IJRAR.ORG E-ISSN: 2348-1269, P-ISSN: 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) | IJRAR.ORG

An International Open Access, Peer-reviewed, Refereed Journal

Collaborative Learning in Digital Environment

Dr Swasti Srivastava

School of Life Sciences and Biotechnology, CSJM University (Formerly Kanpur University)

Abstract: Collaborative learning involves group interactions in real time to handle learning tasks at hand. The evolving needs of professional sectors have moved learning in traditional classrooms to blended environments enabled by collaborations across the globe. These changes have made learning flexible, self-paced, and structurally monitored and outcome based. The collaborative learning in digital environments involve computer supported cooperative and peer learning. The digital learning environments are characterized by interactivity, synchronous and asynchronous communication, autonomy and sharing of digital spaces. Various digital tools and platforms like Slack, Microsoft teams, google workspaces, Jamboard, Quora etc. are used for communication, document and project management, discussions. Activated learning, global reach, connectivity, inclusivity and development of interpersonal skills are some of the benefits of collaborative digital learning. However, the challenges encountered in digital learning experiences may span across technological issues, individual competency to digital interfaces, isolation, participant privacy and infrastructural facilities. The pedagogical strategies to minimize these challenges would be to select appropriate tools to blend the benefits of traditional and digital learning environments, include diverse voices equally, building digital competencies, promoting peer learning and fostering digital citizenship. The success stories of basic schools, higher educational institutions, research groups, and professional training institutes in implementing collaborative digital learning are validations of theories given by Vygotsky, Collins, Topping and other educators. The future of digital learning environments lie in integration of artificial intelligence, virtual classrooms, internet of things, data-analytics, and advanced interactive collaborative tools. Social and emotional learning platforms should enable accessibility and inclusion to nurture ethical digital characters. The adoption of collaborative digital tools in diverse learning situations is inevitable for building team consciousness and a highly efficient society.

Keywords- Digital literacy, collaboration tools, learning outcomes, pedagogical studies, asynchronous learning

1. Introduction

The COVID-19 pandemic changed the perception of different sectors and their importance in human welfare. Education was such a sector which faced major challenges related to teaching methods, student engagement, and resource optimization. The classroom teaching was adversely challenged by the pandemic (Alsayer, 2023). The digital innovations addressed these challenges by transforming learning, student interaction and collaboration. A global shift from traditional to digital methods offers new opportunities for students to engage with peers, teachers and use resources beyond physical classrooms. Collaboration in education is vital for several reasons, as it promotes deeper learning, enhances skill development, and prepares students for real-world experiences (Maraza-Quispe et al, 2019). It promotes student-faculty interaction, student retention, self-esteem and responsibility.

1.1 Definition of collaborative learning- Collaborative learning (CL) is an educational procedure where individual learners work in pairs or groups to accomplish common learning objectives by solving a problem, completing a task or creating a product (Laal & Laal, 2012). Students tutor each other by addressing grouping misunderstandings and clarifying misconceptions, organizing and managing resources by themselves. The process actively engages the learners and each member of the group works with their own skill sets to promote the group**.** It gives the opportunity to put forth individual viewpoints on a topic and gain an understanding of

how others perceive the same topic. Collaborative learning is an active educational approach that emphasizes teamwork and collective problem-solving.

1.2 Shift to digital environments- Traditionally collaborative learning involved face to face interaction providing immediate feedback and non-verbal cues which enhanced communication and understanding. The learners interacted in a disciplined and focused classroom environment with hands-on activities. The monitoring of group interactions and participation was convenient. A transition has been observed from face-to-face activities to the use of global reach of internet and mobile technologies to create more inclusive, diverse and interactive learning experiences. The transition from traditional to digital settings was fast and inevitable. Learners could interact and co-create from different time zones, at their own pace and engage in problem-solving in innovative ways through video conferencing, shared documents, discussion forums and collaborative softwares (McCarthy et al, 2023). As for other pedagogical strategies, collaborative learning has its own set of challenges including digital literacy, access to technology and student engagement (Qureshi et al, 2023). The digital tools are reshaping collaborative learning; the benefits and challenges that arise from this transformation help educators to effectively integrate digital collaboration into modern learning environments (Kwiatkowska & Wiśniewska-Nogaj, 2022). A blended approach that combines aspects of traditional as well as digital environments can provide the best of both worlds.

1.3 Impact of digital technologies on collaborative learning- The digital environment for collaborative learning led to blending of online platforms, digital tools and virtual classes to improve group based learning experiences across geographical boundaries and diverse student groups. The connectivity and accessibility enabled students and professionals to work together, regardless of their physical location. The digitisation of learning fostered communication and knowledge sharing in real-time or asynchronously enabling flexibility in collaboration (Stahl et al, 2006). The development of diverse tools like google docs, Microsoft teams, slack and tools for project management have streamlined information sharing, task coordination and feedback management (McCarthy et al, 2023). These tools often include features like version control and real-time editing which have facilitated smoother collaboration.

Digital technologies offer multiple modes for communication viz. text, video and voice allowing more significant and effective collaboration nurturing different preferences and needs. The interactive platforms like Moodle, Canvas and Blackboard have provided spaces where learners can effectively engage in discussions, group activities and access resources for participatory learning experience. The documentation of participation, contributions and achievements was a challenge before the digital technologies were implemented in education. The advanced analytic tools now facilitate educators and team leaders to assess collaboration effectiveness and provide targeted support (Wang et al, 2024). The breakdown of geographical and temporal boundaries enables learners and professionals to associate with peers from around the world, bringing diverse perspectives and ideas into the collaborative process. It nurtures critical thinking, communication, teamwork, and problem-solving skills, making it a valuable approach in both academic and professional contexts. The gamification approaches and interactive simulations enhance engagement and motivation, making collaborative tasks more enjoyable and effective (McCarthy et al, 2023, Boateng et al, 2024). The digital technologies allow for scalable collaboration, accommodating large groups and projects more easily than traditional methods. Overall, these technologies have made collaborative learning more flexible, efficient, and inclusive, enhancing the learning experience for everyone involved.

2. Theories and Models of Collaborative Learning:

The understanding of the concept of collaborative learning resulted in formulation of various theories and models. Theories of collaborative learning focus on how learning occurs through social interaction and shared experiences, while models provide structured approaches to implementing collaborative activities in educational settings. Both aspects are essential for creating effective collaborative learning environments that enhance student engagement and understanding.

2.1. Theories of Collaborative Learning:

The importance of collaboration in learning was understood and supported by various educationists and psychologists like Vygotsky, Collins, Topping and many others. Some of the remarkable works that finally evolved as theories have been discussed below-

2.1.1. Theory of social constructivism- Vygotsky (1978) proposed theory of social constructivism emphasizing the role of culture and interaction to develop cognitive abilities. He devised the concept of the Zone of Proximal Development (ZPD) where learners achieve more by collaborating with others than they could alone. Social interactions result in formation of knowledge through dialogue and shared experiences. The importance of peers was identified by him who were later introduced by Collins et al (1989) as more-

knowledgeable-other (MKO). MKO works as a scaffold till the learner is enabled to complete the task independently. The learners acquire skills and knowledge by collaborating with MKO through modeling, coaching. The model focuses on identifying expert thinking and promoting progressive learning.

2.1.2. Cognitive Load Theory- John Sweller propounded this theory in 1988 emphasizing on reducing overloading of working memory to maximize learning. The theory envisages students to work in groups for managing distribution of cognitive load across multiple learners. The collaborative interactions help reduce individual load and enhance understanding through shared problem-solving.

2.1.3. Constructivist Learning Theory- Jean Piaget, a biologist by profession, father of constructive view of learning, opined learning is modeling, transforming and understanding the way in which an object is constructed. Effective teaching can be achieved by engaging students in collaborative real-world environments to test their understanding, reflect on different viewpoints leading to deeper learning. Students learn to do tasks rather than simply learn how to do tasks.

2.1.4. Situated Learning Theory- Inspired by the works of Dewey and Vygotsky, Lave & Wenger, (1991) proposed this theory where learners with common interest or practice learned through 'communities of practice'. The concept underscores the importance of social interactions and shared practices in learning and raising more skilled learners for the community. According to the theory, collaborative learning environments mimic real-world settings, challenging students to use critical thinking and kinesthetic abilities. The students are engaged in authentic tasks that foster a sense of community and shared purpose.

Hutchins, (1995) developed the theory of cognition in the wild by amalgamating culture and cognition. According to him knowledge and cognition are distributed across individuals, tools and environments which can be shared and support collaborative learning processes. These theories conclusively accentuated the importance of interaction, social context and shared responsibility to augment the learning experience. The understanding of these theories provides insights for developing effective collaborative digital learning environments.

2.2. Models of Collaborative Learning:

Collaborative learning can be structured in various ways, and several models have been developed to facilitate effective group work. Here are some prominent models of collaborative learning:

2.2.1. Cooperative learning: Cooperative learning is also incorporated at times into collaborative learning. The learners work together with a defined role in the group to achieve shared goals of structured work. Cooperative learning, as per Johnson & Johnson (1998) focuses on positive interdependence, individual accountability, face-to-face interaction, social skills development and group accountability promoting group success. Collaboration is achieved by techniques like jigsaw, think-pair-share and group investigations. In the jigsaw method, each student is assigned the role of expert on a segment of the topic to learn and teach it to other group members. This helps students to trust one another for complete understanding of the topic. The think-pair-share allows students to work in pairs, think and discuss a problem before sharing the insights to a larger group. Students are encouraged for individual reflection, peer discussion and group sharing (Huang & Lajoie, 2023). Alternatively, students can be motivated to cooperatively collaborate in groups to solve complex real world problems for problem-based learning. Critical thinking, self-directed learning and knowledge enhancement is promoted by working in a team.

2.2.2. Peer teaching- Topping (2005) propounded the idea of peer-learning and peer tutoring, enhancing understanding through explanation and discussion. Students take on the role of teachers, explaining concepts or skills to their peers. The process fosters active participation and learning through peer teaching providing personalized support and feedback. This model encourages engagement, confidence building and stimulates collaborative communication skills.

2.2.3 Online collaborative learning: Computer-Supported Collaborative Learning (CSCL) is a more recent concept of utilizing digital tools to support and enhance collaborative learning (Staahl et al, 2006, Gan et al, 2015, Ludvigsen & Steier2019). Technological tools like discussion forums, collaborative documents and virtual classrooms facilitate interaction, communication and joint problem-solving among learners. These provide flexibility, accessibility and opportunities for diverse interactions across geographic boundaries. A distinction was identified between learning "with" and "from" computers leading to development of tools that could improve learning (Kirschner & Erkens, 2006).

In addition to the above models many others collaborative learning models have been suggested worth to be mentioned. Garrison proposed a self-directed learning model integrating self-management, self-monitoring and motivation to achieve worthwhile learning outcomes (Garrison, 1997). Student centered models based on cases help students to analyze real-life cases in small groups by application of practice. The case-based learning models stress on critical thinking, contextual understanding and collaborative analysis to foster discussion and inclusion of diverse perspectives. Similarly community based learning nurtures long

term collaboration among groups of students and teachers focusing on collective learning. Collaborations can also be motivated by creation of collaborative learning spaces like group tables and break out rooms enabling interaction, resource sharing and group support. These models collectively cover various aspects of collaboration, from structured roles and responsibilities to flexible discussions and problem solving. Each theory and model offers unique insights into how collaboration can enhance learning, and they can often be integrated to design effective learning experiences.

3. Characteristics of Collaborative Learning in Digital Environments

Collaborative learning is a dynamic educational approach where students work together to achieve common goals. Collaborative learning in a digital environment is supported by digital technologies which impart distinct characteristics not observed in traditional face-to-face interactions. Some key characteristics are summarized in the following discussion:

3.1. Interactivity- The digital environment gives opportunity to learners across the globe to interact seamlessly. Learners develop communication skills, group tolerance and team-spirit through discussions, problem solving (Huang & Lajoie, 2023). The learners are transformed into active learners rather than passively receiving information. Collaborations help create innovative contents by knowledge sharing among learners from diverse geographical areas and time zones (Wang et al, 2024). Collaborative real-time chats and problem resolutions cultivate responsibility and accountability of contributors for group success.

3.2. Asynchronous and synchronous communication- Collaborative learning with incorporation of digital resources blends the benefits of asynchronous and synchronous communications. Learners interact asynchronously via digital discussion platforms and collaborative tools according to their learning time schedules. Real-time video conferencing, communication tools and chat rooms synchronously facilitate immediate feedback and collaboration (Williams & Augustine, 2015).

3.3. Group autonomy- The collaborative groups work to achieve success for the group. The groups are formed and reformed as per problems assigned to work effectively for results. The digital platforms help to track contributions, progress and success providing autonomy and self-direction to the group (Vembye et al, 2024). The roles and responsibilities are fixed, making each member accountable for their own learning and contributions towards common outcomes of the learning process (Hemingway et al, 2015). The learning is self-paced and managed according to individual abilities and time schedules.

3.4. Shared digital spaces- The collaborative platforms like Google docs, Microsoft teams, discussion forums, and virtual whiteboards empower individuals from different geographical locations and backgrounds to collaborate beyond boundaries (Tan et al, 2022). The contents like videos, images, infographics and multimedia resources can be exchanged over these platforms to support learning and communication (Gan et al, 2015). The information sharing extends reach and inclusivity promoting diverse perspectives and experiences into the learning process. The group interactions are organized, scaled up and managed for better collaborations (Williams & Augustine, 2015).

The characteristics of digital collaborative learning (DCL) emphasize the opportunities and challenges encountered in its implementation. It equips the learners for future challenges so as to contribute effectively in team based tasks. The amalgamation of synchronous and asynchronous activities, technology and meaningful interactions lead to result driven digital collaborations.

4. Tools and Platforms for DCL-

Collaborative learning instills team spirit, critical thinking, communication skills and enhanced learning of subject content. A variety of tools and platforms can be used to facilitate digital collaboration (Tan et al, 2022). The growing need for customized solutions has led to development of many collaborative tools and platforms (Gan et al, 2015). The commonly used tools and platforms with their distinct features and applications are summarized in table 1.

Table 1- Features and uses of different digital tools and platforms. (Herrera-Pavo, 2021, Cherbonnier et al, 2024).

Tools/Platforms		Features	Use
Communication Tools	lack	Organized chat rooms or channels for conversations, integrates many third party services, allows both private and public channels for direct messaging, file sharing.	It can be used in group discussions and project management.
	Microsoft Teams	Allows one to many users to chat through video conferencing, share files, edit documents. Provides small interactive spaces like break out rooms. The platform is integrated with Microsoft Office.	It can be applied to real-time and asynchronous communication among learners and tutors.
	oom	Video conferencing, screen sharing and recording.	Excellent for live discussions, group meetings, and virtual classroom settings.
Collaborative Document and Project Management	Google Workspace (Docs, Sheets, Slides)	It allows real-time document editing, collaborators can add comments, and share resources.	Learners and tutors can collaborate to create content, analyze data.
	Trello	Kanban-style boards, lists, cards, and task assignments make the tool helpful for task management.	Useful for creating content. Tutors are enabled to monitor and manage projects.
	Asana	Task goals for the group can be assigned with strategic plans, and track progress on a single platform.	Managing projects, setting goals, and tracking progress can be made easy.
Virtual Whiteboards	Miro	Virtual workspace that facilitates remote and distributed team communication and project management.	Helpful in collaborative creating and designing of new innovations
	Jamboard	Digital online whiteboard where collaborators create shapes lines or designs with drawing tools, sticky notes, and digital erasers.	Useful for real-time collaboration, brainstorming sessions and visual collaboration among diverse learners.
Discussion Forums	Discourse	Open source online forum with facility of threading, tagging, and moderation of discussions,	Helps in structured meaningful conversations and creation of civilized learning communities.

		live updates, and real-time notifications.	
	Reddit	Features like Subreddits, threaded comments, upvoting/downvoting, and community moderation are incorporated. Blockchain chain backed avatars available.	Useful for community based content creation. Learners are engaged in focused discussion across various areas.
	Quora	Multilingual with large language models	Learners can collaborate to create content by posting questions and answers on a topic.
Learning Management Systems (LMS)	Moodle	Free and open-source with course management, forums, quizzes, assignments, and grading features. Community - sourced plugins are available.	Useful for online, blended and distance learning.
	Canvas	Educator friendly forum for interactions, blended and online teaching, integrating various learning tools.	Provides an environment for improved teaching and learning experience.
	Blackboard	Incorporates digital and real-time virtual class sessions,timely assessments, notifications and reminders for project management class sessions.	Multidimensional learning takes place. Learners have access to personalized information, interactions for efficient learning. Tutors are empowered by AI.
File Sharing and Storage	Dropbox	Integrates teams, content resources and diverse tools for collaborative tasks.	Useful for sharing and storing files among teams.
	OneDrive	Features like cloud storage, file sharing included. The app is integrated with Microsoft Office.	Convenient for storing and collaborating on files within the Microsoft ecosystem.

The integration of these tools and platforms help to cater diverse needs of learners and educators. The advances in technology will help build a digital collaborative environment for better learning experience.

5. Benefits of collaborative learning in digital environments

Collaborative learning has been used to support and enhance the learning experience of learners. The inclusion of digital technologies has transformed the level of collaborative learning by ensuring flexibility, accessibility and equity to all learners. The balance of traditional methods and technology enhances the collaborative experience and learning outcomes. Some of the benefits, but not limited to those discussed here, are summarized as follows-

5.1. Active and facilitated learning- Digital spaces help learners to learn from one another, benefitting from each other's strengths and helping to fill gaps in knowledge (Laal & Ghodsi, 2012). Learners initiate discussions, share ideas and contribute to group tasks promoting deeper and meaningful understanding of content (Hemingway et al, 2015). Peer learning also builds a sense of community and provides emotional support, enhancing the overall learning experience. Peers support and learn from each other's contributions and feedback (Vembye et al, 2024). Digital collaborative environments engage learners in self-paced,

independent work as well as collaborative activities (Abd-El-Fattah, 2010). Learners take different roles in groups, increasing their contribution to the goal helping to sustain interest and motivation in the process.

5.2. Flexibility and accessibility: In digital settings learners can work collaboratively from different locations across different time zones. The work schedules can be set as per learner's convenience, making learning inclusive giving opportunity to learners restricted by time and space barriers. Scalable solutions provide representation to underrepresented learners, which may be not possible in traditional settings (Vembye et al, 2024). The facilitated accessibility fosters global collaboration and fulfills individual learning needs (Sharma et al, 2024). The integration of digital technologies with learning models provides learners access to multimedia resources, digital libraries and online databases (McCarthy et al, 2023). The learning of learners is enriched with customized support and accessible resources. The digital environments are empowered by tools for project organization and management, content sharing and progress monitoring. The collaborations are promoted making tasks organized, time bound and more productive (Lindín et al, 2024).

5.3. Development of interpersonal skills- The future of learning lies in cultivation of digital skill, collaborative teamworks and problem-solving attitudes. Collaborative assignments require students to express their opinion clearly, listen to others, negotiate ideas and solutions and engage in constructive dialogue teaching them empathy, patience, and how to navigate conflicts positively and productively (Johnson et al, 1998). Effective communication tools create opportunities out of different opinions essential for maintaining engagement and ensuring that all voices are heard, instilling better social and emotional skills (Huang & Lajoie, 2023). Digital tools like video conferencing, chat, and collaborative documents facilitate both real-time and asynchronous communication, which can lead to more dynamic and continuous collaboration. Groups regularly reflect on their processes and outcomes, providing constructive feedback to one another to improve future collaboration (Laal & Ghodsi, 2012). Digital tools often provide immediate feedback and documentation of interactions. They support ongoing reflection and improvement by allowing learners to review their contributions and interactions making it easier to build and maintain group dynamics (Vembye et al, 2024). Richer engagement with multimedia, digital tools and platforms develops essential digital literacy skills for the digital demands of the modern workforce and society (Karhapää et al, 2024, Sharma et al, 2024). Learners learn to respect individual privacy, practice positive communication, and engage in constructive discussions ensuring an effective and respectful digital environment for everyone involved (Kwiatkowska & Wiśniewska-Nogaj, 2022). The digital etiquettes foster inclusivity and accountability of all participants for success of group and individual learning.

5.4. Diverse perspectives encourage inclusivity and innovation- The extent of collaboration has been expanded by inclusion of digital tools. The participants from different backgrounds and experiences collaborate to enrich discussions and problem-solving processes by incorporating a wide range of viewpoints and expertise. A combination of different perspectives allows students to think out of the box and come up with novel solutions that they may not have developed independently (Laal & Ghodsi, 2012). The equitable access to digital environments and diverse tools stimulate creative thinking and innovation (Selfa-Sastre et al, 2022). Learners learn to experiment with new ideas and approaches in a collaborative setting. Embracing diversity in digital spaces encourages inclusivity, respect for diverse perspectives and fosters global awareness and understanding of different cultural contexts (Huang & Lajoie, 2023).

The potential benefits of DCL environments are many. The apt mobilization of digital platforms provides dynamic and flexible support in education. It is bound to support learning making it inclusive and accessible to one and all.

6. Challenges in DCL

Every technology with evolving features is bound to become vital in the eras that follow its discovery. However, until all loops and holes are tapped, any new technology is posed to present challenges. Learning in digital environments is no exception and there are some common issues for concern. These issues extend over technological regimes, interpersonal skills, and collaborative coordination.

6.1. Technical issues- Learning in digital environments are dependent on digital connectivity, available software and hardware (Gan et al, 2015). Access to competent servers, software failures and hardware limitations disrupt collaboration and learning. Feedback and fair evaluation are a necessity in digital learning. The assessment of individual contributions becomes complex. Robust technologies and support systems are required for minimizing disruptions, ensuring smooth operations and justified feedback.

6.2. Issues of communication, conflict resolution and team bonding- The digital environments reduce face-to-face interactions giving rise to conflicts due to lack of non-verbal cues, unclear messages. Some learners may not be comfortable with digital tools and platforms creating hindrance to effective collaboration (Matee et al, 2023). Learners feel isolated, demotivated, especially in an asynchronous environment. The diverse

cultures, languages and geographical spaces can affect relationship-building and team bonding (Le et al, 2017). Sensitivity and adaptability to diverse needs of group and individual may fail to foster team spirit and effective collaborative learning. Strategies and tools need to be devised to develop mutual understanding, trust, interest and motivation within the group for inclusive learning outcomes.

6.3.Unequal participation- Many times collaborators are stationed across different time zones which makes scheduling interactive activities and coordinating them becomes a challenge (Qureshi et al, 2023). The continuous support and motivation to be actively engaged in activities is to be provided for balanced contributions among learners. A lack of synchronization among all participants results in unfair role assignment and loss of efficient learning in a team environment (Matee et al, 2023). The careful planning of activities and schedules can help learners to manage better collaborations.

6.4. Overreliance on technology- Excessive use of technology may override the fundamental benefits of collaborative learning (Le et al, 2017). Moreover, the monitoring and documentation by digital tools are a constant threat to learner privacy and data misuse. A balance of traditional methods and digital technologies can lead to holistic educational experience (Herrera-Pavo, 2021).

The challenges of collaborative environments can be resolved by effective planning, clear communication and balanced use of technology. The learners and educators may benefit with scaffolding support through well integrated technological and pedagogical strategies. Mitigating these challenges can have a long term impact on learning and progressive improvement in demanding areas.

7. Pedagogical Strategies for Effective DCL

The role of an educator is to facilitate the learning process. Therefore, to effectively maximize DCL, strategically planned pedagogical strategies in coherence with technology and supportive practices need to be implemented (Assis et al, 2009). Some key strategies that can be recommended for educators are listed in table 2.

Table 2- Summary of suggested strategies, their implementation and impact on DCL. (Alsayer, 2023, Lindín et al, 2024))

Suggestions	Strategy	Implementation	Impact
Define clear objectives and expectations	Specific learning goals, and expected participation, contribution with outcomes are given.	The details of the task, instructions for collaborative interaction, and assessment criteria are communicated.	The participants realize their roles and need for collaboration. Learning becomes focussed and result-oriented.
Select and integrate diverse tools and resources	Different digital tools and resources are chosen, which fulfill collaborative needs of the participants. Tools for data privacy and protection are incorporated.	Tools like Google workspace for document sharing, microsoft teams for communication, project management tools etc should be used for collaborative teaching. Learners are educated about best digital privacy practices.	Learner preferences and needs are taken care of to enrich collaborative learning.
Utilize synchronous and asynchronous learning	Synchronous and asynchronous strategies should be combined for flexibility and real-time collaborative interaction.	Tools like discussion boards, shared documents, and video conferencing should be used.	Real time communication takes place across diverse learning schedules adapting to different learning styles.

Application of active learning	Engage learners actively in structured projects by setting time-bound targets and definitive roles. Facilitate creative thinking and experimentation.	Problem based learning methods, case studies, real-world problems; peer assessment methods should be used. Brainstorming sessions and rewards are given for innovative suggestions.	Learners are prompted to think critically, take decisions and contribute actively to solve a problem. Individual contributions are enabled for fostering group successes.
Scaffold learning and collaboration	Activities are structured to facilitate learners in using digital tools and platforms	Supporting resources like tutorials, templates and instruction manuals should be distributed. Practice and feedback should be provided for digital skill development.	The collaborative interactions become manageable and effective.
Ensure Equity and inclusivity	Provide access to digital tools and resources and opportunities to one and all as per needs and preferences.	The collaborative tasks should be scheduled to include diverse learner requirements, and equitable reach to digital resources.	All learners are able to contribute and benefit from collaborative tasks.
Development of collaborative attitude	Conducive environment for open discussions, feedback, and mutual respect for fellow team members should be provided.	Discussions should be moderated by ice-breaker activities, regular check-ins, and confidence building measures.	Community relationships trust and quality collaborations are promoted. Conflicts are resolved as and when they arise.
Set up Monitoring Evaluation for Feedback and Reflection	Active monitoring is done to provide feedback and reflection on effectiveness of activities. Supportive tools are used for improving performance of both individuals and groups.	Monitoring tools, regular feedback sessions, peer reviews, reflective discussions are encouraged to analyze and address any strategic improvements required.	Fair evaluations help learners to identify their strengths and weaknesses, gaps to be covered so as to promote continuous learning.

The use of above suggestions can help to create an effective and engaging DCL environment. The incorporation of digital innovations with organized and functional pedagogical strategies may help to achieve successful outcomes.

8. Case Studies and Applications of DCL

The application of digital technologies to DCL has changed the learning experience for learners by promoting collaboration, engagement and resource sharing (Ludvigsen et al, 2019). Any pedagogical approach can only stand the test of time with valid testaments and experiences from its institutional beneficiaries. Many case studies and applications of DCL have been reported beyond the regional boundaries citing the success of these strategies in real-world settings (Assis et al, 2009). Some of the case studies across various educational and professional contexts are worth mentioning here:

8.1. Incorporations in K-12 education- A middle school from California applied DCL using platforms like Google Classroom and Padlet and Flipgrid for a project-based science curriculum. Many institutions used Edutopia's "Global Collaboration" initiative to increase collaborations through Padlet and Seesaw tools. Successful global collaborations have been observed by using Minecraft Education and google classroom (Mazzoni et al, 2010)**.** The collaborative projects and problems motivated peers to exchange their resources over digital platforms and synthesize conclusive solutions (Boateng et al, 2024). The students interacted in real-time to present findings and receive instant feedback from participants. This improved understanding of scientific concepts and familiarity with digital technologies.

8.2. Examples from higher education institutions- Tools such as Zoom, Slack, and shared Google Docs were used for group assignments and discussions in an MBA program. The students from diverse geographical locations were required to collaborate on case studies, using shared documents and video conferencing to complete assignments. As expected, increased engagement and incorporation of diverse perspectives was found. Such approaches enhance critical thinking and communication skills fostering a strong sense of community among remote learners (Herrera-Pavo, 2021). Similarly, universities implemented a problem-based learning approach using digital tools like Miro and Microsoft Teams. Students worked in virtual teams to solve complex problems, creating and sharing their solutions through collaborative platforms. The enhanced critical thinking and problem-solving skills, improved teamwork and communication observed were in coherence with suggestions of many workers (Dahal, 2022, Tan et al, 2022). Online Collaborative task proctored by University of Edinburgh commissioned Google Docs and other collaborative writing tools to support group writing assignments. Students co-authored documents, provided peer feedback, and tracked changes in real-time.The task resulted in better writing skills, group assignments and opportunities for learning and feedback.

8.3. Experiments with Massive Open Online Courses (MOOCs, Coursera, edX), Virtual classrooms- Virtual classrooms and science labs have been proposed by many educators (Williams & Augustine, 2015, Paulsen,et al, 2024, Paulsen,et al, 2024). In line with these suggestions, schools from the U.S., UK, and India partnered for virtual exchange programs to engage students in collaborative cultural projects using platforms like Edmodo, Flipgrid, Google Workspace and Zoom. Online simulation tools were used by Stanford University to conduct scientific experiments and analyze data. The experiments with these new tools and digital tools resulted in high level lab experiences, international cooperation, increased interest in global citizenship, and flexibility for remote learning.

8.4. Community Education: TechSoup's digital literacy program was tried for adults, using platforms like Zoom and Google Docs to facilitate digital skills development. Participants were engaged in group tutorials, sharing their experiences and challenges, which boosted their confidence and digital competency (Ludvigsen et al, 2019, Kwiatkowska & Wiśniewska-Nogaj, 2022).

8.5. Research Collaboration: A consortium of universities used collaborative tools (e.g., Zotero, Mendeley) for joint environmental research projects in environmental science Researchers shared resources, co-authored articles, and engaged in discussions across institutions. Harvard University's Berkman Klein Center for Internet & Society utilizes digital platforms like Slack and Trello for collaborative research projects. Enhanced research efficiency, improved communication among team members was observed resulting in increased research output and funding opportunities.

8.6. Interprofessional Learning- University of Calgary integrated DCL in health sciences program to facilitate interprofessional education among nursing, pharmacy, and medical students to collaborate on case simulations using virtual platforms. The outcomes confirmed Männistö's view of improved understanding of each profession's role promoting better healthcare services and gelling diverse professionals into a team (Männistö et al, 2020). International Society for Technology in Education (ISTE) used digital platforms for collaborative practices, sharing resources, and engaging in ongoing learning for professional development of educators. A community of practice as proposed by Lave & Wenger was formed among educators generating development opportunities with simultaneous integration of technology in learning (Lave & Wenger, 1991, Karhapää et al, 2024).

These case studies validate the effectiveness of DCL across various educational contexts, highlighting its potential to enhance engagement, learning outcomes, critical thinking, teamwork and community building. These changes in education and learning using digitechs are a testimony to discussions made by Matee and Wang (Matee et al, 2023, Wang et al, 2024). The cases in context testify the potential for enhanced collaboration, improved learning outcomes, and the development of essential skills in digital environments (Wei, 2023).

9. Future Trends in DCL

The collaborative learning will gain eminence with the advances and innovations in digital technologies (Ludvigsen et al, 2019). The digital advances are expected to make learning sophisticated, personalized and inclusive with better educational outcomes and experiences.

9.1. Integration of artificial intelligence- The integration of advanced artificial intelligence and machine learning will transform the future of this educational approach. The analysis of learner behavior, needs, real-time progress and preferences will help personalized learning experiences in group and individual settings (Sharma et al, 2024). Holistic learning platforms incorporating collaborative tools, content delivery, assessment and feedback may be a reality. The learning will be streamlined for seamless integrated collaborative activities (Wei, 2023).

9.2. Enhanced virtual reality (VR) and augmented reality (AR)- Virtual spaces simulating real-world scenarios and augmented technologies will promote immersive and interactive hands-on learning experiences for learners (Lindín et al, 2024). The VR and AR technologies will incorporate virtual field trips, labs for delivering rich, experiential learning opportunities in both virtual and physical environments (van der Meer Nesse et al, 2023, Paulsen,et al, 2024). Such blended environments will offer benefits of traditional as well digital learning (van der Meer et al, 2023).

9.3. Integration of blockchain, IoT (Internet of Things), data-driven insights and analytics- Blockchain technology will be applied to track, digitalise and verify achievements ensuring transparency in the documentation of skills and collaborative contributions. IoT devices could be integrated into learning environments to collect data on student interactions and behaviors (Wang et al, 2024). The application of data analytics tools through IoT and blockchain technology are poised to change the way educators track learner participation, engagement and performance in collaborative activities (Gan et al, 2015). The educators will be able to make data-informed decisions and intervene to effectively support learners.

9.4. Gamification and interactive learning techniques- Gamification elements, such as leaderboards, badges, and game-based learning platforms, will become more prevalent making collaborative activities more engaging and motivating. Game-like elements, simulations and interactive challenges in the curriculum will boost engagement, participation and problem-solving (Matee et al, 2023, Lindín et al, 2024).

9.5. Advanced collaboration tools- Collaborative tools for real-time language translation, advanced data visualization, problem-solving platforms integrated seamlessly will be prevalent (Lindín et al, 2024). The global learning networks will connect learners and educators across the world for collaborative projects and exchanges. Cross-cultural collaborations among diverse and distributed teams can be anticipated, enhancing communication and productivity (Wei, 2023). AI driven virtual assistants will manage group tasks and provide real-time support for collaborative problem solving (Karhapää et al, 2024). This will further develop critical thinking, creativity and ability to work as a team.

9.6. Enhanced accessibility and inclusion- Adaptive learning platforms and continued evolution of supportive techniques are bound to make learning inclusive and equitable for differently abled learners as well as for learners with diverse needs. Data analytics will help to customize content and activities based on individual and group performances. Personalized learning adapted to individual learning styles, interest, goals, preferences and progress will allow learners to pursue their interests while working on collaborative projects (Abd-El-Fattah, 2010, Herrera-Pavo, 2021). The open educational resources will be equally accessible to educators and learners fostering collaborative content creation and sharing.

9.7. Integration of social and emotional learning (SEL) - The SEL elements will be used to instill social and emotional skills critical for better teamwork will be encouraged. The essentials of digital citizenship including online etiquette, privacy, and ethical use of technology will be ingrained for responsible and respectful interactions (Sharma et al, 2024).

The upcoming trends and innovations are bound to change DCL. The learning process will be more engaging, inclusive and effective. A continuous analysis of these trends and innovations may help to develop better integrated educational practices (Dahal, 2022).

10. Conclusion

More institutions can implement DCL by adopting best practices like selecting appropriate tools that facilitate easy collaboration, communication, and access for all participants. The collaborative environments should provide opportunities for open communication and build strong ethical conduct in the participants. The strategies to promote collaboration should ensure equal participation for all learners and respect for diverse ideologies. A proper framework of guidelines and regulations are required for executing collaborative tasks with digital technologies. DCL is set to acquire a central stage in learner oriented digital education systems to foster future teamwork in professional settings.

References

1. Boateng, S.L., Penu, O. K.A., Boateng, R., Budu, J., Marfo Alsayer, A. A. (2023). Learners' Experiences in an Online Learning Environment: An Analysis of the Impact of International Collaboration. Sage Open, 13(4). https://doi.org/10.1177/21582440231208524
2. Assis, M. P. and Almeida, M. E. B. (2009). Collaborative Learning in the Digital Learning Environment. People, Technology and Pedagogical Practices. Proceedings of ED-MEDIA 2009-World Conference on Educational Multimedia, Hypermedia & Telecommunications, Honolulu, Hawaii, USA, pp 1567-1572.
3. , J.S., Asamoah, P. (2024). Educational technologies and elementary level education – A bibliometric review of scopus indexed journal articles, Heliyon, Volume 10, Issue 7, e28101, https://doi.org/10.1016/j.heliyon.2024.e28101.
4. Cherbonnier, A., Hémon, B., Michinov, N., Jamet, E. & Michinov, E. (2024). Collaborative Skills Training Using Digital Tools: A Systematic Literature Review, International Journal of Human–Computer Interaction, pp 1-12, DOI: 10.1080/10447318.2024.2348227
5. Collins, A., Brown, J.S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. Knowing, Learning, and Instruction: Essays in Honor of Robert Glaser, 453-494.
6. Dahal, N. (2022). Understanding and uses of collaborative tools for online courses in higher education. Advances in Mobile Learning Educational Research, 2(2), 435-442. https://doi.org/10.25082/AMLER.2022.02.012
7. Gan, B., Menkhoff, T., & Smith, R. (2015). Enhancing students' learning process through interactive digital media: New opportunities for collaborative learning. Computers in Human Behavior, 51, 652-663.
8. Garrison, D (1997). Self-Directed Learning: Toward a Comprehensive Model. Adult Education Quarterly- ADULT EDUC QUART, 48, 18-33;.10.1177/074171369704800103
9. Hemingway, C., Adams,C., & Stuhlsatz, M. (2015). Digital collaborative learning: identifying what students value. F1000Research, 4, 74. https://doi.org/10.12688/f1000research.6223.1
10. Herrera-Pavo, M.A.(2021). Collaborative learning for virtual higher education, Learning, Culture and Social Interaction, Volume 28, 100437, https://doi.org/10.1016/j.lcsi.2020.100437.
11. Huang, X., Lajoie, S.P., (2023). Social emotional interaction in collaborative learning: Why it matters and how can we measure it? Social Sciences & Humanities Open, Volume 7, Issue 1, 100447, https://doi.org/10.1016/j.ssaho.2023.100447.
12. Hutchins, E. (1995). Cognition in the Wild. MIT Press.
13. Johnson, D. W., Johnson, R. T., & Smith, K. A. (1998). Cooperative learning returns to college: What evidence is there that it works? Change: The Magazine of Higher Learning, 30(4), 26-35.
14. Karhapää, A., Rikala, P., Pöysä-Tarhonen, J., Hämäläinen, R. (2024). Digital environments as sites for informal workplace learning in knowledge work. Journal of Workplace Learning, Volume 36, Issue 9, Pages 19-36, https://doi.org/10.1108/JWL-11-2023-0184.
15. Kwiatkowska, W., & Wiśniewska-Nogaj, L. (2022). Digital skills and online collaborative learning: The study report. Electronic Journal of E-Learning, 20(5), 510-522. DOI: 10.34190/ejel.20.5.2412
16. Laal, M., Ghodsi,S.M.(2012). Benefits of collaborative learning, Procedia - Social and Behavioral Sciences, Volume 31,Pages 486-490,https://doi.org/10.1016/j.sbspro.2011.12.091
17. Laal, M, & Laal, M. (2012). Collaborative learning: what is it?. Procedia - Social and Behavioral Sciences, Volume 31, Pages 491-495, https://doi.org/10.1016/j.sbspro.2011.12.092
18. Lave, J., & Wenger, E. (1991). Situated Learning: Legitimate Peripheral Participation. Cambridge University Press.
19. Le, H., Janssen, J., & Wubbels, T. (2017). Collaborative learning practices: teacher and student perceived obstacles to effective student collaboration. Cambridge Journal of Education, 48(1), 103–122. https://doi.org/10.1080/0305764X.2016.1259389
20. Lindín, C., Engel, A., Gràcia, M., Rivera-Vargas, P., & Rubio, M. J. (2023). Literature Review on Emerging Educational Practices Mediated by Digital Technologies in Higher Education, Based on Academic Papers. Sage Open, 13(4). https://doi.org/10.1177/21582440231204677
21. Ludvigsen, S., Steier, R.(2019). Reflections and looking ahead for CSCL: digital infrastructures, digital tools, and collaborative learning. Intern. J. Comput.-Support. Collab. Learn 14, 415–423. https://doi.org/10.1007/s11412-019-09312-3
22. Männistö M, Mikkonen K,Kuivila HM, Virtanen M, Kyngäs H, Kääriäinen M.(2020). Digital collaborative learning in nursing education: a systematic review. Scand J Caring Sci. 2020;34(2):280-292. doi: 10.1111/scs.12743. Epub 2019 Sep 5. PMID: 31487063.
23. Maraza-Quispe, B., Caytuiro-Silva,N., Castro-Gutierrez, E., Alejandro-Oviedo, M., Choquehuanca-Quispe, W.,Fernandez-Gambarini, W., Cuadros-Paz, L., & Cisneros-Chavez, B. (2019). Towards the

development of collaborative learning in virtual environments. International Journal of Advanced Computer Science and Applications, 10(12), 270-276. https://doi.org/10.14569/ijacsa.2019.0101237
24. Matee, G. L., Motlohi, N., & Nkiwane, P. (2023). Emerging perspectives and challenges for virtual collaborative learning in an institution of higher education: a case of Lesotho. Interactive Technology and Smart Education, 20(1), 73-88.
25. Mazzoni, E., Gaffuri, P., & Gasperi, M. (2010). Individual versus collaborative learning in digital environments: the effects on the comprehension of scientific texts in (Laal & Ghodsi, 2012).first year university students. In Seventh International Conference on Networked Learning, Aalborg (Danmark) (pp. 03-04).
26. McCarthy, A. M., Maor, D., Andrew McConney, A., Cavanaugh, C. (2023). Digital transformation in education: Critical components for leaders of system change, Social Sciences & Humanities Open, Volume 8, Issue 1, 100479, https://doi.org/10.1016/j.ssaho.2023.100479.
27. O'Donnell, A. M., & Hmelo-Silver, C. E. (2013). Introduction: What is collaborative learning?: An overview. In The International Handbook of Collaborative Learning(pp. 1-15). Taylor and Francis. https://doi.org/10.4324/9780203837290-6
28. Paulsen, L., Dau, S. & Davidsen, J. (2024). Designing for collaborative learning in immersive virtual reality: a systematic literature review. Virtual Reality 28, 63. https://doi.org/10.1007/s10055-024-00975-4
29. Qureshi, M. A., Khaskheli, A., Qureshi, J. A., Raza, S. A., & Yousufi, S. Q. (2023). Factors affecting students' learning performance through collaborative learning and engagement. Interactive Learning Environments, 31(4), 2371-2391.
30. Selfa-Sastre M, Pifarré M, Cujba A, Cutillas L, Falguera E. The Role of Digital Technologies to Promote Collaborative Creativity inLanguage Education. Front Psychol. 2022 Feb 9; 13:828981. doi:10.3389/fpsyg.2022.828981. PMID: 35222209; PMCID: PMC8865196.
31. Sharma, K., Nguyen, A., Hong, Y. (2024). Self-regulation and shared regulation in collaborative learning in adaptive digital learning environments: A systematic review of empirical studies. British Journal of Educational Technology Volume55, Issue4 , Pages 1398-1436.https://doi.org/10.1111/bjet.13459
32. Stahl, G., Koschmann, T., & Suthers, D. (2006). Computer-supported collaborative learning: An historical perspective. In Cambridge Handbook of the Learning Sciences (pp. 409-426). Cambridge University Press.
33. Tan, C., Casanova, D., Huet, I., & Alhammad, M. (2022). Online Collaborative Learning using Microsoft Teams in higher education amid COVID-19. International Journal of Mobile and Blended Learning (IJMBL), 14(1), 1-18. http://doi.org/10.4018/IJMBL.297976
34. Topping, K. J. (2005). Trends in peer learning. Educational Psychology, 25(6), 631-645.38. Udvari-Solner, A. (2012). Collaborative Learning. In: Seel, N.M. (eds) Encyclopedia of theSciences of Learning. Springer, Boston, MA. https://doi.org/10.1007/978-1-4419-1428-6_817
35. van der Meer Nesse , van der Werf Vivian , Brinkman Willem-Paul , Specht Marcus (2023). Virtual reality and collaborative learning: a systematic literature review. Frontiers in Virtual Reality, volume 4, DOI.10.3389/frvir.2023.1159905
36. Vembye, M. H., Weiss, F., & Hamilton Bhat, B. (2024). The Effects of Co-Teaching and Related Collaborative Models of Instruction on Student Achievement: A Systematic Review and Meta-Analysis. Review of Educational Research, 94(3), 376-422. https://doi.org/10.3102/00346543231186588
37. Vygotsky, L. S. (1978). Mind in Society: The Development of Higher Psychological Processes. Harvard University Press.
38. Wagino, W, Hasan, M., Wawan, P., Krismadinata, K., Suhendar, S. & Rahmat, K. (2023).Exploring the Full Potential of Collaborative Learning and E-Learning Environments in Universities: A Systematic Review August 2023 TEM Journal 12(3):1772-1785 DOI: 10.18421/TEM 123-60
39. Wang, C., Chen, X., Yu, T. et al. Education reform and change driven by digital technology: a bibliometric study from a global perspective. Humanit. Soc. Sci. Commun. 11, 256 (2024). https://doi.org/10.1057/s41599-024-02717-y
40. Wei, Z. (2023). Navigating Digital Learning Landscapes: Unveiling the interplay between learning behaviors, digital literacy, and educational outcomes. J Knowl. Econ. https://doi.org/10.1007/s13132-023-01522-3
41. Williams, C., & Augustine, S. E. (2015). Collaborative learning in a virtual classroom: Its status in the current digital era. European Journal of Research and Reflection in Educational Sciences Vol, 3(5), pp 45-51.