Collaborative Learning Using Technological Tools - A Framework for the Future

Tord Talmo[1(✉)], Maria Sapountzi[2], George Dafoulas[3], and Alessia Valenti[4]

[1] Norwegian University of Science and Technology, Trondheim, Norway
tord.m.talmo@ntnu.no
[2] Radbound University Nijmegen/Active Citizens Partnership, Athens, Greece
[3] Middlesex University, London, Great Britain
g.dafoulas@mdx.ac.uk
[4] CESIE, Palermo, Italy
Alessia.valenti@cesie.org

Abstract. This paper focuses on educational technology designed for collaborative learning, or more correct these tools' abilities for enhancing collaboration in the learning environment. The paper reports on findings from the Erasmus+ -project Learning Through Innovative Collaboration Enhanced by Educational Technology (iLikeIT2). The main aim of the project is to develop a new response technology directed towards collaboration in the learning environment, but in order to do so it is necessary to investigate previous development within the area. The paper presents data from analysis of 48 different tools, and their abilities to be applied in collaborative environments. Secondly the paper reports on 7 different pilots done with different tools, and the qualitative data collected from questionnaires and reflectional conversations with 31 students and instructors after the pilots. The paper thus investigates a wide range of different functionalities that are useful for collaboration, coordination and communication when doing case work in a learning environment. The paper presents pros and cons with different tools, trying to answer the research question: "How can educational technology best enhance collaborative work, and which functionalities need to be present in order to make the tool work positively for the collaborative work?". Even if the paper is not able to conclude in a significant direction, 28 areas of interest for collaborative work with Educational Technology are identified. The paper points at possible improvements for both the tools themselves, but also for the methodology being applied when using the tools.

Keywords: Collaborative learning · Collaborative work · Education · Technology · Digital tools

1 Introduction

A mantra in modern teaching is collaboration and active learning in the student group. Drawing heavily on theories developed by Piaget and Vygotsky, constructivism has been a dominating principle on how knowledge is constructed. The idea is that students

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should participate actively in exactly constructing their knowledge more than simply acquire it passively: Thus constructivism does not believe that there are set principles for learning "which […] are to be discovered and tested, but rather that learners create their own learning" [1, p. 230]. These theories have brought a change in the pedagogy in the 21st Century, that is further enhanced with the major impact of digital tools, skills and opportunities in the educational system arising and constantly being improved throughout the beginning of the century.

Digital skills are considered as vital 21st century skills. This has greatly impacted the educational sector, which is also needed. We know that there is an increasing worldwide demand for higher education. According to the European Commission this demand is expected to make an increase of the number of students from 100 million currently to 250+ million by 2025 [2]. Following the growth in students as well as the demand for more constructivist ideas of learning, it is obvious that Higher Education Institutions (HEI) needs to explore the opportunities provided by digital solutions. This is also vital for the wider society, and for the competencies sought by employers when studies are finished.

In the 21st century digitalization of the society is vital for achieving higher rates of satisfaction, efficiency and improved learning outcome. This is also considered by the European Commission. In their European Framework for Digitally Competent Educational Organizations, which is a key component in the Europe 2020 strategy, the emphasize on this type of competence is highly recommended. It is greatly encouraged that educational institutions consider their institutional strategies in order to coop with the new demands: "To consolidate progress and to ensure scale and sustainability, education institutions need to review their organizational strategies, in order to enhance their capacity for innovation and to exploit the full potential of digital technologies and content" [3]. As shown in a previous article by Talmo et al. this change has not yet been fully considered: "Still, the majority of job announcements do not mention the need for digital skills at all. One could, of course, discuss the necessity for what we have defined as old-fashioned skills, but at least these announcements relate to the strategies at some level." [4, p. 411]. In this study the need for digital competencies when being hired in HEI was investigated. It was anticipated that the priorities from the Commission, as underlined in "Digital strategy for the period 2015–2019": "The internet and digital technologies are transforming our world. Barriers online can deny people the full benefits that digital developments can offer" [5], should penetrate also the strategies on institutional level. EU shows the importance of reevaluating and increasing the knowledge of digital skills in all sectors, which makes it necessary also to research the learning effects and the availability and usage of digital tools and software in HEI.

As the last element of the background for this study it is necessary to mention the ability to work in groups. This is a part of the constructionist theory, enhancing the construction of meaning through collaboration with peers, and is also considered vital for the development of 21st Century skills: "The collaborative learning environment challenges learners to express and defend their positions, and generate their own ideas based on reflection" [6]. Combining digitalization of Education and society together with constructivist ideas of pedagogy, shows clearly that the development of new digital

innovations can aid the success of collaboration in modern classrooms: "With the development of new ICTs innovative forms of collaboration are also emerging (Leadbeater, 2008, p. 10)" [7]. Accordingly, recent studies show that using response technology facilitates more classroom interaction and communication [8].

Thus this study aims at answering the research question: "How can Educational Technology best enhance collaborative work, and which functionalities needs to be present in order to make the tool work positively for the collaborative work?".

2 Background

The research reported in this article has its basis in three different phases. In the first phase forty-eight tools already available in the market was tested to see how well they facilitated for collaborative work. It was designed a template for summarizing and assessing the characteristics of the tools. Beside identifying information, the designed template aimed to assess each tool according to the following main criteria:

- *Functional + Usable - Ease of Use* (degree to which the tool can be used by the specified users to achieve the specified objectives): including assessment of learnability, efficiency, effectiveness and memorability of the tool;
- *Reliable - Data, Privacy & Security* (Is the solution set up to give you the data you need in a sustainable way and are you clear and comfortable with the privacy policies?): including identity and access management, data privacy and protection compliance and quality of support;
- *Pleasurable - User Experience* (how a person feels about using the tool): including Satisfaction and Social value;
- *Scalability* (Does the system has the potential to grow or be adapted to a differed need?).

In total seven researchers were involved in the testing of these tools, meaning that it was essential to create a solid and reliable template that was recognizable for all. To achieve this, there was agreement that the research should focus on three keywords/terms in all aspects; **1) Communication**, **2) Collaboration** and **3) Coordination**; the three C's. Based on previous research towards what functions when designing a new collaborative software, the three C's seems as the most functional framework for development [9–11]. The research aimed at identifying tools that had a clear potential for to be used for collaborative work. Initially the aim was to look at in-class-usage, but due to the pandemic situation, the aim was modified to also include possibilities for enhancing collaborative work in online environments.

The tools were tested, analyzed and noted by the researchers, and discussed during weekly meetings in the whole period lasting from March 2021 till September 2021. Additionally, one technical expert assessed the solutions for the tools to ensure quality control. The results were displayed in a comparative table (Fig. 1) that gave an overview of different characteristics found in each tool.

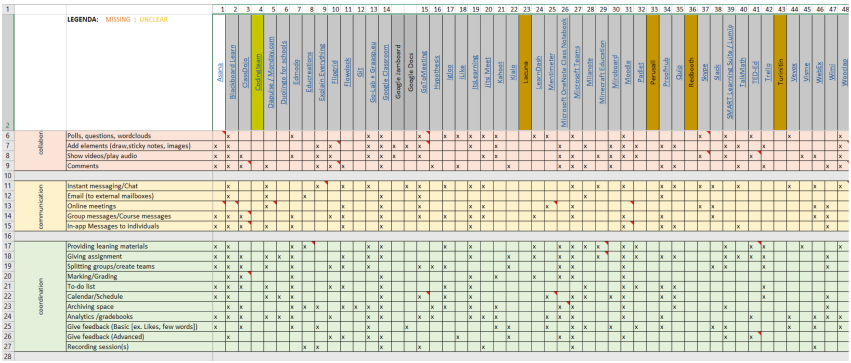

Fig. 1. Table of characteristics existing tools for collaborative work

Figure 1 shows all the criteria that the researchers used to assess the tools, categorized according to the three C's. The marks indicates if the tools possess the functionality in some way, or fulfills the functionality in any way at all. Based on the accessibility to functionality tools were picked to pilot the most valuable functionalities for collaborative work in phase three.

In phase two the aim was to identify the functionalities that needs to be inherit in the tools to enhance the collaboration aspect of a learning process. This was done through literature review, and ended up in eight different functionalities that suits the three C's in an educational tool:

1. Chat/video/recording/messaging system - (communication)
2. Shared whiteboard/screen - (collaboration)
3. Accumulation/internal voting/internal - (communication)
4. Content development - (coordination)
5. Teacher interaction - (coordination)
6. Presentations/sharing doc internally - (collaboration)
7. Group formation/role allocation - (coordination)
8. Assessment/feedback - (collaboration)

Comparing the table presented in Fig. 1 with the functionalities, eight different tools was picked for the piloting in phase three. These were ZOOM [12], MiroBoard [13], forms.app [14], GoogleDocs [15], iLike [16], Microsoft365 [17], Blackboard [18] and Kahoot [19]. The tools did not necessarily need to provide opportunities for all the three C's, but at least one of these. It was the functionalities that was important for this study, not the tools themselves. Thus the researchers when moving into phase three needed to focus on isolating the functionality to be used more than focusing on the tool itself. The third phase is described under "4 Methodology".

3 Theoretical Framework

It is crucial to point out what collaborative learning - work means in terms of education. Firstly, it refers to a teaching technique that teachers, educators, or trainers adopt during

their classes. The term has been clearly and thoroughly explained by Goodfell, Smith & MacGregor in their research *What is Collaborative Learning* (1994). According to them, this educational term includes the intellectual merger attempt made by students together or students and teachers. In this case, students are split into a group of two or more people. Their main goal is to work together, cooperate, find a common solution, create a final product, come to a conclusion, or get the full apprehension of something they study. Regarding the activities that students in collaborative work are involved in, these vary according to the needs of the curriculum. Nevertheless, these activities always focus on the "exploration or application of the course material" [20, p. 1] and not solely implementing the teacher's presentations.

Collaborative learning and work have a point to replace the common teaching- or lecture-centered learning in classrooms or tertiary education [20]. Collaborative work enforces and reinforces the students' intercourse and diligent work alongside the traditional method of taking notes during the lecture. As Goodfell, Smith & MacGregor mention, educators who implement this learning technique during their classes tend to consider themselves as "expert designers of intellectual experiences for students- as coaches …. of a more emergent learning process." [20, p. 1].

With the breakthrough of Information and Communication Technologies (ICTs) and their constant usage in the educational sector by academics, today more than ever it is effortless for students to access learning anywhere and any time [21]. In this context, professors and students should be flexible and motivated to apply and participate in this learning process since the technological achievements change or are updated rapidly [21].

3.1 Collaborative Learning and Work in Technological Ecosystems

But what happens when the modern mobile applications and learning platforms, such as MOOCs, online systems, robots programming, the usage of augmented virtual reality, etc., take advantage of the learning and teaching process and become more and more widespread day by day? According to Fonseca and Garcia-Penalvo (2019), the recently updated teaching techniques "based on gamification and collaborative interaction with the context and the learning process" drive to the alternation of the teacher's role [21].

Research has shown that when academics make use of such alluring technologies that caption students' attention, they are capable of engaging students and increasing their motivation to participate in the lecture and advance their academic results [21].

3.2 Effectiveness of the Collaborative Work

Pombo et al. (2010) studied a university-based environment by examining the effectiveness of making use of solely one digital tool. The results had "practical implications for the design of the collaborative activities and innovative assessment in blended learning environments" [22, p. 217]. By utilizing only, a digital tool, inter-group collaboration was boosted amazingly.

The results were quite positive when the students-participants called to use asynchronous communication tools for peer assessment. This technique would allow them to be aware of each other's assignments and performance to become more collaborative in the digital environment. For instance, while students were working together their comments were elevated. Thus, this means the effectiveness of the collaboration process showed high interaction [22]. The same results can be found in a study by Nielsen et al (2014) in Norway. More than 200 h of video materials on students using a response tool, showed how interaction increased in class, and how strategic methodological approaches from the instructor enhanced the leaning outcome from the work: "Change of methodology, from classic to peer instruction, increases the argumentation time with 91%. Most of this time is used to present explanations, related to curricula." [23].

Through the study of Cesar and Santos (2006), the results were quite impressive and more than expected. The most crucial of them revealed that through collaborative peer work, the students acquired an interest in courses that they did not like to, accepted sharing roles, succeeded in collaboration, and started promoting other students' work. Furthermore, Cesar and Santos concluded that students working in inclusive learning environments could support working in various pulses without making them feel restrained. It was also reported the enhance "higher mental functions, like language and reasoning" by advancing "social and cognitive competencies" [24, p. 339]. To conclude, most of the students agreed that working collaboratively led them to feel included in the learning process.

3.3 Theoretical Framework Software Development

When developing an educational tool for collaborative one needs to focus on providing those functions that are deemed essential for supporting collaborative work in educational contexts. The main challenge is to determine how different technical features can be combined to support the various social aspects associated with collaborative learning. The work carried out in this research falls under the umbrella of (CSCW), which places "emphasis on collaborative work settings, where social interactions and analysis are paramount" [25]. This indicates that educational tools should provide the necessary platform to support Computer Supported Collaborative Learning (CSCL) which results in improving "student motivation and critical thinking" [26].

During the early years shaping CSCL Lehtinen et al. (1999) argued that "there are not too many well controlled experiments, which could answer the questions concerning the wider applicability of CSCL in normal classrooms and the added value of computers and networks in comparison to collaborative learning environments without technology" [27]. Since then there was a dramatic increase in CSCL solutions, which are usually classified as (i) virtual learning environments (e.g. repositories of educational content), (ii) collaborative platforms (e.g. whiteboards), and (iii) communication tools (e.g. video conferencing). An aim is to combine certain functions to support the communication, coordination and collaboration of learners online. This is illustrated in the following figure, representing a software development framework implemented in the ongoing EU co-funded project Learning Through Innovative Collaboration Enhanced by Educational Technology (iLikeIT2) [28]. The framework includes six categories of features that are commonly met in the CSCL solutions identified above. When designing the iLikeIT2

tool we focused on integrating a number of features that are essential for collaborative work in different learning scenarios. More specifically, the six elements of the iLikeIT2 framework are:

- *Delivery* – we believe it is necessary to enable instructors and learners to collaborate and communicate without interrupting the delivery of learning that may involve a teaching presentation, demonstration of an application, use of browser to show a website, display of visual content or video, as well as sharing of files.
- *Interaction* – we determined that the main exchanges between instructors and learners during a teaching session would be in the form of assessment, questioning and polling.
- *Learner support* – we anticipated that learner support during scheduled sessions is affected by the fact that emphasis is on covering certain content, therefore small interventions should be driven by the instructor's ability to access statistics about the progress of the entire class, the performance of certain groups and achievement of individual learners.
- *Communication* – we expected that instructors and learners would use either audio or chat functions to exchange information during a session.
- *Collaboration* – we determined that collaboration would require the formation of teams and allocation of roles.
- *Coordination* – we established that instructors would need to coordinate the learning activity by (i) reflecting whether certain tasks need improvements, (ii) appraising which topics are challenging for the learners, (iii) testing which questions are appropriate for the session, (iv) evaluating whether groups perform according to certain thresholds and (v) assessing individuals' knowledge and understanding.

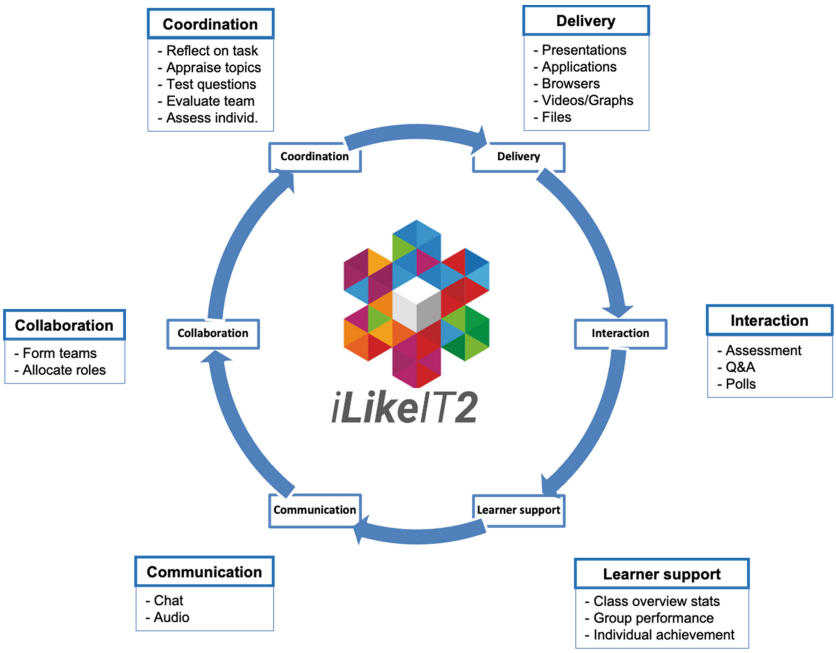

Fig. 2. The iLikeIT2 software development framework

Thus, the aim of this research is to address the activity needs of collaborative learning by addressing both analytic and design components as defined by for example Stahl et al. (2006). More specifically "analysis of meaning making is inductive and indifferent to reform goals", while design is "inherently prescriptive—any effort toward reform begins from the presumption that there are better and worse ways of doing things" [29]. The six elements of the iLikeIT2 software development framework enable users of the tool to engage in various learning activities during scheduled, synchronous sessions. Combined with pedagogical practices and theory, this background provides a framework for the research and results being presented in this article, and aids answering the research question: "How can educational technology best enhance collaborative work, and which functionalities need to be present in order to make the tool work positively for the collaborative work?".

4 Methodology

Phase three of the study included seven pilot tests in four different countries with participants from different sectors and levels of the educational system (see "5 Results"). Pilot testing help to identify the issues related to the use of a tool for collaborative work and to know how user-friendly and how easy a tool should be for an individual to navigate through its features. Pilot testing's primary purpose is to scope out user requirements and collect input to see how the functionality affects the collaborative aspects in a group.

The researchers needed to provide real-life scenarios for the groups. The participants to the pilot testing were selected from previous experience, actual studies and/or based on previous experience, motivation and expertise. It is important to secure input from as many areas as possible in order to obtain good qualitative data in a pilot-phase like this. The pilots were organized as seen in the bullet points below:

Organization of pilot testing:

a. Modus: Small focus groups of 5–10 participants
b. Participants' profile:
    i. Instructors/Teaching staff: Lecturer and senior lecturers, Trainers, Learning support workers, Academic developers
    ii. Technicians
    iii. Students
c. Equipment: Case work plan. equipment to test the tools (laptop, tablet, smartphone) + tools to be tested
d. Time limit: Between two and three hours for the whole pilot including questionnaires and reflectional conversation)
e. Pilot settings:
    i. Groups: Groups of 4 or five participants with one facilitator running the cases.
    ii. 1 facilitator observe the collaborative work
    iii. Additional technician to ensure that the tool functions if needed

iv. Actual teaching situations might include more students.

f. Requirements: For recording of pilot testing might partners need to comply with national and institutional law regarding privacy protection. Participants need to sign a statement of consent
g. Pilot workplan:

i. Preparation: Participants provided with all the necessary information regarding the project and the activity: aim of the pilot testing and what participants had to do during the testing period, accurate description of the chosen tool and case and intentions regarding the expected final results. Lastly, a time limit was provided for carrying out the chosen cases' single tasks or main activity to participants for the test.
ii. Deployment: Ensured that all the participants have understood the project's goals and the activity basic working, proceed on working on the chosen case with the tool required to be tested.

To ensure the correct data being collected, and that the functionalities would be the focus point, the researchers made one subject specific case for each pilot. These cases were developed based on both the level of the participants, their previous knowledge, the subject the instructor was familiar with and to ensure that the participants needed to actually work together on the same task. Each case was planned to use an activity plan that included information about:

- Objective of the case
- Time required to deliver the case
- Methodology for delivering the case
- How to collect data about the use
- What to do with the data

Additionally, based on the same activity plan, the researchers included one generic case, about successful communication, that all pilots should run, no matter the participant's profile. This was to ensure that all participants were exposed to one similar task, so that the reflectional conversations would be more focused and obtain the same type of data afterwards. The generic case was modified a bit in each pilot due the tool being chosen for testing. When the participants were done with their testing, their inputs about what they feel about the activity and what changes they would like to see in the tool they worked with was collected through a questionnaire[1] and a reflectional conversation. The use of Reflectional conversations (focus groups) is a research method that is intended to collect data, through interactive and directed discussions. In this study the reflectional conversation took form of a 'reflection-on-action' [30]. This can take place in tranquility or designers can pause in the midst of the action to make a "stop-and-think". In either case, the reflection has no direct connection to the present action. Designers can pause to think back over what they have done, exploring the understanding that they have brought

[1] The results from the questionnaire are not included in this research.

to the handling of the task." [30, p. 2] The conversation was done after the tasks being done in the focus group, but still in the process of developing a new software based on the information provided in the conversations.

A focus group is a form of qualitative research where a group of people are asked about their perceptions, opinions, beliefs, and attitudes towards certain issues that the researcher wants to study. Using focus groups can be categorized as a form of qualitative research where a group of people are asked about their perceptions, opinions, beliefs, and attitudes towards certain issues that the researcher wants to study. This allows deeper insight, as well as providing the researcher with the opportunity of asking follow-up questions.

Although focus groups are similar to in-depth interviews, they have some fundamental differences. The researcher asks some questions in an interactive group setting where participants are free to talk with other group members. The researcher uses a discussion guide that has been prepared in advance of the focus group to guide the discussion. Generally, the discussion starts with overall impressions and gradually becomes more specific. By using this approach, it is possible to gain access to the experiences of many different individuals and, as individuals interact with one another, data is enriched, enabling views to be reformulated through exchange.

For this study the researchers developed guidelines for the reflectional conversation based on the main points shown in Fig. 2 (Fig. 3):

Main principles for reflectional conversations. iLikeIT2

	How ?	Why ?
Moderator/facilitator	*Dual structure*	One facilitator to lead the conversation, one instructor included in the conversation. The instructor will provide valuable insight to the case.
Structure	*Semi-structured*	The conversation has an aim, and it is necessary to not deviate too much from this. Participants should be urged to discuss freely.
Settings	*Formal*	Part of a lecture in some cases. Needs to be recorded and transcribed.
Communication	*Flexible*	Balancing act between flexibility, allowing a free-flowing conversation, and structure, ensuring that the conversation does not stray too far from research objectives. Flexibility will allow a larger number of responses from all participants.
Cooperation	*Equality of contribution*	Moderation between introvert/extrovert persons. Allowing instructor to participate without dominating.
Expressions/Limitations	*Personalized*	Subjective meanings are interesting in this study. Discussions are welcome and the facilitator should moderate for such.
Time frame	*30 min.*	It is foreseen that the participants might be tired if the conversation last longer than 30 minutes. Still, if interesting discussions and engagement, this is not a maximum.

Fig. 3. Main principles reflectional conversation

Based on these main principles in Fig. 2, the following guidelines were designed and distributed to all facilitators:

1. As participants arrive, the facilitator should welcome them and thank them for coming. Once everybody is present and seated, the facilitator should provide a brief introduction outlining the purpose of research. Next, each participant introduces themselves, giving name and a brief bit of background.
2. Upon completion of the piloting, facilitator ask participants to sit in a circle. The facilitator lays ground rules for conversation (one person to talk at a time, all views welcome, confidentiality) and stress that there is no hidden agenda, and that all views will be treated in confidence. The participants are asked to sign a statement of consent.
3. The facilitator introduces the opening topic/question, which should be fairly general, and capable of generating discussion. Attempts should be made to make everyone contribute. It may be necessary for the facilitator to intervene quite a bit by asking questions, and generally keeping the discussion going.
4. During the discussions, the facilitator needs to make sure that all points are covered and promote group discussion.
5. The facilitator will use a guide with a list of topics/questions to be covered. It is advisable however to have memorized this list in advance, as to read from questions will look forced and inhibit discussion.
6. The groups should discuss every topic.
7. Before ending the focus group, participants should be encouraged to state their final position on key topics and offer any additional comments relevant to the group's key purpose. It is very important to end the discussion on a positive note and also to thank people for coming.

Even if it is not advisable that the facilitator intervenes, participates or lay restraints on the discussion the facilitator needs to get the participants started and intervene if the discussion in moving towards a side-track or stops entirely. Some pre-made questions are made available for the facilitator in order to cover the most important parts of the research question:

1) Describe a normal setting for collaborative work in your learning environment?
2) What helps you to use collaborative tools effectively in your teaching?

    a. Perceived usefulness - Degree to which they believe that using a particular technology would enhance their job performance: Work more quickly? Improved job performance? Increased productivity? Effectiveness? Useful?
    b. Perceived ease-of-use - Degree to which they believe that using a particular system would be free from effort: Easy to learn? Clear and understandable? Easy to use? Controllable? Easy to remember?
    c. Attitude toward use – teacher's positive or negative feeling about using the tool
    d. Behavioral intention - The degree to which the teacher has formulated conscious plans to use the tool
    e. Social influence processes

3) Do you have any advice for those who would like to use collaborative tools in their courses?

4) Which functionalities are working according to the intention of the case?
5) What functionalities of the tools do you consider to be important and useful for collaborative work?
6) Identify the limitations of the tool according to the intention of the case?
7) What challenges do you see in using this tool for collaborative work?
8) What functionality do you miss? Is there any function that you wish you could use in your courses?

5 Results

In total seven pilots have been run in five different countries: Norway, Italy, Greece and Spain. A total number of 11 different cases has been used, where three of these were based on the same generic case about communication. A total number of 86 informants have been participating in the pilots. Five of the pilots have been done solemnly online, while two were done with physical presence.

A total number of 31 informants have been participating in the reflectional conversations:

Students, age 22–30: 11
Instructors: 20

In the student group, only students at NTNU, Norway had some previous experience with the tool being used in one of the pilots (Google Docs). In the instructor group seven instructors were used to the tool being used (iLike and Micosoft365). In one of the pilots there were difficulties when logging into the tool, which meant that the instructors changed to a familiar tool (Microsoft365). The low number of physical presences in the pilots is due to the pandemic situation (Covid19) throughout the world and restrictions put in place by institutions. In an Educational Technology-project/research this was not considered to have any effect on the results.

The results from the reflectional conversation were collected in a focus group grid, focusing on six main thematic areas:

1. Normal setting for collaborative work
2. Effective use of collaborative tools
3. Advices
4. Working functionalities
5. Limitations/Challenges
6. Needs /Wishes

During the interpretation of the conversations, the researchers identified sub-themes within each of the main categories. These sub-themes were identified through specific statements from the participants. Several of the sub-themes were identical, even if the tools in use being different, and the functionalities being tested were not the same. Thus, we claim that we have found a total of 28 areas that must be taken into consideration when designing and using educational tools to enhance collaborative learning in the learning environment. Table 1 shows an overview of the different areas identified, with a short explanation to each of them based on input from the reflectional conversations.

Table 1. Areas identified as essential for making collaboration better when using Ed.Tech.

CSCL categories	*Areas of interest*	*Description*
Delivery	**Time efficency & control**	The instructor's ability to monitor the work being done and the time saved when delegating tasks and groups
	Split screen	Possibility of sharing multiple content at the same time
	Visuals	Results need to be visualized in a clear and appealing fashion for the plenary/group
	Dynamics	The ability the tool provides for organization and creation of continuous work
	Misuse	The tools need to be used for the intention, not for everything else, i.e. laziness from the instructor, private chats, games or similar
	Cost & fees	Important that the tools deliver what you expect them to do, indifferently the cost and/or fees being paid
	Connection	All technical solutions need to be secure and available, like internet connection and AV-equipment, as well as an easy access/registration for all participants
Interaction	**Recording**	The ability to record the session, allowing both students and instructor to watch the session post activity
	Learning effect	The opportunity to increase motivation and provide immediate feedback on tasks
	Responsibility	The possibility to monitor and access the peers work, thus making responsibility for the tasks clearer
	Teacher view	The instructor is allowed easy monitoring and access to all aspects of the collaborative work, in real time and after ended task
	Statistics/results	Both displaying results immediately and saving statistics for later discussions

(*continued*)

Table 1. (*continued*)

CSCL categories	*Areas of interest*	*Description*
Learner support	**Initiation**	The ability of instantly getting into interaction and in-depth learning
	Preparation	Easy to understand for the students, and abilities of preparing for different scenarios
	Control system for the moderator	The ability of customization. Also important to monitor and moderate misuse
	Learning design	Clear guidelines and explanation of the task. Needs to be available in the tool somehow
Communication	**Sharing**	The ability of not being physically present to attend and contribute in a collaborative work
	Communication	The possibility of exchanging ideas and discuss during the task, written or orally
	Regularity	Both students and instructors need to be used to the tool and methodology
	Messaging system	The ability of answering specific messages and create new threads of communication
Collaboration	**Peer learning**	The idea of students helping and aiding each other
	Collaboration	The ability to communicate efficiently and interact with other members of the group, both for students and instructors
	Indicating uncertainty	The ability to show the group and/or instructor uncertainty with the answer or disagreement with the groups result
	Roles	The possibility of selecting a "leader", and to identify who is responsible for each task

(*continued*)

Table 1. (*continued*)

CSCL categories	*Areas of interest*	*Description*
Coordination	**Collaboration/Assignments**	The ability of creating both individual and collaborative tasks. Allowing the instructor to easily change between the two according to the learning design
	Coordination	The ability to delegate tasks, store materials and work simultaneously in the same task
	Grouping	Allowing flexibility when dividing in groups
	Teachers' preparation	Instructors needs to be prepared, both for the methodology, but also for the possibilities the tools allow for

The table is sorted according to the six categories found in the CSCL framework. The description of the areas are interpreted from a synopsis of different statements from both students and instructors during the conversations.

6 Discussion

As seen previously there are clear indications in literature that educational technology can improve the learning process for the students. Based on this study there are especially two things that are essential for making the process positive; 1) The tools chosen must be appropriate and contain the correct functionality, and 2) the instructors need to be prepared, strategic in their learning design and know the tools capabilities. In this study, the eight functionalities being researched clearly shows that there are several tools delivering functionality good enough for using in a learning environment, even if there seems always to be lacking something[2]: "In Zoom: there is no 'someone has raised their hand' emoticon, nor does it have a sound to alert me." or "what you showed us with the graphics etc., can absorb the attention of the students and the individual,". Most of the statements are agreed upon by other informants in the conversation, and also appear more commonly than others. It seems as if the instructors are often looking for functionality that resembles the physical group work: "The students may participate either through the chat or by raising their hand and you give them permission to enable the microphone." There are several of the areas identified for successful collaborative work in Table 1 that points towards this, like "Time efficiency and control", "Teacher view", "Misuse" and "Control system for the moderator". The instructors are still positive to the effects the tools are providing and implementing, which is also emphasized by the students.

[2] All quotes in this part are quoted directly from the transcripts. These are available by contacting the authors of this publication.

Mainly it seems as if the students like the opportunities of creating new dynamics, easy communication and coordination of the group work: "Dividing people in group, make them able to act simultaneously on the same task is a great asset for lessons."

Additionally, it is obvious that the instructor's role as a facilitator for learning is essential. Technology is nothing without methodology, and when applying educational technology in the learning environment, it is vital that the instructor know the tool and its possibilities: "If the teacher was two hours without looking at the chat. They were two hours without responding to anything." This is something the instructors in the study is well aware of: "… can immediately motivate the student, get into in-depth learning, meaning there is interaction, and since technology is constantly evolving, I think we are all called upon to keep up with all these modern media, because the learning environment is becoming more modern.". No matter the access to the new tools, instructors need to allocate their time between accessing new tools and focusing on learning design: "I discover potential and functionalities of tools but I do not have the time to try them". Thus, the areas identified in Table 1 connected to the instructor's part as a facilitator, like "Control system for the moderator", "Statistics" and "Teachers preparation", is something that needs to be supported in an efficient educational tool for collaborative work. Other areas, like "Indicating uncertainty", "Learning design", and "Preparation" are aspects that are perceived as important. In order to design a functional tool one needs to develop for flexibility when creating new questions or selecting from existing ones. This is as part of the interaction element of the tool. The visualization of results is critical. All results and statistics must be easily accessible and visually attractive to the participants. It is also essential that the tool emphasize the importance of the instructor being the facilitator of collaborative learning.

It is always interesting to look for areas where the agreement is higher than others. In this research it seems as three areas is especially interesting. Firstly, there are several informants, both instructors and students pointing at the importance of making sure the systems/tools are working. If the tools are inadequate for the work being designed, the session will not be very useful: "It happened I had to completely change what I had planned because the tool was not helpful." A useful tool needs to be secure, working and useful for the task.

Secondly there is a common agreement that the tools need to provide additional engagement and motivation in the student group: "A tool needs to be appealing also in terms of graphics". Even if the graphics might be more important for the younger targets, a nice graphic stimulates the feeling of fun and game. As important as the gamification of the tool, is the opportunity to make the work more efficient and dynamic: "When working in group, a shared document makes dividing tasks easier". This area is something that several emphasize and agree upon in the conversations.

Thirdly it seems to be common agreement about the ability to communicate with peers:

> "I would like to say that the plan helps on 2 levels: individually for each person because it helps them to place their thoughts as a central idea and then to develop them, because it gives them easier goals, that is, starting from a central idea and slowly managing to break it down more to divide it into smaller branches, so that the final result becomes easier. Also, when you are a team, everyone can create

> their own branch and this way everyone in the team is more comfortable and they can have control over everyone's project."

This is not surprising, but there are informants providing information that even the most common tools do not have the necessary communication channels available for the work that needs to be done:

> "Well, I am thinking about the discussions that appear while we sit and write for example. Now we have to call or use a different tool compared to when we wrote the definition about communication, then the communication part was constant, and we therefore came to a conclusion."

Even if there is much to discuss it is possible to conclude on the research question for this paper: "How can Educational Technology best enhance collaborative work, and which functionalities needs to be present in order to make the tool work positively for the collaborative work?". In the results part we have identified 28 areas of interest when assessing and identifying tools that may enhance the learning effect in a collaborative work. These areas clearly underline the two main factors identified in the literature: the tools inherit functionalities and the instructor's ability to use them in a meaningful way. It is possible to see some areas as more important than others, but still there is several informants pointing at all areas, and it seems to be agreement among the participants on these 28.

There are several limitations to the results obtained in the study. The results have been collected and interpreted by five different researchers only able to communicate and discuss online. This may affect the results. All transcripts are available via the authors and will be published at a later stage[3].

The fact that there were eight different tools with different functionalities available being included in the study provides a large amount of data but might also make the focus less sharp. The study aimed at looking at functionalities, and cases were run according to the latter. This reduces the focus on the tool itself.

It is difficult to claim that the results are significant due to the low number of participants. Still, almost five hours of reflectional conversations are analyzed. All recordings are available via the authors.

It is also a possible uncertainty in the 28 areas identified. Not all of them are mentioned as often as the others, and some of them are not agreed upon by all. The study was concerned about agreement, this was included in the focus grid designed before the pilots, and areas only mentioned by one participant and not agreed upon, has not been included.

This research is not sufficient to make clear conclusions. Still the recommendations are valid, and the 28 areas identified are significant when applying Educational Technology in modern learning environments. For the future there should be done studies on the learning effects on groups using different tools, to identify achieved academic performance and to figure out how the implementation of the tools changes the dynamics of the collaborative work. Even if there are 28 areas identified, these could be more

[3] All results and appendices will be published in the project Learning Through Innovative Collaboration Enhanced by Educational Technology (iLikeIT2) [30].

detailed, and research could have been done in order to figure out which areas are more important.

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