

Exploring the impact of computer-supported collaborative instructional design on the development of creative and critical thinking skills

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Suggested citation: Doğan, C., Sirvermez, U., & Birişçi, S. (2026). Exploring the impact of computer-supported collaborative instructional design on the development of creative and critical thinking skills. *Journal of Educational Technology and Online Learning*, 9(1), 1-21.

Highlights

- This study systematically integrates instructional design (ID) principles into Computer-Supported Collaborative Learning (CSCSCL) to enhance student engagement and skill development.
- Findings suggest that a structured ID-aided CSCSCL environment facilitates students' creative and critical thinking skills.
- The study offers practical guidelines for stakeholders to implement ID in promoting engagement, which should be incorporated in collaborative studies.

Abstract

This study aims to explore the impact of a computer-supported collaborative instructional design process on enhancing critical and creative thinking skills. This research employed a case study methodology involving 12 sixth-grade students in northwestern Türkiye. Data collection included audio recordings of collaborative sessions and structured views on the research process. The results indicated that the participants' exchange of ideas in group discussions developed their thinking skills, with respondents attributing their developmental experiences to the characteristics of the designed learning environment. Collaborative sessions further promoted the acquisition of technological proficiency by embedding group activities within technological contexts. While this study emphasizes the importance of structuring collaborative learning paradigms within a systematic instructional design framework, it is also believed to significantly contribute to developing complex thinking skills, which are characterized as creative and critical.

Article Info: Research Article

Keywords: *K-8 technology education, complex thinking skills, instructional design, computer-supported collaborative learning*

1. Introduction

The International Society for Technology in Education (ISTE) has introduced the ISTE Standards for students, which outline essential attributes for 21st-century students: empowered learner, digital citizen, knowledge constructor, innovative designer, computational thinker, creative communicator, and collaborator (ISTE, 2016). Achieving these skills requires a transformation in educational approaches, as acquiring knowledge fundamentally influences how individuals engage with it and fosters their ability to take charge of their learning. Traditional teacher-centered models, which primarily focus on passive knowledge transmission, often fail to equip students with the necessary critical thinking, problem-solving, and adaptability skills. In response to this challenge, the active learner model has emerged as a paradigm shift that places students at the core of their learning process (Cavanagh, 2011; Herman, 2013; Johnson & Johnson, 2009; Lumpkin, Achen, & Dodd, 2015; Prince & Fedler, 2007). This approach promotes

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constructivist principles, where learners actively build their understanding through exploration, collaboration, and hands-on experiences (Williams, 2017).

Traditional learning settings often lack structured opportunities for students to reflect on their thought processes or engage in metacognition. By grounding in the premise that design skills are essential for students' cognitive development, particularly in fostering creative and critical thinking (Borge et al., 2019; Tang et al., 2020). Moseley et al. (2005) outline various stages of thinking skills, including basic operations, problem-solving, decision-making, critical thinking, and creative thinking. These skills are essential cognitive processes (İnan & Özgen, 2008) that require diverse teaching methods for comprehension and enhancement. Addressing the development of these skills aligns with current educational priorities (Anderson, 2012; Lor, 2017).

Research has shown that students participating in collaborative, active learning environments outperform their peers in traditional, passive classrooms in terms of both academic achievement and the development of critical thinking skills (Freeman et al., 2014; Gokhale, 1995). In a collaborative learning process, two or more people are required to learn something together by communication and negotiation. Within the division of tasks on the problem situations that the instructor possesses is tried to be solved and learning outcomes can be occur among group members (Dillenbourg, 1999). Collaborative learning, which is grounded in a constructivist approach that places students at the center of the learning process, offers significant academic, social, and psychological benefits compared to traditional methods (Birişçi & Karal, 2011; Birgin & Acar, 2022; Gezgin et al., 2022; Kılbaş et al., 2022; Kaya & Gökalp, 2021; Okumuş, 2020; Ramirez & Monterola, 2022; Yıldırım-Yakar, 2022; Zabolotna et al., 2022). In a collaborative learning process, two or more people are required to learn something together by communication and negotiation. Within the division of tasks on the problem situation that the teacher possesses is tried to be solved and learning outcomes can be occur among group members (Dillenbourg, 1999).

Existing research has predominantly focused on the impact of Computer-Supported Collaborative Learning (CSCL) on technical and collaborative skills, often overlooking its potential to enhance critical and creative thinking (Dennen & Hoadley, 2013). De Becker et al. (2022) examined how CSCL influences students' conceptual understanding, self-efficacy, and motivation. Birişçi and Karal (2011) demonstrated the positive impact of collaborative group work in computer-supported environments on students' creative thinking skills. Ünal and Özdiñç (2019) reported favorable responses from pre-service teachers regarding CSCL environments, highlighting the need for further investigation into their effects on higher-order thinking skills, such as critical thinking, reflection, and problem-solving, as well as motivation and attitudes toward learning. Ramirez and Monterola (2022) investigated the effect of scenario-building steps on logical reasoning within CSCL frameworks. Meanwhile, Zabolotna et al. (2022) explored how group organization and social exchange stages within CSCL environments—such as planning, task comprehension, strategy use, and evaluation—facilitate knowledge construction. Their findings highlight the supportive role of CSCL environments in knowledge construction and advocate for developing tailored pedagogical tools for specific learning domains.

Reigeluth (1999) emphasizes the importance of knowledge construction in the process of instructional design (ID), and states that this can be achieved by including team-based knowledge-sharing and collective decision-making processes. This makes it essential to meet these needs by structuring learning environments. A computer-based group learning process will address these needs, but the focus should systematically cover the features of the elements to be included in the learning environment. Thus, instructional design models can help to bridge the gap between theory and practice (Fernández-Sánchez & Silva-Quiroz, 20-21; Gros, 2001). Several studies highlight the impact of well-structured instructional design on the effectiveness of CSCL about fostering engagement and motivation (Khalil & Elkhider, 2016; Kirschner, Sweller, & Clark, 2006; Shukor et al., 2014; Sun & Rueda, 2012), and enhancing collaboration quality (Kapur, 2016). By integrating CSCL with instructional design procedures, students can engage in deeper, more meaningful collaboration (Hadjileontiadou, Nikolaidou, & Hadjileontiadis, 2012). This

integration enhances the traditional design's emphasis on active learning and collaboration and introduces an additional layer of engagement through technology. Such a combination is crucial for fostering critical and creative thinking skills as it encourages real-time collaboration, reflection, and problem-solving in an authentic, technology-driven environment. Most CSCL-instructional design studies focus on higher education or content-specific applications (Jeong & Hmelo-Silver, 2010; Shukor et al., 2014). Our study fills a gap by applying these principles in a K-8 environment focusing on creative digital expression through Web 2.0 presentation tools, offering insights into students' collaborative project development. Also, collaborative engagement and knowledge construction are common outcomes in CSCL studies (Kagan, 2009; Stahl et al., 2006), this research will extend this on how structured design enhances critical and creative thinking skills through real-world tasks and peer interaction. By adopting this framework focusing on creative and critical thinking, this research addresses a theoretical gap and offers actionable insights for educators. Recognizing the significance of systematic teaching activities for skill development, this study aims to explore the influence of instructional design on complex thinking skills, specifically critical and creative thinking, within the context of CSCL. In doing so, this study seeks to address the following research questions:

- (1) How does the emergence of complex thinking skills differ in ID-supported CSCL activities?
- (2) What are the opinions of participants about CSCL aided learning process?

2. Conceptual Framework

2.1.1 Complex Thinking Skills

Numerous classification studies have delineated a hierarchy of skills that range from simple to complex (Bloom, 1956; Briggs & Wager, 1981; Gagné, 1985; Gagné et al., 1988). Within this framework, a wide array of concepts have been proposed to define complex thinking skills, which include active questioning, exploration, creative thinking, critical thinking, decision-making, evaluation, higher-order thinking, inquiry, insight, logical thinking, metacognition, problem-solving, scientific reasoning, rational thinking, reflective thinking, and synthesis (Goodson, 2000). Cohen (1971) categorized complex thinking skills into four main areas: problem-solving, decision-making, critical thinking, and creative thinking. These complex thinking skills are interrelated and often overlap in practice, enhancing individuals' cognitive flexibility, adaptability, and problem-solving abilities across various domains and contexts. The interconnection and necessity of complex thinking skills—such as adaptive expertise, creative thinking, and complex problem-solving (CPS)—in the context of contemporary, rapidly changing circumstances is a fundamental premise of modern thought (Gube & Lajoie, 2020). Furthermore, research has demonstrated a strong relationship between thinking skills and metacognitive abilities (Moreno et al., 2021; Patiño et al., 2023). This comprehensive set of skills forms the foundation of cognitive prowess and is elaborated upon further below.

2.1.2 Critical Thinking

Critical thinking skills are the ability to analyze thoughts and articulate previously unexpressed ideas and biases by recognizing them (Yoldaş, 2009). Another definition describes critical thinking as a cognitive process in which individuals direct and evaluate their own thinking while engaging with problems, objectives, assumptions, perspectives, data, information, evidence, concepts, opinions, inferences, and interpretations (Paul, 1991). Critical thinking encompasses actions such as reasoning, logical analysis, advanced cognitive processing, intelligent behavior, and creative thinking (Grant, 1988, as cited in Parlar, 2014). Critical and creative thinking are associated with various cognitive processes, and empirical evidence suggests that open-minded individuals exhibit specific personality traits (Yang & Lin, 2004). Therefore, critical thinking can be understood as the capacity to be aware of, discern, and interpret distinctions. Based on the definitions provided, organizing experiences that will equip students with critical thinking skills and enable their application in the classroom. Language plays a crucial role in problem-solving skills and content preparation due to its communicative functions (Akay, 2023).

2.1.3. Creative Thinking

Creativity is the process of generating an original product, however, there remains no consensus regarding the processes involved or how to define them (Haymana & Özalp, 2020). Rhodes (1961) defines creativity through four fundamental concepts: human, procedural, milieu, and output. An integrated framework for comprehensively understanding creative expression consists of four essential elements: the individual, the creative process, the resulting product, and the external environment (Hasırcı & Demirkan, 2003). The individual engages in the creative process, encompassing experiences, reasoning, and learning (Puccio, Talbot, & Joniak, 2000). The environment refers to the context in which the individual interacts, while the product is the outcome of the creative process. Creative thinking yields an original and aesthetically pleasing product through both logical and intuitive reasoning (Yoldaş, 2009). Interdisciplinarity plays a significant role in fostering creativity (Kızılay et al., 2023). In addition, Karataş and Özcan (2015) state that creativity involves producing original products and generating novel outcomes from existing information, solving problems, adapting to varying conditions, and perceiving the functionality of objects beyond their conventional uses. Creative thinking can be viewed as a series of logical processes undertaken to create an original product.

2.2. Instructional Design

Instructional design directs instructional activities toward achieving desired educational outcomes (Reigeluth, 1983). This field of study focuses on the practical aspects of learning and creating new instructional materials or systems that facilitate student learning (Rowland, 1993). The process aims to create a conducive learning environment and achieve specific learning outcomes by informing the selection of instructional methodologies (Reigeluth, 1999; Şimşek, 2021). Instructional designers can employ a variety of approaches and theories to determine the most suitable learning activities for their students (Smith & Regan, 2004). Regardless of the model employed, instructional design is universally acknowledged as a systematic process that begins with identifying educational needs and culminates in creating a learning system designed and tested to meet those needs (Häkkinen, 2022). The ADDIE model (i.e., Analysis, Design, Development, Implementation, and Evaluation) consists of several steps to develop a practical course or program that assists developers in adopting a learner-centered approach (Peterson, 2003). Well-organized instructional design is essential for effectively facilitating creative project development in active learning environments, enhancing learners' creativity and problem-solving abilities (Nurrijal et al., 2023). These strategies equip individuals to tackle authentic, real-world challenges and foster their problem-solving mindset. The constructivist approach to instructional design has gained prominence in education, cultivating metacognitive and creative thinking skills while promoting active learning (Karagiorgi & Symeou, 2005; Tezci & Gürol, 2003).

2.3. Computer-Supported Collaborative Learning (CSCL)

Collaborative learning, a pedagogical approach pioneered by researchers such as Bruffe (1984), and Johnson and Johnson (1999), involves students of varying abilities, genders, races, and social skills coming together in small groups to achieve shared learning objectives and provide mutual support. This approach has garnered significant attention in recent educational literature due to its departure from traditional teaching methods. By providing students with collaborative opportunities that align with the constructivist approach, collaborative learning environments stimulate creative thinking and foster a more profound understanding through peer interaction and collective problem-solving (Johnson & Johnson, 1989; Slavin, 1995). Research conducted by Johnson and Johnson (1999) has highlighted the positive effects of collaborative learning on student achievement, social skills, and attitudes toward learning. Through collaborative activities, students enhance their academic knowledge and develop essential interpersonal skills such as communication, teamwork, and conflict resolution, which are crucial for success in both academic and professional settings (Gillies, 2007; Kagan, 2009). The significance of group work as a means of facilitating cognitive and social development within the context of learning has been emphasized in studies examining the multifaceted aspects of collaboration (Chen et al., 2018; Yilmaz et al., 2020; Zheng et al., 2019). This new paradigm of learning is based on technology that facilitates student interaction.

The integration of digital technology into collaborative learning has expanded the possibilities for interactions among students. Computer-Supported Collaborative Learning (CSCL) represents a paradigm shift in educational practice, utilizing technology to facilitate collaborative learning experiences (Dillenbourg, 1999; Koschmann, 1996; Lipponen, 2002; Stahl et al., 2006). In CSCL environments, students can participate in collaborative activities and share knowledge without the constraints of physical proximity, thanks to digital tools and online platforms. The use of digital technologies in collaborative learning enhances access to educational resources and promotes greater flexibility and adaptability in instructional delivery. With internet-based communication tools like video conferencing and online discussion forums, CSCL has emerged as a viable alternative to traditional face-to-face interactions (Beldarrain, 2006; Bryant, 2006; Karadag, Su, & Ergin-Koçtürk, 2021; Watermeyer et al., 2021). Furthermore, CSCL environments have positively impacted students' critical and creative thinking skills (Ramirez & Monterola, 2021). These online platforms allow students to engage in collaborative learning activities, regardless of geographical barriers, thereby fostering a global community of learners. These studies showed the positive outcomes of learning activities in CSCL settings. However, participants' contributions to learning and the impact of the designed environment on engagement must also be considered.

3. Methodology

This study aimed to examine the effect of a computer-supported collaborative instructional design on complex thinking skills. To achieve this objective, a case study research design was employed. Case studies involve an in-depth examination of a system using multiple data collection tools to understand its working and functions (Chmiliar, 2010). Although various designs can be utilized in conducting case studies, the nested single-case design is regarded as having more than one substrate or unit for a single case (Yin, 1984).

3.1. Participants

The sample consisted of 12 sixth-grade students attending a middle school in northwestern Türkiye. One of the researchers was employed as a teacher at the same school, which influenced the selection of participants. Table 1 provides an overview of the demographic characteristics of the participants.

Table 1.

Demographics of the participants

Variable	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
Gender	F	M	M	M	F	M	M	F	F	M	F	M
Age	11	12	11	11	11	11	11	11	12	11	11	13
Experience with computer usage (years)	3	8	0	0	1	0	7	6	6	3	6	1
Did he/she use a presentation program?	N	N	N	N	N	N	N	N	N	N	Y	N

Note: S: Student, F: Female, M: Male, N: No, Y: Yes

Table 1 indicates that the study included 12 students: 7 males (58.3%) and 5 females (41.7%). Their ages ranged from 11 to 13 years. Notably, 91.6% of the students with computer experience had not previously utilized a presentation program.

3.2. Research Process

The CSCL activities conducted during the research were organized within the framework of the ADDIE instructional design model. Table 2 illustrates the steps outlined in this model, along with their corresponding explanations.

Table 2.**Instructional design phases performed in the study**

ADDIE Phase	Objectives	Key Activities	CSCL Considerations
Analysis	- Prior knowledge of computer-based presentation skills. - Ensure technological equipment (devices, internet connectivity). - Identify challenges in collaborative learning.	- Assess students' familiarity with PowerPoint software as a pre-test. - Perform an infrastructure check to ensure technology accessibility. - Identify situations by reviewing literature about the relationship between collaboration and thinking skills.	- A group-based learning approach is adopted to ensure peer-to-peer interaction and feedback.
Design	- Design instructional content. - Select CSCL tools and define the collaboration model. - Design group formation.	- Apply a problem scenario based on a real-world task. - Incorporate group-based learning with computers and use Google slides. - Ensure scaffolding structures (peer feedback, instructor support).	- Encourage students to engage in peer learning and feedback loops. - Utilize interactive digital tools for collaboration and content creation.
Development	- Develop an engaging, collaborative project. - Ensure that the CSCL environment is user-friendly and accessible.	- Develop a well-guided assignment where each group works on. - Held an orientation session for the group members to get to know each other and familiarize themselves with the online platform. - Develop a rubric to reveal group discussions and an interview form to assess learning outcomes.	- Embed guided questions on the assignment to ensure all students contribute easily. - Enable synchronous collaboration through Google Slides. - Identify common collaboration outcomes.
Implementation	- Guide students through a structured collaborative learning experience.	- Provide clear guidelines and roles of collaboration. - Provide a collaborative learning environment through questioning and knowledge sharing through Google Slides. - Monitor discussions and provide feedback.	- Encourage peer assessment and co-construction of knowledge. - Interaction requires collaborative argumentation and representing shared task outputs.
Evaluation	- Assess improvements in thinking skills and digital outcomes.	- Conduct summative assessment based on recorded group discussions. - Assess students' familiarity with PowerPoint software as a post-test.	- Monitor participation and engagement through recordings of group discussions and evaluate expected outcomes.

3.2.1. Analysis

The initial step in the process involved identifying the central problem of the research. Given that participants lacked experience in creating computer-based presentations, this became a crucial factor in defining the problem. The planned research aimed to provide students with relevant experience in using presentation software. Through a needs analysis, the existing knowledge gaps among students were identified. Consequently, it was determined that activities should be conducted using Google Slides, an online presentation application that facilitates the creation, formatting, and collaborative functions (Yıldırım-Yakar, 2022). Also, participants performed drawings using Microsoft Paint.

3.2.2. Design

In this phase, instructional content was designed to educate students on using PowerPoint presentation software. This content included a teacher's lesson plan and student collaborative group activities. The lesson plan consisted of four sessions, each lasting 160 minutes. The first session began with a two-hour (80-

minute) teacher-led lecture about how to use Google Slides, followed by an orientation to the CSCL environment. Subsequently, the next two hours (80 minutes) were dedicated to computer-assisted collaborative group sessions on the assigned activity. The scenario of this activity was related to a real-world problem that focused on creating wearable technology intended for use in schools, homes, and public transportation to mitigate the risks associated with the Covid-19 pandemic. Group activities were structured to collaborative learning activities for Web 2.0-based PowerPoint development. In this regard, Google Slides was chosen as a tool to prepare presentations collaboratively on a peer-review basis.

At this stage, arrangements were made for group work in the computer laboratory equipped with 20 computers. Participants were divided into four groups of three members each, with each group assigned an individual computer to facilitate interaction collaboratively. Students are required to have basic computer skills, as collaborative group work will be conducted via internet-based applications. To ensure heterogeneity, students were assigned to teams based on ascending and descending order of their end-of-year grade averages from the previous semester, as detailed in Table 3. This approach balanced skill levels within each team to promote peer support and collaboration.

Table 3.

Information on group formation

	Successful Students				Middle Achieving Students				Low Achieving Students			
Student queue	1	2	3	4	5	6	7	8	9	10	11	12
Student code	A	B	C	D	D	C	B	A	A	B	C	D

As outlined in Table 3, students were categorized based on their average success rates into three performance levels: successful (1-4), moderately successful (5-8), and unsuccessful (9-12). Subsequently, groups were sorted by assigning students a code as A, B, C, and D in both ascending and descending order. Following group formation, each group were encouraged to select a group name, fostering a sense of shared responsibility. The names chosen by the group members are as follows: Group A - Ay Yıldız Team, Group B - Geleceğe Dönüş, Group C - Geleceğin Koruyucuları_1, and Group D - Geleceğin Koruyucuları_2. Figure 1 illustrates the layout of the groups within the computer lab.

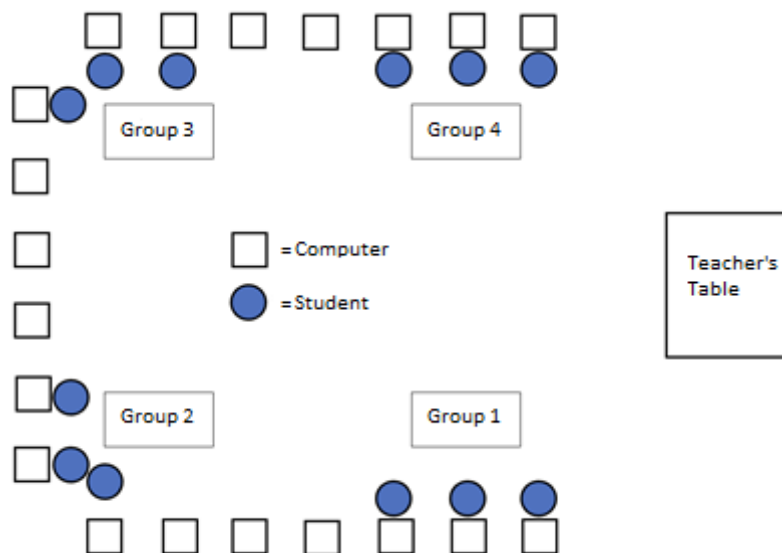


Fig. 1. Distribution of computers among groups in the class

3.2.3. Development

Based on the previous CSCL considerations of the analysis and design phases, a hand-out-based group task was developed that included problem situation. The task explained in detail how to find a solution to the problem and what the group members' roles were. A faculty member specializing in educational technology

evaluated and refined these activities. Additionally, an 80-minute orientation meeting was held with the participating students. This session provided an overview of the research objectives, a guide to what a CSCL activity is, the online environment, and the roles of group members. A rubric was also developed to evaluate group members' discourses while performing in-group tasks at this stage.

3.2.4. Implementation

Following the orientation, group members logged into the provided internet address using their email addresses to access the online slide preparation environment for collaborative group work. Upon receiving confirmation of participation of all group members, the researcher distributed the hand-out outlining the problem-solving activity. Throughout the 80-minute group work session (spanning two class periods), conversations among group members were audio-recorded using voice recorders strategically placed within each group to capture collaborative discussions. The instructor had the opportunity to observe group studies and encourage group members to be involved in the collaboration process. Based on the collaborative discussions between members, they provided solutions collectively and preferred to use Web 2.0 Google Slides features visually. When questions were asked about the project tasks, the instructor did not give direct answers but briefed what was expected. Simultaneously, the instructor monitored the group activities, provided guidance, and addressed any challenges encountered by the participants.

3.2.5. Evaluation

The initial stage in assessing the effectiveness of the research procedure involved identifying the discourses documented based on group discussions. Students who participated in group work were surveyed about their experiences with computer-supported collaboration and learning skills. Subsequently, the efficacy of the instructional design was evaluated by analyzing data from pre-and post-test questionnaires.

3.3. Data Collection Tools

3.3.1. Discourse Identification Form

The reactions of group members to problem situations were assessed through the exchange of ideas. The types of dialogues within the group during problem-solving were identified by using the Discourse Identification Form (DIF). The researchers developed the DIF by analyzing in-group conversations recorded with voice recorders placed on the group tables. The structural features of the transcribed conversations were examined, and discourse patterns were classified. These patterns included consulting the group, providing explanations, offering suggestions, agreeing or disagreeing with group members, offering opposing ideas, and organizing the group. Table 4 outlines the discourses within the groups and examples of expressions associated with each discourse pattern.

Table 4.

Discourse Themes, Descriptions, and Sample Expressions

Discourse Theme	Description	Example expressions
Asking a Question (AG)	Collect information from group members regarding problem situations.	-... is there a transparent color in here? -...how can I draw a transparent mask for this?
Providing Explanation (PE)	Expressing ideas to address the problem.	-... I'm going to make an adjustable T-shirt from a watch. -... I will also put dots, and disinfectant will gush them out.
Suggestions to Improve (SI)	Group members shared their proposed solutions.	-... you could make it like a panic room, like an earthquake room. -... for the background, you can use this technique.
Confirming Groupmates (CG)	Group members support to another's actions and remarks.	-... you are right, it has to be Times New Roman. -... was it? That's what it says on the explanation sheet, all right.
Object to Groupmates (OG)	Challenge or oppose the ideas presented by the group.	-... no, no. The color of what is written must be different from black. -... don't be like that. You have to come up with new ideas.

Present an alternate viewpoint (PAV)	Group members contributed a variety of ideas to address the issue.	-... can't you write the hospital in Turkish? -... but it will be wearable. That's not what you invented.
Organizing Group (OG)	Motivating group members to engage in group discussions.	-... come on guys, we have 80 minutes, let's say something.

3.3.2. *Opinion Identification Form*

Group members' views on learning outcomes as a result of CSCL studies were assessed using an opinion identification form that includes two parts: (1) a survey of presentation practices (PPSF) and (2) views identification on behalf of CSCL implementation. The PPSF was administered during the pre-and post-phases of the CSCL instructional design process. This assessment aimed to evaluate the participants' proficiency in presentation preparation and consisted of four questions (e.g., "Can you prepare a presentation on any subject?" and "Can you make changes to a prepared presentation?") that were rated as yes, partially, or no. An instructional technology expert reviewed the questions and adjusted them to align with the participants' skill levels. In addition, it was aimed to reveal group members' views to evaluate the impact of CSCL studies on their thinking skills and their influence on their learning process. Interview questions were posed to students and asked them to express their written opinions on the related questions (e.g., "How did you find the group work experience?" and "What differences do you notice between Google Slides and PowerPoint?", and "Did the problem situation and collaborative work contribute to the enhancement of your thinking skills?").

3.4. *Data Collection and Analysis*

During the CSCL studies, the discourse analysis technique was used to analyze the interaction process between group members. Discourse analysis involves several stages, including reading, classification, interpretation, and structuring (Baş & Akturan, 2008). Based on these, group conversations were recorded and transcribed, revealing the group's verbal interactions. The DIF was employed to code and illustrate students' reflective responses, and they were classified based on Polya's heuristics stages (understand, devise a plan, implement, evaluate). To ensure reliability, the authors of the paper read transcribed versions of group discussions and coded them separately. This iterative coding process fostered inter-rater reliability, as discrepancies were resolved through consensus discussions among the research team. After sharing and discussing discrepancies, the IRR for the data of the groups is as follows: Group 1 was 97%, Group 2 was 83%, Group 3 was 84%, and Group 4 was 84%. Hartman (1977) states that an IRR level of around 75-90% is typically acceptable. We used these acceptance rates to assess how discourses identified in in-group interactions were incorporated into the relevant heuristic stages. Student opinions were qualitatively analyzed using descriptive techniques. To ensure reliability, student views were reviewed and evaluated jointly by the researchers, with direct quotations utilized to convey student opinions. Participants within the same group tended to respond similarly, highlighting the importance of direct quotations for clarity. To protect participant confidentiality, pseudonyms (e.g., S1, S2) were assigned and used consistently in reporting quotations and in-group discussions. To address potential bias, triangulation was employed by cross-referencing to both group recordings and student views. Students learning outcomes related to digital presentation development skills were assessed using the PPSF, administered before and after CSCL activities. Responses in PPSF were categorized as "I know," "I partially know," and "I don't know" and analyzed quantitatively.

4. **Findings**

The results of the research practices are presented below under the research questions.

4.1. *Findings Regarding the First Research Question*

The dialogues among group members during CSCL studies in response to the posed authentic project task were analyzed using the DIF. Table 5 presents the significant discourses observed in "Group 1 - Ayyıldız Team", and sample discourses.

Table 5.

Findings Concerning Group 1-Ayyıldız Team's Sample Discourses

Understanding	Devise a Plan	Implementation	Evaluation
-...are we starting paint software now? (AG)	-...what is the solution to this problem? (GD)	-...points are added, and disinfectant is released from them. (PE)	-...now it looks like a sweater with a hole in it. (PE)
-...we will develop a wearable technology to protect against the coronavirus. (PE)	-...please complete the tasks regarding public transport. (SI)	-...the font color is not black. (OG)	-...what is this? We should have our phrases that complement each other (PAV)
-... will there be a presentation at the end of the project? (AG)	-... I will create a T-shirt that is adjustable with a watch. (AG)	-...how do I change the color? (AG)	-...mine is very useful. The unit has temperature measurement, disinfectant application, and time display capabilities. (PE)
-...how should we save this presentation? (AG)	-... I will draw a clock by sketching a circle and adding some markers. (AG)	-...how can you write it in a row like this? (AG)	-... and now there is a new name for the virus. Should I note this? (AG)
	-... I'll add something else, don't delete it. (PAV)	-...I will be able to include a background image on the cover page. (SI)	

Table 5 illustrates the discourses within Group 1. Upon reviewing the table and the provided dialogues, it becomes evident that the members of Group 1 primarily engaged in discourses such as AG, PE, OG, and PAV throughout their project development. The prevalence of AG and PE discourses suggests that the members were actively prepared to apply their knowledge when encountering the problem. During the implementation phase, consensus was achieved based on the suggestions and warnings exchanged among the members. Despite encountering some opposing opinions, the group successfully reached collective decisions. Notably, the third member of Group 1 played a pivotal role in guiding their peers, identifying and resolving issues, and contributing to the final product through statements such as, "*...but it's the same as mine*", "*By the way, the articles will not be in black, correct them immediately*," and "*What are these? These shapes will complement each other to create a unique design*."

Table 6 presents the discourses put forward by "Group 2 – Geleceğe Dönüş 1".

Table 6.

Findings Concerning Group 2 - Towards the Future 1 Sample Discourses

Understanding	Devise a Plan	Implementation	Evaluation
-... we have 80 minutes to discuss our understanding. Let's begin. (OG)	-... we can design a living environment. (SI)	-...we have a lot of work to do, so let us get on with the task at hand. (OG)	-...it is like a room. I want everyone to have a room on the bus. (SI)
-...there are three problems. One person should take the first, another the second, and I will take the third. (SI)	-... we need to focus on individuals with a designated section, allowing for mask-free riding. (PE)	-...that one has been disinfected, and the colored ones also. Additionally, there is a protector on his head. (PE)	-...see how it looks? (AG)
-...the text specifies the types of clothing worn while using public transportation. (PE)	-... how about building an airplane? (SI)	-...when worn, this product is intended to protect against the coronavirus. (SI)	-...it doesn't look good. (OG)
-... about the idea that wearing this can help protect against COVID-19 (AG)	-...you can design an environment like a panic room. You know, the rooms you go into during an earthquake. (PAV)	-...creating an environment that feels like home rather than a school environment is necessary. (PAV)	
	-Yes, it makes me sense. (CG)	-...did you write public transportation in the title? What should I write? (AG)	

Table 6 presents the sample discourses among the members of Group 2. Here are some examples of the distinctions within Group 2:

Group 2 - S2: I have the most creative idea besides yours.

Group 2 - S1: Why?

Group 2 - S2: Because I drew a mask.

Group 2 - S1: Don't do that; develop a new idea.

Group 2 - S2: How do you feel about the idea that wearing this can protect against COVID-19?

Group 2 - S1: That is a bit more like a school environment. It would be best if you made it like a home environment.

Upon reviewing the sample dialogues provided above, it was observed that the members of Group 2 exhibited a range of responses to suggestions and warnings, displaying both agreement and disagreement with each other. Notably, the members in the first and third positions within Group 2 demonstrated greater assertiveness in expressing conflicting ideas and taking responsibility for their contributions to the work.

Table 7 presents the discourses put forth by “Group 3 – Geleceğe Dönüş2”.

Table 7.

Findings Concerning Group 3 – Geleceğe Dönüş 2 Sample Discourses

Understanding	Devise a Plan	Implementation	Evaluation
-...are we going to divide it into three? (AG)	-...let's choose one of them. (SI)	-...the color of our main title should be different from black. (SI)	-...let the guardians of the future be our title. (SI)
-...each of us will design it separately. (PE)	-...I'll take the home environment then. (PE)	-...but it needs to be protected from viruses, so you need to add something to it. (PAV)	-...I will color it red. (PE)
-...you are right. It should be wearable. (CG)	-...who wants to take the school environment. (AG)	-...how can I design a sweater on a slide? (AG)	-...excellent (CG)
-...what was the purpose of the transparent mask? (AG)	-...amazing. (CG)	-...I am making a water mask; one can drink water without opening it. (PE)	-...no, I don't think so. (OG), we can use this for the background. (SI)
	-...you will make a hole in the mask drawing, and people will breathe through it. (AG)	-...this text will be formatted in Times New Roman. (PAV)	
	-...but it will be wearable, not the one you created. (PAV)	-...the title will be bold and italicized. And change the color. (SI)	
	-...I think a mask with ears can be made. (SI)		
	-...2nd and 3rd slides are mine, the others will be yours. (OG)		

Table 7 presents the sample discourses among the members of Group 3. The following dialogues can be used as examples when examining the distinctions within Group 3.

Group 3 - S3: How about if I draw a bus and I do a couple of things?

Group 3 - S2: But it will be wearable, not the one you invented.

Group 3 - S1: I'm drawing a nice sweater.

Group 3 - S2: But it has to protect it from the virus. You need to add something to it.

Upon reviewing the dialogues above, Group 3 members disagreed with some explanations during the implementation phase. The guidance provided by the second member of Group 3 was crucial in resolving the issue and achieving the desired outcome.

Table 8 presents the key discourses proposed by Group 4, “Geleceğin Koruyucuları”

Table 8.

Findings Concerning Group 4 – Geleceğin Koruyucuları Sample Discourses

Understanding	Devise a Plan	Implementation	Evaluation
-... we need to do this for designing clothes to protect us from covid. (PE)	-...I will design wearable clothes for vehicles. (PE)	-...I want to draw a protective fabric around the clothes. (PE)	-... I couldn't do it just as I wished; it was a late idea. (PE)
-... how do I make the eraser tool bigger in Paint? (AG)	-...let's decide and start as soon as possible. (OG)	-...I think you should put dots around it so that disinfectant comes out. (SI)	-...you need to delete your theme from your slide; it will only be on the cover page. (SI)
-... the wheel and the body can be designed with the help of a shape tool. (SI)	-... let's go to Google Slides at the same time. I think we can see each other. (SI)	-...good idea. (CG)	-...the houses we both drew in the design are similar. (PE)
-... how should we write a message inside of an image? (AG)	-...those who have completed painting should move on to the next task to avoid wasting time. (PAV)	-...how were we uploading pictures to the slide? (AG)	
		-...go to the insert menu and click on upload from my computer. (PE)	
		-...right click on an empty place on the slide, you can add it from there. (SI)	

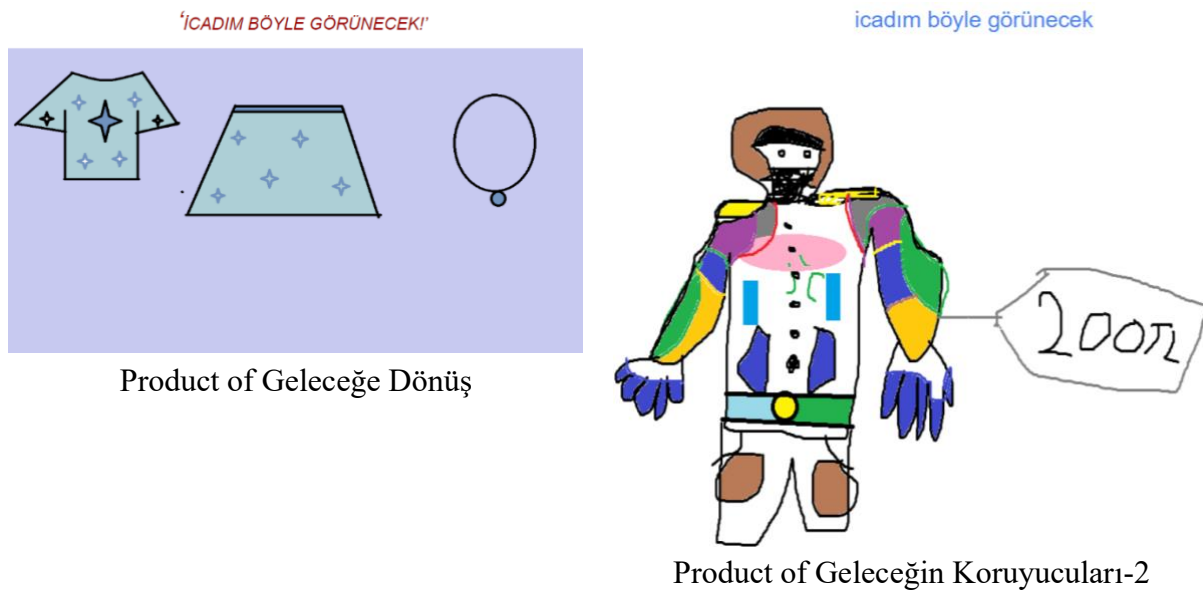
Table 8 presents sample discourses among the members of Group 4. Upon examining the table and the provided dialogues, it is evident that the 2nd and 3rd members exhibited greater assertiveness in presenting opposing ideas and assumed more responsibility in creating the project. When analyzing the dynamics within Group 4, the following dialogues exemplify these distinctions:

Group 4 - S2: I want to draw protective fabric around the clothes.

Group 4 - S3: OK, but how will a man wear this?

Group 4 - S2: I don't know.

Variations in group decision-making processes likely influenced the comprehension of these implementation steps. Although the group decision-making process was more active in Group 4, it was observed that group members reiterated instructions for presentation preparation during implementation, resulting in some abstract directives. Teacher intervention was necessary to clarify these abstract elements, allowing for the reorganization of the prepared materials (see Figure 2).

**Fig. 2.** Sample products in groups-4

4.2. Findings Related to the Second Research Question

The interviews were conducted to address the second research question, which aims to reveal the effectiveness of CSCL studies and how thinking skills occur during the project tasks. The students'

responses showed they were all satisfied with the CSCL. S1's statement in Group 1, "*The collaborative atmosphere was conducive; each member contributed, compensating for individual shortcomings*" showed that he was satisfied with peers' assistance, particularly in mastering the intricacies of the presentation software. Most of them also said that they liked the computer support and wanted similar applications in future semesters and courses. Some of the group members highlighted the problem scenarios in the directed project worksheets, emphasizing their role in fostering inquiry-driven skills. For example, S1 in Group 2 noted the study's focus on real-life scenarios, such as Covid-19 precautions. Likewise, S3 in Group 3's opinion, as "*Upon noticing my peer's error, I promptly intervened and explained their misunderstanding*" suggests that group deliberations ensued, facilitating a dialectical exchange of ideas and the exploration of alternatives. S3 in Group 2 also interpreted the group work similarly and described the process of learning together "It was very nice because everyone helped each other. We can do what we cannot do by asking our groupmates."

Within the scope of this sub-problem, students' responses to a presentation practices questionnaire administered before and after the problem-solving activity were analyzed. The findings are summarized in Table 9.

Table 9.

Findings Related to PPSF

Questions	Status	Before Implementation		After Application	
		Frequency	Percentage	Frequency	Percentage
Do you know about presentation programs?	I know	1	%8.3	11	%91.7
	Partially know	1	%8.3	1	%8.3
	I don't know	10	%83.3	0	%0
Can you prepare a digital presentation by using presentation programs?	I know	3	%25	11	%91.7
	Partially know	2	%16.6	1	%8.3
	I don't know	7	%58.4	0	%0
Can you make any changes to an already prepared lecture presentation?	I know	2	%16.6	11	%91.7
	Partially know	2	%16.6	0	%0
	I don't know	8	%66.8	1	%8.3

Table 9 presents the findings of the students' answers on PPSF. Before the activity, 10 students (83.3%) lacked knowledge about PowerPoint presentation software, which increased to 11 students (91.7%) based on the post-activity. Preparation ability rose from 3 participants (25%) to 11 students (91.7%), and the capacity to make desired changes surged from 2 students (16.6%) to 11 (91.7%) after the activity. These results showed that the CSCL-guided activities contributed to the students' ability to prepare presentations and develop projects in the digital environment.

5. Conclusion and Discussion

5.1. The Effect of the CSCL Environment on Students' Complex Thinking Skills

When analyzing the dialogues within Group 1, it was observed that discourses primarily involved SI and PAV alongside AG and PE. This pattern suggests that cognitive activities fostering critical discourse and creative thinking were prevalent within Group 1. Notably, the third member of Group 1 played a pivotal role by reading the problem scenarios aloud, providing explanations of problem-solving approaches, and seeking feedback from fellow group members, thereby facilitating the generation of solutions. Furthermore, the decision-making process in Group 1 followed individual deliberations. In contrast, Groups 2 and 3 determined task allocation through the discourse of a single member, supplemented by AG and SI. Consequently, in Groups 2 and 3, PAV and CG were observed alongside SI.

In Group 2's problem scenario, discourses involving SI, OG, CG, and PAV were evident in developing and presenting specified products. This indicates frequent engagement in activities that foster critical and creative thinking skills within Group 2. Consequently, Group 2 approached problem situations differently

than Group 1, with students taking individual responsibility for product creation and collectively demonstrating critical decision-making processes.

In Group 4, similar to Groups 2 and 3, task allocation was based on SI and AG. However, unlike the other groups, Group 4 emphasized adherence to instructions, frequently using AG, CG, and PAV discourses. While critical thinking skills were evident in Group 4, they had a lesser influence on creative thinking skills than the other groups. Nevertheless, it was noted that Group 4 operated more efficiently, with a stronger focus on productivity and a greater sense of individual responsibility than the other groups.

When analyzing group discourses, the most active stages of in-group interactions were identified as implementation (n=101), planning (n=44), understanding (n=36), and evaluation (n=30). During the implementation phase, students delivered computer presentations and digital products by discussing the information expected to be learned through presentation programs. Since the problem situations aligned with the course learning outcomes, implementation was pivotal in achieving the teaching objectives. Comprehension emerged as a crucial stage for fostering students' awareness before engaging with their groupmates, and students initially focused on understanding information related to problem situations. Students took individual responsibility during the planning phase, shared challenges, and engaged in discourses to develop unique products.

In contrast, the evaluation stage saw minimal discourse, with discussions primarily focused on product quality and functionality, and assessing each other's creative thinking processes. Rhodes' (1961) framework of the fundamental structures of creativity is evident in the previous stages. Individual self-awareness and accountability are reflected in discourses during the understanding and planning stages. Materials used, interactions with groupmates, and environmental factors influence critical thinking skills and contribute to the creative thinking process.

Based on the findings above, CSCL environments positively influence students' creative thinking skills, which are closely linked to critical thinking skills. Students effectively prepared and presented materials for scripted problem situations facilitated by CSCL. This aligns with the findings of Birişçi and Karal (2011), who demonstrated that collaborative learning processes enhance creative thinking skills. As Ramirez (2021) noted, integrating questioning activities within CSCL further enhances cognitive skills by stimulating deeper and more meaningful intellectual discussions. However, Ünal and Özdiç (2019) found no significant difference in creative thinking skills and academic achievement before and after technology-supported collaborative learning processes. The focused nature of this study limits the ability to draw definitive conclusions on its impact on academic achievement, indicating a need for longitudinal studies, particularly involving secondary school students.

Conversely, studies examining the relationship between CSCL environments and students' critical thinking skills, such as Okumuş (2020), reported positive effects of argumentation-supported collaborative learning with pre-service science teachers. Similar outcomes were observed in this study involving middle school students. Kaya and Gökcalp (2021) observed that middle school students actively engaged in mathematics courses through collaborative learning, motivating one another and learning together. Similarly, Birgin and Acar (2022) found CSCL compelling across various grade levels in mathematics education. Gezgin et al. (2022) highlighted the positive impact of collaborative learning environments on teamwork and co-learning processes. In CSCL settings, students' interest and motivation in course content increased, with peer teaching facilitated through shared responsibility for learning. This heightened sense of learning accountability fosters the development of critical thinking skills among group members during the creation of presentations.

This study indicates that the observed enhancement in metacognitive skills—specifically in planning, task execution, and evaluation processes—strengthens students' creative and critical thinking abilities. Examining the findings reveals expressions of logical and critical thinking in discourses during the understanding, planning, and implementation stages, as well as in product creation and presentation within the CSCL process. Furthermore, Zabolotna et al. (2022) concluded that CSCL enhances metacognitive skills, while Ramirez and Monterola (2019) suggested that CSCL has long-term positive effects on logical

thinking processes. It is obvious to see positive outcomes of the CSCL process and well-structured learning design principles. Khalil and Elkhider (2016) highlighted the importance of the instructional design process embedded within learning theories to achieve desired learning outcomes. Shukor et al. (2014) also describe how integrating learning principles into a developed model can be made possible for online learning. They concluded that students' success in online learning often relies on the design of the learning environment. By employing systematic instructional design principles, this study showed the influence of CSCL by elaborating thinking skills and digital competencies (Gros, 2001).

5.2. The Process of Problem Situations Revealing Critical and Creative Thinking Skills

The impact of problem situations on critical and creative thinking skills was evaluated through post-application interviews with students. Across all four groups, students unanimously expressed positive perceptions of the CSCL environment as conducive to learning. Consistent with student feedback, it was inferred that problem situations effectively stimulated critical and creative thinking skills. Furthermore, pre- and post-application surveys revealed that problem situations enhanced learning in presentation programs. The findings of the study indicated that problem-solving scenarios within CSCL environments are an effective means of cultivating critical and creative thinking abilities (Chen, Looi, & Tan, 2010; Koroneou, Parakeva, & Alexiou, 2013; Ramirez & Monterola, 2019). It is thought that problem situations in the instructional design process, prepared by triggering students' thinking skills, led to their differentiation.

The study highlighted diverse discourses employed by the four groups to understand the problem situations presented to them. Notably, they engaged in confirmatory discussions about the features outlined in these situations, seeking validation from their group mates. Existing research has demonstrated that instructional design positively affects collaboration quality, engagement, and cognitive skill development in CSCL settings. Kapur (2016) highlighted the importance of productive failure, showing that well-designed CSCL activities encourage students to struggle with complex tasks, leading to deeper understanding. Additionally, discussions arose concerning the selection of tools (such as presentations and drawings) beyond those specified in the problem situations, indicating the use of GD discourses. Moreover, PE and PAV discourses related to tool selection for AG were observed. Differences were noted among the groups in their interpretation of the instructions for problem situations. In Groups 1 and 4, frequent use of AG and PE discourses was noted to facilitate their understanding of the instructions for implementing the presentation program.

In the planning phase, Groups 2, 3, and 4 initially shared the problem situations, utilizing AG and SI discourses in proportion to the number of group members. During the implementation phase, OG and CG discourses were frequently employed across all groups (G1, G2, G3, and G4). Notably, these discourses extended to implementing instructions that incorporated outcomes alongside product design, highlighting the integration of cognitive aspects of critical thinking into the application dimension. It is important to note that the learning situations presented in CSCL environments should be designed to encourage students to engage in critical and creative thinking, as well as discourse (Birişçi, 2013; Noroozi et al., 2013; Weinberger et al., 2007).

6. Implications

The findings of this study provide valuable insights for educators and instructional designers seeking to implement CSCL-based instructional design frameworks in diverse learning environments and underline its importance for the development of thinking skills and digital literacy. The following recommendations offer practical strategies for educators and instructional designers while utilizing a CSCL-based instructional design to maximize student engagement, foster collaboration, and enhance digital skills. As for educators, structured roles and peer interactions should be embedded to minimize passive participation and ensure equal engagement during CSCL studies. It is also offered for educators to assess the impact of such CSCL designs on student learning outcomes in various contexts. To accurately evaluate collaboration effectiveness, instructional designers should implement multi-modal assessment techniques. To measure

teamwork contribution, peer reviewing can be included, and self-reflections will be employed to assess students' perceived learning. Given the age and developmental level of the students, a Web 2.0-based platform was employed throughout the design process to encourage collaboration and project development. Instructional designers should also consider the role of technology in encouraging and facilitating intellectual conflict among students. Selecting proper CSCL platforms based on students' technological access, usability, and cognitive load considerations. Additionally, the principles of peer scaffolding, heterogeneous group formation, and technology-mediated collaboration involved in this study can be adaptable to larger classrooms. However, it is important to consider the instructional design process on structured group roles, technology-mediated collaboration, and teachers' roles across diverse populations. While larger groups may differ about the critical elements of student-centered learning, collaborative problem-solving and self-regulation remain (Johnson & Johnson, 2009). Future studies with a broader range of participants can refine the strategies in this study by incorporating diverse student skills and learning preferences.

7. Limitations

The study was conducted with a small number of students, which may affect the generalizability of the results. Future research can include more student samples from different levels to increase the representation and generalizability of the findings. This study demonstrated the contribution of CSCL-based activities in the project development process by enhancing students' complex thinking skills in K-8 level. However, the project outputs generated in this study exhibit certain limitations regarding the web-based platforms used to facilitate collaboration. Future research could supplement materials directed at students with various platforms to address these limitations, thereby enabling the exploration of diverse skills and abilities. Additionally, conducting experimental studies by employing long-term observations with different age groups or educational contexts in schools could provide valuable insights into the sustained effectiveness of ID-embedded collaborative learning approaches. The ADDIE framework shaped the CSCL activities conducted in this study. The realization of the research process by integrating the features of other ID models may contribute to the CSCL literature from a different perspective.

8. Conclusion

While CSCL environments offer opportunities for rich peer interactions, their success depends on well-structured instructional scaffolding that ensures meaningful, equitable, and effective collaborative learning. This study highlights how instructional design plays a crucial role by providing a structured, engaging, and goal-oriented learning experience that enhances students' self-regulation challenges and technological difficulties in CSCL.

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