Perception versus reality: Computer-Assisted Collaborative Problem Solving Skills in Students

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Abstract

While it is expected that university students can work flawlessly in groups, students themselves still report problems while working in groups. Therefore, the aim of the present study is to investigate the perceptions of university students about the quality of a collaboration. Moreover, this perception is compared with the quality as established through a coding scheme from the literature, focusing on equal participation and sharing knowledge. 30 university students worked together on a jigsaw task, which was to create a concept map about three plane crashes. A questionnaire at the end measured the students' perception and the coding scheme "Effective Collaboration" was used to objectively determine the quality of the collaboration. Groups that scored the lowest on the observed effectiveness seemed to have the biggest gap between the actual observed effectiveness and their perception about the effectiveness, suggesting that those groups do not know what effective communication entails.

Introduction

Working together is present in our everyday life (Slavin, 2015). To account for this, schools and universities often incorporate collaboration in their program. They often make use of collaborative learning, which can be defined as 'the instructional use of small groups so that students work together to maximize their own and each other's learning' (Johnson, Johnson, & Smith, 1991). In educational programs, technology proved more and more useful, also for promoting effective communication. This lead to a new kind of collaborative learning: Computer-Supported Collaborative Learning (CSCL) (Ludvigsen, & Steier, 2019). CSCL can be defined as a triad structure of collaboration that is mediated by a computational artifact (Ludvigsen, & Steier, 2019). A meta-analysis from Kyndt et al. (2013) revealed that collaborative learning is often superior to individual learning when it comes to academic achievement. However, effective collaborative learning depends on a lot of factors and circumstances (Dillenbourg, Jarvela, & Fischer, 2009). One example is that the effectiveness of collaborative learning seems to largely depend on the quality of student interaction (Kaendler, Wiedmann, Rummel, & Spada, 2015; Dillenbourg & Tchounikine, 2007). The current study investigated the effectiveness of the collaboration within such a CSCL learning environment by focusing on the interactions between students. Processes do not always go smoothly in a collaboration and this is no different for university students. Therefore, the aim of the present study is to investigate these processes and to investigate how the students themselves perceive these.

An important role in the research into the effectiveness of CSCL is played by contextual factors, which can influence the processes in a collaboration. An example is group composition factors (Strijbos, 2016; Notari, Baumgartner, & Herzorg, 2014), which include the size of the group (Wilczenski, Bontrager, Ventrone, & Correia, 2001). Working together with one person is vastly different from working together with four persons, since one has to deal with a lot more wishes, personalities and knowledge. Consequently, a lot more coordinating and negotiation is needed (Head, 2003). On the other hand, the more people, the more sources of information are available that can help with the task. The same counts for the instruction, laying the focus on the task has different consequences than if the focus is laid on the collaboration (Strijbos, Martens, & Jochems, 2004). Hence, the manner in which the collaboration is shaped has an influence on the collaboration processes that are being stimulated.

Another focus in the research into the effectiveness of CSCL evolves around which group processes are associated with learning gains for both the individual and the group

(Dillenbourg et al., 2009). Before discussing the literature on the effectiveness of CSCL, it is first needed to define what is meant with 'effective collaboration'. Head (2003) defined effective collaboration as a collaboration that not only leads to individual benefits but leads to a success that is unique to the group and could only be achieved by the group. Head (2003) also had an idea of what this looked like. He believed that effective collaboration resulted of acts that were about coordinating group work, consulting other group members if they still understood, communicating about tasks and cooperating together. Meier, Spada and Rummel (2007) also conducted research on what defines effective collaboration, and they came up with a similar yet more elaborate model. Firstly, they state that effective communication was important. Zhu, Xing, and Popov (2019) described this as sustaining a shared understanding and managing the dialogue. Secondly, they found that joint information processing, which entails information pooling and reaching consensus, is also an indicator of successful collaboration. Other research also confirms the importance of perceived and objective consensus in effective collaboration (Harney, Hogan, & Quinn, 2017). Thirdly, they think that coordination and monitoring is needed in effective communication, just as Head (2003). Vivian, Falkner, Falkner and Tarmazdi (2016) indeed found that less successful groups adopted fewer monitoring strategies. This was also found by Salas, Sims and Burke (2005), who also found that adapting behavior is vital. Lastly, they also pointed out the role of giving feedback and motivation (Meier et al., 2007).

Another indicator of successful collaboration is a transparent decision-making process, meaning that every member knows that decisions are made and also why they are made (Miller, 2011). Other research confirmed this and found that an equal engagement of team members (Fransen, Weinberger, & Kirschner, 2013) and whether or not the members function effectively as a group (Slof, Nijdam, & Janssen, 2016) are other indicators of an effective collaboration. Wiggins and Damore (2006) identified two main additional parts of effective collaboration, namely positive attitude and team process. Positive attitude entails a positive feeling and view towards collaboration, as well as a consistent engagement in the group work (Wiggins, & Damore, 2006). Team process revolves around active communication and respecting other's values and decisions, while still being friendly (Wiggins, & Damore, 2006). To end with elements of online effective collaboration is the absolute number of messages, as it suggests that members deliberated and were engaged more in the project than you would expect with fewer messages (Rodriguez, Price, & Boyer, 2017).

While it is evident that CSCL does not seem to result in a significant shift in the way teaching occurs (Blin, & Munro, 2008), since group interactions are not always structured to

foster effective collaboration (Baker, & Clarke, 2010), perceptions of the students themselves are often not taken into consideration. However, the research that exists about the perceptions show contradictory results, on the one hand, perceptions about interpersonal skills did not predict group performance (Slof et al., 2016), while in another study student perception about the group process was critical for the success of group collaboration in a technological environment (Pektaş, & Erkip, 2006). An explanation of this discrepancy can be that students' perception can change relatively quickly. Hence, one study found that positive collaboration experiences will likely result in better collaboration in the future, because a positive attitude likely results in an open mind and more engagement (Webb, & Miller, 2006).

In the research that has been done on perceptions of students on collaboration, Wilson and Whitelock (1998) found that only half of their respondents, students, wanted to work in groups, meaning that students themselves are also not always enthusiastic about the use of CSCL learning environments. It was even concluded that students are more satisfied with offline collaboration than with online collaboration, while there was no evidence of difference in performance (Cho, & Cho, 2014). This can be explained by the fact that students often experience challenges in working with groups, such as lack of non-verbal communication, free-riding and friendship. While it was found that unequal participation was indeed more likely to occur when there was online collaboration (Freeman, & Greenacre, 2010), students themselves also stated that they preferred offline collaboration because the communication was easier and misunderstanding and free-riding were less likely (Cho, & Cho, 2014). That students perceive friendship as an obstacle is a bit surprising, as Tolmie and Boyle (2000) concluded that knowing the other group members actually improved the performance in online collaboration.

One solution that is often suggested to get students involved is having tools that give some instruction on how to behave in a collaboration (Burdett, 2003). However, its use does not lead to a more effective communication per se, since you cannot assume that providing help tools automatically lead to improved communication (Prins, Sluijsmans, Kirschner, & Strijbos, 2005). Eshuis, ter Vrugte, Anjewierden, Bollen, Slikken, and de Jong (2019) suggested that this resulted from a gap between knowing how to behave and actually doing it, because motivation for the task and perceived relevance also play a role. Eshuis et al. (2019) focused on this gap by using tools to make students not only aware of what effective collaboration entails, but also to let them think about how this really happens in groups. Therefore, awareness is created that can lead to a better collaboration (Webb, & Miller, 2006). With university students, it is often expected that they can work in groups without any

problems, but research shows that problems also often arise in these working groups (Cho, & Cho, 2014; Burdett, 2003). Main reasons that are being named are the division of labor and the different opinions about the quality of the work (Burdett, 2003). Therefore, the present study will investigate if student's perception on collaboration match how effective the collaboration really was. The present study also aims to elaborate existing literature on student's perceptions by finding out how students produce these perceptions, and if the reasons can maybe account for the discrepancy/match. Moreover, the perceptions about the collaboration are compared with a student's overall perception about collaboration, to see if that might be of an influence. This led to the following research question: *"How do university students judge the effectiveness of a computer-assisted collaborative learning task and does this perception stroke with reality?"*. Furthermore, the study explored the following subquestions;

1. What perception do the students possess regarding the quality of the collaboration?
2. What is the observed quality of the collaboration?
3. To what extent do the observed quality and perception overlap and differ?
4. Do members of the same group agree with each other regarding the quality of the end product and the major strategy the group used?

The current study will explore this by using questionnaires to measure students perceived quality and by rating the quality of collaboration using, with the latter being rated with the use of a coding scheme that is based on literature (Damşa, 2014). In this coding scheme the focus lies on the following indicators of effective collaboration: Idea up-take, Creating shared understanding and Sharing knowledge (Damşa , 2010). In order to check the amount of domination from group members and if this matches the view of the students, the Gini co-efficient was used to calculate the amount of equal participation.

Method

Participants

30 university students participated in the present study, recruited via snowball sampling and participated voluntarily. Their age ranged from 18 to 23 (M=20.47, SD=1.042), with 21 participants being female. Groups of three were formed by the participants themselves, since they could sign in on a specific timeslot. Everybody met the requirements, meaning that no groups were deleted.

Task & domain

The subject of the task was to learn about three plane crashes, creating knowledge about the course of events and the causes of the crashes. The topic plane crashes was chosen since this fits the level of knowledge from the students while also being relatively unknown. A jigsaw task was used in order to lower the chances of dominance, since such a task is a useful method to enhance communication (Mengduo, & Xiaoling, 2010). Furthermore, this subject is very suitable for a jigsaw since the type of information makes it easy to divide it into subtasks. Instructions for the task were included in the document "READ FIRST". The task was to come up with a concept map based on three separate texts, which each participant had to read one of, because the combination of jigsaw groups and concept maps proves to be an effective way to enhance collaboration (Zheng, Yang, Cheng, & Huang, 2014). The three texts were made based on information from the internet ("Wikipedia") and all involved the same three plane crashes, namely Saudia Flight 163, Arrow Air Flight 1285, and Pacific Southwest Airlines Flight 1771. However, not each text was identical. For each plane crash (each flight), there was a part that was the same as the other two texts, but there was also a part that differed for each text. Identical information was information about the general course of events, the number of deaths and the scheduled city of arrival. Different information regarded the specific course of events, such as causes, the investigation and different parts of the crash. Because of the different information, participants had to communicate in order to get all the information. This text had to be read before the timeslot but could also be opened during the task since the task was not about remembering a text. All three texts are included in Appendix C.

Materials

General perception. The first questionnaire was put together specifically for this study, since no questionnaire completely fitted the needs for the present study. It comprised

six items. The aim of the questionnaire was to measure the general perception of the participants regarding their general level of collaboration and communication. Both questions about this used a 10-point Likert scale. Reliability analysis of these two items revealed insufficient internal consistency ($\alpha = 0.36$). Moreover, demographics (gender, age, nationality) were also asked in this questionnaire and one question about their time spent on social media was included, since the present study made use of ICT-based communication. The participant could choose if they used social media multiple times a day, daily, weekly, or monthly. The complete questionnaire can be found in Appendix A.

Students' perception. The other questionnaire consisted of ten items and measured students' perception about the collaboration specifically. This questionnaire was based on the questions that Hadwin, Bakhtiar and Miller (2018) used to guide the reflections about the collaborative process students had to write. From this list of questions only a few were adopted, since many were not applicable to the current study. Questions were asked about their perception, on what they based their perception and what they thought was the group's biggest strength and challenge. One question was for example 'Do you consider this collaboration to have been effective?'. Reliability analysis revealed poor internal consistency ($\alpha = 0.28$). The full questionnaire can be found in Appendix B.

Quality of the collaboration. The coding scheme "Effective Collaboration", developed by Damşa (2014), was used to determine the effectiveness of the collaboration. The goal of this coding scheme was to code the quality of the collaboration objectively. The results were used to compare the reality with the perception of the students. After the independent coding of one random chat excerpt by a second coder, an inter-rater agreement was achieved of 45%. The full coding scheme can be seen in Table 1.

Table 1.
Coding scheme with descriptions and examples.

Action	Description	Example
Epistemic; Creating awareness		
Identifying focus	Naming the topic, subject, concept, discipline etc., that represent the project focus	Okay ehm we have to create a mindmap of those 3 crashes.
Stating problems	Naming difficulties that impede the group from finding a solution to the problem they are solving or from elaborating on the solution they are working on	The space is too small hahaha.
Identifying lack of knowledge	Identifying gaps and missing knowledge in relation to various aspects of the problem or of the solution	Btw i am not great at mindmap.
Epistemic; Sharing knowledge		
Sharing information (from sources)	Informing other members about sources of information	Right. but it is not the meaning to be hours hours busy. but it is not the meaning to do in 30 min. just finish it.
Sharing knowledge from sources	Informing other members about the content of information sources and their possible use	In my text they say that the crew failed to open the doors on the ground.
Epistemic; creating shared understanding		
Creating explanations to concepts or ideas	Explaining concepts or ideas using definitions and knowledge from sources	I think we all have the main info (the first part of the text), but different second parts.
Structuring new concepts/ideas	Organizing concepts or ideas the group is discussing	I think the main subject is that a lot of people died.
Problematizing	Questioning understanding and explanations of concepts/ideas	Okay I am a bit confused. sorry I am thinking a bit now.
(Re)framing problem/focus	Reformulating focus or problem	Alright so we have to combine information I guess.

Epistemic; generative collaborative actions		
Generating new ideas	Bringing in ideas that can contribute to solving the problem or elaborating the solution	Maybe we should start with the reasons why the planes crashed?
Negotiating new ideas	Constructing arguments in favor of the ideas brought in or challenging other group members to do so	I think the date is better?
Idea up-take	Building up on own other members' argument in order to provide explanations and elaborations	Yeah good idea.
(Co-)elaborating concepts/ideas	Formulate explanations, arguments, illustrations, or provide examples for the ideas discussed	Maybe yeah. it is kind of important info of crash.
(Constructive) use of feedback	Use feedback provided by other group members or the teacher to elaborate on ideas	Well 7 december 1987 is another flight.
Regulative; regulative actions		
Planning	Formulating goals for the group project activities, and creating a plan of activities together	We will check afterwards.
Coordinating process	Organizing activities within the group, dividing tasks, and assigning responsibilities	Alright, maybe is it nice if we all do one crash.
Monitoring process and object progress	Checking on the status of tasks that must be fulfilled and others' contributions	I'm done as well I guess.
Reflecting on individual and collective actions	Discussing about the progress of the group work and members' participation	We're doing great hehe.
Other		
Other types of statements	Engaging in social talk unrelated to the task	I should work as a reporter or something lol

Learning environment. For the development of the questionnaires and the task, the online learning and authoring platform "Graasp" was used. Graasp provides teachers and educational designers with a what you see is what you get editor for online learning environments. Graasp is part of the Go-Lab-Platform GoLabz, a digital environment to aid investigative learning in beta subjects in high school and was made during EU-projects coordinated by the University of Twente. The platform makes it possible for students to work together simultaneously, which is why it was suited for the present research. Figure 1 depicts a screenshot of what a student will see when he or she logs in.

Instructions for the platform, together with overall information from the study, were included in the document "READ FIRST". When logging in, the participant could see that the experiment was divided in three phases. In the first phase, the first questionnaire about general perception was found, which had to be filled out individually. In the second phase, the concept mapper could be found, where each student could add concepts and arrows, and additions could be done simultaneously. In the third phase, the participant could find the final questionnaire about the students' perception. Again, this part was done individually. Through all the phases a chat box was shown on the right in which the students of one group could communicate with each other.

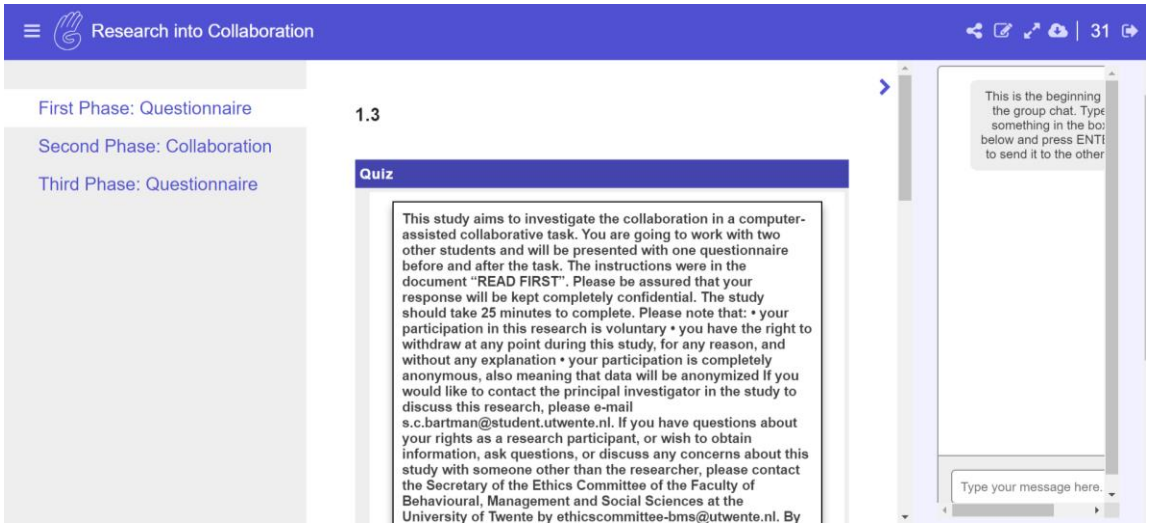

Figure 1. Student view from the Graasp platform.

Note. On the left of the screen, the three different phases are displayed, which the students could freely move between. In the middle the phase is displayed which one is selected and on the right the chat is shown in which students of the same group could talk.

Procedure

The participating students worked together in groups of three, with each group receiving one timeslot over the mail. This mail contained a link to the online platform with

their logins and two documents, all displayed in the Appendix. Each student had to read the "READ FIRST" and the text before the timeslot started. The text assigned to the participant was determined by the order of sign-up, with the first participant of a group receiving the first text. When a student logged in at the beginning of the assigned timeslot, the starting screen showed three so called 'rooms', each representing one phase of the experiment. Then each student filled out the first questionnaire, found in the first room. In this questionnaire each student first had to give an informed consent, which followed with questions about demographics and overall perceptions about collaboration and communication. After finishing, all three students went to the second room, which contained the collaboration task (concept mapper). The students were instructed to communicate through the chat and to start only when all group members were present. Moreover, students could see where other students' pointers were and where they were typing. When a concept map was made and everybody was content with it, each student filled out the last questionnaire, again individually. The questionnaire ended with thanking them for their participation and the instruction to close the screen. The whole procedure took the participants between 45 minutes and one hour.

Data analysis

For the data to be used in the analysis, all three students of the group had to be present during the whole collaboration. Since no students were missing, no data of the chats were deleted. Moreover, no individual data of the questionnaires were left out because there was no missing data in either questionnaire.

Quality of the collaboration. To assess the collaboration objectively, the chats were used in which the students communicated. Chat messages were derived from the chats and it was determined that the chat data was going to be segmented into utterances. Here, an utterance represents a coherent entry by a student that was sent into the chat by pressing Enter. If a consecutive chat message was entered by a single student and represented a spelling correction, it was combined with the previous message and treated as one utterance. Then, the utterances were coded based on their content, using the coding scheme of Damşa (2014).

A total of 2,195 utterances were coded, with an average of 219.5 utterances per team. Each utterance was first coded at the Dimension level, as being "Regulative", "Epistemic" or "Other". Then only "Regulative" and "Epistemic" utterances were coded at the second level, which represented the Category (of the action). "Regulative" could only receive a "Regulative

actions" code, while "Epistemic" utterances could receive a "Creating awareness", "Sharing knowledge", "Creating shared understanding" or a "Generative collaborative actions" code. Lastly, each utterance was then coded at the third level, which stated the action itself.

The resulting codes from the first coder were used to create percentages (the proportion of a specific type of utterance out of the total number of utterances) as indicators for the quality of the group's collaboration. This was only done for the five most important codes for this task, which Hadwin et al. (2018) states is sharing knowledge and keeping a shared understanding for a jigsaw task. Idea up-take was also added, since it is important that everybody agrees to the ideas. A percentage for each group was computed by adding the codes of "Idea up-take", "Creating shared understanding" and "Sharing knowledge", and then dividing this number by the total number of relevant chat messages. These relevant chat messages are the total number of chat messages minus the number of messages that were codes as "Other". Based on these percentages, the groups will be divided into three categories regarding effectiveness: not effective, average effective and effective. The cut-off point will be 70% for the effective class, since Kwon, Liu, and Johnson (2014) also used this as cut-off point although they used different codes. It was chosen to put the lower cut-off point at 30%, since 70% is 30% away from 100%. However, equal participation is also an indicator for good collaboration (Fransen et al., 2013), which can be assessed at an individual level or group level. However, it was chosen to create a group-level measure based on Eshuis et al. (2019) that represented the Gini coefficient, which was calculated using the total number of a student's utterances within a team. It represents the sum of the deviation of team members from equal participation for each team. This sum is divided by the maximum possible value of this deviation. The coefficient ranges between 0 and 1, with 0 being the perfect equal distribution between team members and 1 meaning that only one member was responsible for all of the utterances. The Gini coefficient is not influenced by one team having more utterances than another team, because it is about proportions.

Another percentage was then created for each group, representing an indicator of the amount of focus on the task. This percentage was calculated by dividing the amount of "Other" codes by the total number of chat messages. The higher the number, the more students were engaging in social task, suggesting a lower task focus.

Students' perception. To investigate the criteria that students use to base their perceptions on, their answers on question four from the second questionnaire were used. Because the goal is exploratory, the data was not analyzed with a pre-determined coding scheme, but through thematic analysis. Thematic analysis is defined by Braun and Clarke

(2006) as method for “identifying, analyzing, and reporting patterns (themes) within data” (p. 79). With thematic analysis it is important to create an exhaustive as well as mutually exclusive coding scheme. This means that the scheme should cover all topics displayed by the data as well that the codes should not overlap with each other. In the present study, a theme represented a pattern that could not be combined with another pattern anymore. This means that themes were all patterns that were different from the rest of the patterns.

Firstly, so-called fragments from the answers of question four were determined. Here, fragments represent small parts of the individual answers, that could vary from several words, to part of a sentence, to a full sentence. Then, all answers were read, and the meaning of individual sentences was written down. After reading all the answers, all the written meanings were compared, and a few themes became immediately clear out of this. This regarded the themes of “task characteristics”, “quality of the end product” and “time”. The answers that did not fit into these were originally divided in an “individual level” theme and an “intrapersonal theme”. However, this proved not to be mutually exclusive when coding an answer. Therefore, these themes were changed in “dividing”, “working together”, “discussing” and “participation”. Additionally, an “other” theme was added to make the coding scheme fully exhaustive.

Investigating similarities and differences in groups. The closed questions of the two questionnaires were analyzed in SPSS. Firstly, descriptives and frequencies were calculated to investigate the data. Besides question four of the second questionnaire, all questions were then used to investigate to what extent people in the same group agreed with each other. This was done by looking how much percentage of the questions matched all three the group member’s opinion. Big differences were singled out and will be discussed in more detail in the results section.

Results

Effectiveness of the collaboration

The chats ranged from 57 to 371 chat messages, with an average of 219.5 messages per group. After calculating the percentages, the groups were divided into three groups by using the cut-off scores of 30% and 70%. In total two groups were placed in the Low Effectiveness Group, 8 in the Average Effectiveness Group, and 0 in the High Effectiveness Group. What is noticeable is that one of the two groups in the Low Effectiveness Group had by far the lowest amount of chat messages, namely 57. Furthermore, almost all Gini-coefficients ranged around the 0.2, except for three groups. Group 7, 8 and 9 had 0.39, 0.08 and 0.08 respectively. Moreover, calculated percentages for the "Other" category ranged from 4.1% to 21.8%.

Perception on the effectiveness

In order to code the perception of the student, the coding scheme from the qualitative analysis of the open questions from the questionnaire was finalized using the following eight codes: "Division of labor", "Working together", "Communicating/discussing", "Participation", "Task characteristics", "Quality of the end product", "Time", and "Other". The codes are described below in Table 2. Notable patterns are discussed separately below.

Firstly, it was notable that almost everybody mentioned communicating or discussing together as an important condition for effective collaboration. This suggests that students have a fairly equal image of collaboration, namely that for effective collaboration communication is needed. Secondly, it became clear that in most groups students first divided the task into subtasks and subsequently, started to discuss the task. However, this did not lead to a high frequency of the code 'Division of labor'. Therefore, the task division did not serve the division of labor, but was merely a way of creating chunks that were manageable. Thirdly, students reported difficulties with the task and the learning environment, resulting in a high frequency of the mentioning of task characteristics as a measure. This is seen in some examples, namely "*the program made it difficult for us to work on the mindmap*", "*the system made it somewhat harder because the screen sometimes jumped to the center*" and "*when one person dragged the screen, it was changed for the others as well*".

Similarities and differences

For checking the similarities and differences in the groups, it was checked to what extent participants had similar answers regarding the effectiveness of collaboration, the strategy of the group, the contribution of each group members and the quality of the end product. Beginning with the effectiveness of the collaboration, only one group stood out, namely group

2. The participants rated the effectiveness as a three, a five and a four respectively. This represented the only group where participants scored more than 1 point apart. Only two groups had the same three scores as answer, but the others mainly differed by a single point.

When turning to the strategy of this group, more differences could be seen. Participants could choose if the main strategy was to divide the tasks or to make all the decisions together. Only five groups reported the same strategy. The remaining five groups chose different strategies as the main strategy, suggesting that some groups used both.

Regarding the similarities and differences on the contribution of group members, no big differences were found. Most groups agreed with each other that everybody did the same amount of work and only a few people commented that another member of the group did more work than the others.

Lastly, the quality of the end product was scored vastly different in groups. In only one group all members agreed with each other. In the other groups, the scores were also vastly different, not just one-point difference. The biggest difference was found in group 4, where members scored the end product as a 5, a 4 and a 2 respectively. Another example of a group with different answers was group 5 where the participants scored the quality a 2, a 1, and a 3. This pattern was found in several other groups, where all members scored something different, but only 2 points apart from each other.

Discussion

This study aimed to identify the perception of students regarding an online collaboration task and if these perceptions stroke with the objective measure of effectiveness. Thematic analysis revealed seven themes on which participants based their perception, namely “Division of labor”, “Working together”, “Communicating/discussing”, “Participation”, “Task characteristics”, “Quality of the end product”, “Time”. When rating the quality of the collaboration, two groups were categorized as Low Effective and eight groups were categorized as Average Effective.

Perception of the students

In order to investigate the perception of students, open questions were coded which resulted in seven themes. The seven themes in the current study are partly in line with previous research. Communicating and discussing proves to be an important factor on which students base their perceptions. This is in line with the findings of Merritt and Kelley (2018), since they found that consensus and shared understanding are often associated with effective

collaboration. One aspect that is contradictory to previous research is the level of free riding. Cho and Cho (2014) stated that offline collaboration made communication easier and free-riding less likely. In this study, not a single person reported free riding, neither did anyone mention anything about the communication as opposed to offline communication. Another aspect that was different compared to previous literature was the amount of references to the quality of the end-product. Because Vivian et al. (2016) found that schools often assess their students based on the quality of the end-product, it was expected that students themselves would incorporate this aspect in their perception. However, only nine participants mentioned anything about it, while also naming other aspects of the collaboration. This suggests that students were aware of the difference between the result and the process towards it. Taking the fact that free riding and the quality of the end-product were less important than anticipated, it seems as if the perception of students is viewed wrongly. Making sure that perceptions of students are understood correctly is vital in enhancing their collaboration skills.

Observed quality of the collaboration

In order to rate the quality of the collaboration, a Gini coefficient and two percentages were computed. Regarding the Gini coefficient, only three groups did not have a number ranging around 0.2, meaning that those groups stand out. For the first group, with a Gini co-efficient from 0.39, it became clear that participation was not equal. When looking into the chat it became apparent why, since one participant took the role of leader upon himself. He guided everything and made sure everything was done by instructing the other group members. So even though the jigsaw method was chosen to prevent dominance, this person was so used to being the leader that he automatically took that role upon himself. This is interesting since he did not know more than the others, but the others also did not protest. The chat also revealed that the other members accepted him as a leader, since no one went against him when he proposed an idea that was not in line with the instruction. The other two groups, with Gini co-efficient from 0.08 and 0.08, it stands out that they also scored the highest percentages for the level of effectiveness. This means that indeed equal participation has its benefits, as Cho and Cho (2014) also stated. The focus on shared understanding is also evident, since the two groups scored the lowest of percentages with regard to the “Other” theory. These numbers make it clear that they were indeed focused on the task and not on social talk.

Another combination that was a notable observation was the fact that one group that scored the lowest on the percentage of codes was also a group who scored the lowest on the

percentage of the “Other” category. This revealed that they were focused on the task, but probably focused on the wrong aspects of the task. This is also evident in the fact that this group only sent 57 chat messages in total, suggesting that this group was focused more on the concept map than on communicating with each other. Consequently, it was not possible that someone would know what the other was doing which probably created misunderstanding due to lack of knowledge. This is line with research, since Cho and Cho (2014) found that misunderstanding happens a lot faster than offline collaboration. Cho and Cho (2014) specified this by finding that the lack of non-verbal communication and loss of intonation are possible reasons for the higher chance of misunderstanding in online collaboration.

To conclude, the percentages revealed that two groups were Low Effective and eight groups are Average Effective. This suggests that in general people can work effectively online. The other data, such as the Gini-coefficient, confirmed this categorization. It became evident that focusing on the task did not per se lead to effective communication, because you can also focus on other parts of the task rather than on the communication.

Perception versus observed quality

When combining the qualitative with the quantitative data, one clear pattern appeared. It stood out that from the two groups in the Low Effectiveness category four participants called their collaboration very effective and two participants stated they found their collaboration moderately effective. Furthermore, it can be seen that on their answers to the question of the effectiveness, they commented that they all had a level of understanding of the task, but that the tool was not working. As examples the students provided aspects like ‘*when somebody moved the screen, everything moved*’ and ‘*the chat did not work for me at first*’. Overcoming these challenges were often mentioned as effective because many groups solved this by communicating and sharing ideas about it. Moreover, they said that their main strategy was task division. The task was designed in a jigsaw way to facilitate that at some point the students need to exchange information. Since both groups have this in common, it could have been the case that by stressing the students just did not perform the task as intended by focusing too much on the individual task. Another possibility is that the interaction itself had gone wrong. Namely, this was found by Kaendler et al. (2015). However, this pattern suggests that people who score low on effectiveness also have score low on task understanding and have the highest discrepancy between their view of the collaboration and the reality. This means that they probably do not know what effective communication entails. This is an important finding, since discovering this problem can lead to new ways to improve

collaboration techniques. This is in line with the findings of Eshuis et al. (2019), who found that creating awareness improved the quality of the collaboration.

To conclude, the results were in line with the literature, but not completely. Task characteristics was named more and the quality of the end product was named less than the literature suggested, meaning that task characteristics are more important and quality of the end product less important than the literature stated.

Limitations, strengths and directions for future research

Familiarity with the working partners might have differed between groups. Because participants had to sign up to a timeslot themselves, it is likely that some signed up together with their friends or classmates. Therefore, some of the participants might have worked in a similar group setting before, and might have established ways of working with these peers. This suggestion is underscored by the low reliability scores of the questionnaires. However, in the present study familiarity and previous working experience with group members was not checked for, meaning that it could not be taken into account in the analysis. Future research should definitely include this to control for familiarity. Secondly, the present study took place in an online setting. In online settings communication might be hindered (Cho, & Cho, 2014**)** due to lack of specific social cues such as gestures or facial expressions. This might make it more difficult to pick up indicators of emerging disagreement for example. On the other hand, chat messages offer a sort of shared archive of the conversation and therefore make it easier to refer back to previous statements. All in all, this implies that the findings of the current study do not translate one to one to a face to face setting. More research is needed to investigate how the patterns hold in a face-to-face setting, maybe revealing differences between the two settings. Moreover, due to the online nature it was also hard for the experimenter to check if all participants followed the procedure of the experiment. It is suggested that future studies include observation from the experimenter or some type of video calling or web conferencing in their online collaboration to ensure equal participation. Other research could be investigating whether giving students feedback on the effectiveness of the collaboration can lead to an improved effectiveness, also addressing the problem of unequal participation. This means that students are given insight based on found differences and thereby get an early indicator if something is wrong. This is important since the results show that groups falling in the Lower Effectiveness Category have a lower insight in their own effectiveness, shown by the bigger gap with their perception. Possible reasons for this are that these groups miss the knowledge about what effective collaboration entails or that they have a lower task understanding. Therefore, it seems that for these groups awareness and tools are especially

important to address these aspects in the hope that that will lead to higher effectiveness of their collaboration.

Another consequence of the online nature is that the researcher could not ask participants to explain their answers. The researcher was not present as a mediator in order to create a collaboration that was as natural as possible. This would make interpreting the answers harder, since one could only guess what was meant by certain sentences. A fourth shortcoming is that the tool played a huge part in many of the collaborations. As could be seen in the results, many participants named the struggle they had with the tool in their answers, suggesting that the tool played a bigger part than expected. Future research can account for this by using a task that mimics collaborations exactly done at Universities. Moreover, in University the majority of the tasks require collaboration over a period of weeks in the context of project based education, while in this research an individual task was used. It would be interesting to see if the same results hold when a tool is used that the students find easy to work with.

Another important note is that the design of this study represented a situation that is seen more and more in education. Due to the coronavirus, distant education has become more relevant than ever, leading to an increase need for learning environments. The period of social distancing asked for online assignments, even the smaller ones that were first mostly offline.

Practical implications

The main practical implication arising from the present study is the creation of a tool that can interfere when a group does not communicate or when the communication is unequal. This tool can provide feedback and support the group in overcoming these problems. Because the nature of this study is exploratory, the main implications are to have received a better insight in the perceptions of students and how they relate to the objective effectiveness of the collaboration. This study provides a first exploration of how University students' perception of the collaborative learning experiences relates to the collaborative learning processes as it was coded by the researcher using a coding scheme based on the criteria for collaborative learning.

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Appendix

Appendix A. READ FIRST document

Welcome to the research into the collaboration between university students. In this document, I will briefly explain the online environment and what is expected of you.

About the research:

When you click on the link you will get a screen which asks you for your nickname. The name you should put here was sent to you via email. After inserting the right name, you will be led to a screen in which you see three phases on the left side. You will work through these phases from top to bottom, so first a questionnaire, then the task, and then a second questionnaire. Below is a brief description of each phase and what you have to do.

In "*First Phase: Questionnaire*" you find a short questionnaire, in which you also have to give informed consent. You will do this individually.

In "*Second Phase: Experiment*" you will find the task 'Concept-Mapper'. The idea is that you will make a mind-map together with 2 other students. You have to make a mind-map based on a text you had to read. This text was attached to the email. You are now going to communicate with the 2 other students to come up with one mind-map. The layout is completely up to you, there are no guidelines. You will communicate through the chat, which you can open by clicking on the speaking box on the right top of your screen. Make sure that all students are present before you start making the mind-map (so ask in the chat if everybody is there). If you don't see the other cursors anymore, or nobody is responding in the chat, you can refresh the page. This will solve these problems.

In "*Third Phase: Questionnaire*" you will find the final questionnaire, which will take around 5/10 minutes. Only move to this part when you made a mind-map which you all agree with. After you finished the questionnaire, you are done and you can close the screen.

A lot of thanks in advance for participating!

Contact Information Researcher:
Sofie Bartman – s.c.bartman@student.utwente.nl

If you have questions during or after the experiment please email me!

Appendix B. Questionnaire 1

This study aims to investigate the collaboration in a computer-assisted collaborative task. You are going to work with two other students and will be presented with one questionnaire before and after the task. The instructions were in the document “READ FIRST”. Please be assured that your response will be kept completely confidential.

The study should take 25 minutes to complete. Please note that:

• your participation in this research is voluntary
• you have the right to withdraw at any point during this study, for any reason, and without any explanation
• your participation is completely anonymous, also meaning that data will be anonymized

If you would like to contact the principal investigator in the study to discuss this research, please e-mail s.c.bartman@student.utwente.nl.

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher, please contact the Secretary of the Ethics Committee of the Faculty of Behavioural, Management and Social Sciences at the University of Twente by ethicscommittee-bms@utwente.nl.

By clicking the button below, you acknowledge that your participation in this study is voluntary and that you are aware that you may choose to terminate your participation in the study at any time and for any reason.

o I consent
o I do not consent

Code SPSS	Number	Question	Response scales
GENDER	1	What is your gender?	Male, female, rather not say
AGE	2	What is your age?	Open
NATIONALITY	3	What is your nationality?	Dutch, German, Other
TECHUSE	4	How often do you use a computer or laptop?	Open
COLLABORATIVE	5	On a scale of 1 to 10, how collaborative you think you usually are?	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
COMMUNICATIVE	6	On a scale of 1 to 10, how well do you consider yourself to be in communication?	1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Appendix C. Questionnaire 2

Code SPSS	Nummer	Vraag	Response schaal
AGREEDMAP	1	First of all, did your group come up with a mindmap everybody agreed to?	Yes, No
TASKUNDERSTAND	2	Now that the task is completed, I think my task understanding was	Completely inaccurate, inaccurate, somewhat accurate, very accurate, perfectly accurate
EFFCOLL	3	Do you consider this collaboration to have been effective?	Not at all, not very, moderately, very, extremely effective
	4	For this research it is really important that we know why, so please explain your answer on your previous answer elaboratively (minimal 150-200 words):	Open
STRATEGYGROUP	5	The group most often:	Divided the labor between the group members, answered the questions together
CONTRIBUTION	6	Do you feel like the group members' contribution was equal?	Yes, No I did more, No a group member did more
	7	Our biggest strength as a team was…	Open
	8	Please state what your group's biggest difficulty was and explain what you/the group did to overcome this.	Open
QUALITYPRODUCT	9	Overall, our groups' final product was … than what I could have accomplished on my own.	Much worse, worse, the same as, better, much better
	10	Looking back, please explain what you would have done differently.	Open

Appendix D. Texts for mindmap

D.1 Text 1

Plane crashes

Saudia Flight 163

Saudia Flight 163 was a scheduled passenger flight from Riyadh to Jeddah on 19 august 1980. After the plane caught fire midair, it made a successful emergency landing at Riyadh Airport. However, captain Khowyter failed to evacuate the aircraft immediately. The aircraft bursted into flames and was consumed by fire, killing all 287 passengers and 14 crewmembers.

Why the captain failed to evacuate is still not sure. However, the ground rescue personnel lost contact with the crew a few minutes after the engines were finally shut down. No external fire was visible at this time, but flames were observed through the windows at the rear of the aircraft. Twenty-three minutes after engine shutdown, the R2 door (second door on the right side) was opened by ground personnel. Three minutes later, the aircraft burst into flames, and was consumed by fire.

Arrow Air Flight 1285

Arrow Air Flight 1285 was carrying U.S. troops from Cairo to Fort Campbell in Kentucky, via Cologne (Germany) and Gander (Canada). On the morning of 12 December 1985, shortly after takeoff from Gander en route to Fort Campbell, the aircraft stalled, crashed, and burned about half a mile from the runway. All 248 passengers and 8 crew members were killed, making it the deadliest aviation accident to occur on Canadian soil.

The death toll still constitutes the United States Army's single deadliest air crash in peacetime. Of the 248 servicemen, almost all were members of the 101st Airborne Division (Air Assault). To remember the victims, there are three memorials founded. One overlooks Gander Lake; another one is stated at Fort Campbell and there is a Memorial Park in Hopkinsville.

Pacific Southwest Airlines Flight 1771

Pacific Southwest Airlines Flight 1771 was a scheduled flight from Los Angeles to San Francisco. On 7 December 1987, the aircraft crashed in San Luis Obispo as a result of actions by one of the passengers, David Burke.

First it was thought that David Burke committed suicide after killing several people on board, but the evidence suggests otherwise. FBI investigators were able to lift a print from a fragment of finger stuck in the revolver's trigger guard, which positively identified Burke as holding the weapon when the aircraft crashed. If he had committed suicide, the gun would have fallen out of his hand, thus not leaving a fragment of a finger.

D.2 Text 2

Plane crashes

Saudia Flight 163

Saudia Flight 163 was a scheduled passenger flight from Riyadh to Jeddah on 19 august 1980. After the plane caught fire midair, it made a successful emergency landing at Riyadh Airport. However, captain Khowyter failed to evacuate the aircraft immediately. The aircraft bursted into flames and was consumed by fire, killing all 287 passengers and 14 crewmembers.

Why the captain failed to evacuate the aircraft promptly is not known. Saudi reports stated that the crew could not get the plug-type doors to open in time. It is assumed that most passengers and flight attendants were incapacitated during the landing roll, or they did not attempt to open a door on a moving aircraft. Further, the crew were found still in their seats, and all victims were found in the forward half of the fuselage. Autopsies revealed that they died from smoke inhalation, which indicated that they had died long before the R2 door was opened by the ground rescue personnel.

Arrow Air Flight 1285

Arrow Air Flight 1285 was carrying U.S. troops from Cairo to Fort Campbell in Kentucky, via Cologne (Germany) and Gander (Canada). On the morning of 12 December 1985, shortly after takeoff from Gander en route to Fort Campbell, the aircraft stalled, crashed, and burned about half a mile from the runway. All 248 passengers and 8 crew members were killed, making it the deadliest aviation accident to occur on Canadian soil.

There were two reports published by the Canadian Aviation Safety Board, since there was and is disagreement about the cause. The majority report states that the cause of the crash was the aircraft's unexpectedly high drag and reduced lift condition, most likely due to ice on the wing together with an underestimated onboard weight. A minority report stated that the accident could have been caused by an onboard explosion of unknown origin, since they did not believe that a thin layer of ice brought down the aircraft.

Pacific Southwest Airlines Flight 1771

Pacific Southwest Airlines Flight 1771 was a scheduled flight from Los Angeles to San Francisco. On 7 December 1987, the aircraft crashed in San Luis Obispo as a result of actions by one of the passengers, David Burke.

The exact sequence of events is still not completely known, but the best guess comes from the pattern and audible volume of the shots on the CVR. Burke first wrote Thomson a note, which was later found by investigators and revealed his motive. Then, he probably shot Thomson twice. Then, he made his way into the cockpit, killing the flight attendant on the way. The CVR recorded Burke saying, "I'm the problem", before killing the captain and first officer. Several seconds later, the CVR picked up increasing windscreen noise as the airplane pitched down and accelerated. It was probably caused by Burke pushing the control column forward into a dive.

D.3 Text 3

Plane crashes

Saudia Flight 163

Saudia Flight 163 was a scheduled passenger flight from Riyadh to Jeddah on 19 august 1980. After the plane caught fire midair, it made a successful emergency landing at Riyadh Airport. However, captain Khowyter failed to evacuate the aircraft immediately. The aircraft bursted into flames and was consumed by fire, killing all 287 passengers and 14 crewmembers.

The investigation revealed that the fire had started in the C3 cargo compartment. The fire was intense enough to burn through the cabin floor, causing passengers seated in that area of the cabin to move forward prior to the landing. The source of the fire was never found. One early theory was that the fire began in the passenger cabin when a passenger used his own butane stove to heat water for tea, but there was no evidence to support this theory. After the event, the airline revised its training and emergency procedures.

Arrow Air Flight 1285

Arrow Air Flight 1285 was carrying U.S. troops from Cairo to Fort Campbell in Kentucky, via Cologne (Germany) and Gander (Canada). On the morning of 12 December 1985, shortly after takeoff from Gander en route to Fort Campbell, the aircraft stalled, crashed, and burned about half a mile from the runway. All 248 passengers and 8 crew members were killed, making it the deadliest aviation accident to occur on Canadian soil.

On the day of the crash, responsibility was claimed by Islamic Jihad. The claim was dismissed by the Canadian and U.S. governments soon afterward. The call was made by an anonymous caller to a French news agency in Beirut.
Because the Canadian Aviation Safety Board did not agree about the cause, they issued two separate reports. This was one of the reasons why there wasn't much confidence in the investigations performed by the CASB, which is why it was replaced in 1990 by the Transportation Safety Board of Canada.

Pacific Southwest Airlines Flight 1771

Pacific Southwest Airlines Flight 1771 was a scheduled flight from Los Angeles to San Francisco. On 7 December 1987, the aircraft crashed in San Luis Obispo as a result of actions by one of the passengers, David Burke.

David Burke was an employer of USAir, until he was fired after being caught stealing $69 from the company which was recorded on camera. He had a meeting with Ray Thomson, his manager, who then rejected Burke's request for reemployment. Burke was furious and booked a ticket for Flight 1771, known to be taken a lot by Ray Thomson. Using USAir employee credentials that he had not yet surrendered, Burke managed to get a gun on board. After the incident, a law was accepted in which everybody should pass through security, including employers. Moreover, employers should hand over their credentials immediately after being fired.