STUDENT-CENTERED PROBLEM CONSTRUCTION AS A WAY OF CONSTRUCTING ENGAGING PROBLEMS FOR STUDENTS?

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Abstract: Although there have been several contributions of what constitutes an engaging problem in Problem Based Learning (PBL), limited research has looked into the process and outcomes of letting the students construct the problem. In this paper an analysis of video recordings showing how Engineering students in a PBL environment negotiate and construct the problem area they wish to engage with, without any tutor/supervisor being present in the room, is presented. It will be analyzed how students in collaborative processes arrive at a decision in terms of what problem-area they wish to engage with. The study gives insight into decision making processes in PBL-groups when a supervisor is not present and what students deem relevant, when they construct their problem.
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Introduction

The word problem derives from the Greek word "problema" meaning obstacle (Jonassen, 2011). In a Problem-Based Learning (PBL) context the problem serves several functions; they trigger students' motivation, they afford the content knowledge to be studied, they contextualize the content knowledge and they provide a working space for students to apply their content knowledge (Hung, 2016). Most importantly in PBL problems acts as the starting point of the learning process (De Graaff & Kolmos, 2003). Another central aspect of PBL is knowledge transfer; teaching students how to use their relevant content knowledge in a real world situation. Problems which take it's point of departure in real world situations is said to solve this issue with the additional benefit of teaching important 21st century skills, increasing the intrinsic motivation and enhancement of long term knowledge retention (Moallem, 2019).

The question thus arises how to develop good and engaging problems that will adhere to the functions described above? While Hung has developed several models of how instructors can design effective PBL problems (Hung, 2006, 2009, 2019) in this paper the attention will be turned toward a principle of Student Centered Problem Construction (SCPC). While the underlying philosophy of SCPC will be elaborated in another publication (Velmurugan & Stentoft, Unpublished) the principle should be understood as one where students themselves construct problems that adheres to the learning goals of the semester. The reason for letting the students construct the problem can be found in a quote from Dewey, who stated that:

"it is indispensable to discriminate between genuine and simulated or mock problems. The following questions may aid in making such discrimination. (a) Is there anything but a problem? Does the question naturally suggest itself within some situation or personal experience? Or is it an aloof thing, a problem only for the purposes of conveying instruction in some school topic? .... Is it the pupil's own problem or is it the teacher's or textbook's problem, made a problem for the pupil only because he cannot get the required mark or be promoted or win the teacher's approval, unless he deals with it?" (Dewey, 2001, p. 161).

In the above quote Dewey differentiates between a "*genuine*" and "*simulated or mock problems*" The genuine problem is described as something that naturally suggests itself or takes it's point of departure in the natural experience, where the simulated or mock problems are described as something aloof only for the purpose of conveying instruction. Furthermore, the emphasis is put upon whether it is the pupil's own problem or the teacher's problem. The central message thus is, that the students need to conceive it as problem, if they do not, the focus changes to giving the teacher what he wants instead of trying to solve the problem, which will then limit the students' learning and transfer abilities (Dewey, 2001).

Turning our gaze towards a real life example of SCPC Aalborg University (AAU) has had a long tradition of allowing the students to construct the problem themselves as long as they adhere to the learning goals of the specific semester. The Aalborg PBL Model is based upon Problem- Based Project Work (Askehave, Prehn, Pedersen, & Pedersen, 2015) where the students organize themselves in groups and over the course of a semester write a project. The students get a supervisor who is a researcher himself or in the process of obtaining a Ph.D. The researcher gives feedback to the students during the course of the semester and feedback to different sections of the report the students send to the supervisor. Meanwhile they still follow coursework which they might use in their project. Other courses have more traditional examinations. The project accounts for 50 % of the semester's credits.

The author of this paper has followed a group of third semester Engineering students from the first day of the semester (September 3rd, 2018), where they constructed their group to the examination (January 27th, 2019). The students handed in a written project before Christmas and had to orally defend it on January 27th, 2019. Engineering students at AAU are given a group room for the course of a semester where they can meet and do all their project work. Two cameras were put in the room a 360 degree camera and stationary camera. Approval was obtained from the university and the students signed confidentiality agreements allowing the researcher to use and present the video in research journals, conferences and teaching activities. The students themselves would turn the cameras on and off every day and switch the memory

cards in the cameras. Once a week the researcher would empty the memory cards. Once a month the researcher would be in the room to observe the students and take field notes. Approximately 300 hours of video was recorded. In the following a clip from their first day working together, where they decide the subject of their project will be analyzed in order to determine how the students negotiate and construct the problem area, they wish to write a project about. In the following I will elaborate on why looking at video recordings makes sense in a PBL perspective.

Theoretical Framework

PBL is based in a constructivist approach to learning (Savery & Duffy, 1995). People learn by a mental process of actively constructing new knowledge from external stimulation instead of getting knowledge transferred from one person to another. A parallel can be found in Vygotski's writing that states the formation of mind is a social process where the child internalizes external stimulation and through the mirroring of ones action in the social context learn and construct what significance and meaning that social action has (Vygotskiĭ & Cole, 1978). Because knowledge cannot be directly transferred from one person to another but actively constructed by the stimulation one receives, this opens up for many ways of structuring the world. The best way of ensuring a comprehensive understanding of a subject is thus viewing and actively discussing phenomena from different perspectives (Hung, Moallem, & Dabbagh, 2019). As such to gain an understanding of how students make sense of their subject an active discussion of how they have perceived and constructed new knowledge becomes relevant. The focus therefor becomes how the students negotiate what problem to study and write a project about. This will be done with a theoretical framework developed to analyze social action through interaction, namely interaction analysis.

Interaction Analysis

"*Interaction analysis … is an interdisciplinary method for the empirical investigation of the interaction of human beings with each other and with objects in their environment.*"(Jordan & Henderson, 1995, p. 39)

The purpose of interaction analysis is to investigate human activities such as talk, nonverbal interaction and the use of artifacts and technologies. It implies like Vygotski that knowledge and action are social constructs and they are situated in social and material ecologies

(Jordan & Henderson, 1995). Knowledge and practices are thus best understood as situated in interaction among members of particular communities. There are different ways of during interaction analysis, in this paper we will combine mediated discourse analysis with an ethnomethodological and multimodal approach.

Mediated discourse analysis focuses on linkages between discourse and action (S. W. Scollon & de Saint-Georges, 2012). The primary analytical focus is the social action which according to mediated discourse analysis can be found in an intersection between discourses, interaction and historical body (a form of habitus among the participants). Actions are mediated through different mediational means (R. Scollon & Scollon, 2004) which are tools uses to utilize the different actions. What we will take from this approach is the overall focus on social action and how discourses are a part of this social action. The social action under study will be the first decision the group takes in order to construct their problem. To analyze the interaction taking place inspiration is taken from multimodal interaction analysis which also have a primarily focus on social action.

Social action is, as the name entails, social and done through communicative actions, all actions communicate, even if you do them alone and nobody picks up on it, it communicates something and not performing that social action (such as brushing one's teeth) also communicates something. In this paper the social action of deciding what subject to write a project about will be analyzed further. This will be done by studying how the group members interact. Multimodal Interaction Analysis defines interaction as any action that a social actor performs in which the actor communicates a message (Norris, 2014). However, "*All interactions are multimodal*"(Norris, 2004, p. 1) when we interact with other people, we do not only use language to communicate to the other, we use gestures, body, tone of voice, proximity and material structures in our surroundings through which we deliver our message. In order to analyze the complexity of this interaction, multimodal interaction analysis uses the theoretical concept of mode, which they define as systems of representation or semiotic systems with rules and regularities attached to them (Norris, 2014) or a system of mediated action (Norris, 2013), it could for example be gestures, body, proximity or material structures. Modes are theoretical concepts invented for the specific case of analysis in order to elucidate the complexities of the interaction under study. They are not fixed entities but are defined by the researcher in each analysis according to which mode is relevant under the present interaction. The concept of mode will be used, to analyze interactions that are mediated by other modes than language in order

to get a thorough understanding of the interaction going on. Another central concept taken from Multimodal Interaction Analysis is the frozen mediated action, which is defined as: "*an action embedded within an object or the environment that tells of the previously performed actions*" (Norris, 2019, p. 45), in short it is a concept for the material structures and how they affect the interaction going on.

For the linguistic interaction and language used, ethnomethodology that focus on meaning created in interaction instead of something, that is created in the mind or derived from subjects in for example interviews will be used (Raudaskoski & Kjær, 2016). The focus centers around how meaning is created through the cooperated interaction between the social actors (Garfinkel, 1967) the focus thus is on everyday naturally occurring interactions and how meaning is created and negotiated among participants in this regard. Therefor when engaging with video or speech it is important to transcribe every little notion (like breaks, pauses, overlapping conversation etc.) as it all have meaning for the interaction under study.

Interaction analysis is a complex way of looking at interaction, and one could therefor ask, what is the point of dissecting social actions into these micro entities as modes and what benefit will the general PBL literature gain from an inclusion of this approach? When looking at the videos, it becomes clear, that interaction is mediated through different material structures, both the computers but also very much the blackboards as will be seen in the analysis. By looking at both how our students interact and cooperate with each other, but also what mediational means they use in their cooperation, gaining an insight into how to foster better learning environments for the students, but also an insight into what matters when students cooperate. To capture these complex situations of interactions a theoretical framework is needed, that can capture the minor details of how students work and construct knowledge together. Furthermore, researchers look at different modes when studying interaction because the modes have and constitute meaning that the other social actors pick up on, as such it gives us a framework to capture a detailed account of the interaction that can be used to develop better learning environments and better knowledge of useful cooperation. Additionally, as learning is viewed as a social process an insight to what the students deem important in regard to what constitutes a good problem in PBL is relevant.

Analysis

Making a thorough Interaction Analysis of how the students construct the problem, would take far more space than what is allowed in this paper. As the problem is examined during the course of a semester ones first intuition might be, that the students choose a problem and then examine and try to solve that problem during the course of their semester. That is not the case. The problem keeps evolving and transform during the course of the semester, both because the students get more knowledge but also because their supervisor encourages them to take certain directions during their project work. The aim of the analysis for this paper is to zoom in on the first instance where the group themselves choose the domain of their project. They do not choose a problem, but they choose the area they wish to work with, from which they will later construct a problem. This again is a result of a group discussion in which they have brainstormed for quite a bit. In the analysis the focus will be when one of the students takes a decision, and how the other reacts to that decision, relevant instances of previous interactions will be presented when they explain the behavior zoomed in on. As such the videoclip is 42 seconds long as it marks the beginning and end of a higher level action: choosing the area to write a project about.

Setting the scene

It is the first day of the semester. The students have met in to a semester introduction, where the coordinator of the semester is holding a lecturer where he introduces the learning goals for the project and the courses and other examinations they have to follow during the semester. Another agenda of the day is the formation of project groups. Different supervisors have created project proposals that were put on Moodle (the intranet for the students), the thought is the students choose the project they want to work on, and from that the groups are formed. I am there as a researcher in Problem-Based Learning. The goal of the day for me is to find a group to follow during the course of the semester, the coordinator introduces me for the students. An interesting thing happens during the group formation. Two students (S and M) have their own suggestion for a project which would center around energy storage, the coordinator approved the subject on the merits they could find other students who were interested and willing to write a project about it. They succeeded and I asked them if I could follow them during the course of their project. They all agreed. I did not plan on starting my filming that day, because I needed access to their group room (which they would be given this

day) and time to set up the cameras. However, the students choose to begin right away, once they entered the group room. Because of this I had to quickly improvise, the result being using only a handheld camera, that I would hold in my hand trying to focus on the ones talking (which did not succeed all the time). The group had a total of 6 members, which is shown in the pictures below:

The letters above their heads are put in, because they symbolized how I have named them. As this is an interaction comprised of six students, it is quite complex. The students start by brainstorming what their project should center around. The first step of this analysis will be to focus on one of the frozen actions, when entering the videoclip:
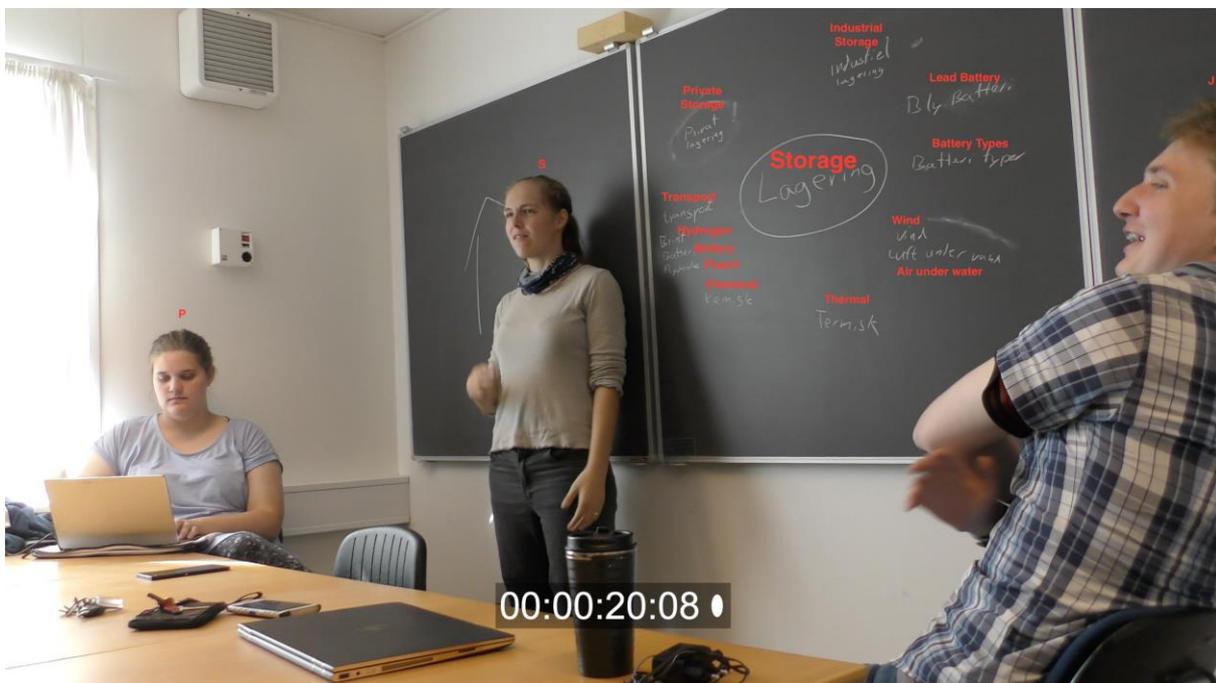
The timer in the bottom is a symbol of the clip, which has a duration of 42 seconds, these 42 seconds have been chosen, as they are a symbol of a higher level action, namely the start and endpoint of the group taking a decision. However, the blackboard is a result of what the group has been doing up until entering the clip, they are 13 minutes in their meeting. The

red text is edited in as translation for what they have written on the blackboard. Notice the center in which they have written lagering [storage] all ideas spring out from this center, which defines their main topic. Also notice how around privat lagering [private storage] there is a circle as well, which then got erased. Private storage was the first thing written after storage, but the circle was erased right after it was drawn without any comments from the others in the group. As is quite evident from the blackboard their brainstorming is a free round of associations and even though they are all connected to the main topic (storage) they are quite different in nature, some points towards different sectors (private, transport, industry), other points at concrete storage technologies (lead, hydrogen) others again to the scientific nature of the storage (chemical, thermal) and some points towards the source of the energy (wind, air under water). Safe to state the frozen higher level action of the text on the blackboard is a result of a free association among the students towards what could be interesting to write a project about, without any systematical way of narrowing down, other than the fact we are talking about storage of energy.
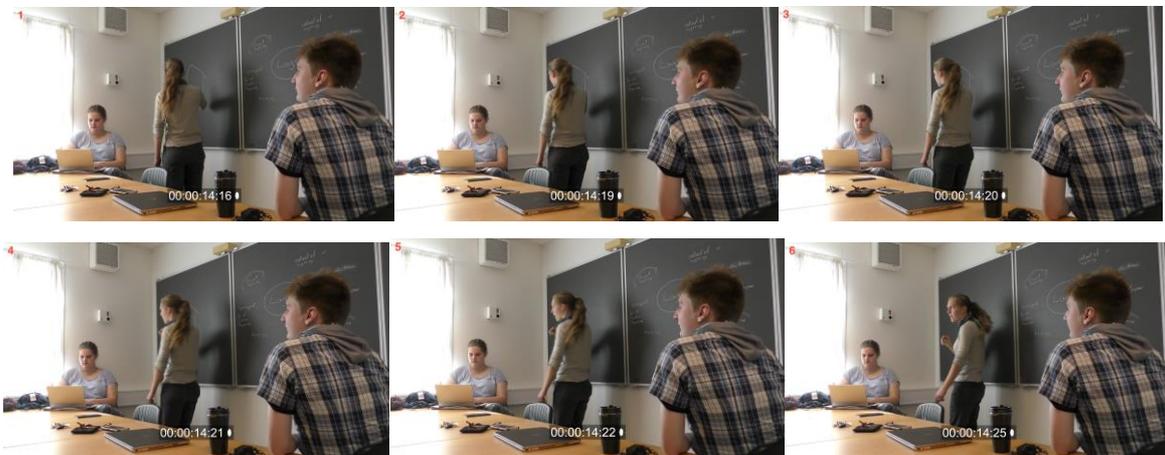
Next, looking at the mode of speech. Jefferson transcript notation (Jefferson, 2004) will be used in this regard. The whole transcript from the 42 second clip is shown below. [] symbolizes overlapping speech, ° symbolizes lower tone of voice ↑ rising pitch. For a full view of the transcript notation, please consult the Jefferson transcript notation (2004).

```
1 J:        I can do that I can do that
2 M:        [stine can't you can't you] draw a house in the middle
3 P:                                    [°> that is almost scarry<°]
4 M: = on that blackboard
5 S:     ((turns towards the blackboard))
6 P:     you think some of the equations we(1.0)
7 S:                      [((draws hard on the blackboard)]
8 M:                                    not so big
9 P: °used the last time°
10 S:    house
11 M:    yes
12 p:    house
13 F:    (unclear)
14 M:    and then how would we like to get our energy (.) should it be wind
      turbines or solar panels
16 S:    well have we ↑chosen have we chosen shouldn't we ↑choose if we
      would choose it first
18 M:    we do that(.)we have chosen (.)
19 J:    ha ha ha:aah that is a veto right there
20 S:               [↑does everybody agree or]
```
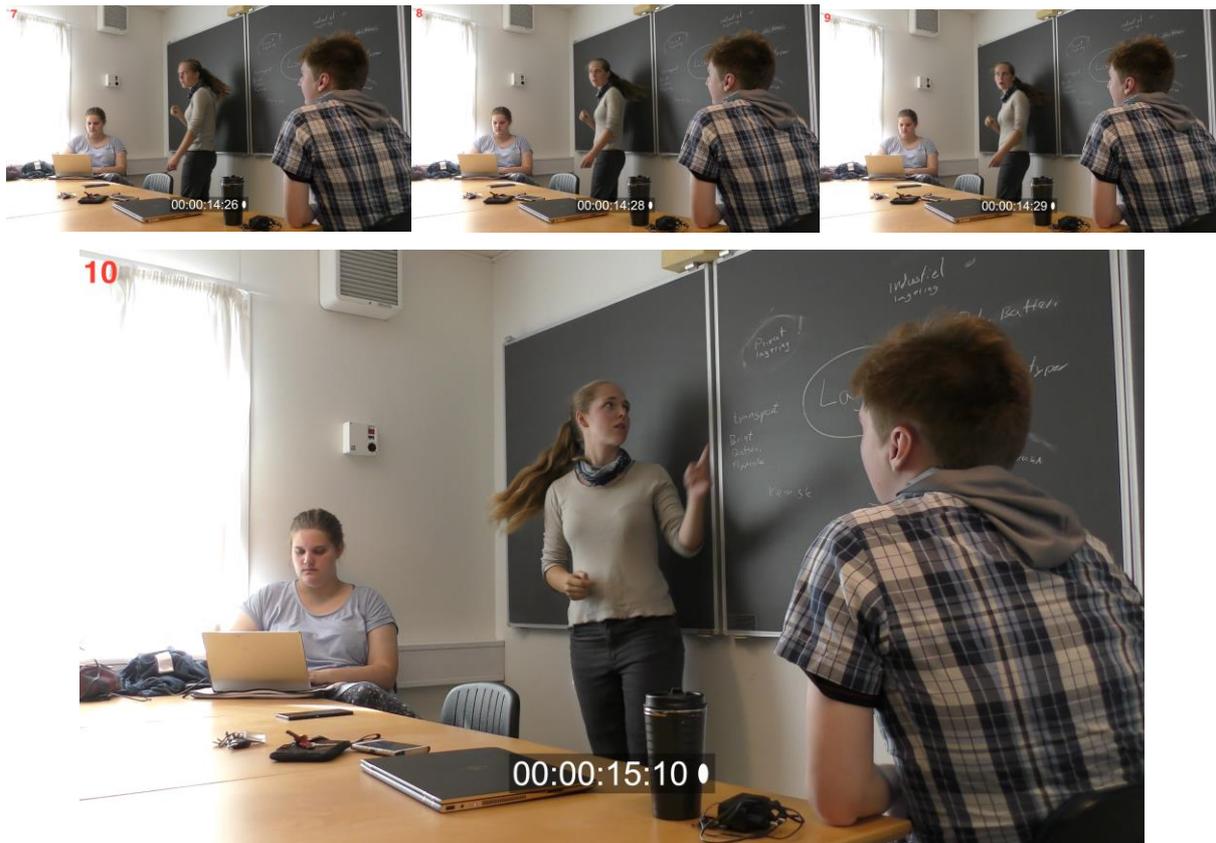
```
22 F:                                              [yes]
23 S: are there anybody who would rather do something else (2.0)°I am
looking around now°
24 F:     well I think private storage also
25 S:     okay because we shouldn't just choose that if there i::s if there
   i::s somebody who thinks otherwise maybe
27 M:             [we are just standing here] stating that we want that all
   of us
29 S:     ↑okay (.) that is okay
30 T:                   [I mean it will be] a bit easier to test
31 S:     ↑I know ↑you say a lot but there might be someone in the group
   who are not so outspoken
32 J:     [ohh yeah                      (1.0)hi::::nt]
33 S:     ((draws a circle around private storage on the blackboard))
34 M:     then you gotta ehh then you gotta speak up
35 S:                   [↑well cheers] did you say something
36 M:     yeah
37 S:     (hhh)
```

Notice in line 14, when M asks how to get the energy to the house S has just drawn. S. now turns her body towards the blackboard where they brainstormed and point towards the private storage text, asking if they have chosen this, as seen below:

The movements in the picture above and line 16 is uttered as the same time:

```
16 S:    well have we ↑chosen have we chosen shouldn't we ↑choose if we
         would choose it first
```

She repairs her sentence several times during her utterance: `have we ↑chosen have we chosen shouldn't we ↑choose` which might be interpreted as a state of confusion, her upward pitch on choose might also indicate an emphasis on the fact that they have not chosen anything yet, and she is challenging the legitimacy of M stating that is what they will work it. Furthermore, when turning her body towards the other blackboard and pointing at it, she is including all the participants in the room in the decision of whether they have chosen the specific subject.
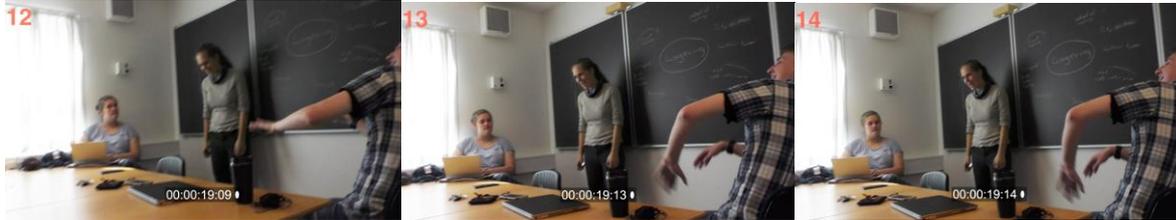
M responds:

```
18 M:    we do that(.)we have chosen (.)
```

Notice how (.) symbolizes break, so when M states they have chosen silence is the first response, he then repeats himself followed by silence. Then the response initiates laughter from J:

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```
19 J:    ha ha ha:aah that is a veto right there
```
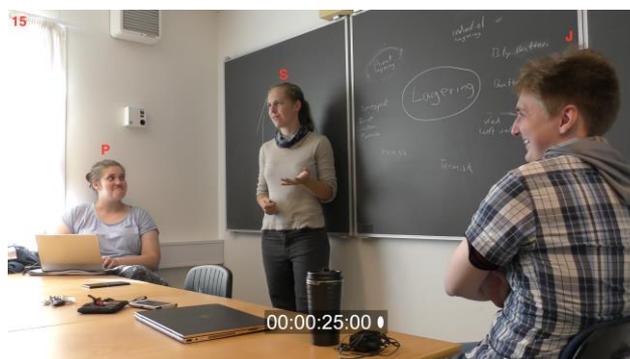
With the following gestures:

J is lifting his hands up and then pushing them out in the air and then draws them back simultaneously smiling at the utterance M made, at the same time S is smiling. From the hand gestures towards M which might be symbolic of how M pushes his way through but also resemble how football fans cheers their favorite players on the stadium. J is thus complimenting and uplifting M and his utterance. As is seen in the pictures S smiles at M's utterance, but she gets back to hearing whether everybody agrees on the decision:

```
20 S:                    [↑does everybody agree or]
22 F:                                       [yes]
23 S: are there anybody who would rather do something else (2.0)°I am
   looking around now°
24 F:    well I think private storage also
25 S:    okay because we shouldn't just choose that if there i::s if there
   i::s somebody who thinks otherwise maybe
27 M:            [we are just standing here] stating that we want that all
   of us
29 S:    ↑okay (.) that is okay
30 T:                    [I mean it will be] a bit easier to test
```

When S asks if everybody agrees F immediately joins in and says yes (line 22), in line 23 S asks if there are others, who would do something else, although P does not state anything verbally, she does look at S and shakes her head:

Because S does not get a preferred response from anyone else, she clearly states she is looking around, but does that in a reduced volume. In line 24 F repeats his yes, with a longer utterance stating he would like to do private storage as well. In Line 25 S repeats they should not do anything unless everybody agrees where M in line 26 clearly states that they do all agree and they are all stating that, simultaneously T states in line 30 (his only line) that private storage will be easier to test.

Discussion and further perspectives

The extract chosen for this paper is the first active choice the group makes. When entering the clip, it is evident they had been brainstorming where they mentioned thoughts that came in their head in accordance with private storage, there were no systematic way of brainstorming in that process, people just mentioned what they thought could be interesting. Before M. asks S. to draw a house J. has stated that his personal favorite is private storage, but the group had rightfully as S states not made that decision yet. M. states they had, looking at the video in its entirety it is clear they had not, but J. had mentioned that subject was what he preferred, and the other group members had not talked it down. So, it might be, that M. just stated, what he thought everybody in the room felt, but the interesting thing, is not if M. was right, the interesting thing is that both S and J. seemed to disagree with him on the notion a choice had been made. J. praises M for making a choice and S asks the other people in the room, if they agree with that subject. Everybody seems to agree convincing M he was right as he states in line 27. Here interesting group dynamics are shown; even though no official leader or leaders are chosen, people take leadership or moves forward in the decision making process. There are broader discourses that collide with each other, one of inclusion (S) and another of taking decisions and leaving the responsibility to other group members to speak up if they disagree (M). As such some could say the discourses represents different ways of leading a group.

The choice on private storage was the first thing written on the blackboard and the subject the group was formed upon, however everybody in the group agreed a further brainstorming would be productive in order to see what other directions they could take, it is interesting here, that the students mentions what they find interesting within the field, not what they think can end with a good grade (with the exception of T, who mentions it is easier to test in line 30). According to Dewey that is the way to find a genuine problem that will foster deep and transferable learning. However, it is not that easy. The next step the students have to go

through is to align their problem-area with the learning goals, and then see if their supervisor agrees with their problem or not. Further micro analyses are thus needed.

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