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Interactions in the Collaborative Online Platform for Design Studio Courses through Blended Learning

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Abstract. This study explores the interaction design of collaborative learning in blended design studio courses, where collaborative digital platforms augment co-located teamwork. These platforms function as designed interaction environments, shaping how students communicate, co-create, and express their ideas. Using a mixed-methods approach; observation, User Experience Questionnaire, and focus group interviews, the study proposes the Blended Collaborative Learning (BCL) model. BCL builds upon Harasim's Online Collaborative Learning, integrates the Community of Inquiry model's presence dimensions, and aligns with the technological pedagogical content-knowledge (TPACK) model. Collaborative interaction is analyzed across three stages; Idea Generating, Idea Organizing, and Intellectual Convergence, each expressed through distinct modes (e.g., democratic vs. autocratic, cooperative vs. collaborative, consensus vs. voting). The findings show that platform affordances support multimodal communication and influence the quality of collaboration. BCL positions blended learning as a designed educational experience that combines digital interfaces, embodied presence, and pedagogical objective.

Keywords: Blended Collaborative Learning, Interaction Design, Online Collaborative Platforms, Design Studio Courses.

1 Introduction

Universities have been forced to switch from face-to-face to online learning due to the COVID-19 pandemic [1][2]. Lecturers now have obligations related to technology literacy [3] and are required to design inventive and creative learning environments [4]. According to previous studies, implementing online learning during the pandemic changed the educational system, including the lecture paradigm, learning motivation, and intellectual satisfaction [5][6]. During the pandemic, many universities in Indonesia began replacing lectures with online learning [7]. However, student independence can be increased by applying classical online guidance based on the character values [8]. Even after the Covid-19 pandemic is over, it is likely that online learning will remain a part of university lectures. This is because quality online learning is now a standard component of course delivery in the majority of universities, and online learning has gained acceptance [9]. However, as the pandemic progressively subsided, the lectures were switched to blended learning.

The results of this study provide evidence to support the effectiveness of blended learning in addressing students' motivational requirements, especially because of the possibility that blended learning will become the new norm in higher education during the Covid-19 pandemic [10]. Other research results indicate that blended learning was largely effective during the COVID-19 pandemic and represents a 21st-century development [11]. Blended learning programs combine the finest aspects of face-to-face and digital, and they have a bright future [12]. Information technology, while driving societal change, has also transformed the design paradigm. Once centered on producing physical artifacts, design has evolved to address fundamental human and social needs. In response, design education must remain contextual to these shifts and be prepared to develop the competencies essential for the 21st century. The education system should adapt to this situation, including how students interact, collaborate, and shape their goals in a digitally mediated environment, which is becoming critical.

Practical studio lectures as a signature pedagogy [13] have shaped designers' professional skills for decades in design education. Studio-based learning traditionally emphasizes co-presence, material manipulation, critiques, and visual dialogue. However, practical studio lectures in higher education institutions have been interrupted by the Covid-19 pandemic. Maintaining educational continuity during a pandemic requires innovative use of technology and online learning. Online learning has become the most popular educational method during pandemics. However, online learning poses obstacles in terms of social interaction and collaboration between students and teachers.

One research [14] recommended for the growth of online collaborative models in relation to online learning satisfaction. The use of online collaborative platforms to share ideas and engage in discussions enables users to collaborate online in various locations. Miro, Mural, [15], and Figma [16][17] are collaborative platforms that are commonly used in online collaborative learning. Some research [18] investigating aspects of social interaction such as affective expression, open communication, and group cohesion of online collaborative platform. Research on collaborative interaction in physical, digital and blended spaces has produced

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pedagogical pattern for teaching collaborative interaction [19]. Research related to online collaborative activities in design lectures shows that various types of online platforms based on text, visuals, and speech can be used for this purpose. These platforms include Jamboard, Padlet, Whimsical, Miro, and Figma, in addition to Zoom Meeting, Google Meet, WhatsApp Group, and Line Group for convenience of verbal communication [20]. The move toward digital platforms and blended learning formats requires more than simply transferring content; it calls for reimagining the interaction itself. How do students generate ideas, collaborate, and communicate in both the physical and digital environments?

The global education system has undergone modifications due to the Covid-19 pandemic. However, as the pandemic gradually decreased, institutions of higher education faced challenges in determining appropriate learning strategies. In addition to face-to-face learning, online learning is now a component of higher education; therefore, blended learning is an appropriate solution. Thus, this article will also discuss what has occurred after the pandemic has gradually decreased and how the use of collaborative platforms in blended learning methods remains relevant in design education at the university level. This study discusses collaborative activities in a studio course using blended methods. This study focuses on the use of online collaborative platforms such as Miro, Mural, and Conceptboard in studio coursegroup work conducted on-site. This article examines the impact of these platforms on the learning experience, collaboration process, personal expression, and communication in student collaborative activities using blended learning techniques. It is anticipated that the implementation of this collaborative platform will increase social interaction and collaboration capabilities. From an interaction design perspective, educational platforms are not neutral. Their tools actively shape how students engage with peers and with learning content. Interfaces, spatial structures, annotations, feedback systems, and multimodal affordances influence the atmosphere and quality of collaborative engagement. Understanding interactions in learning as designed experiences allows for a deeper analysis of how platform features mediate social presence, participation styles, and cognitive processes in blended environments. Two questions were posed: a) Does user experience differ when interacting with various online collaborative platforms? b) How is student interaction and collaboration with online collaborative platforms implemented in on-site classrooms using a blended learning approach?

2 Related Works

Discussing collaboration in blended learning requires an understanding of the collaborative process, quality of interactions, and context of instructional design.

In blended learning in design education, where physical studios are combined with online collaborative platforms, theoretical understanding is required. This study is based on three interrelated model: the technological pedagogical content-knowledge (TPACK), Harasim's Online Collaborative Learning (OCL), and the Community of Inquiry (CoI). In learning that uses technology with a specific platform, it is also necessary to examine the aspects of interaction design and user experience that arise from such interactions.

2.1 Technological Pedagogical Content Knowledge (TPACK) model

One model for understanding the relationship between elements in learning is the Pedagogical Content Knowledge model, which was later developed by Koehler and Mishra [21] into the Technological Pedagogical Content Knowledge (TPACK) model. This model combines the elements of Technology, Pedagogy, and Content (Fig. 1). Within the technological element, developments in information technology and the internet have given rise to online learning.

This study demonstrated through their experiments that online learning requires greater time allocation and adjustments to content and pedagogical strategies than traditional learning does. From a student perspective, the effort, duration, and level of enjoyment in learning differ from those experienced during face-to-face learning. The TPACK model emphasizes that the use of information technology, particularly in the context of online learning, must be designed using a specific approach.

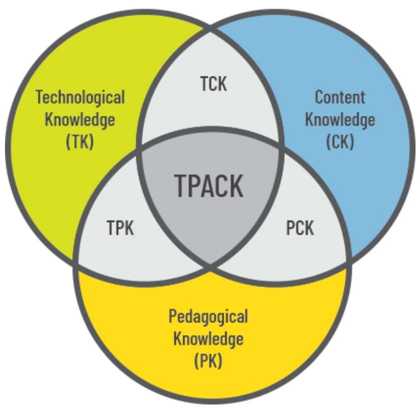

Fig. 1. Technological Pedagogical Content Knowledge model.

In a study [22] related to the TPACK model, respondents were asked to design a technological solution to a pedagogical problem. They learned that technology use is highly contextual and depends on pedagogical goals and classroom situations. They recognized that each design decision (e.g., platform selection) has consequences that can impact other aspects of learning.

Another study [23] related to TPACK measured perceptions of technology use using a blended system that combined face-to-face and online learning. The respondents felt that the blended system supported successful navigation of materials, tasks, discussions, and collaboration.

Another study examined university lecturers' experiences designing and teaching online learning [24]. Respondents reported a shift from traditional roles to course design and facilitation in online environments. Another finding was their concern about the loss of social interaction with students during online learning.

Reflecting on the TPACK model, the use of technology, especially online learning technology, requires attention to the synergy between two other aspects: content knowledge and pedagogical knowledge. Furthermore, the social aspect, which is less strong in online learning environments, can be a barrier to the development technology implementation, particularly in online learning.

2.2 Online Collaborative Learning model

The implementation of technology, particularly online learning, also fosters collaborative learning methods, as explained by the Online Collaborative Learning model. One of the principles of social constructivism is learning, which emphasizes collaboration. Collaborative learning provides a space for members to participate and interact to jointly produce a final result. This differs from the concept of cooperative learning, in which each group member contributes to the completion of task pieces that are combined into a complete result. According to Harasim, the process of collaborative learning includes three stages: divergent and convergent thinking [25]. These three stages are Idea Generation (IG), Idea Organization (IO), and Intellectual Convergence (IC). The IG stage refers to the process of divergent thinking within a group, such as discussions, verbalization, gathering information, and sharing ideas and positions on a particular topic or problem. The IO stage provides conditions for group members to challenge and test different ideas and group ideas based on relationships and similar themes. Strong ideas were selected and weak ones were discarded. The next stage is the convergent thinking process in the IC stage. At this stage, group members share understanding, both agreeing and disagreeing, to contribute together in constructing the understanding and knowledge of the final result (Fig. 2). This model is called Online Collaborative Learning (OCL).

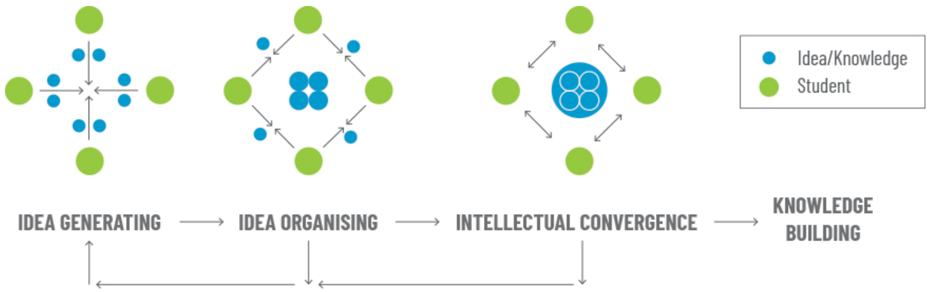

Fig. 2. Online Collaborative Learning (OCL) model.

One study applied OCL principles to high school students using Google Docs as a medium for online collaboration [26]. The results show that collaborative knowledge construction significantly increased engagement and knowledge acquisition. Cooperation, interest, and participation align with the OCL concept that states that social processes require active participation. Students appreciated their peers' explanations and reinforced the notion that learning is networked discourse.

Another study investigated OCL at the higher education level focusing on collaboration, satisfaction, intrinsic motivation, and attitudes toward technology [27]. The results show that OCL significantly increased collaboration, satisfaction, and intrinsic motivation. Intrinsic motivation may be a mediator that links collaboration to reduced technology anxiety and increased self-confidence.

The statement from the study [25] states that asynchronous collaborative online learning is more effective than face-to-face meetings because it provides 24/7 access to time for discussion and reflection, allowing all students to have opinions and avoid discrimination. However, according to [28], this explanation is more rhetorical than the reality that actually occurs in online learning, online learning places more emphasis on cost-effectiveness than pedagogical effectiveness.

Based on these studies, the OCL model has been shown to improve engagement, motivation, and attitudes toward technology. However, in reality, its pedagogical effectiveness is questionable.

2.3 Community of Inquiry

A criticism of the Online Collaborative Learning model is that collaborative activities are conducted through online media. The limitation of online collaboration is the lack of social interaction [24] because students and teachers conduct activities within the restrictions of screens. The importance of social presence is explained in the Community of Inquiry model [29].

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The first aspect, social presence, is student-centered, with interactions among students related to emotional expression, open communication, and group cohesion. The cognitive presence aspect focuses on knowledge and interaction with content. Cognitive presence begins with the creation of a perception, entering the exploration stage for reflection, and integration into concepts. The teaching presence aspect relates to instructional management, understanding building, and direct instruction (Fig. 3).

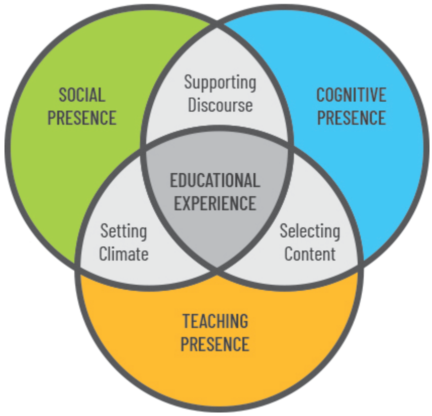

Fig. 3. Community of inquiry model.

One study compared the effectiveness of online and blended learning on social, teaching, and cognitive aspects [30]. In terms of social presence, online learning displayed more affective expression, whereas blended learning demonstrated stronger group cohesion. In terms of teaching presence, blended learning participants perceived a higher teaching presence than online learning participants. In terms of cognitive aspects, structured meaning-building was higher in blended learning, whereas online learning demonstrated a stronger emphasis on idea exploration and brainstorming. This study shows that each learning method has its own advantages.

A study [31] analyzed the social presence in online learning. The study found that the higher students' perceptions of social presence, the higher their satisfaction with the distance learning experience. Two-way interaction, emotional engagement, and social support through online media contribute to a sense of "being present" in distance learning.

Another study [32] investigated the factors influencing knowledge-sharing behavior in virtual learning teams. This study found that team members who trust each other are more likely to share information and ideas with each other. Open communication positively contributes to knowledge sharing. While technological support is important but not sufficient, the quality of interactions is a key determinant of successful knowledge sharing. Members with intrinsic motivation are more active in sharing their knowledge.

2.4 Interaction Design and User Experience

When someone uses learning technology in the form of a digital platform, concepts related to interaction design and user experience become important to ensure effective learning. There are five dimensions in interaction design [33]: words, visual representations, physical objects, time, and behavior.

Words are visual forms in the form of text and sentences, whereas visual representations are visual forms such as layouts, buttons, menus, and interfaces in general. Physical objects are devices that can come in various shapes and sizes, such as PCs, laptops, tablets, and mobile devices. Time is related to media that changes over time, such as the movement of objects in animations, videos, and audios. User behavior is related to the results of the interactions that occur. These interactions shape the user experience (Fig. 4).

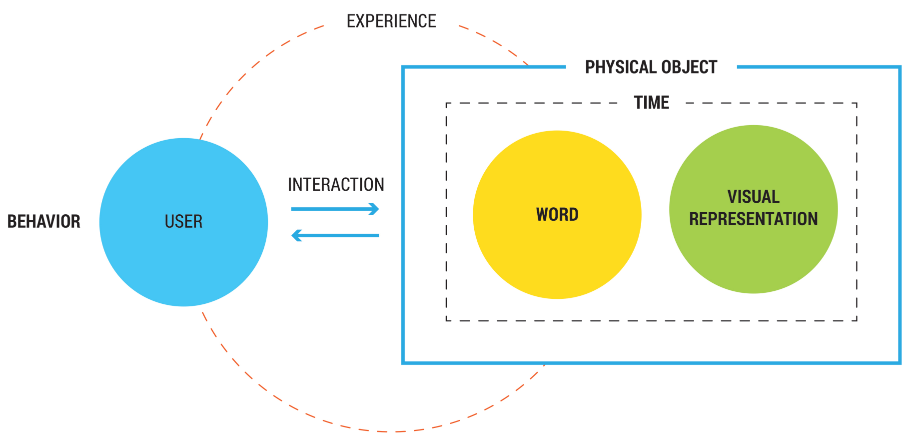

Fig. 4. The dimension of interaction design .

The experience resulting from this interaction can be divided into two main parts: the pragmatic and hedonic aspects [34]. The pragmatic aspect relates to the functional aspects of an object (digital), whereas the hedonic aspect relates to the psychological and emotional aspects of the user as a result of interaction with the object.

User experience can be formed hierarchically from something functional to something emotional, providing value to the user. One study [35] explains that this UX hierarchy begins with functional, reliable, usable, convenient, pleasurable,

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and meaningful. Meanwhile, another study [36] describes the hierarchy as beginning with dependability, efficiency, perspicuity, stimulation, novelty, and attractiveness. A combination of these studies is illustrated in the diagram (Fig. 5).

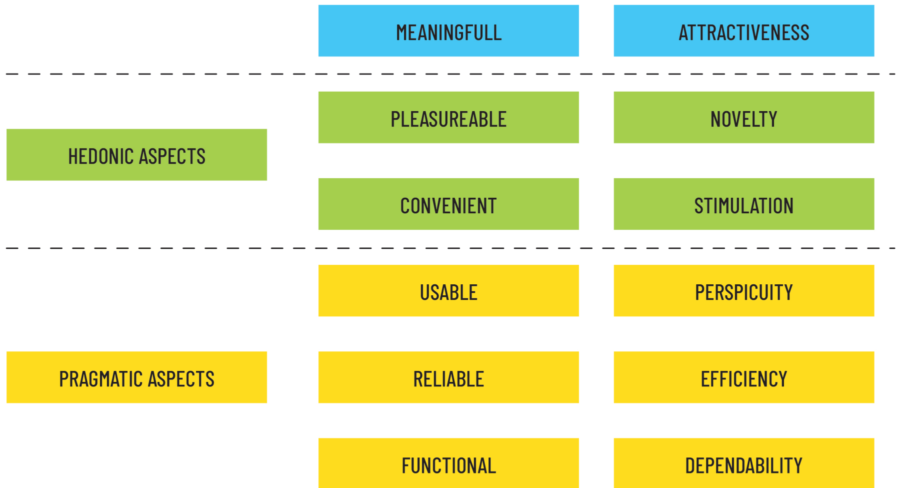

Fig. 5. The hierarchy of user experiences.

In study [36], user experience was measured using the User Experience Questionnaire (UEQ) to examine the pragmatic, hedonic, and attractive aspects of interactions through the platform used by users.

3 Methods

This study used a mixed-methods approach [37] to explore how online collaborative platforms shape student interaction in blended design studio environments. Based on the interaction design perspective, this method focuses not only on learning outcomes but also on how interactions are designed, mediated, and expressed across physical and digital spaces. The design was informed by three interrelated theoretical lenses: Harasim's Online Collaborative Learning (OCL) model (structuring collaboration into Idea Generating, Organizing, and Convergence stages), the Community of Inquiry (CoI) model (focusing on presence and engagement), and the TPACK model (analyzing tool-task-pedagogy alignment).

3.1 Participants and Context

The participants were undergraduate students enrolled in the Studio DKV 3 course during the 2022/2023 academic year at Telkom University, Indonesia using various online collaboration platforms. Each class using one type of online collaborative platform: Miro, Mural, or Conceptboard. The selection was based on the ranking of the most popular whiteboard software from Software Advice (softwareadvice.com) and Saasworthy (saasworthy.com) and Software Reviews (softwarereviews.com).

Data collection was conducted in three classes of "Studio DKV 3" courses in the fourth semester (2022/2023) of the Visual Communication Design program at Telkom University. On average, students were born after 2010 and were categorized as Generation Z [38]. The course, part of the Visual Communication Design curriculum, involved about 100 students across three class sections:

1. Class DE-44-A (N=30) used Conceptboard (conceptboard.com),
2. Class DE-44-B (N=29) used Miro (miro.com),
3. Class DE-44-C (N=41) used Mural (app.mural.co).

Each class conducted face-to-face studio sessions, augmented with a collaborative platform. Students worked in small groups to complete a user-centered design task using empathy maps, tools common in design thinking. Each class was divided into several groups of four to six students.

3.2 Task Design

The activity was intentionally structured to scaffold the three OCL-based collaboration stages:

1. Idea Generating (IG): brainstorming insights on sticky notes,
2. Idea Organizing (IO): organizing inputs spatially on the board,
3. Intellectual Convergence (IC): reaching group decisions through consensus or visual markers.

These tasks were designed using TPACK principles, with platform-specific templates and group configurations ensuring alignment between technological tools, pedagogical objective, and interaction content.

Each class was given the same topic related to analyzing student experiences when interacting with the university's academic information system (Integrated Telkom University System, iGracias). The topic was discussed in the form of an empathy map, which is a collaborative visualization tool used to articulate user types. This tool aims to externalize understanding of user needs and decision making [39]. In design thinking, empathy maps are used in the empathize stage to understand users and identify pain points in their experiences during interactions.

Traditional empathy maps are divided into four quadrants (say, think, do, and feel).

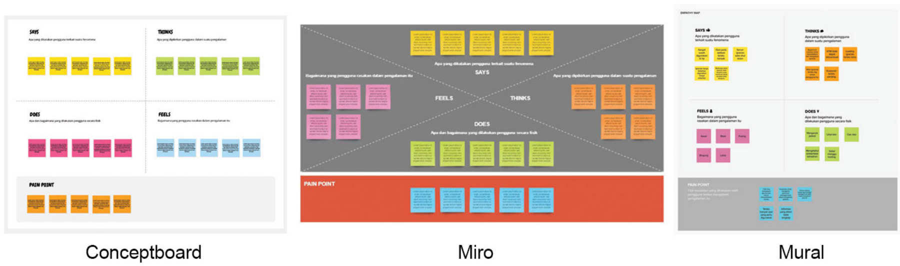

Fig. 6. Empathy map display on each platform.

The empathy map was then applied to each online collaboration platform, namely, Conceptboard, Miro, and Mural, in the previously selected classes. The empathy map was designed with four quadrants: says, thinks, does, feels, and pain points according to the interface and elements of each platform. Each platform has digital sticky notes that can be used to write specific sentences. The sticky notes were filled with the generic sentences "Lorem Ipsum," which could later be replaced with the students' brainstorming results (Fig. 6). Onsite observations were conducted in the studio classroom by observing the behavior of individuals within the group, the interactions that occurred, the collaboration process, and the communication methods used when each student utilized the platform for collaboration.

3.3 Data Collection

Three types of data were collected to capture both the observable interaction design and subjective user experience.

1. Structured observation: researchers conducted direct observations of student behavior in the physical studio space, focusing on interactional modalities (e.g., use of shared vs. personal devices, verbal vs. written communication, and platform navigation).
2. User Experience Questionnaire (UEQ) [36]: Students completed a standardized 26-item UEQ to evaluate the pragmatic, hedonic, and attractiveness aspects of their platform interactions. The UEQ consists of 26 items that use a seven-point semantic differential scale. The pragmatic aspect consists of the attributes of dependability (the ability to control interaction), efficiency (the ease of completing tasks), and perspicuity (ease of learning the system), whereas the hedonic aspect consists of stimulation

(user motivation in usage) and novelty (innovation and creativity factors). These UX metrics complement the interaction design analysis.

3. Semi-structured Focus Group Discussions (FGDs): students from each class participated in FGDs to reflect on their collaborative process, structured using Harasim's IG–IO–IC model, and enriched by CoI's presence dimensions (e.g., comfort with expression, perception of guidance, ease of coordination).

3.4 Analytic Approach

The analysis followed a multi-layered strategy.

1. Qualitative interaction analysis focused on how students used the platform's affordances (e.g., emojis, voting, comment threads) to express ideas, negotiate meaning, and organize contributions.
2. A comparative UEQ analysis assessed platform-based experiential differences across the three classes. The UEQ analysis is conducted by looking at the range of value parameters that include Extremely Good ($2 < n \leq 3$), Good ($0.8 < n \leq 2$), More Neutral ($0 < n \leq 0.8$), Less Neutral ($-0.8 < n \leq 0$), Bad ($-2 < n \leq -0.8$), and Horribly Bad ($-3 < n \leq -2$).
3. Thematic coding of interview data used a deductive–inductive method: deductively informed by OCL, CoI, and TPACK constructs and inductively refined through emergent patterns related to digital-physical coordination, social presence, and peer decision-making.

Through this triangulation, the method captures the blended collaboration learning concept in practice, revealing how digital interaction design, physical co-location, and instructional structuring converge to shape student collaboration in studio-based blended learning.

4 Finding

Collaborative activities were conducted onsite in the studio classroom of classes DE-44-A (N=30), DE-44-B (N=29), and DE-44-C (N=41) using online collaboration platforms. The 30 students in class DE-44-A were divided into eight groups, with each group consisting of 3 or four students. Most devices used were laptops, although some students used mobile devices. During the ideation phase, students collaborated with each other. They were very enthusiastic about using the Conceptboard platform and interacted directly, exploring the tools and discussing ideas either by commenting on the platform or speaking directly with their group members. Some groups worked by dividing tasks, whereas others directed their teammates to work together (Fig. 7).

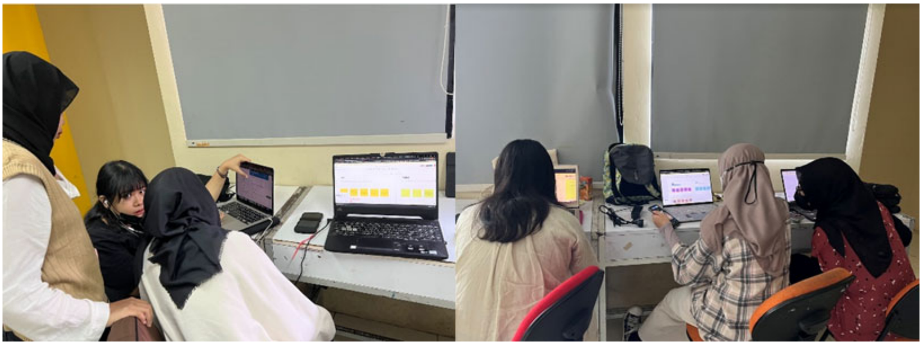

Fig. 7. Students discuss through their devices while interacting with their colleagues in class DE-44-A.

None of the groups in class DE-44-A encountered difficulties in using the Conceptboard platform. The students were able to use the features and tools on the Conceptboard smoothly and complete the discussion with their groups in approximately 50-60 minutes. The students in class DE-44-A had a pleasant experience, as they were able to collaborate online while having face-to-face discussions in class, which was conducted on-site through blended learning methods.

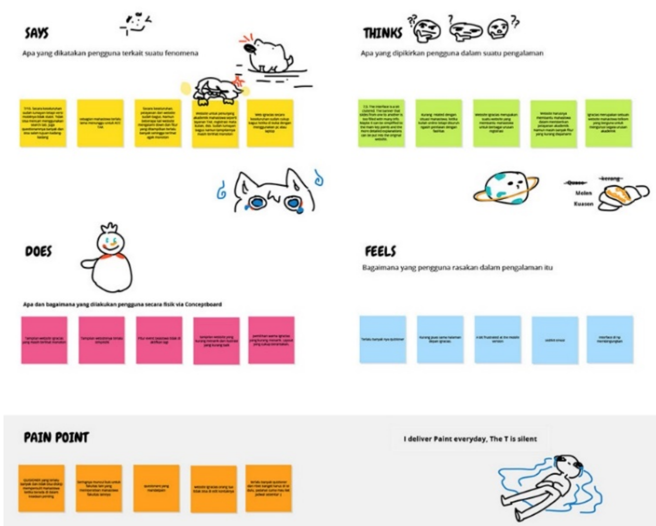

Fig. 8. Visual expression on the Conceptboard in class DE-44-A.

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During the discussion, students verbally shared their opinions and wrote them in sticky notes on the Conceptboard platform. In addition to the text format included in the sticky notes, students explored the available tools by drawing characters or leaving comments outside the discussion process. Students in the visual communication design program seemed enthusiastic about being able to express themselves through visual elements while still maintaining their focus on the ongoing discussion (Fig. 8).

The situation in the DE-44-B class (N=29) using the Miro platform showed no significant differences. Other groups discussed them while focusing on their own devices and talked directly with their peers. In general, the discussion in the DE-44-B class was dominated by groups using a single device, whereas the other group members provided feedback. The discussion was guided by a student assigned to write down the opinions of group members (Fig. 9).

Fig. 9. Students discussing through one device in class DE-44-B.

Fig. 10. Comments, stickers and emoji on the Miro platform in class DE-44-B.

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In class DE-44-B, students used the comment feature on the Miro platform to provide feedback on their peers' opinions. The other group members read and revised their comments accordingly. Miro also allowed users to contribute visual elements such as stickers and emojis, which helped prevent discussions from becoming too formal (Fig. 10).

Class DE-44-C (N=41) was dominated by the use of personal devices during discussions on the Mural platform. Various types of devices have been used for this purpose, including laptops, tablets, and mobile phones. The discussion process was generally carried out by dividing the tasks into specific parts of the empathy map (Fig. 11).

Fig. 11. Use of Mural platform through various devices in class DE-44-C.

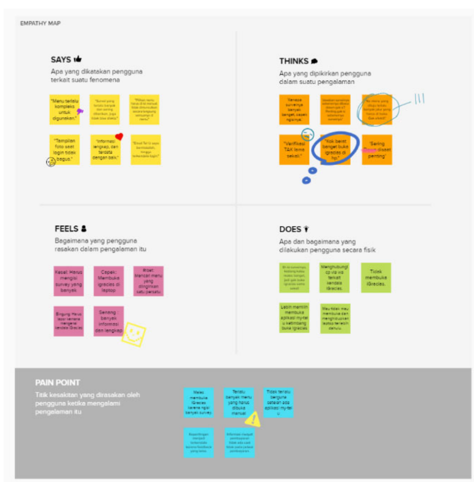

Fig. 12. Comments, stickers and emoji on the Mural platform in class DE-44-C.

The interaction on Mural is similar to other platforms, where students can not only add text to sticky notes but also comments, images, and stickers. Visual elements can facilitate collaboration, or simply add aspects to the working field (Fig. 12).

The results of the user experience of the DE-44-A class that utilized the Conceptboard platform are presented in Table 1, which was measured using UEQ. Overall, the attribute scores on the UEQ indicate a positive user experience when interacting with the platform. All the UEQ scores had values above 1, indicating a good grade. In terms of pragmatic aspects, the perspicuity attribute had the highest score (2.050), indicating an extremely good grade.

Table 1. UEQ scale on Conceptboad - Class DE-44-A (N=30).

Aspect	Attribute	Mean	Variance
Pragmatic	Dependability	1.925	0.78
	Efficiency	1.767	1.65
	Perspicuity	2.050	1.00
Hedonic	Stimulation	2.125	1.14
	Novelty	1.608	1.37
Attractiveness		2.183	1.03

The stimulation attribute obtained the highest hedonic aspect (2.125), whereas the attractiveness attribute obtained an extremely good-grade experience (2.183). Among the six attributes, attractiveness had the highest score, whereas the novelty attribute had the lowest score.

The results of the user experience of class DE-44-B using the Miro platform showed lower results than the experience on the Conceptboard (Table 2). Overall, it is positive and still in the good grade range ($0.8 < n \leq 2$). The dependability attribute obtained the lowest score (1.353) compared to the other attributes in the pragmatic aspect. Regarding the hedonic aspect, the novelty attribute obtained the lowest score (1.284), which was also the lowest score among all attributes. For attractiveness, a score of 1.644 was obtained, which was the highest score for all the aspects.

The DE-44-B class user experience using the Miro platform showed lower results than the experience on the Conceptboard (Table 2). Overall positive value and still in good grade ($0.8 < n \leq 2$). The dependability attribute had the lowest score (1,353) compared to the other attributes in the pragmatic aspect. For the hedonic aspect, the lowest score was obtained for the novelty attribute (1,284), which was also the lowest score for all attributes. For the attractiveness aspect, a score of 1,644 was obtained, which was the highest score for all aspects.

Table 2. UEQ Scale on Miro - Class DE-44-B (N=29).

Aspect	Attribute	Mean	Variance
Pragmatic	Dependability	1.353	0.52
	Efficiency	1.448	1.10
	Perspicuity	1.509	1.05
Hedonic	Stimulation	1.474	0.87
	Novelty	1.284	0.81
Attractiveness		1.644	0.77

The results of the user experience from students in class DE-44-C, who used the Mural platform, are shown in Table 3. These values were similar to those obtained using the Miro platform (Table 2). Overall, the experience generated from interacting with the Mural platform is positive and still falls within the good grade range (0.8 < n ≤2).

Table 3. UEQ Scale on Mural - Class DE-44-C (N=41).

Aspect	Attribute	Mean	Variance
Pragmatic	Dependability	1.518	0.90
	Efficiency	1.518	1.25
	Perspicuity	1.689	0.95
Hedonic	Stimulation	1.470	1.30
	Novelty	0.951	0.98
Attractiveness		1.675	1.12

The average overall score was above 1, with only the novelty attribute being slightly below 1 (0.951), which was also the lowest score. The highest score was obtained for attractiveness (1.675). Dependability and efficiency attributes had the lowest scores for pragmatic attributes, whereas perspicuity had the highest score. Stimulation attribute had the highest hedonic score.

A comparison of the students' experiences when interacting with the Conceptboard, Miro, and Mural platforms is presented in Table 4. The evaluation was based on the mean UEQ score, which consisted of pragmatic, hedonic, and attractiveness aspects.

Table 4. UEQ Scale on Conceptboard, Miro and Mural.

Aspect	Conceptboard (DE-44-A)	Miro (DE-44-B)	Mural (DE-44-C)
Pragmatic Quality	1.91	1.44	1.58
Hedonic Quality	1.87	1.38	1.21
Attractiveness	2.18	1.64	1.67
Averages	1.99	1.49	1.49

The DK-44-A class that interacted using the Conceptboard showed a higher level of user experience than the DE-44-B and DE-44-C classes that used Miro and Mural. All three platforms received an overall rating of good grade ($0.8 < n \leq 2$). Attractiveness had the highest value for all platforms, followed by pragmatic and hedonic quality in succession.

Semi-structured interviews were conducted to further understand this situation. The interviews were conducted in a group through a Focus Group Discussion (FGD) consisting of 15 students, with five students representing each class that used Conceptboard, Miro, and Mural (Fig. 13).

Fig. 13. DE-44-A, DE-44-B, and DE-44-C FGD students.

The discussion covered students' experiences when interacting with online collaboration platforms and the process of collaboration based on Idea Generating (IG), Idea Organizing (IO), and Intellectual Convergence (IC) [25]. The results are as follows.

1. Interface and Interaction on the Platform. Although the mouse is simpler to use for actions on the platform than the touchpad, students with laptops typically use the touchpad instead of the mouse. Users of tablets or mobile phones may not be comfortable because of the smaller monitor size compared to that of a laptop, and the frequency of inadvertent workspace touches. To comprehend the work process on a platform, students must first understand the available interfaces. Some features facilitate work; however, it takes time to understand them. In general, the Conceptboard, Miro, and Mural platforms are user friendly.

2. Idea Generating (IG). Online collaboration platforms are generally used in two ways during discussion. The first method is for users to provide feedback through their own devices and verbal discussions while the platform is updated. The second method focuses on a single device, where each member provides an opinion directly related to the platform's topic of discussion. One student acted as a leader by writing and advancing discussions. No communication barriers were identified for either direction. Typically, group members comprehend a problem and communicate directly with each other.

3. Idea Organizing (IO). As previously described in Idea Generation (IG), there are two methods for expressing an opinion. Ideas can be organized in either of these ways. The first step is to designate tasks to each member so that they can contribute to the group. After the members drafted the idea, the group discussed it as a whole. The second method focuses on the group leader and accommodates all the ideas to be written and read with the rest of the group. Each member can respond directly to the opinions and contributions of others in the group.

4. Intellectual Convergence (IC). Due to the fact that all members meet face-to-face, an agreement can be explicitly discussed verbally. However, if consensus cannot be reached, it can be achieved through voting. In this case, online collaboration platforms enable voting on opinions. Students can represent themselves by using stickers or symbols.

5. Respondents' feedback. There are numerous improvements requested by students to this online collaboration platform. Digital sticky notes were required for all collaboration platforms. Users can write brief sentences on sticky notes that are easily movable and can be colored differently for various subjects. Custom templates are a requirement for this platform because users must be prompted to participate in specific categories of discussions. Stickers or emojis can be used to lighten mood and serve as visually appealing voting instruments.

Future features that may be developed by online collaboration platforms are topics of discussion. One of these is the search function, as it is possible that the number of ideas and discussions will increase the number of visual and textual elements. Anticipating an increase in data, users require search engines within their current workstations. The use of pages may facilitate user access to the section being discussed. Information related to the history of the actions performed can aid in understanding the evolution of discussions, making it easier to locate specific data. Generation Z students prefer the dark mode for reading and writing, so they require a platform to support this. Eye comfort was considered when the product was used. When students engage in discussions or brainstorming sessions, the use of online collaborative platforms will continue, and they may replace the traditional means of communication involving traditional equipment, such as whiteboards and writing instruments. In addition to being applicable onsite, online remote collaboration among students is also possible.

5 Discussion

Collaboration among students in a group is a dominant aspect of studio courses. This process embodies the application of the community of practice [40], which is in line with industrial practices in Visual Communication Design. The online collaborative platform previously used for online collaboration purposes can be implemented onsite through blended learning methods. The disadvantages of online learning can be overcome through face-to-face classroom instruction. Viewed from a TPACK model perspective, this is in line with the study [23] where respondents felt that the blended system supported collaborative learning. In addition, concerns about the loss of social interaction [24] in online learning can be resolved through blended learning.

Online collaboration platforms used during the Covid-19 pandemic include Miro, Mural, Collaboard, Ideaboardz, Limnu, Lucidpark, Mindmeister, Padlet, and Stormboard [41]. Web-based collaborative tools such as Miro and Mural facilitate group problem-solving processes [42]. Miro and Mural are often used in virtual meetings or workshops as icebreakers to encourage engagement and active participation [43]. Moreover, these platforms are effective for project-based learning (PBL) because they allow students to collaboratively work on complex real-world problems and apply their knowledge to formulate solutions [44]. In the TPACK model, selecting the right technology, in this case a collaborative online platform, supported by pedagogical aspects and right content, will strengthen the effectiveness of learning [21].

According to the research [20], students collaborating with online collaborative platforms need to add other communication applications such as Google Meet, Zoom Meeting, WhatsApp Group Call, and LINE Group Call. Oral communication was conducted to explain the visual display. In some cases, communication is also done using text, such as on platforms like Whimsical and

Miro. Unstable Internet connections hinder online communication among group members. Some written notes may be missed by group members because of the abundance of visual elements on online collaborative platforms [20]. Collaboration and communication barriers in online learning using the Miro collaborative platform are related to autocratic teaching styles in some countries, which prevent democratic discussions from taking place [45]. Nevertheless, the use of online collaborative platforms can enhance social presence and collaborative learning in online learning [46]. This is also in line with online learning collaboratory research [47] identifies four objectives for the online learning collaboratory; evaluation and refinement of instructional designs, interdisciplinary communication through design patterns, design pattern implementation, and bridging communities of practice. The communication process when the idea is conveyed also depends on the quality of the interaction that occurs [32]; in this case, the interaction occurs on the screen and directly with colleagues in the group.

The objections to the effectiveness of Online Collaborative Learning presented in a study [28] may be resolved in research currently being conducted. Incorporating online collaborative platforms onsite through blended learning methods enables students to conduct individual student reviews, peer reviews with group members or other groups, and teacher reviews. These review activities are reflective stages that occur during studio classes, especially during "reflection on action" phase [48]. When applied on-site, students can conduct reviews directly by providing verbal feedback to their group members. This differs from the case in which it is applied online. When conducted online, one cannot easily see the facial expressions and nonverbal cues of their conversational partners. Viewed from a Community of Inquiry model perspective, this is also in line with the study [30] which states that blended learning demonstrated stronger group cohesion and perceived a higher teaching presence. The use of this online collaborative platform can also demonstrate an emphasis on idea exploration and brainstorming [30] in Idea Generating (IG) and Idea Organizing (IO) [25].

The results of the UEQ in this study indicate that there were not many differences in students' experiences of interacting with the Conceptboard, Miro, or Mural platforms. All these platforms scored the highest Attractiveness attributes compared with the other attributes. This suggests that the Conceptboard, Miro, and Mural platforms provide enjoyable, good, pleasing, pleasant, attractive, and friendly experiences for students when interacting. Information obtained from interviews with students indicated that all the platforms were easy to use and learn. This is consistent with the functional element represented by the pragmatic aspect of the UEQ, which states that the interaction experience with the platform is understandable, easy to learn, clear, organized, efficient, practical, predictable, supportive, and meets expectations.

Based on the findings of this study and considering the TPACK, Community of Inquiry (CoI), Online Collaborative Learning (OCL), and User Experience (UX), a model called the Blended Collaborative Learning (BCL) was developed (Fig. 14). This BCL model describes the relationship between the physical environment (green area) and the digital environment in the form of an online collaborative platform (blue area).

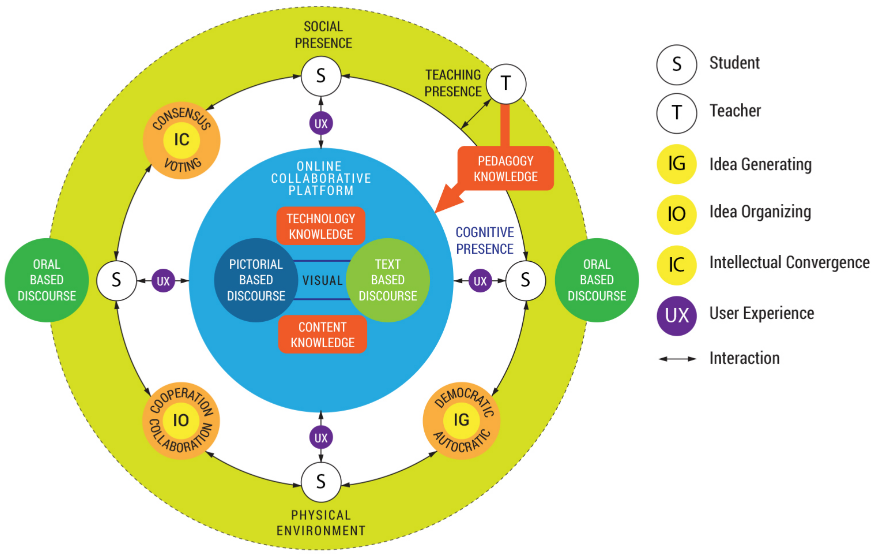

Fig. 14. Blended Collaborative Learning model.

In physical enviroment, teachers provide pedagogical knowledge to students through direct classroom interaction. This concept aligns with the Pedagogy Knowledge (TPACK) while also presenting Social Presence (CoI) in the classroom through interactions with teachers and other students. The discourse that occurs in the physical environment is Oral-based Discourse. Pedagogy Knowledge and Content Knowledge are delivered through the Online Collaborative Platform media, which in this study were Conceptboard, Miro, and Mural. Online media platform is also part of Technology Knowledge, which, together with Content and Pedagogy, forms the TPACK model.

The content of this Online Collaborative Platform is based on a visual approach. There are two types of discourses between students and the content on the Online Collaborative Platform: Pictorial-based Discourse and Text-based Discourse. The visual components of Conceptboard, Miro, and Mural encompass both types of visuals. The process by which students understand the material within the platform is related to the Cognitive Presence (CoI) element.

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The interactions that arise from learning include teacher-student, teacher-platform, student-platform, and student-student interactions. The collaborative process that occurs through the platform and is conducted directly in class involves the stages of Idea Generation (OCL) with democratic and autocratic approaches, Idea Organizing (OCL) with cooperation and collaboration, and the Intellectual Convergence (OCL) stage with consensus and voting. Collaboration is carried out in a blended manner through an online collaborative platform with pictorial-based discourse and text-based discourse, as well as face-to-face with oral-based discourse.

User interaction, in this case, involves students interacting with the display monitor and its interface, giving rise to the concept of user experience resulting from interaction with the platform itself. The quality of the experience that emerges from the interaction depends on the platform's pragmatic, hedonic, and attractiveness (UEQ) aspects.

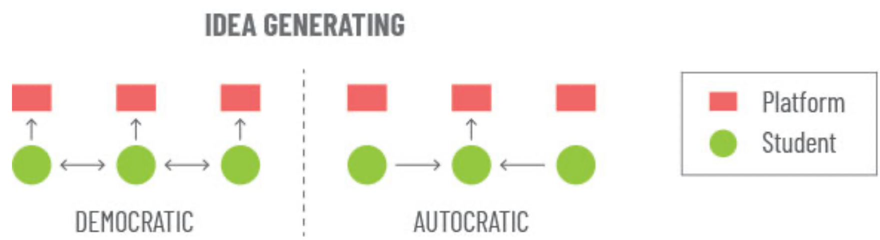

Fig. 15. Idea Generating (IG) stage in BCL model.

Furthermore, the collaboration that occurred is explained in this section. Based on the observations and interviews, the collaborative stages were adjusted accordingly. In the Idea Generating (IG) stage, there are two collaboration methods: democratic and autocratic (Fig. 15). The democratic method allows students to give their opinions on an online collaborative platform on their devices while discussing face-to-face with their classmates. The second is the autocratic method, in which one member becomes the leader and guides the discussion while receiving input from other teammates.

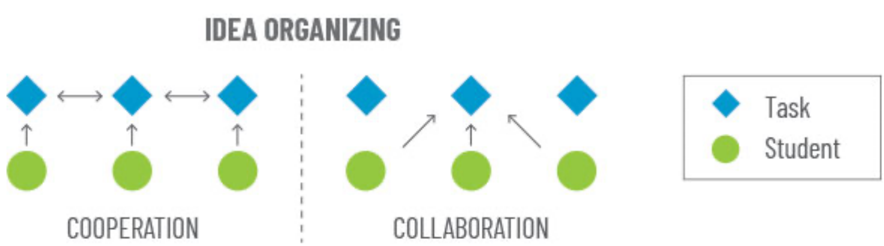

Fig. 16. Idea Organizing (IO) stage in BCL model.

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The next stage is Idea Organizing (IO), which is related to the management of ideas when discussing a problem. From the observations and interviews conducted in this study, two methods of task allocation for managing emerging ideas were obtained (Fig. 16). The first method is cooperation, which is a model of task allocation in which each group member focuses on a specific part of the problem. After each member completes their part, they discuss each other's completed tasks to reach an agreement. The second method involves collaboration. In the context of collaboration, each member focuses on a specific task, discusses it, and attempts to reach an agreement. After completing one task, the group moved on to other tasks.

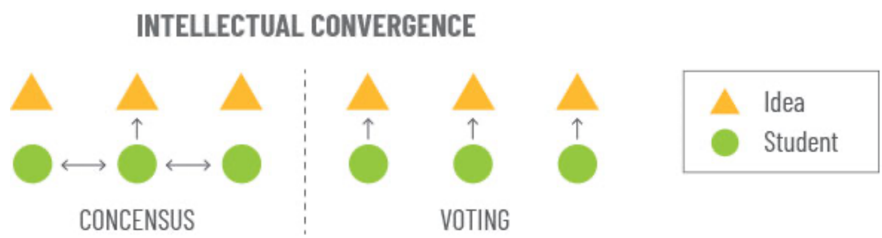

Fig. 17. Intellectual Convergence (IC) stage in BCL model.

The final stage of BCL is Intellectual Convergence (IC). At this stage, each member undergoes a process of reaching an agreement on the opinions or ideas conveyed through the online collaborative platform (Fig. 17). There are two methods to reach this agreement: The first is consensus. Each group member discusses and strives to reach a consensus on the selection of specific ideas or topics. The agreement on the chosen idea was then recorded on the collaborative online platform as a joint consensus result. The second method involves voting. Each member can use these features on a collaborative online platform to select ideas or topics that represent their opinions. Sticker or emoji features or a separate voting feature can be utilized to determine the majority choice of the group. The selection process can be performed by using the devices of each member.

The development of the Blended Collaborative Learning model in this study shows that a blended learning environment can foster collaborative and reflective learning. When positioned within the concept of Open Educational Practices (OEP), the BCL model aligns with the broader educational movement that emphasizes openness, digital literacy, strengthening social learning, and challenging traditional teaching roles [49].

OEP has been developed beyond the mere use of Open Educational Resources (OER) towards learners as active co-creators of knowledge [50][51]. Learner participation using online collaboration platforms is carried out in a physical classroom environment demonstrates the aspects of open sharing, remixing, and co-production of knowledge in interconnected group settings.

Online collaboration platforms such as Miro, Mural, and Conceptboard not only facilitate blended collaboration but also form open learning artifacts; digital footprints that can be revisited, adapted, and used by other students in future learning cycles. This encourages the creation of open-access repositories for student projects and for collaborative outputs.

In the BCL model, teacher orchestrate technology-mediated interactions, scaffold collaboration, and cultivate social presence, aligning with the OEP concept with an open pedagogical approach that emphasizes transparency, dialogue, and student empowerment [52]. The nature of the BCL model combines the convenience of face-to-face mentoring with the scalability and inclusivity of online participation.

6 Conclussion

In general, the theoretical contribution of this study is to integrate three main frameworks Harasim's Online Collaborative Learning (OCL), Community of Inquiry (CoI), and TPACK into a new model: Blended Collaborative Learning (BCL). Furthermore, it offers a new perspective that interactions in learning occur not only in physical or digital spaces but also as designed experiences.

Furthermore, it provides a typology of collaborative interactions (democratic vs. autocratic, cooperative vs. collaborative, consensus vs. voting) that can be used as a reference for analyses in interaction design and collaborative learning studies. The results of this study also demonstrate how the evaluation of learning experiences can be expanded beyond learning outcomes to include interaction quality and platform affordance.

This study makes a practical contribution to design learning by providing a practical framework for lecturers to design blended learning-based studio learning that maintains the strengths of traditional studios (direct critique, non-verbal expression) while utilizing the advantages of digital collaborative platforms (accessibility, documentation, visualization).

The implication for educational institutions is that they can adopt BCL as a standard model for project or studio-based courses, not just those limited to design. The BCL model enables richer peer learning; students not only collaborate offline but also leave a digital footprint that can be evaluated and reflected on.

A limitation of this research is that it was conducted solely on a single course at a single university, specifically involving visual communication design students; therefore, its generalizability to other disciplines is limited. Furthermore, collaboration analysis was conducted on an empathy map assignment; different types of assignments (e.g., prototyping, design evaluation, or complex problem-solving) may yield different interaction patterns.

Further research, including cross-disciplinary research (e.g., architecture, engineering, business, or education), should examine whether the BCL model remains relevant outside the design context. Furthermore, the long-term impact of BCL on student learning outcomes, creativity, and satisfaction should be examined.

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