

Collaborative Learning and ICT

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Introduction

The idea of collaborative learning is not new. Isaac Newton once said: “If I have seen further than others, it is by standing upon the shoulders of giants.” Great inventions and discoveries are usually attributed to several scientists who work in a team. In addition, they often build on past knowledge and discoveries as foundation for creating new knowledge. In recent years, there seems to be a revival of interest in collaborative learning. This is partly due to the emergence of knowledge-based economy, which makes it compelling for knowledge workers to work in teams to solve complex problems and create innovative products. Group process and communication skills become important assets for us to survive and thrive in the new economy. In addition, the advent of computer-mediated communication technologies, such as discussion forums, weblogs, and conferencing systems provide opportunities to extend classroom discussions beyond the constraints of time and space. In this chapter, we examine the concept of collaborative learning, its theoretical foundations, different paradigms of learning related to collaborative learning, the roles of ICT for collaborative learning, and strategies for implementing collaborative learning with ICT.

The Concept of Collaborative Learning

Collaborative learning is a social process whereby students learn through interacting with others. It involves students expressing their thoughts and opinions, solving problems and performing inquiry together, observing how others think and learn, and teaching each other reciprocally. It requires students to develop the abilities to co-construct understanding, to commit to a line of inquiry, to engage in knowledge building discourse, to assess soundness of ideas based on appropriate evidence or supporting theories, and to resolve conflicting views (Bereiter, 2002; Scardamalia, 2002). The key component of these activities is the negotiation of meaning among the learners within the setting of joint activity (Stahl, Koshmann, & Suthers, 2006). In other words, it involves setting common learning goals among the learners and co-construction of knowledge for the achievement of the goals.

As a form of pedagogy, collaborative learning has been in the classrooms for a long time. Socratic dialogue can be regarded as one of the earliest forms of collaborative learning

and it fully demonstrates the power of such dialogue in extending students' understanding and their ability to think. In the early 70s, collaborative learning is more commonly referred to as cooperative learning. Some educators see cooperative learning as a type of collaborative learning with more structures being put in place (for example, Summers et al., 2005). Others, such as Dillenbourg (1999), proposed that there is distinction between cooperative learning and collaborative learning. In cooperative learning, the learning task is divided among the learners who will each accomplish their parts, followed by the re-assemble of these parts into the whole. Collaborative learning, on the other hand, involves ongoing efforts in meaning negotiation and the establishment of shared understanding (Dillenbourg, 1999) among the learners. Thus, cooperative learning still focuses on how individuals learn within a group setting whereas collaborative learning examines group learning or cognition.

Our review of collaborative learning shows that successful groups manifest the following features (Dillenbourg, 1999; Johnson & Johnson, 2009):

- Establishment of common goals
- Unambiguous division of labour/co-labouring
- Clear individual and group accountability
- Positive interdependence
- High interactivity and negotiability
- Mature group processing

The above features of collaborative learning are interrelated, and it is obvious that simply putting students in groups does not engender collaborative learning. For collaborative learning to be beneficial to students, it would have to begin with the establishment of common/joint goals. Assuming that the problems or learning tasks are complex in nature, and therefore necessitate group work, group members would need to examine the learning tasks or problems and discuss the goals that they want to achieve. This has to be followed by negotiation of who are to be in-charge of which parts of the problem, and usually also by when should certain tasks be completed. Clear understanding of each member's responsibilities leads to individual and group accountability, which could avoid confusion and unnecessary friction within the groups. Positive interdependence refers to the conditions where all group members realise that they are dependent on each other to successfully solve the problem; they "swim or sink" together. These conditions have to be established by the

teacher or the students through open and interactive negotiation. In short, successful collaboration requires mature group processes, which need time, practice and teacher's facilitations to foster. At the initial introduction of collaborative group learning in the classrooms, it is clear that teachers have to bear the main responsibilities to design the learning environment that would foster the emergent of the above group features through careful design of learning tasks, group composition and perhaps explicit teaching of group processes. As such, the roles of teachers change from transmitter of information and director of the classroom to more of a guide, facilitator, and collaborator with students.

Indicators for Collaborative Learning

For a researcher or educator, it will be useful to know how to recognise collaborative learning when it happens. A teacher who implements collaborative learning strategies might also ask "how would I know if I have successfully fostered collaborative learning among my students?" Some concrete indicators could be helpful in these situations. The following indicators signify the roles of teachers in creating a collaborative learning environment.

Teachers' indicators

- Create multiple and appropriate opportunities to generate and promote collaboration among students
- Design learning experiences that require positive interdependence among students
- Develop students' communication skills and interpersonal skills
- Provide conflict management strategies on resolving diverse or conflicting views
- Use various assessment methods to assess both individuals and group learning and performance
- Provides feedback on individual learning and group learning and performance

The teachers create a learning environment conducive for collaborative learning among the students. Instead of adopting the passive role of a knowledge recipient, the students are now required to take more active role in the learning processes. The following are indicators of students who demonstrate successful collaborative learning.

Students' indicators

- Able to negotiate and set common goals

- Contribute own ideas clearly and consider other points of view objectively
- Ask questions to clarify and offer constructive feedback
- Take on different roles and tasks within the group to achieve group goals
- Work towards completing individual's assigned tasks as well as help group members achieve group goals
- Reflect on group and individual learning processes

The manifestation of these students' indicators signifies that positive learning has taken place. Several pedagogical benefits that are related to these indicators have been reported. They include improvement of communication skills, team process skills, critical thinking skills, and possible contribution to self-directed learning skills. Collaborative group work can also foster better social integration among students and enhance retention (see Summers et al., 2005). Research on learning communities using computer-mediated communication indicate that it promotes communication skills and learning outcomes that helps prepare students for the knowledge society (Bereiter & Scardamalia, 2006, Jonassen et al., 2008). The emergence of these benefits is related to the development in learning theories that support collaborative learning. In the next section, we will discuss the theoretical foundations of collaborative learning.

Theoretical Foundations of Collaborative Learning

Collaborative learning is supported by Vygotsky's (1978) socio-cultural theory of learning. Vygotsky discovered that the children's thinking abilities are developed through internalization of interpersonal interactions. For example, when a boy interacts with more capable people like his parents or older siblings, he has the opportunity to hear or read how the more capable people conceptualize and solve problems. When he internalizes the patterns of thinking of the more capable people, he acquires a new way of thinking. The implication of Vygotsky's finding is that it is important to structure opportunities for children to interact with others. Interacting with more capable people creates for the learner a Zone of Proximal Development (ZPD), which is defined by Vygotsky (1978) as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). Interactions in ZPD provide the learner

opportunities to appropriate ways of seeing and problem solving that are mediated through language.

Empirical studies on the effects of interactions have provided some supports to Vygotsky's theory. For example, Hasan (2002) observes differences in the patterns of interaction from Australian working and middle class. The interaction patterns between mothers and children of the working class did not seem to offer much encouragement for the children to think deeper. On the other hand, middle class children were encouraged to ask more questions and the parents offer more information to their children. As the patterns of interaction can be internalized by the children as a pattern of thinking, children from the working class may be disadvantaged. In similar vein, Wells (2007) argues that the patterns of talk in classrooms tend to fall into two modes: monologic or dialogic mode. The dialogic mode encourages meaning construction while the monologic mode demands listening ears. Both modes of communication serve important cultural functions. The monologic mode transmits knowledge for cultural preservation while the dialogic mode provides opportunities to cultivate the dispositions necessary for cultural renewal through the improvement of received knowledge. Unfortunately, classroom research has indicated that monologic mode is still prevalent; it is desirable that more collaborative learning be structured into classroom learning. It serves to prepare the students better for the new economy that demands highly creative and flexible individuals.

Recent theories of learning such as that of Community of Practice (CoP) and distributed cognition also attest to the importance of interactions for the purpose of learning. These theories, together with Vygotsky's theories, are generally known as the social constructivist theories of learning. Lave and Wenger's (1999) notion of Community of Practice (CoP) builds on Vygotsky's theories with additional emphasis on the critical role of situated cognition. In the social setting of apprenticeship, apprentices are provided with opportunities to participate in various activities that constitute the practice. For example, a medical intern learns to be a doctor by doing housemanship, shadowing experience doctors for an extensive period of time. S/he observes how the doctor interacts with patients; laboratory technicians and other doctors. S/he can also query the doctor when they have doubts. At appropriate time, s/he will be invited to offer opinions on the cases and given feedbacks on his/her diagnoses. Through such participation and interaction, the apprentice will gradually learn the craft of a practitioner. Lave and Wenger characterized the learning journey of an apprentice as one that moves from legitimate peripheral participation to central participation of the practice. Through this journey, the apprentice learns to act professionally

by participating in the practice. The authentic context allows the apprentice to understand why and how practitioners talk and solve problems in certain ways. Given that in real life, most professions require the workers to work collaboratively, it is important for teachers to structure rich learning environments that closely resemble the context of the practice.

Another key idea supporting learning through group-based interactions is that of distributed cognition in a collaborative setting (Pea, 1993; Roth, 1999). In group-based learning, learners share the responsibilities of difficult and complex learning tasks. This avoids cognitive overload of individual members and allows members to develop differential expertise (Roth, 1999). At the same time, learners with different backgrounds and abilities enter the learning environment with different ideas and perspectives. Even children in the same age group are likely to be different in terms of their language and thinking abilities and their prior knowledge. The diversity in ideas, abilities and perspectives forms the collective resources that members can draw from during collaborative learning. Putting children in groups, especially in the case of heterogeneous group, creates multiple ZPDs where all members can support each other mutually towards the achievement of learning goals (Oshima, 1998). In order to achieve the jointly established goals, group members have to articulate their ideas, question each others, defend or support their ideas with evidences, negotiate for consensus building, and discuss members' roles. These activities help students elaborate and improve their ideas about the phenomenon they are studying and acquire group process skills.

Building on the above theories, Bereiter and Scardamalia (2006) put forth the theory of collaborative knowledge building that focuses on facilitating the development of students' dispositions to be knowledge creator. Their theory is premised on the model of research and development teams from company and university. A research team is usually formed by individuals who have some common research interests. The team members formulate research questions and sub-questions, generate some initial ideas or hypotheses based on what they already know, identify what they need to understand and proceed with the research. To answer their research questions, team members usually have to make use of existing materials collected from a variety of sources such as journals, books and the Internet. They have to conduct empirical studies such as experiments, field trips or surveys to verify their hypotheses. The data collected are then compared with the team's initial ideas and are used to refine the ideas. This process helps the research team in understanding the phenomenon being investigated. The process inevitably requires members to meet regularly either face-to-face or online. The meetings allow members to share information, build on each other's findings and

ideas, and thus advance the team collective understandings. Naturally, such processes involve serious discourse as the mediator of learning among team members.

Based on the above theories, Lipponen, Hakkarainen, and Paavola (2004) differentiated three different metaphors of learning. They are learning as acquisition, learning as participation and learning as knowledge creation. These metaphors provide a useful way to distinguish the underlying purposes that drive the design of collaborative learning environment, the selection of ICT tools to facilitate the group processes, and the different approaches to the assessment and evaluation of collaborative learning (Strijbos & Fischer, 2007). Learning as acquisition is primarily concerned with the use of group processes for individual attainment and internalization of knowledge. It is related to behaviorist or cognitivist theories of learning that focuses on individuals' learning. Learning as participation focuses on developing the abilities to participate in professional activities that the practitioners of the subject matter engage in. It is closely linked to the theories of communities of practice, situated cognition and distributed cognition reviewed earlier. The knowledge creation paradigm focuses on developing knowledge building abilities, even among young learners. Acquisition metaphor of learning applies to traditional collaborative learning strategies like reciprocal teaching, where the focus is still on individual's learning through teaching. Participation metaphor of learning applies to learning through participation in a community of practice or in a learning community. Knowledge building metaphor is similar to learning in a community, but with the emphasis on knowledge building discourse.

ICT and Collaborative Learning

As discussed earlier, the rapid development in computer-mediated communication technologies could contribute to the revived interest in collaborative learning. Information and Communication Technologies (ICT) could support collaborative learning in three main ways: (1) As an interpersonal communication tool to support collaborative learning strategies that are used in face-to-face settings; (2) computer-supported collaborative work where the learners work on a common document; and (3) computer-supported collaborative learning where the focus is to support negotiation of meaning among a group of learners.

ICT to support interpersonal communication

The technologies that support interpersonal communication include synchronous tools like chats, short messages, and video conferencing as well as asynchronous tools like email and discussion boards. With computer mediated communication tools, it is possible to implement

several collaborative learning strategies that were designed for face-to-face settings. Some of these strategies include Student Teams-Achievement Divisions, Teams-Games-Tournaments, Jigsaw I and Jigsaw II, Team Accelerated Instruction, Cooperative Integrated Reading and Composition, Group Investigation and Learning Together. If you are interested, you can read up these strategies in books (e.g. Aronson & Patnoe, 1997; Sharan, 1994; Slavin, 1995, 1998) or from the Internet.

Most of these strategies are carried out over a short timeframe, and technologies must allow a learner to participate in a small group discussion and switch to a larger group discussion at a particular time. Some online chat rooms could be used for this purpose. For example, we could support a Jigsaw classroom using online chat. Hong and Sullivan (in press) described the strategies involve in establishing a jigsaw classroom:

Every member of every group was responsible for learning all the curriculum material, but individual students had direct access to only their part of the material—the part they were to teach others. Since they had to depend on groupmates for access to the rest of the materials, it became essential for all groupmates to do a good job of communicating their parts of the material...In essence, the students in each group were putting their knowledge together a piece at a time, each student contributing a piece of the jigsaw puzzle of material. (Aronson & Patnoe, 1997, p.91)

Note that the underlying perspective of learning for Jigsaw method is learning as acquisition; it still focuses on one person teaching another person. One advantage is that it empowers the students to do the teaching.

There are strategies that focus on learning through participation. For example, Group Investigation and Problem-based Learning. They require a longer time frame and can be supported by asynchronous tools like a discussion board. In Group Investigation, the students decide on or are assigned a topic for investigation; they then divide the investigation into smaller parts so that each student is responsible for one part. The students then share their information as a group and synthesize a product (e.g. a report) before presenting to the whole class. An online discussion board, for instance, could provide the platform for small group discussion and sharing of materials. Another similar example is problem-based learning. Hong and Sullivan (in press) described a typical cycle of problem-based learning as 1) identify useful information of the problem scenario, 2) generate possible problem

solutions, 3) identify knowledge gaps that need to be filled so as to solve the problem, 4) apply the newly acquired knowledge to solve the problem, and 5) consolidate the knowledge gained through reflection.

Using ICT to support traditional methods of collaborative learning has its advantages. First, it enables many-to-many interaction which is not possible to achieve in a traditional classroom (Chai & Tan, 2005). It thus changes the discourse pattern of teacher initiate, students respond, teachers evaluate, which necessary position teacher as the controller of discourse. In an online forum, the social presence of teacher or a dominating person is reduced. It gives more students opportunities to participate in the discussion. In addition, the online environment captures the talks, which allows the learners to review and reflect on their past discussion. In contrast, classroom talks are ephemeral; many good ideas are lost once the students step out of the classroom. The flipside of computer mediated communication is that the students cannot rely on non-verbal cues in their communication, which can sometimes lead to miscommunication if the students could not express themselves adequately in text.

Computer-Supported Collaborative work (CSCW)

In Computer-supported Collaborative Work (CSCW), sometimes known as shared workspace or groupware, students work on a common document mediated by computer or networked computers. Wikis is one such example where group members contribute and edit the same set of online documents using Web browser with simple markup language. You can refer to Chapter 15 for more detailed description of the use of Wikis. Other example is CMap which allows online collaborative concept mapping. Interactive whiteboard (IWB) can be considered CSCW in that students work on the same document through IWB in a face-to-face setting.

One distinct characteristic of collaborative work is that instead of discussing *about* ideas, there is a concrete product at the end of the collaborative session. The technology plays the role of (1) capturing the information, (2) tracking the development of the collaborative work, and (3) displaying the work in progress.

Computer-Supported Collaborative Learning (CSCL)

Computer-supported collaborative learning, or CSCL, is an emerging branch of study under the field of Learning Sciences. One example is the use of Knowledge Forum, a web-based discussion forum, to support the knowledge building process. While the jigsaw classrooms

and problem-based learning may help to foster important group skills and perhaps in-depth learning of materials, Bereiter and Scardamalia (2006) argue that it may be insufficient to foster knowledge creation dispositions. Hong and Sullivan (in press) argue that learning as knowledge creation require the learners to embark on progressive problem solving, which demands the learners to exercise metacognitive control of their thinking processes. They cited the knowledge-building community (Scardamalia & Bereiter, 2006) as the ideal pedagogical model. You can refer to Chapter 13 of this book which provides a detailed explanation of the model.

Unlike using computers just for teaching communication, CSCL focuses on meaning making among students. This is achieved by scaffolding students' talk. For example, in Knowledge Building, the following sentence openers are commonly used: "My Theory is...", "I need to understand...", "A better theory is...". To support debate, a separate set of scaffolds could be prepared. The key difference between CSCL and CSCW is that the latter focuses on a collaborative product, whereas the former focuses on meaning making.

Implementing Collaborative Learning with ICT

Regardless of the paradigms of learning one subscribe to, there are some common design elements that teachers have to consider. We can consider three key aspects of change: (1) Classroom practices, (2) student-teacher-computer interactions, (3) cultural change.

In terms of classroom practices, the overarching design aim of collaborative learning is "to increase the probability that some type of (intended collaborative) interaction occurs" (Dillenbourg, 1999, p. 5). This usually includes the design of initial situation, such as a problem scenario which determines the main content to be learned. Other design considerations include design of scaffolds, selection of initial resources for the students to kick start the meaning making processes, and determine ways of monitoring and regulating of interaction (Dillenbourg, 1999). Furthermore, some rules that promote exploratory talks may be necessary. The following is a set of interaction rules recommended by Mercer (2004).

- Seek contributions from all group members, ensuring that everyone has a chance to speak
- Actively listen and stay involved
- Be positive and open to new ideas
- Question others about their ideas
- Respect and value other people's opinions and feelings

- Explain your ideas concisely but clearly
- Give clear reasons for your opinions, and expect them from others
- Challenge and discuss points if you disagree
- In case of alternative proposals, decide together which is supported by the best reasons
- Keep to the subject
- Be ready to compromise and reach agreement if possible

(Mercer, 2004, P.2)

In terms of student-teacher-computer interaction, we need to consider how computers are used in classrooms and how students and teachers interact with each other through the computers. For example, we could provide one computer to each student or require the students to share a computer. If a group of students are assigned to a computer, we may need to establish some rules so that the students could take turns to play different roles. We also need to consider how to weave the face-to-face instructions with online collaboration. For example, it might be contrived to force students to talk through computers in a face-to-face setting. Knowledge Forum, for instance, allows students to key in a group note in class. The groups should be given time to capture the key points of their face-to-face discussion and post an online message before the lesson ends. After curriculum hours, the students could then contribute individual notes by building on the group note. It is also important that the teacher refers to the online discussion content in a face-to-face setting so that the students know that online collaboration is an integral part of the lesson rather than a nice-to-have activity.

The use of ICT to support collaborative group learning is yet to be a common phenomenon in today's classrooms (for example, see Becta, 2007). A teacher needs to build the culture of collaborative learning, both online and offline over a period of time. Building a collaborative classroom culture is an ongoing process, and requires continual effort. Some strategies include: praise a group for their collaborative effort, demonstrate how different ideas can be combined to build a better idea, assess the students based on group effort, and show to students how they have progressed as a group over time. Sustained period of professional development is also necessary for teachers to develop the competencies needed for computer-supported community-based learning (Chai & Tan, 2009). Chapters 13 to 18 provide elaborated discussion of various forms of computer-mediated communication technologies can be employed to facilitate students' co-construction of knowledge.

While collaborative learning is supported by strong theoretical and empirical foundations, it is clear that the quality and the forms of dialogue that will play out in the classrooms depend very much on the teachers' pedagogical skills in structuring the learning environment and facilitating students' interactions. Group-based learning is definitely not without problems. These problems can be classified as motivational difficulties, interaction difficulties and logistical problems. Problems such as encountering free-riding or domineering members in the group could reduce the motivation of other members to contribute to the group. Interpersonal conflicts, whether in the form of personality clash or differences in values or problem representations, constitute the interaction challenges that have to resolve through skillful conflict management. Group size and composition and the sharing of resources and equipments constitute the logistical problems (Pauli, Mohiyeddini, Bray, Michie, & Street, 2008).

Conclusion

Collaborative learning offers many opportunities for students to acquire important knowledge and skills. Given the context of joint problem solving, students naturally are required to engage in explaining one's thought, seeking clarification, helping each other and performing mutual regularization. These activities activate a list of cognitive functions such as knowledge activation, externalization, regulation and internalization (Hron & Friedrich, 2003). When teachers are willing and able to guide, engage and encourage students to learn collaboratively, they open up ways for students gain access to many useful ways of thinking and using language (Mercer, 2004). It is therefore important for teachers to develop collaborative learning as a core component of their pedagogical skills.

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