-world contexts.

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1. Introduction

Writing is a foundational skill essential for academic success, personal development, and career readiness. Mastering writing, however, is a demanding process that requires structured guidance, practice, and the ability to think critically and reflectively[1]. Unlike speaking, which often develops naturally, writing requires deliberate cognitive engagement, including planning, organizing, and revising ideas, which makes it especially challenging for students[2]. Research shows that many students worldwide struggle to acquire effective writing skills, creating a gap between school-based instruction and the types of writing tasks needed for real-world communication[3]. Addressing this gap requires writing instruction that not only develops technical skills but also engages students in meaningful, experience-based writing.

A promising approach to deepen students' engagement with writing is through authentic writing tasks that connect directly to their personal experiences and realities[4]. Such tasks draw on students' unique insights, making writing more meaningful and encouraging them to reflect on and take ownership of their work[5]. However, without instructional support that incorporates metacognitive strategies, students may struggle to connect their writing with their lived experiences in ways that enhance their growth as writers[6]. A key challenge is that students often lack the ability to reflect on and regulate their own writing process[7]. This underscores the importance of metacognitive regulation, which can enable students to actively monitor and adjust their writing approaches for improved outcomes.

Given the limited research on integrating metacognitive regulation into Chinese writing instruction and the need for more meaningful, student-centered writing approaches, this study aims to fill these gaps. Traditional writing instruction in China often emphasizes memorization and formal accuracy, which can restrict students' engagement and limit their creative expression[8]. To address these limitations, there is an increasing interest in adopting instructional strategies that foster active learning, critical thinking, and personal relevance in writing. A shift toward such student-centered approaches could encourage self-reflection and metacognitive regulation, which are essential for helping students connect their writing to their lived experiences.

One promising way to support this shift is by incorporating a web-based constructivist learning environment model that promotes metacognitive regulation in writing[9]. Such an approach, leveraging digital tools and online platforms, could foster collaboration, peer feedback, and self-regulation, while making writing tasks more accessible and engaging.

2. Literature Review

2.1. Constructivist Learning

Constructivist learning, rooted in the theories of Piaget[10] and Vygotsky[11], emphasizes the importance of learner-driven knowledge construction and active engagement in educational contexts. Piaget's theory highlights the value of experiential learning, where students internalize knowledge through direct interaction and problem-solving[10, 12]. Vygotsky's sociocultural theory further enriches this by stressing the role of social interaction and collaborative learning in cognitive development[11]. These principles have led to the incorporation of authentic, real-world tasks, including collaborative projects and peer feedback, to enhance motivation and the relevance of writing[13, 14]. While these constructivist strategies foster engagement, they often lack structured opportunities for students to regulate their own cognitive processes, which is crucial for tasks like writing.

Despite the success of constructivist approaches in promoting active learning, there remains a significant gap in the integration of metacognitive regulation strategies within these models. Metacognitive regulation—encompassing planning, monitoring, and evaluating one's cognitive processes—is vital for effective writing but is often overlooked in constructivist settings[12]. While constructivist environments encourage collaboration and engagement, they often do not adequately address the need for students to manage their own learning processes during complex tasks such as writing[12]. This gap underscores the need for an integrated

model that combines constructivist principles with metacognitive strategies, empowering students to take charge of both the social and cognitive aspects of their writing process. Incorporating metacognitive regulation within constructivist environments will allow students to not only engage actively but also self-regulate their progress, leading to more effective and meaningful writing experiences.

2.2. Metacognitive Regulation in Writing Instruction

Metacognitive regulation—the process by which learners plan, monitor, and evaluate their cognitive activities—plays a critical role in effective learning, particularly in writing. Initially defined by Flavell[15] as 'cognition about cognition,' metacognition encompasses both metacognitive knowledge (understanding one's cognitive processes) and metacognitive regulation (strategies for managing those processes)[12]. In writing instruction, metacognitive strategies have been shown to enhance students' abilities to set goals, monitor their progress, and evaluate their performance, which are essential for addressing complex writing tasks[6]. Research supports the benefits of these strategies, such as improved textual revisions[16], increased goal orientation[18], and enhanced writing quality[17]. These findings highlight the significance of successfully incorporating metacognitive regulation into writing learning.

Despite the well-established benefits of metacognitive regulation, a significant gap exists in its systematic integration within web-based constructivist learning environments to support authentic writing. While many educational programs promote collaborative learning and authentic tasks that foster metacognitive reflection[6, 18], they often fail to offer structured opportunities for students to engage in sustained self-regulation of their writing processes. This inconsistency can impede students' ability to engage deeply with their writing and limit their capacity for self-directed learning. Furthermore, more study is needed to determine how metacognitive methods might be explicitly taught, supported, and assessed in web-based constructivist environments in order to maximise their impact on writing performance. Addressing this gap is vital, as integrating metacognitive control inside a web-based constructivist framework can considerably enhance the writing process. Educators can increase students' writing skills and overall learning outcomes by creating an environment in which students actively prepare, monitor, and assess their own writing. This approach is consistent with modern educational aims and provides students with vital lifetime learning abilities, emphasising writing as a dynamic, reflective process necessary for improving writing competency.

2.3. Authentic Writing in Educational Contexts

Authentic writing refers to writing tasks that are meaningful and relevant to students, involving real audiences, purposes, and contexts beyond the classroom. It contrasts with traditional writing assignments that often lack real-world applicability, leading to disengagement. Studies show that when students engage in authentic writing—such as expressing personal thoughts and experiences—they feel more motivated and invested in the writing process[19]. Such tasks foster ownership, engagement, and deeper learning, as students are more likely to take pride in their work and actively seek feedback[5].

Despite the documented benefits of authentic writing, its integration into educational curricula remains inconsistent, particularly in certain cultural contexts. While authentic writing thrives in English-speaking countries, where students engage in tasks with real-world relevance, similar practices are notably scarce in Chinese education. Chinese writing instruction traditionally emphasizes rote learning, adherence to standardized formats, and formulaic approaches, which can limit students' opportunities to connect their writing to real-life contexts[19]. This gap creates a crucial need for the incorporation of authentic writing in Chinese classrooms to help students develop practical writing skills that align with the demands of modern, global communication. The lack of such practices not only diminishes student engagement but also impedes their ability to engage with diverse audiences beyond the classroom. Thus, integrating authentic writing into educational contexts, particularly in culturally diverse settings, can bridge the gap between classroom writing tasks and real-world applications, promoting deeper engagement and ultimately enhancing writing proficiency through more relevant and meaningful experiences.

2.4. Integrating Metacognitive Regulation with Constructivist Approaches

The integration of metacognitive regulation within constructivist learning environments has been shown to signif-

icantly enhance students' writing skills. Constructivism, which emphasizes active engagement, collaboration, and real-world applications[13], fosters a learning environment where students take ownership of their learning. When metacognitive strategies—such as planning, monitoring, and evaluating—are embedded in these environments, students develop greater self-awareness and become more engaged in their learning[7]. Research supports that when students actively plan, monitor, and evaluate their writing, particularly in collaborative settings, they not only improve their writing proficiency but also gain deeper insights into their own learning processes[6, 14]. This integration encourages students to approach writing tasks more thoughtfully and systematically, using metacognitive strategies to assess both the process and the outcome of their writing.

In light of the clear advantages of combining metacognitive regulation with constructivist approaches, significant gaps remain in literature. While many studies have examined metacognitive strategies or constructivist practices individually, limited research exists on how these elements can complement each other within writing instruction[7]. Furthermore, the majority of existing research focuses on English language learners[6, 16, 18], leaving a notable gap in understanding how these strategies can be adapted for diverse educational contexts, particularly in non-Western settings like China. This gap underscores the need for further research exploring the interplay between metacognitive regulation and constructivist approaches in varied cultural and educational environments, ensuring that writing instruction can be effectively tailored to the needs of students from different linguistic and cultural backgrounds.

Notwithstanding the wealth of research on constructivist learning[13], metacognitive regulation[12], and authentic writing[20], significant gaps remain in how these elements were integrated into a unified model that effectively enhances authentic writing skills. While constructivist learning environments have been shown to foster active engagement and collaborative learning[11], and metacognitive strategies are known to improve writing outcomes[6], there has been limited research on systematically combining these approaches within writing instruction[7, 14]. Additionally, although authentic writing tasks have been demonstrated to increase motivation and writing quality[5], few studies have explored how constructivist environments can support authentic writing through the integration of metacognitive regulation. This lack of integration highlights a critical gap in existing models and calls for a design and development approach that incorporates these three elements. Therefore, this study focused on Phase 1: the design and development of a constructivist learning environment aimed at enhancing Grade 10 students' authentic writing skills through metacognitive regulation. This phase will contribute to filling the identified gaps, particularly within the context of non-Western educational settings like China, where the integration of these strategies into writing instruction remains underexplored[19]. Given these gaps, the research questions guiding this study were:

(1) What are the key theoretical bases that inform the development of a Web-based Constructivist Learning Environment Model aimed at enhancing metacognitive regulation in authentic writing?
(2) What framework components were synthesized in the Constructivist Learning Environment Model to support authentic writing, and how do these components collectively enhance metacognitive regulation in students?
(3) How do the various components of the Constructivist Learning Environment Model enhance students' metacognitive regulation in authentic writing?

3. Materials and Methods

Therefore, this study aims to develop a web-based constructivist learning environment model specifically designed to enhance authentic writing for 10th-grade Chinese students. Drawing on the work of Richey & Klein[21], Chaijaroen[22], and Rong[23], this model aspires to create an interactive, collaborative environment that promotes active participation and helps students develop essential metacognitive skills for effective writing.

This study adopted the model research design method outlined by Richey and Klein[21], with a focus on the development phase (Phase 1: Model Design and Development). The research process was structured into essential key steps: (1) Conduct a thorough literature review to analyze relevant principles and theories that inform the research (2) exploring instructional contexts to understand the practical application of these theories; and (3) synthesize these insights to design a constructivist learning environment model aimed at en-

hancing metacognitive regulation in high school students' authentic writing.

The research procedures involved during Phase 1 (Model Design and Development) starts with an extensive literature review and analysis to establish a foundation in the field of constructivist learning environments, drawing on existing theories, models, and empirical findings.

3.1. Data Collection

Literature Review and Analysis Record Form. This form is designed to systematically analyze and document the principles and theories pertinent to the design and development of the Constructivist Learning Environment Model. It encompasses key frameworks, including social constructivist theory, cognitive constructivist theory, cognitive theory, media theory, authentic writing theory, and metacognitive regulation theory. The structured approach ensures comprehensive coverage of the theoretical underpinnings that guide the research.

Instructional Context Survey. The instructional context survey investigates the learning management situation within specific subject groups. This comprehensive data collection encompasses fundamental aspects of the educational environment, including basic school information, sensory conditions, seating arrangements, learning schedules, organizational support, and formats for teaching and managing authentic writing[21]. The survey focuses on authentic writing learning among students at Dahe Kan High School and Han Zhong High School in Northwestern China. Data was collected through a detailed investigation of the current learning context. To safeguard participants' privacy, the researcher or a designated research assistant organizes the data into a secure folder, ensuring confidentiality and data protection.

Student Characteristics Survey. The student characteristics survey gathers personal information from high school students participating in the authentic writing learning experiment. Utilizing checklists and open-ended questions, the survey captures qualitative data regarding students' age, gender, ethnicity, familiarity with the Constructivist Learning Environment Model, experience with technology, involvement in authentic writing, current grade level, and metacognitive regulation experiences[10, 21]. Data is collected from Dahe Kan High School and Han Zhong High School, with students submitting their surveys into a designated collection box. To maintain confidentiality, the researcher or research assistant organizes the data in a secure manner.

Teacher Characteristics Survey. This survey collects personal information from teachers involved in the authentic writing learning experiment, employing checklists[10, 21] and open-ended questions to gather qualitative data on their characteristics. Similar to the student survey, data is collected from teachers at Dahe Kan High School and Han Zhong High School. After completion, teachers submit their surveys into a collection box for retrieval by research assistants. Data is meticulously organized in a secure manner by the researcher or research assistant to uphold participant confidentiality.

Model Designer Characteristics Survey. The model designer characteristics survey collects personal information from designers participating in the authentic writing learning experiment. This instrument uses checklists[10, 21] and open-ended questions to capture qualitative data on designers' backgrounds. Data collection occurs through an investigation of designers involved in developing the Constructivist Learning Environment Model. Completed surveys[21] are submitted to research assistants, who ensure data is organized securely to protect participant privacy.

Model Developer Characteristics Survey. This survey[10, 21] is aimed at gathering data on the personal characteristics of developers engaged in the authentic writing learning experiment. Utilizing checklists and open-ended questions, it collects qualitative data on developers' demographics and qualifications. Data is obtained through direct investigation of those involved in the design and development of the Constructivist Learning Environment Model. Participants submit their surveys into a designated collection box, with research assistants handling the organization of data to ensure privacy.

Theoretical Framework Synthesis Form. The theoretical framework synthesis form is utilized to analyze and synthesize literature, theories, and principles relevant to the study. This form compiles original ideas, principles, and analyses from established theories within the field. It records qualitative data, including the topic, theory name, origin, principles, and analyses[21]. The researcher or research assistant organizes this information in a private and secure manner to maintain data integrity.

Designing Framework Synthesis Record Form. This record form is employed to document theories, principles,

and components addressing cognitive development and knowledge construction in the design of the Constructivist Learning Environment Model [22]. It captures qualitative data, including processes, goals, theories, and component details. The researcher or research assistant securely organizes this data on a private computer to ensure confidentiality.

Constructivist Learning Environment Model Synthesis Record Form. This form documents the synthesis process involved in designing and developing the Constructivist Learning Environment Model [22]. The researcher records qualitative data, including principles, key concepts, details, and analyses relevant to the model's synthesis. This data is collated and organized in a secure folder to protect participant confidentiality and data integrity.

Model Development Record Form. The model development record form collects qualitative data regarding the development process of the Constructivist Learning Environment Model [22]. It encompasses information on model performance, challenges encountered during development, and reactions to the process. The researcher or research assistant organizes this data securely to maintain confidentiality.

Model Component Creation Record Form. This form captures the theories, principles, and components relevant to cognitive development and knowledge construction in the design of the Constructivist Learning Environment Model [22]. It facilitates the documentation of qualitative data, including essential components such as the problem base, learning mission, learning resource center, cognitive tool center, collaboration center, metacognitive regulation center, scaffolding center, and coaching center. The researcher or research assistant manages this data securely to ensure participant privacy.

Constructivist Learning Environment Model Evaluation Form. The evaluation form [21] assesses the effectiveness of the Constructivist Learning Environment Model. Measurement and assessment experts utilize this form to evaluate how well the model promotes metacognitive regulation in authentic writing learning for high school students. The evaluation results, gathered qualitatively, are submitted via email to the researcher or research assistant, who organizes the data securely on a private computer to maintain confidentiality.

3.2. Research Procedures

The research procedures involved during Phase 1 (Design and Development) starts with an extensive literature review and analysis to establish a foundation in the field of constructivist learning environments, drawing on existing theories, models, and empirical findings. Next, a learning context conditions study is conducted, which includes comprehensive surveys that explore various factors impacting the educational setting. These surveys examine the instructional context, the characteristics and needs of students, the qualities and perspectives of teachers, as well as the roles of model designers and developers, providing a nuanced understanding of the environment in which the model will be applied. Following this, a synthesis of the Constructivist Learning Environment Model takes place where the theoretical framework is integrated into a coherent structure. This synthesis involves creating detailed records that document each aspect of the design, ensuring that the model is theoretically grounded and practically adaptable. In the model design and development phase, each component of the model is systematically developed and documented, establishing a clear record of the construction process for future reference. The final stage, confirming the quality of the model, involves an evaluation of the Constructivist Learning Environment Model to assess its effectiveness, validity, and alignment with constructivist principles, ensuring that the model is both practically applicable and theoretically sound for educational implementation, as illustrated in **Figure 1**.

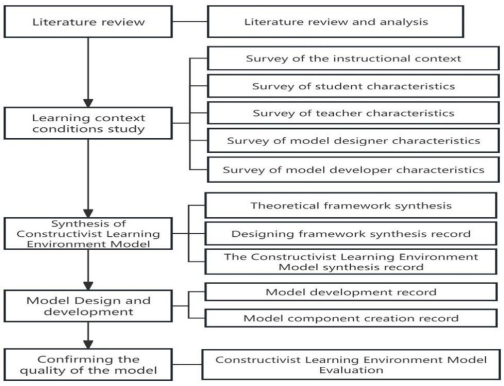

Figure 1. Research procedures implemented in Phase 1 of the present study.

3.3. Data Analysis

This section details the methodology for analyzing data related to the design and development of the Constructivist Learning Environment Model, guided by instructional design (ID) theory [22].

For the Literature Review. The literature review employs descriptive, analytical, and summative data analysis methods to explore the theories, principles, and concepts pertinent to the design and development of the Constructivist Learning Environment Model. This comprehensive examination provides a foundational understanding of existing frameworks and their implications for the study.

For the Learning Context Conditions Study. The study of learning context conditions involves collecting survey data regarding the instructional environment and the characteristics of students, teachers, designers, and developers. The researcher employs descriptive, analytical, and summative data analysis methods to interpret this data, ensuring a thorough understanding of the contextual factors that influence the learning environment.

For the Synthesis of Learning Environment Model. In this section, the researcher gathers qualitative data from relevant literature, theories, and principles through three synthesis forms: the Theoretical Framework Synthesis Form, the Designing Framework Synthesis Record Form, and the Constructivist Learning Environment Model Synthesis Record Form. The analysis of this data utilizes descriptive, analytical, and summative methods, allowing for the integration of diverse perspectives into the model's framework.

For Model Design and Development. The researcher collects qualitative data from the Model Development Record Form and the Model Component Creation Record Form. This data is analyzed using descriptive, analytical, and summative methods to evaluate the efficacy of the design and development processes, focusing on the alignment of the model components with the theoretical underpinnings identified earlier.

4. Results

Through literature analysis and theoretical tracing, the theoretical and design framework of the Constructivist Learning Environment (CLE) model should contain the following elements.

4.1. Theoretical Bases Informing the Development of a Constructivist Web Learning Environment Model Aimed at Enhancing Metacognitive Regulation in Authentic Writing

The Theoretical Framework of the Constructivist Learning Environment Model for enhancing metacognitive regulation in authentic writing integrates six key theoretical bases: psychological, pedagogical, cognitive, metacognitive regulation, media, and technology. The psychological base draws on Piaget's Cognitive Constructivism[10], Vygotsky's Social Constructivism, and metacognitive theories, focusing on how learners construct knowledge and engage in metacognitive processes. The pedagogical base incorporates various constructivist frameworks, including Situated Learning and the SOI model, emphasizing authentic, contextualized learning experiences that foster critical thinking and collaboration. The model identifies seven key components designed to promote authentic writing: the Problem Base and Learning Mission, the Learning Resource Center, the Cognitive Tool Center, the Collaboration Center, the Enhanced Metacognitive Regulation Center, the Scaffolding Center, and the Coaching Center. Each component plays a crucial role in supporting students' engagement with authentic writing tasks and enhancing their metacognitive skills.

The metacognitive regulation base focuses on critical writing processes such as prewriting, outlining, drafting, revising, and sharing, incorporating metacognitive strategies like planning, monitoring, and evaluation. The media theory base underscores the role of media symbol systems in facilitating learning through dynamic and engaging content, while the technology base promotes web-based tools that support collaboration and information sharing. Finally, the contextual base ensures alignment with relevant educational settings, including the compulsory high school curriculum and specific writing course content. By synthesizing these diverse components, the model fosters metacognitive regulation and enhances students' abilities in authentic writing, ultimately promoting deeper learning and self-awareness in the writing process, as shown in **Figure 2**.

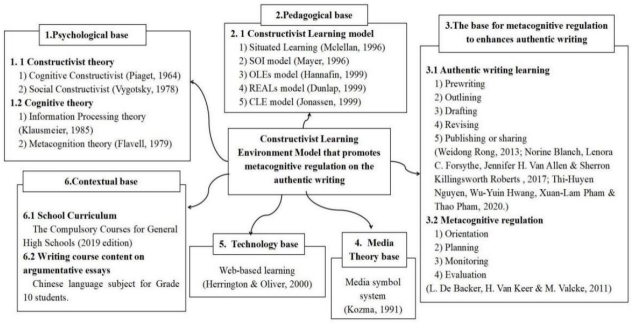

Figure 2. Theoretical framework of the Constructivist Learning Environment Model.

4.2. Synthesized Framework Components in the Constructivist Learning Environment Model Supporting Authentic Writing

The synthesized components of the Constructivist Learning Environment Model for enhancing authentic writing skills include seven integral elements: the Problem Base and Learning Mission, Learning Resource Center, Cognitive Tool Center, Collaboration Center, Enhanced Metacognitive Regulation Center, Scaffolding Center, and Coaching Center. At its core, the Problem Base and Learning Mission immerse students in real-world problem situations, fostering critical thinking and problem-solving through meaningful engagement. The Learning Resource Center supports this by providing diverse materials that promote self-directed learning, tailored to individual needs. The Cognitive Tool Center offers cognitive aids, such as graphic organizers and writing templates, which help students structure their ideas and enhance their writing process.

Supporting collaboration, the Collaboration Center uses social media and collaborative platforms to facilitate teamwork and peer feedback, enriching the learning experience. The Enhanced Metacognitive Regulation Center encourages self-reflection and self-regulation throughout the writing process, promoting strategies like planning, monitoring, and evaluating. The Scaffolding Center provides structured guidance, helping students manage complex writing tasks and build confidence. Lastly, the Coaching Center offers mentorship, with prototypes and professional feedback to refine writing skills. Together, these components synthesize constructivist principles, emphasizing authentic, contextualized learning that engages students and enhances both writing skills and metacognitive awareness. The accompanying Figure (**Figure 3**) illustrates the interplay between these elements, highlighting their connections and roles in the learning process.

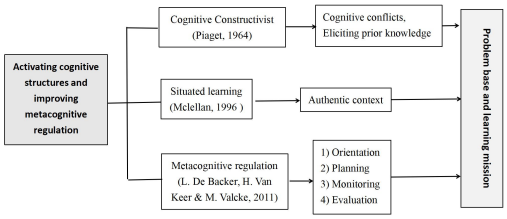

Figure 3. Synthesized Framework components in the Constructivist Learning Environment Model supporting authentic writing.

Figure 4 illustrates the design framework of the Constructivist Learning Environment (CLE), which aims to enhance metacognitive regulation in authentic writing. At the heart of this model is the concept of supporting cognitive equilibrium and strengthening cognitive structures. The framework integrates several theoretical models to create a comprehensive approach to learning. Key components include the OLEs Model by Hannafin[24], which promotes open learning environments that encourage active student engagement, leading to deeper understanding and knowledge construction. Jonassen's[13] CLE Model emphasizes the importance of context, advocating for authentic tasks that help learners connect theoretical concepts with real-world applications. Klausmeier's[25] Information Processing Theory focuses on how information is processed and stored, supporting the design of tasks that align with cognitive processes like attention, memory, and recognition.

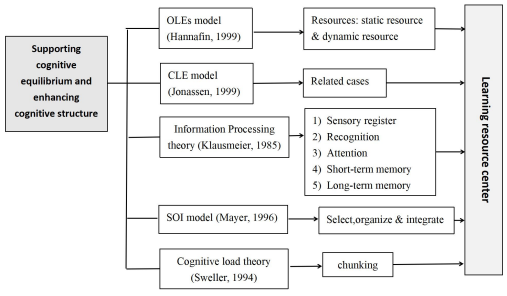

Figure 4. Designing framework of the Constructivist Learning Environment (supporting cognitive equilibrium and enhancing cognitive structures).

Additionally, the SOI Model[26] provides strategies for organizing and integrating information, critical for effective learning and retention. Cognitive Load Theory[27] further informs the design of learning tasks by addressing the limitations of working memory and the need to manage cognitive load for optimal learning. A crucial element of the

framework is the Learning Resource Center, which provides students with a variety of static and dynamic resources to aid problem-solving and knowledge construction. By offering these resources, the center supports students in balancing their intellectual challenges and fosters their ability to generate new knowledge, as depicted in **Figure 4**.

Figure 5 illustrates the design framework of the Constructivist Learning Environment (CLE), which aims to enhance metacognitive regulation in authentic writing. At the core of this model is the promotion of authentic writing, problem-solving, and the development of metacognitive regulation skills. Central to this framework is the Cognitive Tool Center, informed by the Online Learning Environments (OLEs) model [24]. This center includes five key components: a search tool for idea exploration, a collecting tool for gathering information, an organizing tool for structuring thoughts, an integrating tool for synthesizing ideas, and a communicating tool for sharing insights. These tools are designed to assist students in refining their cognitive processes and constructing knowledge, facilitating effective problem-solving in authentic writing tasks.

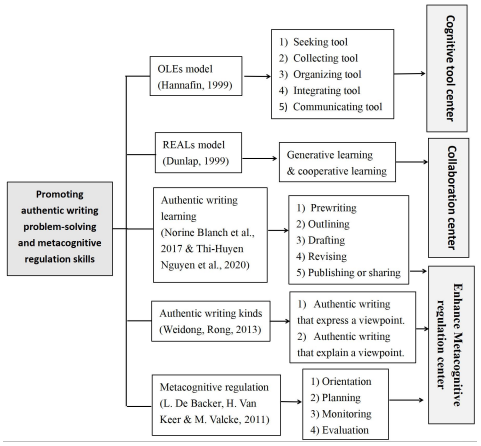

Figure 5. Designing framework of the Constructivist Learning Environment (promoting authentic writing and problem-solving and metacognitive regulation skills).

In addition to the Cognitive Tool Center, the model includes a Collaboration Center, which promotes collaborative learning in line with constructivist principles. This space encourages both in-class cooperative learning and peer-to-peer knowledge exchange, reinforcing the importance of social interaction and shared learning in problem-solving. To further enhance metacognitive regulation, the Enhanced Metacognitive Regulation Center teaches students strategies for planning, monitoring, and evaluating their writing. Using interactive games, this center helps students develop their metacognitive skills while applying them to authentic writing tasks, as shown in **Figure 5**.

Figure 6 illustrates the design framework of the Constructivist Learning Environment (CLE), which aims to enhance metacognitive regulation in authentic writing. At the core of this framework is the Scaffolding Center, which provides essential support for students facing challenges they cannot resolve independently. The center incorporates three key types of scaffolding: conceptual scaffolding, which helps students develop conceptual frameworks around relevant content; metacognitive scaffolding, which encourages students to regulate their thinking and learning processes; and procedural scaffolding, which teaches students how to effectively use learning resources and tools to approach problems systematically. These features are designed to foster self-regulation and help students build the skills necessary for effective problem-solving in authentic writing tasks.

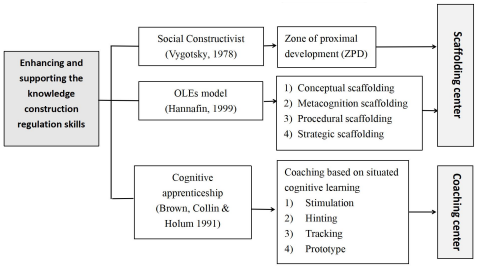

Figure 6. Designing framework of the Constructivist Learning Environment (Enhancing and supporting knowledge construction regulation skills).

If students continue to struggle despite the support from the Scaffolding Center, they can seek additional assistance from the Coaching Center. This center offers expert consultation services, allowing students to connect with specialists in authentic writing for further guidance beyond the classroom. In addition to the support from teachers, students can access a wider network of expertise through the Constructivist Learning Environment Model, enhancing their learning experience and deepening their engagement with the writing process, as illustrated in **Figure 6**.

4.3. The Seven Components of the Constructivist Learning Environment Model Enhance Students' Metacognitive Regulation in Authentic Writing

Figure 7 presents a comprehensive model for a Constructivist Learning Environment aimed at enhancing

metacognitive regulation in students' authentic writing skills. The model integrates both cognitive and social constructivist principles, focusing on the activation of cognitive structures and regulation skills. In one corner, cognitive constructivist strategies, such as eliciting prior knowledge and presenting cognitive conflicts, are applied in an authentic context to foster metacognitive regulation. This process involves four key metacognitive steps: orientation, planning, monitoring, and evaluation, which guide students through problem-solving tasks within the 'Problem Base.' Adjacent to this, cognitive resources and models—including SOI, CLE, and Cognitive Load Theory—help maintain cognitive equilibrium and structure. The 'Learning Resource Center' houses both static and dynamic resources, while models like OLEs and Information Processing Theory assist in managing memory and cognitive load, facilitating structured knowledge acquisition and application in writing.

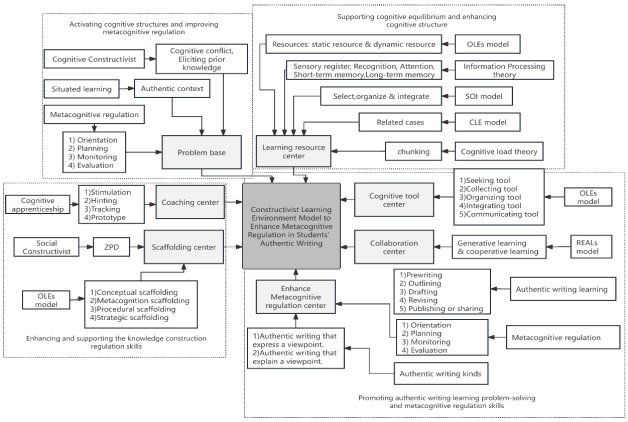

Figure 7. The seven components of the Constructivist Learning Environment Model.

The model also incorporates social constructivist elements in another corner, such as cognitive apprenticeship and scaffolding, which provide tailored support to enhance knowledge construction. The 'Coaching Center' offers stimulation, hints, tracking, and prototypes to facilitate learning, while the 'Scaffolding Center' includes various forms of scaffolding—conceptual, metacognitive, procedural, and strategic—to meet diverse student needs. In the final corner, the model emphasizes authentic writing processes and problem-solving skills, supported by collaborative and cognitive tools. Students utilize 'Collaborative and Cognitive tools' to seek, organize, integrate, and communicate ideas. This process is underpinned by metacognitive regulation, enabling students to manage and enhance their writing independently. The 'Enhance Metacognitive Regulation Center' is integral to supporting students in improving their metacognitive skills, enabling them to monitor, plan, and evaluate their writing strategies more effectively. Authentic writing tasks, such as expressing or explaining viewpoints, encourage students to apply their learning meaningfully, while generative learning fosters cooperative, engaged learning and critical thinking skills, as shown in **Figure 7**.

5. Discussion

5.1. Key Theoretical Bases That Inform the Development of a Constructivist's Learning Environment Model to Enhance Metacognitive Regulation in Authentic Writing

The development of the Web-based Constructivist Learning Environment Model aimed at enhancing metacognitive regulation in authentic writing is underpinned by several key theoretical foundations. The model is primarily informed by constructivist theories, notably the cognitive constructivism of Piaget [10] and the social constructivism of Vygotsky. These frameworks emphasize that knowledge construction is an active and contextualized process influenced by social interactions and individual cognitive processes [13, 24]. By incorporating information processing and metacognitive theories from Flavell [15], the model underscores the critical role of metacognition in learning, promoting self-reflection and regulation throughout the writing process [6, 15, 28]. This theoretical foundation ensures that learners not only acquire knowledge but also cultivate a deeper understanding of their cognitive processes, thereby becoming more effective and autonomous writers. The pedagogical strategies of the model, including Situated Learning and the SOI model, emphasize the significance of authentic and contextualized learning experiences [26]. By immersing students in real-world problem situations, the model fosters critical thinking and collaboration—key components in enhancing authentic writing skills [19]. The seven essential components identified in the model, such as the Problem Base and Learning Mission, Learning Resource Center, Cognitive Tool Center, Collaboration Center, Enhanced Metacognitive Regulation Center, Scaffolding Center, and Coaching Center, work synergistically to create a cohesive learning environment. Each component serves a distinct purpose that aligns

with the overarching theoretical framework, promoting an integrated approach where students can excel in their writing endeavors.

Additionally, the emphasis of the model on media theory and technology enriches the learning experience by leveraging varied and engaging content to facilitate deeper understanding. Laurillard[29] and Chaijaroen[22] highlight that by promoting web-based learning environments, the model not only provides accessible tools for collaboration and information sharing but also ensures that learning aligns with the real-world contexts and students' needs. The inclusion of web-based tools in the Learning Resource Center and Coaching Center allows for real-time feedback and peer collaboration, fostering a dynamic and interactive environment for students to refine their writing skills[27]. Through this multifaceted approach, the model enhances students' writing capabilities while promoting metacognitive awareness, ultimately preparing them for authentic writing challenges.

5.2. Synthesized Framework Components in the Constructivist Learning Environment Model to Support Students' Metacognitive Regulation in Authentic Writing

The Constructivist Learning Environment Model synthesizes seven key components to support authentic writing skills, each informed by principles of constructivist learning. Central to this model is the Problem Base and Learning Mission, which immerses students in real-world challenges that stimulate critical thinking and problem-solving. This hands-on engagement aligns with constructivist principles that emphasize active, learner-centered approaches, fostering meaningful learning experiences[13, 24]. The Learning Resource Center enhances this process by providing diverse resources, promoting self-directed learning that caters to individual interests, reflecting research that highlights the value of resource-rich environments in promoting autonomous learning. Complementing these components, the Cognitive Tool Center offers tools like graphic organizers to aid in structuring thoughts. These tools are grounded in research showing the importance of cognitive aids in facilitating the organization and synthesis of information. Meanwhile, the Collaboration Center emphasizes social interaction, facilitating teamwork through collaborative platforms that enrich students' collective learning experiences. This is supported by Vygotsky's social constructivist theory, which underscores the role of collaboration and interaction in the co-construction of knowledge[11].

Additionally, the Enhanced Metacognitive Regulation Center highlights the significance of metacognitive skills in writing, encouraging self-reflection and regulation throughout the writing process through strategies like planning, monitoring, and evaluating. The importance of metacognitive regulation is well-documented in research on writing, with studies indicating that metacognitive strategies significantly enhance writing proficiency[6, 12, 15]. The Scaffolding Center provides essential support, breaking down complex tasks into manageable parts to boost students' confidence in their writing abilities, drawing on theories of scaffolding that emphasize gradual, structured support to foster independent learning. Finally, the Coaching Center offers mentorship and professional feedback, refining students' writing skills. Research supports the role of timely and targeted feedback in improving writing quality and promoting self-regulation. Collectively, these components create a dynamic learning environment that emphasizes authentic, contextualized experiences, ultimately enhancing students' writing competencies and fostering a deeper understanding of the writing process. The integration of these elements showcases the model's framework and the interplay between cognitive structures, metacognitive regulation, and authentic contexts, empowering educators to cultivate an engaging and supportive atmosphere for student learning.

In **Figure 4**, the design framework of the CLE serves as a robust model for enhancing metacognitive regulation in authentic writing by integrating various theoretical approaches. Central to this model is the emphasis on supporting cognitive equilibrium and enhancing cognitive structure, essential for effective learning. The incorporation of the OLEs Model[13] is particularly significant, as it advocates open learning environments that foster active student engagement, reinforcing research that supports learner-centered environments conducive to exploration and autonomy[24]. This engagement not only facilitates deeper understanding but also empowers students to take ownership of their learning journey, aligning well with the constructivist philosophy of knowledge construction through interaction and exploration[10, 11]. Furthermore, the CLE Model proposed by Jonassen and Rohrer-Murphy[13] underscores the importance of contextualizing

learning through authentic and meaningful tasks. This approach is supported by research that stresses the relevance of real-world applications in enhancing learners' cognitive engagement and knowledge retention [30].

The integration of Information Processing Theory by Klausmeier [25] provides insights into cognitive processes, such as memory stages, which educators can leverage to design tasks that resonate with students' cognitive capacities, supported by work on memory and cognitive load management [26]. Additionally, the SOI Model by Mayer [26] and Cognitive Load Theory by Sweller [27] offer strategies for organizing information and managing cognitive demands, which are key in avoiding cognitive overload while supporting effective learning. The Learning Resource Center is a critical component within this framework, serving as a dynamic support mechanism for students facing problemsolving challenges. By providing access to diverse static and dynamic resources, the center aims to balance students' cognitive load and enhance their capacity to create new knowledge, a process well-supported by constructivist theories advocating for scaffolded learning. This resource-rich environment not only facilitates the acquisition of writing skills but also promotes metacognitive awareness as students engage in self-regulated learning processes, supported by research on metacognitive strategies in educational contexts [12, 15]. Overall, the CLE framework exemplifies a comprehensive and integrated approach to learning, aiming to equip students with the necessary skills to excel in authentic writing while fostering a deeper understanding of their cognitive processes [13].

In **Figure 5**, the Cognitive Tool Center, Collaboration Center, and Enhanced Metacognitive Regulation Center have several key implications for enhancing writing skills and metacognitive regulation. Firstly, the integration of the OLEs model has informed the design of the Cognitive Tool Center, aligning its principles with the developed tools. Supported by studies that emphasize open-ended learning environments as effective for enhancing student engagement and deeper learning outcomes [24], each component promotes metacognitive regulation and facilitates a deeper understanding of the writing process. The effectiveness of these tools in refining cognitive constructs underscores their importance in supporting students' engagement and learning, consistent with previous research on metacognitive scaffolding and tool-mediated learning [13, 15]. Moreover, the Collaboration Center plays a crucial role in enhancing student learning outcomes by fostering peer collaboration and knowledge sharing. Research indicates that collaborative learning environments significantly improve students' critical thinking and problemsolving skills [11]. By encouraging cooperative learning, this space builds a community of practice that enhances critical thinking within authentic writing tasks. The interactions that occur here reinforce the principles of the constructivist learning model and contribute to a richer learning experience, as supported by studies highlighting the value of peer-mediated learning in writing tasks [31].

Additionally, the Enhanced Metacognitive Regulation Center is vital for teaching metacognitive strategies tailored for writing tasks. By utilizing interactive games and structured activities, students are motivated to engage in self-reflection and regulation throughout the writing process, which can significantly improve their writing performance and overall learning experience. Research on metacognitive training supports such activities to enhance student outcomes, particularly in writing [6]. Educators should consider practical applications of these centers in their teaching practices, adapting the frameworks to various educational contexts while emphasizing ongoing assessment to gauge effectiveness, a recommendation that aligns with prior studies on adaptive teaching strategies [12]. Future research directions could further investigate the efficacy of these centers in enhancing writing skills and metacognitive regulation through longitudinal studies, assessing the long-term impacts of these interventions on student learning and writing outcomes. Addressing these points will comprehensively outline the significance of these findings and their implications for educational practices.

In **Figure 6**, the Scaffolding Center is crucial in providing targeted support for students encountering challenges in their learning. Through conceptual scaffolding, students are guided in developing frameworks that facilitate the assimilation of complex information, enhancing their ability to form coherent concepts. Research has demonstrated that scaffolding can deepen understanding and improve the internalization of complex concepts, making it essential for promoting cognitive growth and enabling students to effectively apply their knowledge in writing tasks [14]. Additionally, metacognitive scaffolding empowers students by fostering self-awareness and the regulation of their thinking processes. Brown [30]

argued that such scaffolding enhances learning effectiveness by encouraging students to monitor and evaluate their thought processes, thus cultivating essential skills for meaningful learning, as evidenced by studies on self-regulation in education.

Furthermore, procedural scaffolding supports students by teaching them to systematically leverage various learning resources and tools, enabling them to tackle authentic writing challenges more effectively. Hmelo-Silver highlighted that procedural scaffolding helps learners become adept at using available resources and navigating complex tasks independently, fostering confidence and competence that can improve performance in authentic writing tasks[32]. When challenges persist despite the support from the Scaffolding Center, the Coaching Center becomes an essential resource, offering expert consultation services that allow students to seek guidance beyond the classroom, thereby broadening their support network. Access to specialists in authentic writing enriches the learning experience by providing tailored strategies to address specific writing challenges, reinforcing the notion that personalized coaching enhances skill acquisition and critical thinking, as supported by Rogoff[33] in her studies on guided participation. This multifaceted approach, rooted in the Constructivist Learning Environment Model, underscores the importance of scaffolding and mentorship in fostering student growth and success in writing. Ultimately, the integration of these centers enhances the overall learning environment, equipping students with the necessary tools and support to overcome challenges and thrive in their writing endeavors.

5.3. Seven Components of the Constructivist Learning Environment Model Contributing to Enhance Metacognitive Regulation and Authentic Writing Skills

The findings of this study emphasize the significant role of the seven components of the Constructivist Learning Environment Model (CLE) in fostering metacognitive regulation in students' authentic writing tasks. As shown in **Figures 3–6**, CLE's integration of both cognitive and social constructivist principles creates a robust framework for guiding students through reflective practices such as orientation, planning, monitoring, and evaluation. These steps align with recent research on metacognitive regulation in writing, particularly in how learners actively engage in self-reflection to plan, revise, and evaluate their writing strategies. By applying cognitive conflicts and activating prior knowledge, the model enables students to engage in deeper cognitive processing, a process that aligns with metacognitive awareness frameworks. Additionally, the SOI (Select, Organize, Integrate) model helps reduce extraneous cognitive load while enhancing students' ability to organize and synthesize their ideas[27]. This cognitive support helps students engage in authentic writing tasks by allowing them to focus on higher-order tasks like argumentation and coherence, which are essential for producing high-quality written work.

In addition to cognitive scaffolding, the social constructivist components of the CLE model —particularly scaffolding and cognitive apprenticeship—played a crucial role in fostering metacognitive regulation. Drawing on Vygotsky's[11] ZPD, the study shows that guided peer interaction, tailored feedback, and collaborative problem-solving are fundamental to supporting students' metacognitive growth during authentic writing tasks. The Coaching Center and Scaffolding Center provided adaptive support to students, ensuring that they had the guidance necessary to reflect on and adjust their writing strategies. In the scaffolding center, where learners are gradually provided with less direct support as their skills develop. Moreover, the Enhance Metacognitive Regulation Center within the model, which focuses on reflective practices and self-evaluation, supports students in monitoring their writing strategies, an approach consistent with recent research on self-regulated learning. By combining both cognitive and social strategies, CLE model not only fosters metacognitive regulation but also promotes deeper learning through authentic, context-rich writing experiences.

6. Conclusions

This study contributes significantly to the understanding and enhancement of metacognitive regulation and authentic writing skills among Grade 10 students through the design and development of the Constructivist Learning Environment Model. By integrating various theoretical frameworks, including the OLEs model and Authentic Writing Theory, this model provides a comprehensive approach to learning that emphasizes active engagement, collaboration, and personalized support. The expert evaluations affirm the

model's effectiveness, highlighting its clarity, relevance, and accessibility, which are crucial for fostering deep learning experiences.

Despite being in the initial phase of design and development, the model's innovative components showcase its potential to create a supportive learning environment that nurtures students' cognitive and metacognitive skills. This study lays the groundwork for future empirical research to assess the effectiveness of the model in real-world classroom settings, aiming to validate and refine its components further. The novel contributions of this work lie not only in its theoretical underpinnings but also in its practical implications for educators seeking to enhance writing instruction through constructivist principles. Ultimately, this framework offers a promising direction for developing educational practices that prioritize metacognitive engagement and authentic writing, setting the stage for improved learning outcomes in secondary education.

The findings of this study hold significant implications for educational practice, particularly in enhancing metacognitive regulation and authentic writing skills among Grade 10 students. The Constructivist Learning Environment Model, with its integrated components, offers a structured framework for educators to foster active engagement and collaborative learning. By implementing this model, teachers can create dynamic classroom environments that encourage students to reflect on their learning processes, thereby enhancing their metacognitive awareness. Additionally, the emphasis on collaborative spaces within the model suggests that educators should prioritize peer interactions and knowledge-sharing opportunities, facilitating a more supportive community for learning. This approach not only equips students with the skills necessary for authentic writing but also promotes a culture of continuous improvement and self-directed learning.

Despite its contributions, this study is not without limitations. Being in the design and development phase, the model has yet to undergo rigorous empirical testing in varied educational contexts, raising questions about its practical applicability and effectiveness across different settings. The reliance on expert evaluations, while providing valuable insights, may overlook the nuanced experiences of students during implementation. Furthermore, the focus on a specific demographic—Grade 10 students in Northwest China—limits the generalizability of the findings to other educational levels and cultural environments. Future research should prioritize longitudinal studies that explore the real-world effectiveness of the model, as well as its adaptability in diverse classrooms. Addressing these limitations will strengthen the evidence base for the Constructivist Learning Environment Model and enhance its potential impact on educational practices.

Author Contributions

Conceptualization, X.Q. and S.C.; methodology, S.C.; software, X.Q.; validation, X.Q. and S.C.; formal analysis, X.Q.; investigation, X.Q.; resources, X.Q.; data curation, X.Q.; writing—original draft preparation, X.Q.; writing—review and editing, X.Q.; visualization, S.C.; supervision, S.C; project administration, X.Q. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

Not applicable.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Robillos, R.J., 2023. The impact of the FlipGrid application within the genre-based framework on students' writing skills and self-regulation of learning awareness. Studies in Self-Access Learning Journal. 14(4), 456–475. DOI: https://doi.org/10.37237/140404

[2] Graham, S., 2019. Changing how writing is taught. Review of Research in Education. 43(1), 277–303. DOI: https://doi.org/10.3102/0091732x18821125

[3] Sala-Bubaré, A., Castelló, M., 2023. Exploring writing processes in authentic writing tasks: A multimodal mixed-method approach. Journal of Second Language Writing. 61, 101038. DOI: https://doi.org/10.1016/j.jslw.2023.101038

[4] Behizadeh, N., 2018. Aiming for authenticity: Successes and struggles of an attempt to increase authenticity in writing. Journal of Adolescent & Adult Literacy. 62(4), 411–419. DOI: https://doi.org/10.1002/jaal.911

[5] Blanch, N., Forsythe, L.C., Van Allen, J., Roberts, S.K., 2017. Reigniting Writers: Using the literacy block with elementary students to support authentic writing experiences. Childhood Education. 93(1), 48–57. DOI: https://doi.org/10.1080/00094056.2017.1275238

[6] Robillos, R.J., Thongpai, J., 2022. Computer-aided argument mapping within metacognitive approach: its impact on students' argumentative writing performance and self-regulated learning. LEARN Journal: Language Education and Acquisition Research Network. 15(2), 160–186. Available from: https://eric.ed.gov/?id=EJ1358704

[7] Robillos, R.J., Bustos, I.G., 2022. Learners' listening skill and metacognitive awareness through metacognitive strategy instruction with pedagogical cycle. International Journal of Instruction. 15(3), 393–412. DOI: https://doi.org/10.29333/iji.2022.15322a

[8] Gu, Z., Wang, F., Jiang, C., et al., 2023. DEVELOPMENT REPORT ON CHINESE LANGUAGE EDUCATION IN CHINA (2021–2022). Social Sciences Literature Publishing House. Available from: https://www.pishu.com.cn/skwx_ps/bookdetail?SiteID=14&ID=13697456

[9] Wang, X., Wang, J., 2024. Comparing Chinese L2 writing performance in paper-based and computer-based modes: Perspectives from the writing product and process. Assessing Writing. 61, 100849. DOI: https://doi.org/10.1016/j.asw.2024.100849

[10] Piaget, J., 1979. Comments on Vygotsky's critical remarks. Archives de Psychologie. 47(183), 237–249.

[11] Vygotsky, L.S., Cole, M., 1978. Mind in society: The development of higher psychological processes. Harvard University Press: Cambridge, MA, USA.

[12] Schraw, G., Moshman, D., 1995. Metacognitive theories. Educational Psychology Review. 7(4), 351–371. DOI: https://doi.org/10.1007/bf02212307

[13] Jonassen, D.H., Rohrer-Murphy, L., 1999. Activity theory as a framework for designing constructivist learning environments. Educational Technology Research and Development. 47(1), 61–79. DOI: https://doi.org/10.1007/BF02299477

[14] Sawyer, R.K., 2006. Educating for innovation. Thinking Skills and Creativity. 1(1), 41–48. DOI: https://doi.org/10.1016/j.tsc.2005.08.001

[15] Flavell, J.H., 1979. Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. American Psychologist. 34(10), 906–911. DOI: https://doi.org/10.1037/0003-066x.34.10.906

[16] Allal, L., 2000. Metacognitive regulation of writing in the classroom. In: Camps, A., Milian, M. (Eds.). Metalinguistic activity in learning to write. Amsterdam University Press: Amsterdam, The Netherlands. pp. 145–167.

[17] Teng, F., 2019. The role of metacognitive knowledge and regulation in mediating university EFL learners' writing performance. Innovation in Language Learning and Teaching. 14(5), 436–450. DOI: https://doi.org/10.1080/17501229.2019.1615493

[18] Sumarno, W.K., Kusumaningrum, W.R., Nurhayati, E., 2021. The effects of knowledge and regulation of cognition on the students' writing skills in a metacognitive process-oriented writing instruction. Journal of Language and Linguistic Studies. 18(1). Available from: https://www.jlls.org/index.php/jlls/article/download/2844/987

[19] Dong, R., Fu, D., Zhou, X., et al., 2019. Writing instruction in China: challenges and efforts. International Journal of Information and Education Technology. 9(10), 715–723. DOI: https://doi.org/10.18178/ijiet.2019.9.10.1292

[20] Graham, S., 2006. Strategy Instruction and the Teaching of Writing: A Meta-Analysis. In: MacArthur, C.A., Graham, S., Fitzgerald, J. (Eds.). Handbook of Writing Research. The Guilford Press: New York, NY, USA. pp. 187–207. Available from: https://psycnet.apa.org/record/2006-07885-013

[21] Richey, R.C., Klein, J.D., 2014. Design and development research. Routledge eBooks. DOI: https://doi.org/10.4324/9780203826034

[22] Chaijaroen, S., 2016. Instructional Design: Principles and Theories to Practices. Pen Printing Company Limited: Khon Kaen, Thailand.

[23] Rong, W., 2013. The Main Problems of China's Writing Teaching and Their Solution Paths. Curriculum, Materials-Pedagogy. 11, 62.

[24] Hannafin, M., Land, S., Oliver, K., 1999. Open learn-

ing environments: Foundations, methods, and models. Instructional-Design Theories and Models: A New Paradigm of Instructional Theory. 2, 115–140. DOI: https://doi.org/10.4324/9781410603784-12

[25] Klausmeier, H.J., 1985. Educational psychology, 5th ed. Harper & Row: New York, NY, USA.

[26] Mayer, R.E., 1996. Learning strategies for making sense out of expository text: The SOI model for guiding three cognitive processes in knowledge construction. Educational Psychology Review. 8(4), 357–371. DOI: https://doi.org/10.1007/BF01463939

[27] Sweller, J., 1994. Cognitive load theory, learning difficulty, and instructional design. Learning and Instruction. 4(4), 295–312. DOI: https://doi.org/10.1016/0959-4752(94)90003-5

[28] Moritz, S., Lysaker, P.H., 2018. Metacognition – what did James H. Flavell really say and the implications for the conceptualization and design of metacognitive interventions. Schizophrenia Research. 201, 20–26.

[29] Laurillard, D., 2002. Design tools for e-learning. Ascilite. 3–4.

[30] Brown, L., 2014. Constructivist learning environments and defining the online learning community. Imanager's Journal on School Educational Technology. 9(4), 1–6. DOI: https://doi.org/10.26634/jsch.9.4.2704

[31] Brown, A.L., Campione, J.C., 1996. Psychological theory and the design of innovative learning environments: On procedures, principles, and systems. In: Schauble, L., Glaser, R. (Eds.). Innovations in learning: New environments for education. Lawrence Erlbaum Associates, Inc.: Mahwah, NJ, USA. pp. 289–325. Available from: https://psycnet.apa.org/record/1997-97115-011

[32] Belland, B.R., 2014. Scaffolding: Definition, Current Debates, and Future Directions. In: Spector, J., Merrill, M., Elen, J., et al. (Eds.). Handbook of Research on Educational Communications and Technology. Springer: Berlin/Heidelberg, Germany. pp. 505–518. DOI: https://doi.org/10.1007/978-1-4614-3185-5_39

[33] Rogoff, B., 1990. Apprenticeship in thinking: Cognitive development in social context. Oxford University Press: Oxford, UK.