Augmentation of Collaborative Learning for Design (Engineering) Subjects in Remote Learning

V.R.V. Winson[1*], S.T.V. Narayana[2], S.V. Sailaja[3] and A.M.N. Kashyap[4]

1. *Depth of HBS, GET, GIT Institutions, Rajahmundry, India*
2. *Sri Soma Constructions & Consulting, Eluru, Andhra Pradesh, India*
3. *Teesside University, Middlesbrough, United Kingdom*
4. *Jawaharlal Nehru Technological University-Hyderabad, Telangana State, India*

Corresponding Author: slj228@gmail.com

Abstract

Learning involves sub-skills and socio-cognitive domains that are integrated into the foundation of other learning processes. Current knowledge production involves shared cognitive responsibility and active engagement by learners in a group to create and exchange new theories and information using online platforms. COVID-19 has led the education sector to develop creative approaches to prepare students to reach global standards and address critical societal challenges. Educators must establish a supportive environment for students to acquire knowledge and enhance their abilities. Forming student learning groups (SLGs) is a wise choice to promote collaboration in conventional educational environments. However, more details regarding its application in remote learning are required. Efficient collaborative learning methods are crucial for studying online design-oriented fields such as civil and mechanical engineering. This article elucidates how to impart basic learning concepts to children. Examining the appropriateness of collaborative learning in particular design-based courses requires evaluating the importance of self-efficacy and group work skills and exploring theoretical concepts, virtual laboratories, and small projects supervised by educators adhering to the Board of Indian Standards (I.S) Codes. This article proposes essential measures to address specific obstacles in the education system. The study's results suggest that students' openness to online collaborative learning is significantly impacted by their attitude toward online learning and their level of expertise. The assessment results indicated that the incorporation of online collaborative learning (OCL) had a good impact on their overall development in terms of topic knowledge.

Keywords: Design Based Subjects, Learner's Attitude, Online Collaborative Learning, Student Learning Groups.

Introduction

The COVID-19 pandemic led to a shift from traditional in-person teaching to online methods (Rahman, 2023), prompting students to utilize virtual platforms for learning (Curtis, 2001; Hilliard, 2020). Encouraging students to engage in practical knowledge-building tasks through online learning platforms has led to growing challenges related to financial (Robinson, 2013), demographic (Fung, 2004), sociological (Capdeferro, 2012), and environmental factors that require more investigation (Ahmed & Kumalasari, 2023; Q. Wang, 2010). Thus, students need to develop particular cognitive skills (Santiago et al., 2023), including analytical skills (Hadnagy, 2010), creativity (Beyer et al., 2016), and teamwork skills (Decock, 2021), to tackle urgent concerns effectively (Pradana & Uthman, 2023; Strauß, 2021; A. et al., 2014).

Individuals can exchange knowledge and address communication challenges with other group members through collaborative learning activities rooted in a socio-cultural framework (Alzain, 2019; Jayakodi, 2016; A. Wise, 2011), where knowledge is collectively created (Liu, 2021). Collaboration among students has become increasingly important in today's knowledge society to enhance knowledge production processes and applicable skills (Hadwin, 2018; Suwantarathip, 2014; Vedianty et al., 2023). Collaborative learning is essential in effective teaching since it allows students to discuss and exchange thoughts on a subject from different viewpoints, improving skills development.

Utilizing advanced technologies is critical in promoting collaborative learning and supporting collaboration and sharing situations (Hou, 2011; Su, 2019; Utomo et al., 2023). An exemplary educational institutional model that uses computer-supported collaborative learning (CSCL) technology

is "Knowledge construction," also known as knowledge creation (Angelova, 2016, page number), which contributes value to society (Henry, 2012; Laila et al., 2023). Building knowledge has developed as a positive teaching method in online collaborative learning (Chuang, 2016; Yücel, 2016). Knowledge building is a collaborative process that generates and creates ideas within a particular environment and circumstances (Nasiha et al., 2023). During the construction of knowledge, learners may perceive new information as troublesome and need clarification (Choirudin et al., 2023). The results from several research indicate that expertise is developed through collaborative efforts among group members and that shared knowledge is improved through discussions.

Knowledge construction is now called "knowledge creation" (Arif et al., 2023), which combines the concepts of "knowledge acquisition" and "participation" in learning, blending cognitive and situational aspects (Zahroh et al., 2023). Instructors bear the primary task of equipping learners with the necessary skills to generate valuable knowledge and become proficient participants in collaborative learning. The knowledge-constructing theory is a beneficial pedagogical strategy to prepare learners for online collaborative learning (Winson et al., 2023). This theory emphasizes the significance of acquiring knowledge in collaboration with society and outlines what learners need to achieve to enhance their learning abilities through debate.

Engaging learners in constructive discussion is crucial for developing new understanding in collaborative learning (Cahyadi et al., 2023). The learning process involves sub-skills and socio-cognitive domains that are integrated into the basis of other learning processes (Castro, 2019; Hernández-Sellés, 2019; Noguera, 2018; Rooij, 2016; Mangosteen, 2019; Widyahastuti, 2017; Xie, 2018). The current understanding of the knowledge production process includes shared cognitive responsibilities and active participation of learners in a group to develop and exchange new theories and information via online platforms (Perera, 2009; Zhang, 2021).

This impression has grown with the emergence of an online collaboration and knowledge forum. Networked learning environments are created by incorporating socio-cognitive and socio-technological factors to support knowledge development within the group members. These investigations and conclusions suggest that online-supported collaborative learning is a practical pedagogical method for constructing knowledge. The current project aims to create a new method called Online Collaborative Learning (OCL) for civil and mechanical engineering disciplines related to design, which necessitates a broad range of skills and knowledge.

Materials and Methods

Figure 1 displays an overview of the development of the new Online Collaborative Learning (OCL) technique.
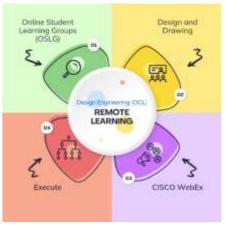

Figure 1. OCL Technique: Remote Learning

Figure 1 outlines the new technique developed for Online Collaborative Learning (OCL) in this document (Fathali, 2018). The method was selected based on the understanding that the learning process includes sub-skills and socio-cognitive domains incorporated into the foundation of other learning processes. Contemporary comprehension of the knowledge creation process necessitates collective cognitive accountability and engaged involvement of learners in groups to generate and share new theories and information through online platforms (C. et al., 2011). COVID-19 has compelled the education sector to develop creative approaches to prepare students to meet global standards and tackle significant social challenges. Figure 1 illustrates the division of the entire class into Online Student Learning Groups (OSLG) groups to reach specific goals (Oliveira, 2011). The topic selected for applying OCLG is Design and Drawing of Reinforced Concrete Structures. The internet platform utilized for delivery is CISCO WebEx. Teams will be formed online by grouping individuals from classes with an average size of 40 into four groups (Zhao, 2014). Students in each group were chosen according to their academic achievement in previous semester evaluations and diagnostic exams aligned with course prerequisites.

The subject selected for diagnostic testing is Advanced Concrete Technology (Wendt, 2014). We categorize all involved students based on the average score of the two selected instruments (Yilmaz, 2020a). We encountered a division among the instruments we examined. Each group comprises one individual with a score beyond 80%, two with scores between 65-80%, and one below 65% (Wendt, 2015). The requirements for group segregation aid in normalizing and establishing a pleasant learning environment to facilitate active participation in all planned activities. This grouping system also aids in monitoring each individual. Thus, personal responsibility and accountability are present. These groups

promote teamwork, ensuring students a stress-free experience. This grouping method categorizes students as fast, medium, and slow learners to create balanced teams and a motivating learning environment. Slow learners benefit from interacting with peers in their group, leading to productive discussions.

Each planned activity was scheduled to last for 1 hour for every group under comparable and optimal online circumstances. Students are exposed to problem-based learning at the start of the session. Students must then collaborate in their designated groups, engaging in essential conversations and implementing various principles to generate the desired concepts. Students are evaluated by utilizing collaborative learning methods, unconditional deadlock, and individual performance in group work. The group's overall performance is determined by calculating the average individual scores, such as 20/20, 18/20, 19/20, and 15/20, received by each student (Yilmaz, 2020b).

Results and Discussion

Online Collaborative Learning (OCL)

Online Collaborative Learning (OCL) allows students to collaborate and gain knowledge effectively (Lin, 2022; Muhammad et al., 2023; Nurdiansah, 2019). Individuals are encouraged to seek new ways to improve their problem-solving skills in real-life scenarios. Teachers are essential in the OCL process, along with students. Pututilization serves as a connection to a community of knowledge. Modern technology and tools are crucial in OCL (Hasanah et al., 2023; Lee, 2015; Sandy et al., 2022). The latter should function as a means for both synchronous and asynchronous communication. An engaging application of social media for exams. It can improve the OCL process by adding enjoyment, creativity, and liveliness.

Online Collaborative Learning (OCL) Concept

Harasim's OCL theory delineates three essential stages in knowledge advancement. These are: a) students collaborate and engage in brainstorming sessions during idea generation. Organizing requires analyzing and categorizing. Managing ideas entails examining and classifying the concepts formed earlier (Ellis, 2016). b) Collaborative intellectual synthesis involves students working together to produce a shared output, such as an essay or assignment (Splichal, 2018). This process is crucial for developing ideas and building knowledge. Following these stages will lead students to the Final Position. Understanding that the OCL is constantly susceptible to revision and will never be deemed final is essential. Students are consistently gaining knowledge and improving their skills.

Traditional vs. Collaborative Learning Concepts Comparison

Online learning occurs virtually, whereas traditional learning occurs in physical classrooms. Both teachers and students are physically present in this situation (Lestari et al., 2023; Yulianeta et al., 2024). In a conventional classroom setting, students can openly discuss their inquiries and ideas with the teacher and classmates. Although traditional learning remains popular, certain obstacles must be overcome. An ongoing concern is the enduring worry related to tests. Usually, youngsters go to school and study to attain high grades. They concentrate exclusively on grades and must ensure to gain knowledge. OCL, in contrast, encourages the development of critical and creative thinking. It also provides extensive scholarly information (Farhin et al., 2023; Farida et al., 2023). In 2009, a report by SRI International for the Department of Education concluded that students who participate in online learning tend to get better academic results than those who receive traditional in-person education.

Sure, students may need help overcoming cultural obstacles when engaging in OCL. Students frequently have varied cultural backgrounds stemming from their distinct origins throughout different places worldwide. Instructors must be aware of any linguistic or cultural obstacles students might encounter. Additionally, teachers may require help with online educational systems. Christine Greenhow, an educational technology professor at the College of Education, stressed the significance of instructors prioritizing their main goals and utilizing technology to achieve them. Educators cannot convert textbooks and lessons into digital formats and expect the same or better learning results.

Developing Online Collaborative Learning (OCL) in India

The OCL design was chosen to incorporate sub-skills and socio-cognitive domains fundamental to many learning processes in India. Current understanding of how knowledge is created requires groups of learners to actively participate and take responsibility for their collective cognitive efforts in generating and sharing new theories and information on online platforms. COVID-19 has forced the education sector to create innovative methods to equip students to reach international standards and address significant societal issues. Educators must create a helpful environment for pupils to gain knowledge and improve their skills. Establishing student study groups (SLGs) is prudent to encourage collaboration in a traditional educational environment (Zamzam et al., 2023). More information is needed about the application of distance education (Ahmed & Kumalasari, 2023). Efficient collaborative learning design is essential for studying online design-oriented disciplines such as civil and mechanical engineering. It comprises various stages:

1. Foster lively discussions among students. Because the activity lasted one hour, a new conversation topic was introduced to the groups every 10 minutes—each group's leader. Enhance student engagement by providing concise 10-minute assignments during class and awarding points or grades based on the assessment. This strategy fosters a good gaming environment as students are motivated to win. This strategy keeps conversations among pupils lively.

2. Motivate inactive members to engage Within the first 10 minutes of the activity, non-participating individuals were efficiently excluded as the top students in the group assigned assignments to others with motivation and guidance. Brainstorming sessions encourage ridesharing among students and boost learning through questions. Group members are actively involved, and a competent leader emerges, allowing the instructor to act as a facilitator.

3. Unconditional Deadlock occurred during short exercises every 10 minutes, specifically between the 4th and 10th minute, around the 40th minute of a 1-hour class, when students could not discuss questions due to congestion. We will start explaining the idea using the course materials provided to the participants. Students can engage in the debate within the groupings specified in Table 1.

Table 1. *Group -Wise Scores (GWs) of Students in the Class.*

Team Number	No. of students participated.	Max.Marks	TeamScore	Total %
1	4	15	15	100
2	4	15	14	94
3	4	15	13	87
4	4	15	14	94
5	4	15	12	80
6	4	15	14	94
7	4	15	14	94
8	4	15	15	100
9	4	15	14	94
10	4	15	15	100

In Table 1, the median score for specific student groups was 14. Critical points on activities necessary to attain this score are outlined in the table showing group-wise scores of students in Table 2.

Table 2. *Critical points on activities Group -Wise Scores (GWs) of Students in the Class.*

GroupNo.	The team performed better than the median score (yes/No/Equal)	One of the most crucial reasons for a group's performance
1	Yes	One of the students in this group, the superior performer, was engaged and eager to impart his expertise to the other members. As a result, there was strong communication and learning within the group, contributing to the team's success.
2	Equal	One student was very engaged in this team and eager to impart his expertise to the others. As a result, there was strong communication and learning between the two, and the team worked effectively. One error was discovered in the test, and I was given a final score of zero.
3	No	One person who stood out as a good performer in this team was active and communicated well with the others. As a result, the group's learning and expected cooperation took place, leading to high performance. The team received two fewer points for the quiz's errors.
4	Equal	A student in this group, known as the Good Performer, excelled in every subject and desired to impart his knowledge to his peers. The group learned well-coordinated information and hence performed effectively. They made a mistake on the quiz and received one less point.
5	No	All of the team members in this group made the same error during the quiz. It must have happened due to widespread misunderstanding of the issue concerning the program. As a result, their performance was determined to be below the median.
6	Equal	One student who did well on the team was highly engaged, contributed effectively to the conversation, and shared expertise with the other members. The crew worked effectively together and learned new things due to these improvements. They lost one point for each quiz error they made.
7	Equal	One student who performed well on this team was highly engaged, contributed generously to the debate, and helped others by sharing their knowledge. The team did well because there was more group cohesion and learning. They received one point less for every quiz error they made.

8	Yes	This group came out on top in nearly every category. The group leader thought it was a great idea and worked hard to get the other participants interested in the conversation and contribute their knowledge. Because of the two's practical cooperation and mutual learning, the group performed well and received a total score.
9	Equal	An individual stood out in this team as being very engaged in conversation and effective at imparting knowledge to others. As a result, there was strong communication and learning between the two, and the team worked effectively. However, they lost one point from their final total because of a single quiz error. This team found it relatively better.
10	Yes	This team came up with results that were generally better. The group leader thought it was a great idea and worked hard to get the other participants interested in the conversation and contributing their knowledge. Because of the two's effective cooperation and mutual learning, the entire group performed well and received a full score.

Feedback was collected from students after completing the class activities to identify individual experiences, draw inferences, and make relevant improvements to the group's approach. Table 3 provides a clear representation of the feedback obtained from various groups**.**

Table 3. Feedback of students

GroupNo.	No. of students participated	Student Feedback/Comments
1	4	We were attracted to this online collaborative learning practice an discussions; this approach made us identify critical concepts an resolve some deadlocks.
2	4	With this approach in the online learning process, we found th method is more practical than the previous conventional onlin teaching process for design subjects.
3	4	This model gave us a better understanding of design-related problem
2	4	The learning environment in the online class was relaxed, which helpe us to feel comfortable learning.
2	4	we appreciate the teachingstrategies which provide us w i t h a ver It is an exciting and informativecourse.
2	4	we were not confident taking thisclass when it was first described t o us. However, the classwas exciting and motivating, and we are glad to enrol.
2	4	We prefer the department these lines as these are interesting an could be pretty helpful to me in the future.
8	4	It gave us the best chance to improvemy public speaking skills.
9	4	We were not sure of taking thisclass when it was first described. However, the class wasexciting and educational, and I'm glad I was enrolled.
10	4	This class gave us an understanding of design-related problems

According to the results, online collaborative learning was adopted in response to the abrupt closure of educational institutions during the COVID-19 pandemic. This research aims to assess the effectiveness of collaborative learning in an online setting, particularly in design subjects where cooperative learning is traditionally used. The research demonstrates that students value the collaborative learning method when conducted online. This study indicates that collaborative learning and teaching online generates significant interest among students compared to virtual sessions conducted individually online. Online collaborative learning was adopted in response to the abrupt closure of educational institutions caused by the COVID-19 pandemic. This method is deemed efficient when applied to design subjects in traditional teaching.

This research aims to assess the effectiveness of collaborative online learning. The median score of the student group exceeds the average for the selected and executed subjects. Student feedback indicates that courses using online collaborative learning with a group dynamic are engaging. Even for educators, it is highly

educational and significantly beneficial. Moreover, this study demonstrates that students believe they have acquired proficient communication abilities in essential civil engineering classes. The results indicate that students have embraced the principles of online collaborative learning, teamwork, and discussion in online classrooms. They also recognize that enhancing communication skills will be advantageous for their future. Engineering faculty should utilize these tools to initiate the development of online collaborative teaching, learning, and teamwork in their courses. Practitioners or instructors should be aware that future graduates may seek to use these notions in their professional environments. The results also corroborate previous research on the efficacy of this learning paradigm in mathematics education, including studies by Karim & Zoker (2023), Retnowati et al. (2016), Schabas (2023), Ulia (2018), (Suharsiwi et al., 2023), Wawan et al. (2018), (Nursaid et al., 2023) and Karimah et al. (2019).

Based on the research results, secondary school and university educators should explore implementing collaborative learning approaches in mathematics education. Joint learning activities focus on promoting mutual understanding, respect, accountability, and tolerance among group members. Implementing the cooperative learning model enhances students' comprehension and attitudes toward mathematics by allowing them to explore online learning resources collaboratively, thus optimizing their critical thinking skills. An educator's function as a mediator is crucial for optimal development of students' mathematical skills. Student collaboration is vital, allowing them to choose the study material, offer learning support, and assess each other. Online collaborative learning has had a beneficial impact on student growth in both cognitive and affective areas.

Conclusion

The reason to adopt online collaborative learning is due to the sudden closure of educational institutions due to the advent of COVID-19, and with the utilization of cooperative learning in the conventional teaching process for the design subjects, it was found to be efficient, and subsequently, in this study, an attempt is made to identify the effectiveness of collaborative learning in online mode. This study result suggests that students better appreciated the adopted Collaborative learning approach online as they were shown much interest throughout the program via collaborative learning and teaching online, even when compared to virtual sessions in isolation of the entire team. The reason to adopt online collaborative learning is due to

the sudden closure of educational institutions due to the advent of COVID-19. The utilization of cooperative learning in the conventional teaching process for the design subjects was found to be efficient and frequent; in this study, an attempt is made to identify the effectiveness of collaborative learning in online mode. For example, the evaluation of student group median scores was above the average for the selected and executed subject. In addition, the student feedback/comments indicated that courses with online collaborative learning in a group approach are interesting. Even in the case of the teachers, it is so informative and much more helpful in the coming days. Further, the study suggested that students perceive they have mastered communication skills in their necessary civil engineering courses. The results further indicated that the students accepted the concept of online collaborative teaching and learning, teamwork, and discussion in the online classroom. They also perceived that the development of communication skills would be a benefit to them in future endeavours. It is time for the engineering faculty to utilize this resource and initiate the growth of online collaborative teaching/learning and teamwork in the courses under their direction. Practitioners or instructors must also recognize that future graduates may wish to apply these concepts in their workplace.

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