

TOOLS FOR VIRTUAL BRAINSTORMING & CO-CREATION: A COMPARATIVE STUDY OF COLLABORATIVE ONLINE LEARNING

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ABSTRACT

Collaboration is an intrinsic part of design education. Studies have shown that diversity of skill and composition of design teams is key to innovation and the creation of new knowledge. The unforeseen global coronavirus pandemic precipitated the adoption of many virtual learning tools that existed before but had low uptake. Teamwork and collaboration proved to be one of the toughest stipulations in the forced adoption of online learning. Our study presents a comparative analysis of three web-based applications used for online classes during this period. We recorded insights from the online classes, corroborated by a questionnaire post course completion. We found that easy learnability was a crucial factor for early adoption, but eventually, cross-functional features were given more importance. The flexibility of the tool adopted also affected student learning outcomes. Empathy with teammates and co-creative approaches were the two areas that were found deficient in the absence of live class interactions in the virtual learning mode.

Keywords: online learning, tools for collaboration, design education

1 BACKGROUND

COVID-19 has posed challenges in every walk of life. There have been rapid modifications in daily routines, our ability to work, day-to-day interactions and our social lives. These changes have significantly reduced face to face interactions which has created challenges in direct social communication, and consequently, in our ability to empathize [1].

Education and teaching are fields that have been greatly impacted by the pandemic. Alternative sources of learning have been adopted to mitigate the losses occurring due to the lack of contact classes. Admittedly, this has created opportunities for students to continue learning remotely, but since the efficacy of these new systems remains untested, the degree of success in the reception by students varies [2]. Educators have rapidly innovated their teaching methods to the remote learning scenario, but the adequacy of these systems remains questionable [1]. New didactic methodologies and concepts have quickly emerged to bridge the gap of routine class interactions. While the prevalence of online classes has increased, students of developing nations have suffered due to limited online learning infrastructure [3]. The learning impediment has been formidable in design education, which relies greatly on communication, collaboration, and physical participation [1][4]. There is no easy way to replicate classroom environs that engage students with raw materials, physical prototypes and machinery. However, technology in its modern form has helped improve the quality of classroom collaborations. A host of teaching tools have enhanced the classroom experience, spiked interest in courses and simplified class discussions and correspondence [5]. This study presents a background of collaborative education and its specific avatar in the digital age. We present our findings on various tools that improve collaboration and interactive learning. We compare three virtual applications selected based on course requirements in a short-term period and draw inferences for longer-term strategies for conducting classes.

2 LITERATURE REVIEW

2.1 COLLABORATIVE LEARNING

Much of the theory followed in online educational technologies today is based on older learning models that have suddenly been brought back into focus due to the COVID-19 pandemic [3]. Collaborative learning, in particular, has been a point of convergence across disciplines, especially in vocationally oriented ones like design. Collaborative learning has been defined by Smith and MacGregor [6] as "a variety of educational approaches involving a joint intellectual effort by students, or students and teachers together..."

mutually searching for understanding, solutions, or meanings, or creating a product". The purpose of collaborative learning is the exploration and application of the theory beyond the teacher's presentation and explication [7]. Studies have also found that teachers who use collaborative learning approaches see themselves as co-creators of intellectual experiences rather than 'expert transmitters of knowledge' that lecture-based learning builds [6]. Collaborative learning allows teachers to move beyond the expertise of content and ideas to novel teaching strategies that can promote a larger agenda for learning [8]. Studies have found a positive correlation between collaborative learning and a sense of community, leading to increased information flow, cooperation, support, and greater commitment towards team goals [5]. But perhaps the most basic and most important reason to incorporate collaborative learning in higher education is that it fulfills the basic postulates of the learning hypothesis.

2.2 THE LEARNING HYPOTHESIS & GOALS

The learning hypothesis is applicable to learning in all dimensions, across all disciplines. The postulates are as follows:

1. **Learning is active:** Learning needs active participation in purposeful ways, integrating new knowledge and reorganizing existing mental models. In the context of design education, creation of the new is often a requirement as well [9].
2. **Learning has context:** Contexts of the learning activity greatly influence outcomes. Conventional learning starts with theory and then looks at applications but collaborative learning often begins by setting forth a problem and co-creating solutions, making learners immediate practitioners [9].
3. **Learning is diverse:** Diverse perspectives emerge more clearly in collaborative activities, benefitting both teachers and learners [10].
4. **Learning is social:** Collaborative learning encourages dialog between teachers and learners, and more importantly, between learners themselves. The mutual exploration, and construction of meaning and mental models of knowledge creates a sense of common purpose in learning [10].

These four postulates are fundamental to the definition, design, implementation and assessment of learning. Based on these, goals for learning can be framed. The three major goals are listed below:

1. Involvement

Involvement is both social and intellectual, and exists between students and teachers, as well as between students and their peers [11].

2. Cooperation

Teamwork and involvement with other students and teachers has been shown to improve student retention and successful achievement of learning outcomes [12]

3. Responsibility

A sense of civic responsibility is essential in shaping ideas and values in learners. Dialogue and deliberation are crucial to leading a civic life and existing collaboratively. These goals have evolved over the last few decades, but their basic essence and spirit remains the same; that of creating rounded future citizens [13].

2.3 APPROACHES TO COLLABORATIVE LEARNING

Collaborative learning refers to learning efforts made jointly as a group of learners with the instructor playing a supportive role. Collaborative learning enhances learning experience through working together as well as encouraging learners to take onus in the learning process. Collaborative learning has coalesced with digital mediums in the modern world to give rise to a new pedagogy of Computer Supported Collaborative Learning (CSCL).

The postulates of the learning hypothesis can be implemented through various methods of collaborative learning. Methods like guided design, case study, simulations, discussion groups and seminars and learning communities are some ways collaborative learning can be carried out [14-17]. Problem based learning has been one of the oldest and most effective approaches to learning in design education, building an understanding of complex relationships, and decision making, especially in the face of uncertainty. Guided design has timely feedback loops built into the process. Case studies help build the ability to make valid judgments. Simulations can recreate real experiences with structured role-playing. Learning communities can help correct structural inequalities [18]. What is essential in all these cases is that time is set aside for 'group processing', 'debriefing' and reflection to help make meaning of the experience [19].

In the past, collaborative learning mainly consisted of small sessions in larger courses or modules within the overall curriculum, but the shift to online learning caused it to be a larger part of most courses. Where earlier collaborative activities were designed around smaller groups with structured tasks, the pandemic saw a forcible adoption of collaborative learning models across entire classes in a more spontaneous fashion. The goal in many cases was to participate in the learning process rather than working towards tangible outcomes. This has led to the creation and success of many processual tools for collaborative learning.

2.4 TOOLS FOR COLLABORATIVE LEARNING

Digital tools for collaboration have existed for the past two decades, even though their use was limited to internal users of large corporations. With greater internet penetration and greatly boosted bandwidths, these digital tools paved the way for the rise of online digital tools for collaboration like Miro, Jamboard, Canva, Figma, Lucidchart etc.

Kirschner et al. [20] hypothesized that comparing online collaboration with in-person methods is like comparing apples or oranges. Instead, they suggest an affordance framework for such collaborative learning environments, in tandem with an interaction design procedure for design, development and implementation of the course. The pandemic period has seen many intensive studies on collaborative tools and frameworks to assess them. Hayashi [21] examined collaborative tools in a gaze awareness study based on feedback and metacognitive suggestions provided by a pedagogical conversational agent. They found that application suggestions and sign-boarding eased the learning process and helped improve learning gains. A survey of 360 students in India found that the use of social media and mobile devices had a significant impact on collaborative learning, interactivity with peers, teachers, and its significant impact on students' academic performance [22]. However, digital collaboration tools must be assessed for affective expression, open communication, and group cohesion first [23] as innovation always creates both challenges and opportunities, and the recent spate of digital learning tools are no different.

2.5 CHALLENGES & OPPORTUNITIES

In-depth studies into users' communication and collaboration behavior have found both opportunities as well as barriers to collaboration in online design activities using online whiteboards [23-26]. Some of the most important barriers are listed below:

1. **Time:** Time is an important factor to be taken into consideration in designing collaborative learning. Teamwork in collaborative learning demands time allocation beyond the class hours. There is a constant tension between the process of student learning and content coverage [27].
2. **Assessment:** Assessment becomes a challenge, especially in the case of first-time users, continuous assessment was found to be crucial to effective design activities in collaborative space [28]. Competition and reward systems also need a revamp.
3. **Outcomes:** Research has also found that collaborative learning methods without specific design outcomes can lead to unsatisfactory outcomes [26].
4. **Medium:** In the past experiments with online collaborative learning, students rated

the convenience highly but reported dissatisfaction with instructional strategy and delivery medium [29].

Barriers notwithstanding, many studies have found social, psychological, academic, and assessment benefits of collaborative learning [25]. An exhaustive study of the past two decades of the use of technology in collaborative learning in higher education recommended attention to group composition, community ethos, focus on methods of interaction, task structuring, methods of meaning-making and time management [24]. A landmark study by Gokhale [30] established an undeniable correlation between collaborative learning and critical thinking through increased interest among the participants, higher levels of engagement and thought, higher information retention and greater responsibility towards learning thus making digital collaborative learning tools an effective aid in design education.

3 METHODOLOGY

We made our observations for this study during two courses that were conducted online during the Covid-19 period. The first course was a 4-week module on Interface Design and the second one was a shorter Design Research module. We recorded insights from the online classes, corroborated by a questionnaire post course completion.

We experimented with a host of tools, techniques and methods to modify our teaching style to corroborate contact classes. Substitution and adaptation of assignments and tasks that were lab dependent was a major challenge. At the outset, assessment of the curriculum and re-evaluation of the existing assignments was done. This brought forth objective information about courses, the category of assignments, and the correlation with course outcomes needed for online study mode adaptation without affecting the quality and depth of learning. Design education regularly requires teamwork and collaborative research. Tools such as brainstorming, mind-maps, SCAMPER, Six Thinking Hats are frequently used by designers and design thinkers. The setup usually requires a classroom to break into groups, put forth their ideas and collate the findings towards the end. Conducting classes online with very limited ways to physically collaborate was the second challenge. Internet connectivity for learners residing in remote areas and the presence of devices that are appropriate for class participation were the other major challenges that hampered the flow of classes. A number of learners often used mobile devices for attending classes which were not adapted for collaborative learning tools.

We focus here on analyzing three online learning tools used during these two courses.

I. Jamboard

Many educators rely on using whiteboards while conducting their classes and Jamboard has been a great digital alternative to bank upon. It functions as a smart whiteboard for jotting down quick information. All learners can be involved in the learning process as it makes learning visible and accessible to all participants digitally. We have used Jamboard for social science inputs in design. Social science courses require a fair amount of discussion and debate during classes and assignments. Jamboard as a tool along with Google Meet for class meetings has been an exceptional tool in bridging the gap of classroom collaborations. It helps put ideas across quickly and effectively. The board has a sharing option that helps save notes. Jamboard was a helpful tool in covering theoretical aspects of courses and projects with the additional benefit of being able to save the boards for future referencing. The learners were also able to create their own boards and share it with their peers. This improved class engagement and learners felt more connected to the discussions.

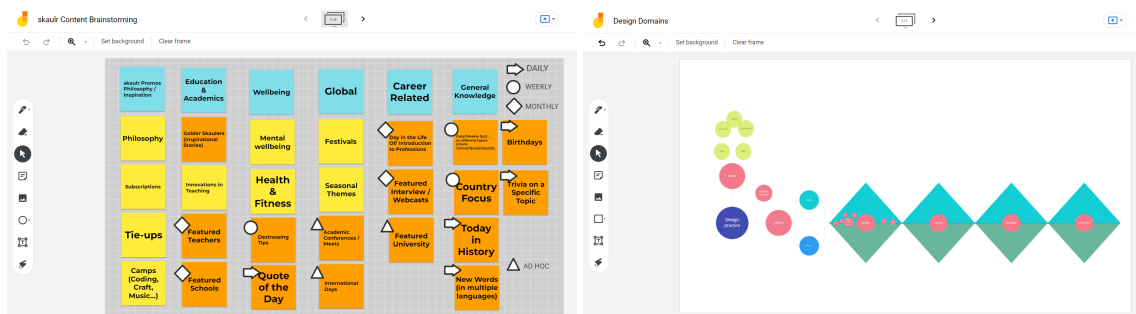


Figure 1: Screen grabs of student Jamboard mindmaps

II. Miro

Miro is an online collaborative white boarding platform which has an important feature of real-time collaboration. The most striking feature of this application is the host of ready templates it offers which can be helpful in brainstorming sessions. During the ideation phase of our projects, we used the templates of mind mapping, Kanban, SCAMPER, What Might We available in Miro. The results were very positive, and it helped in improving the contribution of learners. The classroom sessions while using Miro were extended by an average of one hour due to learners' enthusiastic engagement and participation. The number of learners attending Miro brainstorming sessions was considerably higher than the number of learners attending physical classrooms in general. The learners had

positive feedback for the tool and almost everyone found the interface and navigation easy which piqued their interest and participation.

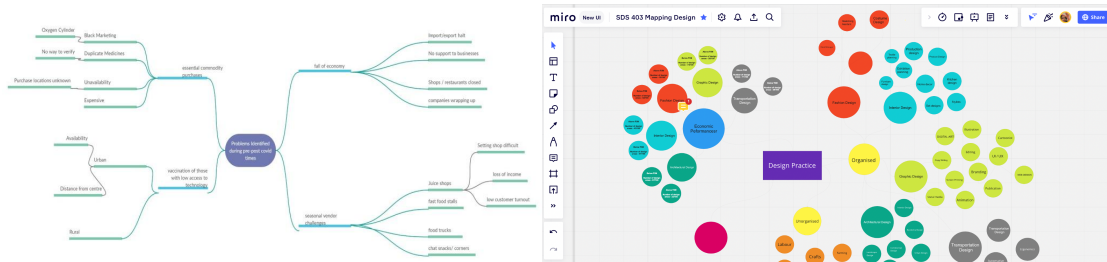


Figure 2: Screen grabs of student Miro mindmaps

III. Figma

Figma is a vector graphic editor and web-based prototyping tool. It has been extremely useful in creating wireframes and mockups of user interfaces. Figma works on a wide variety of platforms and is one of the most versatile cloud-based collaborative tools with real time co-working and tracking. Learners of design use Figma for creating wireframes and user interface prototypes. Its intuitive templates help create UX panels, UI process flows and proto samples of websites or application screens. The learners brainstormed and used Figma to create various applications to alleviate the problems being faced by the general populace during COVID. Figma was helpful in shaping the ideas and concepts into a legible framework for learners' applications and websites. Figma was an important part of the course that required Digital Interface Design with application and website design as a part of deliverables.

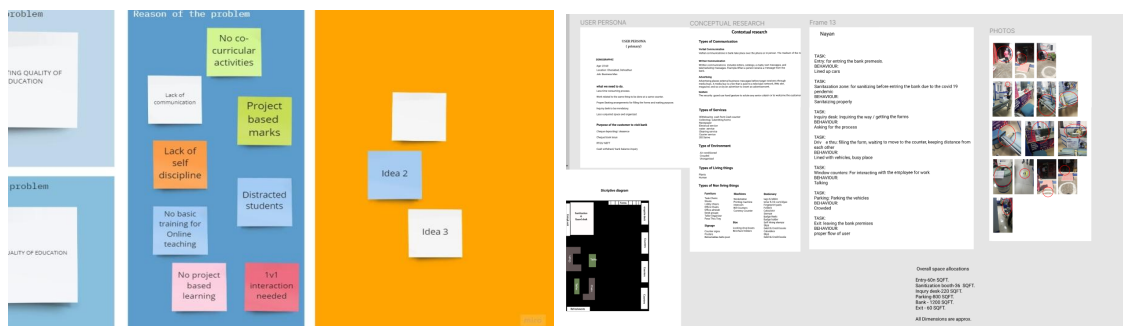


Figure 3: Screen grabs of student idea maps from Figma

In the next section we discuss our observations and insights from the use of the three tools, corroborated by student insights. We reflect upon them in light of the requirements of collaborative learning environments.

4 DISCUSSION

4.1 DESIGN PEDAGOGY

Design education requires hands-on training, physical presence for lab-work, access to physical instruments, equipment, machine tools, digital equipment and different forms of libraries. Educators have faced a dilemma in modifying the curriculum to suit the needs of the restricted access to spaces and resources during the Covid era. Design education requires diverse approaches for different courses. It focuses on an assignment-based approach for learning which is supplemented with relevant theory. All courses require learners' learnings to be presented in the form of assessment-worthy outputs like models, renderings, mockups and product prototypes.

4.2 CHALLENGES DUE TO PANDEMIC

According to the Handbook of Research on Emerging Pedagogies for the Future of Education [31], the COVID-19 emergency has made the teaching community adopt online education, a nascent medium, still experimental in its approach, thereby making it 'the largest-scale internet-based education experiment in the human history' [23]. The most daunting and primary hindrance in teaching design-based courses during the pandemic has been the access to graphic and product design laboratories. Many courses require learners to produce tangible outputs using machine tools and use of resource-heavy software like the Adobe Suite and Autodesk Tools.

4.3 OBSERVATIONS

The general observable impact of collaborative learning via digital medium was the evident improvement in class attendance. The convenience of accessing the classroom from homes improved the participation percentage for all learners. Digital tool usage also led to improved engagement, empathy and understanding among the learners as a group. This has been shown to be conducive to creating positive cooperation and competition in learning in groups. Each tool used during classes contributed to a specific aspect of digital learning. The tools enhanced the experience of learners since they learnt by participation. The involvement of learners was highest during brainstorming sessions as they contributed and built upon each-others' ideas through mutual discussion. Connectivity

issues and lack of motivation due to non-contact classes were the bottlenecks that were the hardest to overcome. Each tool that was used contributed in a unique way. Jamboard was an easy replication of the whiteboard which is used frequently by educators. Miro replaced contact class brainstorming sessions with easy templates and real-feel Post-it notes to create a class whiteboard scenario. Figma transcribed printed and hand created wireframe notes into digital form. Table 1 below sums up the functionality of the 3 applications we compared. When we compare the applications on the postulates set out in the learning hypothesis, we found the three applications were comparable, but Figma had an edge due to its larger offering of digital design applications over the primarily whiteboard functionality of the other two applications. Jamboard was the most basic and easiest to learn so students adopted it easily, but we found many switched to Figma as the course progressed.

	Figma	Miro	Jamboard
Primary Purpose	Specialist platform to create, test, and deliver digital design collaboratively in cross-functional teams with whiteboard feature	Collaborative whiteboard for cross-functional teams to brainstorm and visualize ideas with diverse plug-ins	Collaborative whiteboard with Google optimized handwriting and shape recognition tool
Device Access	PC, Tablet and Mobile	PC, Tablet and Mobile	PC, Tablet and Mobile
Cost	Free for 1 project (Full version Free for Students)	Free for 3 project boards	Free
Involvement: Cross-functionality	Brainstorming and Design	Brainstorming only	Brainstorming only
Involvement: Learnability	Needs familiarity with Interface	Needs familiarity with interface	Uses universal Google Apps functionality
Cooperation	Real time, across platform	Real time, across platform	Real time, after saving
Responsibility	Shared	Shared	Shared

Table 1: Comparison of applications on learning criteria

5 CONCLUSIONS

The most significant aspect of collaborative learning has been the forced yet radical shift it has brought from conventional classroom-centered learning. We differentiate collaborative learning from the webinar-based delivery that some educational institutions have adopted. We contend that it is a mere digitization of classroom lecture-based formats. We focus instead on emergent collaborative learning processes in digital spaces. Collaborative learning challenges many long-held assumptions about conventional teaching and learning. Participation in collaborative learning demands more complex roles and responsibilities by both teachers and students alike. The online classroom is transformed into an interdependent community with complex social interactions. It creates shifts in the power relationships of all the participants, which needs a mental model reset. The conventional teacher-centered, information-transmission model of teaching and learning has received a forcible reboot. The public nature of the interactions enriches the teaching and the evaluation process but also causes complications when traditional structures of learning collide with modern-day requirements.

At the same time, we found that collaborative learning facilitated reflection and metacognition in all participants. Students strove to be heard equally in group work, and there was a healthy sense of competition among them. In our experience, digital learning may not be comparable to contact classes, but it can be augmented with collaborative tools that help in collating ideas in real-time. Early adaptations like usage of software applications and working together in real-time will pave the way for future experiments and innovations in the field of remote education. At these early stages of remote learning and digital social interactions, trial and error, experimenting with digital tools and constant feedback and analysis is the way forward to improve and enhance the online learning experience.

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