Providing Teachers with Individual and Group-Level Collaboration Analytics: A Paper Prototype

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Abstract: Orchestrating collaborative learning in the classroom is a current challenge for teachers. Present MMLA solutions mostly mirror the activities with little consideration of the format of the information to make it actionable for the teacher. For the purpose of supporting learning in collocated collaboration settings, a paper prototype is suggested, which is the output of a previous iteration in a design-based research providing information during the collaboration process on both individual and group level.

Introduction

Collaborative skills are seen as a success factor in modern society (Näykki, Järvenoja, Järvelä, & Kirschner, 2017) and it is a necessity for the future to tackle the difficult issues the world is facing. Making group data available to students and teachers during the actual collaboration might promote self-reflection and promote interventions in situ, rather than to rely on post hoc evaluation (Martinez-Maldonado, Kay, Shum, & Yacef, 2017). The contribution of this paper is a paper prototype having passed the first cycle of feedback with the end users and building upon this information, an improved prototype is proposed.

The prototype is part of a project trying to answer the question how to support teachers in collocated collaborative learning settings using multimodal learning analytics. As the first step in design, sketching was implemented before trying to apply costly multimodal analytics solutions. The initial prototypes were shown to eight in-service teachers asking how they understood the information and how they would proceed if this information were to be available to them in an actual classroom situation. Also, a pilot study was conducted in an authentic classroom collecting data using self-report questionnaires and video observation to see which valuable data collection could be automated and which additional data collection instruments could be usable in an authentic classroom setting. The proposed prototype provides teachers with information on the level of engagement of the students, their degree of challenge, interest and skills.

The prototype is designed to be used in an authentic classroom setting, imagine the following scenario: Teacher Kai has a CL activity planned for the lesson, she opens the dashboard and chooses the class she is having the lesson with. Students enter the classroom, find their group members and start their activity. Teacher Kai looks at the dashboard and sees how far along the students are in their tasks, which students have problems or questions, which group is not working well and can address the issues instantly. She can also use the data collected for input in the group work reflection process, for both herself and the students.

Literature

There is strong evidence for positive relations between student engagement and valued outcomes for students (Vytasek, Patzak, & Winne, 2020). A commonly used framework to study engagement distinguishes three different types of engagement: behavioural, cognitive and emotional engagement (Fredricks, Blumenfeld, & Paris, 2004), where behavioural engagement involves sustained on-task behaviour during academic activity (Fredricks et al., 2004), cognitive engagement, which reflects student involvement in planning, monitoring, and evaluation when accomplishing tasks (Sinha, Rogat, Adams-Wiggins, & Hmelo-Silver, 2015) and emotional engagement entails attitudes towards teachers, classmates, the subjects, and school (Fredricks et al., 2004). Cognitive engagement is the key dimension influencing learning outcomes (Lu, Zhang, Li, Chen, & Zhuang, 2019). However, measuring cognitive engagement is a challenge today as mostly the artefacts created by students have been used to measure cognitive engagement (Vytasek et al., 2020) which could be a valuable source if also qualitative data analysis were applied and not only the number of annotations, posts etc. counted.

Three separate systems of tools supporting the administering of collaborative learning interaction (Soller, Martínez-Monés, Jermann, & Muehlenbrock, 2005) are distinguished: mirroring systems, which display basic actions to collaborators or teachers, metacognitive tools, which represent the state of interaction comparing to the desired state, and coaching systems, which offer advice based on an interpretation of those indicators. Different dashboard visualizations in learning analytics are offered to show information about engagement to teachers, however, these only display learning outcomes and do not suggest possibilities for improving the learning process

(Vytasek et al., 2020). Thus, the tools developed for studying engagement today are mostly mirroring or metacognitive systems.

Discussing the principles of the design, the ACAD framework has been used to analyse and design complex collaborative learning situations (Carvalho & Goodyear, 2014), where the activity of the students is the centre of the analysis. The analysis differentiates between the activity carried out by students, the tasks given by teachers and the setting/ tools used, briefly calling them the set, the social, the epistemic (task) always in co-configuration during collaboration. The teacher will be presented with information on two levels, as teachers who had analytics tools at both the individual and group level have been shown to be more specific when diagnosing and taking action in problematic situations during collaboration (Van Leeuwen, Janssen, Erkens, & Brekelmans, 2014). All three types of engagement will be visualized, learning analytics dashboards currently are dominated with data on behavioural engagement (Vytasek et al., 2020), but do not provide much formative assessment options for cognitive engagement. Emotional engagement out of the three is the least researched.

The goal of the prototype is to provide the teacher with information about emotional, cognitive and behavioural engagement, individual contribution with the possibility of offering support in problematic situations. The difficulties of the design entail designing the models for each type of engagement and contribution without the data collection being overly intrusive for the student and writing the scripts for the suggestions in a way that would be helpful for practitioners.

Proposal for an improved prototype

Based on the results of the first cycle of feedback, teachers seem to be in need of a guiding system with both the mirroring and metacognitive system possibilities. The in-service teacher, when given the opportunity to have technical assistance, appears to want the program do some of the analysis for him/her. Nevertheless, the possibility to see what is behind the process of detection needs to be available as well.

When first looking at the dashboard, the teacher is presented with an overview of the class on both the individual and group level. On the group level, the summative cognitive engagement (*social element*) of the group is visualized as the size of the ball, the bigger the ball, the bigger the engagement. As high cognitive engagement is connected to learning outcomes, it is a valuable source of information to teachers, which was confirmed by 7 out of 8 teachers in cycle 1. In screen 1 (see Figure 1) the students can be seen in groups, under each group is a scale visualizing on a continuum how far along the groups are in their group work, for instance, task 1 or task 4 (*epistemic element*).

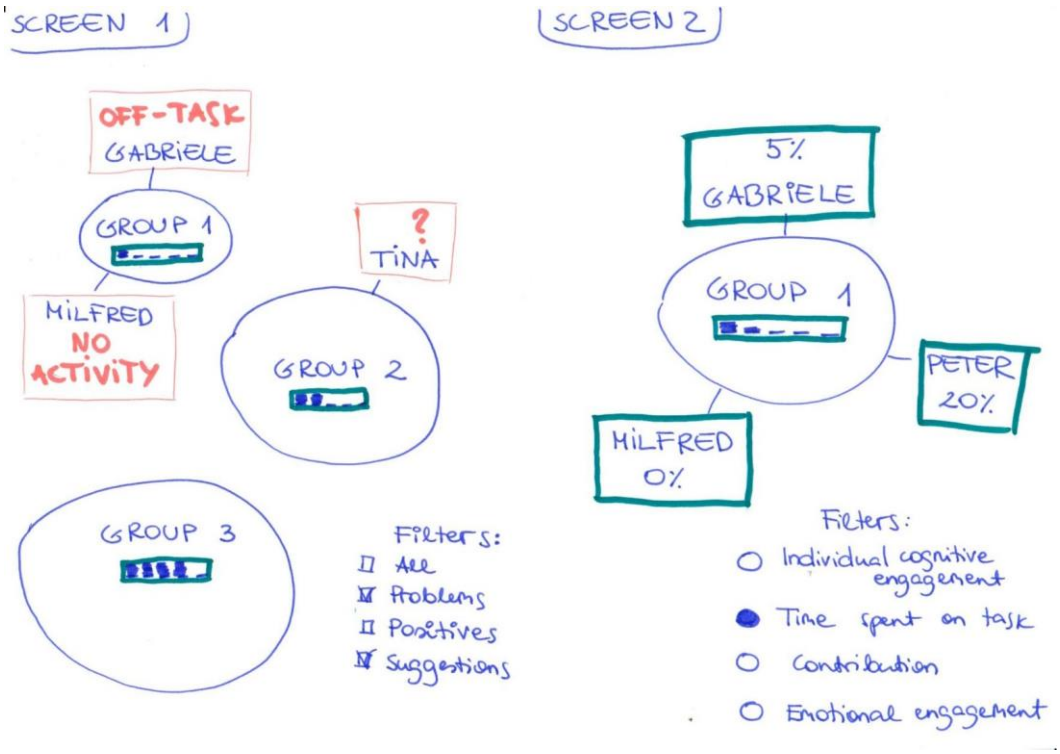

Figure 1. Group overview

The teacher can choose between filters: problems and positives. Although teachers in cycle 1 did usually not react as a result of seeing positive data, the teachers said that getting this type of information would be motivating for them. It was mentioned that sometimes the good students are marginalized in the classroom, having this as an option could possibly give the teachers an input to praise their work/ find new projects etc.

There would also be a possibility to turn the suggestions on or off. The teacher would get suggestions on how to proceed by hovering over the student's name (see screen 4 in Figure 2).

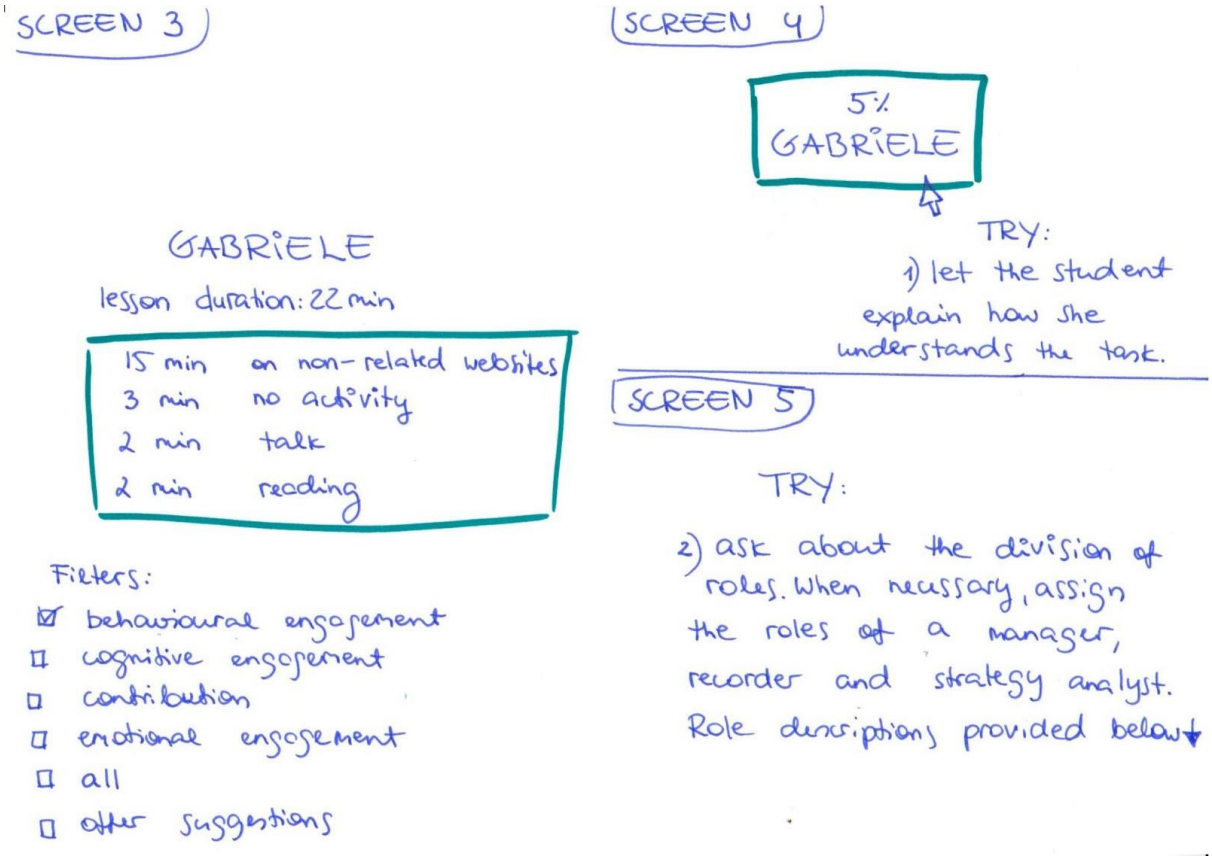

Figure 2. Individual level data (on the left) and suggestions (on the right)

As another improvement, when clicking on the group, screen 2 (Figure 1) opens and the teacher can get contextual information about the group processes, again having a possibility to choose between filters (individual cognitive engagement, time spent on task aka behavioural engagement, contribution, emotional engagement). Automatically the filter detected to be the most problematic could open, in order to minimize the number of clicks needed to be done.

An additional improvement would be to get contextual information about each student by clicking on their name (see screen 3 on Figure 2) and the teacher could see what is behind the number and choose between other bits of information gathered about her/him. Emotional engagement *(set element*) could possibly be the cause for low behavioural engagement. The labels probably need to be rephrased to find more everyday equivalents.

Discussion

Collecting data on behavioural engagement is quite well researched and an abundance of possible tools available collecting trace data, data on eye gaze, posture, head movements etc. However, cognitive engagement and emotional engagement are not well researched and have been mostly measured by self-report or based on artefacts when talking about cognitive engagement, both of which are not the best fit for providing insightful information to the facilitator during the process of collaboration. Some of the questions on the table today are:

- How to measure cognitive engagement without being intrusive?
- Which tool(s) to use in collocated collaborative learning to gather trace data?

- Possible algorithm for helping the teacher with the planning of interventions- the program looks at the problems and based on a formula suggests where and how to intervene first?

Conclusion

The paper at hand introduces an idea for a collaborative analytics tool providing the teacher with on-the-fly information about the level of cognitive, behavioural and emotional engagement, interest, challenge and skill of the student with the option to have a coaching system assist the practitioner during the group work. As part of design-based research, the second iteration paper prototype was designed according to the principles emerging from the first cycle. As the next steps, models for the calculation of the phenomena need to be designed, and scripts for the coaching system need to be constructed.

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