USING CHALLENGE EPISODES TO IDENTIFY SOCIAL REGULATION IN COLLABORATIVE GROUPWORK

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ABSTRACT

In recent years, researchers have shown increased interest in the question of how groups regulate their collaborative work and how this in turn affects their learning experience. There is a lack of empirical studies that explore social regulation in student group work. This study in progress attempts to identify instances of social regulation of learning in group work through examining challenges that students experience throughout interdisciplinary group projects. Building on existing conceptual work, we target different dimensions of social regulation – Planning, Monitoring/Performance and Evaluation. Data is collected from four courses within Tracks – a ten-year educational initiative, aiming to respond to the changing educational needs of future engineers. Within Tracks, students meet and learn collaboratively across programme boundaries and take on relevant challenges with a basis in real-world problems together. Students were asked to self-report in form of reflective writings about challenges and coping strategies. First results indicate that groups employed different forms of social regulation though their affiliation with different study programs made it difficult to schedule collaborative, synchronous meetings. Our findings further highlight the role of motivation in collaborative group work and stimulate a discussion about 'desirable challenges' that act as catalysts for learning in group work.

KEYWORDS

Social Regulation of Learning, Challenge episodes, Co-regulation, Socially shared regulation, Interdisciplinary groupwork, Standards 5, 6, 8

INTRODUCTION

It has been argued that we are in an ongoing paradigm shift in higher education (Barr & Tagg, 1995). A shift from an instructional paradigm to a learning paradigm (Prince & Felder, 2006). This shift represents a departure from a *transmission* view of learning towards a *constructivist*

view of learning. At the same time, the number of students in higher education has increased drastically during the last decades and there has been a transition from higher education for a small elite towards what has been called mass higher education (Reay, 1998). This transition has not only increased the number of students in higher education, but also led to a more diverse student population. Furthermore, university funding does not reflect these changes and the number of students per academic employee has increased gradually (Forest & Altbach, 2006).

At the same time, changes in society and industry are prompting institutes of higher education to rethink engineering education (Hadgraft & Kolmos, 2020). Apart from technical knowledge and skills, engineering graduates are expected to be aware of sustainability issues, the societal effects of their work, and to be able to work on complex projects in collaboration with people from different disciplinary and cultural backgrounds. Institutions of higher education are trying to respond to these challenges by increasingly experimenting with pedagogies that are student-centred and incorporate project-based, collaborative and interdisciplinary learning in authentic learning environments (Hadgraft & Kolmos, 2020).

While these changes are usually implemented within pockets of the curriculum, some institutions have begun to work through more systematic initiatives to introduce those changes (e.g., Crawley, 2018; Enelund & Henricson Briggs, 2020). One of those initiatives is Tracks, a ten-year educational initiative, launched by Chalmers University of Technology, Gothenburg, Sweden. Within Tracks, students meet and learn collaboratively across programme boundaries and engage in interdisciplinary group-projects that take on relevant challenges with a basis in real-world problems. The benefits of participating in collaborative work for student learning have been highlighted extensively (e.g., O'Donnell, 2006; Prince, 2004; Johnson & Johnson, 2009). In recent years, researchers have shown increased interest in the question of how individuals taking part in groupwork are regulating, and being regulated by, others within the group and the group itself (Hadwin et al., 2017). However, there is a lack of empirical studies that explore social regulation in student group work, and interdisciplinary group work in particular. One way to identify episodes of social regulation is through examining challenge episodes that students experience throughout the group project (Järvelä et al., 2013) and that have a significant impact on learning (Orson et al., 2020).

This study in progress attempts to identify challenge episodes, solution strategies and instances of social regulation of learning in interdisciplinary group projects by exploring the following research questions:

(1) What are the challenges and coping strategies that students identified when taking part in interdisciplinary group projects?
(2) How do student groups taking in part interdisciplinary projects regulate their learning?

Based on prompted reflective writing from students in four Tracks courses, we analyse the empirical data through an analytical framework on social regulation that distinguishes the joint cognitive and metacognitive regulatory strategies of *Planning*, *Monitoring/Performance, Evaluation* as well as group motivational efforts and emotion regulation.

The Tracks initiative

Tracks aims at developing, implementing and evaluating an educational model that gives students the opportunity to create multi- and interdisciplinary competencies, allows for more individualized study plans and shortens the lead times for changing the education to embrace new technologies (Enelund & Henricson Briggs, 2020). Courses within Tracks address specific challenges in areas such as healthcare, energy or technological change that may be broad societal and profound research-driven.

Chalmers University of Technology launched its first Tracks courses in the 2019/2020 academic year. These courses are project-centred and are supported by classes that provide students with a base knowledge of the course topic. The courses are intended to be multi- or interdisciplinary in nature and are open to all students across the university. The initial implementation phase, phase 1, concluded in December 2021 with phase 2 – integration - commencing on the 1st of January 2022. This phase will be three years in duration, during which focus will be upon the integration of Tracks into the organization so that Tracks courses become obvious choices as electives for both teachers and students.

There are currently 25 Tracks courses run per year. All the university's departments are represented in the courses' teacher teams, with teachers from across the university taking part. In addition to bachelor and master's students the courses are also open to PhD students and Chalmers alumni, with one course currently run jointly with an industrial partner and offered as professional education. A dedicated physical place on campus for Tracks courses opened on the 1st of March 2022 which provides the students and teachers with more space, facilities and resources to work on their Tracks projects. Phase 2 will also see the emergence of course packages which will contain several Tracks courses primarily from different themes e.g., "Emerging energy technologies". Thus, Tracks is moving from the individual course level that is examined here towards a more programmatic design, creating specific 'Tracks' as the original concept suggests.

PRIOR RESEARCH

Collaborative learning

There is an increasing emphasis on providing students with opportunities to develop teamwork skills through interdisciplinary and intercultural group work in higher education (Fink, 2003). Collaborative learning activities in education can help to create learning experiences that are distinct from learning experiences in one-to-many lecture-based activities (O'Donnell, 2006; Prince, 2004; Johnson & Johnson, 2009). Research has reported positive effects of collaborative learning on students' academic achievement, self-esteem, attitudes and interpersonal relationships (O'Donnell, 2006; Prince, 2004; Johnson et al., 1998a; Johnson et al., 1998b; Sears & Pai, 2012) critical thinking, problem solving skills (Laughlin et al. 2008, Gokhale, 1995; Sears & Reagin, 2013), knowledge transfer across domains (Pai et al., 2015) task persistence (Sears & Pai, 2012; Springer et al., 1999) and retention in higher education (Springer et al., 1999). Furthermore, students' socialization into disciplinary communities has been pointed out as a central element of engineering education (Bolstad et al., 2020).

At the same time, designing well-functioning collaborative learning activities remains a challenge and group work is regularly associated with social loafing and egoism (Davies, 2009). As Wallin (2020) pointed, one of the main reasons for these negative associations might be the lack of spaces for students to discuss and co-create timescapes. In other words, students will judge and compare their own time investments in relation to their group and the lack of opportunities to actively discuss expectations and issues around time, working approaches, group processes, and group dynamics will result in problems for both group work and learning. To create space for these negotiations, trusting relationships and a focus on group processes are paramount (Wallin & Aarsand, 2019; Wallin et al., 2021; Veine et al., 2019).

In addition to a process focus, it is important to consider the general structure within collaborative learning activities. In engineering education, larger, semester based, collaborative learning activities are oftentimes designed as project work where students work in groups on specific, oftentimes, authentic problems over several weeks (Gavin, 2011). This approach emphasises peer-learning, in active and self-regulated forms (De Graaf & Kolmos, 2003; Gavin 2011). Peer-learning encompasses a wide variety of educational strategies and activities (Griffiths et al.,1995), but at its core is 'the acquisition of knowledge and skill through active helping and supporting among status equals or matched companions'. In this way, peer-learning moves the focus from independent learning towards interdependent learning, where students develop skills to plan, organise, work, and evaluate their learning together (Boud, 2001).

Social regulation of learning

Scholars have since long been interested to study how learners regulate their learning, i.e., how they employ processes related to metacognitive, cognitive, and behavioural domains in order to gain knowledge (Zimmerman, 2015; Pintrich, 2004). Self-regulated learning (SRL) can involve activities such as planning, goal setting, evaluation, and self-instruction and requires learners to view their learning as dynamic and a process that they can take control of, as opposed to learning being something that happens to them as a result of teaching practices or their environment (Zimmerman, 2015). While SRL provides a lens onto how an individual regulates and processes their own learning, it is increasingly recognized that SRL is affected by social contexts and influences (Hadwin & Oshige, 2011). But SRL as a conceptual framework alone will not be able to address questions about the social dimension about how groups or dyads manage regulation. Thus, in recent years, there is an increasing number of studies addressing social regulation of learning (SoRL). While the field is still young and undertheorized, many authors distinguish two modes of SoRL: co-regulation (CoRL), and socially shared regulation of learning (SSRL).

Co-regulation (CoRL) is transitional as it is a means for learners to engage in SRL through interactions with others participating in the problem-solving task (Hadwin & Oshige, 2011). These interactions involve one or more participants regulating other participant/s learning e.g., a participant that prompts others in the group to engage in a metacognitive activity such as monitoring or evaluating. The participant taking on the task of regulating others' learning can be considered a "capable other" or expert role with the subject of the regulation taking on the

role of a novice (Hadwin & Oshige, 2011). It must be noted that for CoRL the roles of expert and novice are not permanent for the project as participants can switch between roles throughout the project as required. Similarly, the form CoRL takes is not static and can change during a project as participants become better at this mode of regulation (Lajoie *et al.*, 2015). CoRL as a process can be initiated by one or more participants, tools, or a task and can be applied to individual participants or the group as a whole (Bakhtiar & Hadwin, 2020).

Socially shared regulation of learning (SSRL) occurs if a group collectively regulate their learning, and take part in activities such as planning, setting goals and standards together as a group (Hadwin & Oshige, 2011). It includes the group exercising metacognitive control over tasks together, which may require negotiation of states and processes such as cognition, behaviour, motivation, and emotion (Hadwin et al., 2017). It can therefore be seen as a transactive process as it emerges over time through group interactions and exchanges. It is important to note that while the definition of CoRL above is seen as a transition to SRL, CoRL is also seen by some as a path to SSRL (e.g., Winne, 2015), when one or more, but not all members of a group employ CoRL.

Studies on SSRL and/or CoRL have identified various regulatory areas, categories, coding schemes and frameworks (e.g., DiDonato, 2013; Rogat & Linnenbrink-Garcia, 2011; Ucan & Webb, 2015; Zheng et al., 2019; Zheng & Yu, 2016). Many focus on metacognition, but some include the regulation of motivation, behaviour, or emotion (e.g., Rogat & Linnenbrink-Garcia, 2011; Ucan & Webb, 2015). Reviewing these materials, we note that the most common categories of social regulation were *planning*, *monitoring* and/or *performance*, and *evaluation*. These themes also align with well-established frameworks and models within the SRL literature. For example, Zimmerman's (2013) model contains three phases: forethought, performance, and self-reflection. Similarly, Pintrich's (2004) framework consists of four phases, *planning*, *monitoring of task, making changes, or renegotiating tasks*, and the *evaluation of tasks*. Building and adapting from these frameworks we use a conceptual framework that contains three phases: *Planning*, *Monitoring/Performance* (that includes the observation of progress and the adaptations made in response) and *Evaluation*.

Challenge episodes and SoRL

One way of observing SoRL is to study it through the lens of challenge episodes and solution strategies (Järvelä et al., 2013). It is widely recognized that cognitive, affective, and social challenges have a significant impact on learning (Orson et al., 2020). Challenge episodes encourage learners to regulate, and their past learning experiences influence how groups undertake SSRL (Malmberg et al., 2015). Regulation that is formulated and enacted in response to a challenge episode is an area of study that has received little attention (Hadwin, et al., 2017). The form the regulation will take should depend on the challenge that the group is attempting to solve and can depend on whether the challenge is one to be tackled by an individual member or the group together (Lajoie et al., 2015).

There are a number of studies following a similar approach. Malmberg et al. (2015) observed that the SSRL of their collaborative groups progressed through three phases. The initial focus was put on external challenges such as time management or environmental factors. As the

project progressed, students moved to cognitive or motivational challenges, before finally moving to the third phase where the challenges became motivational to complete tasks and were exacerbated by external constraints such as time. In another study Panadero et al. (2015) found that groups whose members showed higher emotional regulation were better able to analyse goal achievement and to identify potential challenges. Those that displayed better cognitive, metacognitive, and motivational skills were better at establishing group goals, activating strategies in response to challenges, and planned more strategies. Related to that, Bakhtiar and Hadwin (2020) distinguish task-focused or socioemotional focused challenges. They stress the role of positive socioemotional interactions such as group members valuing and seeking each other's opinions, recognising each other's contributions, including group members, and being attentive to others (Bakhtiar & Hadwin, 2020; see even Rogat & Linnenbrink-Garcia, 2011). Finally, Hadwin et al. (2017) conclude that groups should have numerous opportunities to collaborate, accompanied with "guided opportunities to systematically plan for and reflect on their collaborative progress and challenges" (ibid. p.29). They suggest that socioemotional challenges may be mitigated by active engagement in regulatory processes, they do recommend more study in this area.

METHODS

This study adopts a qualitative design with data collected through three waves of reflective writing (e.g., Wallin & Adawi, 2018). Each wave addressed one of the core dimensions of our conceptual framework – planning (one or two weeks in), monitoring/performance (four to six weeks in) and evaluation (on the last week). Each wave consisted of several open questions addressing the participants' challenges and coping strategies with regards to the dimension in focus. The prompts developed for our open-ended questions were carefully designed to stimulate students to reflect not only on their own challenges, goals, motivations, cognitive and metacognitive strategies, but also those of their group's which would allow us to identify instances of SRL, CoRL, and SSRL. In order to account for changes in the students' plans and the iterative nature of project work (Alshamrani & Bahattab, 2015) we asked students to update their answers to the previous questionnaire(s) in each round.

We examined four Tracks courses with a total of 44 Masters and PhD students that ran over the Autumn 2021 semester at Chalmers. The students came from a variety of engineering disciplines and nationalities. All four courses assigned their students into groups of 3-4 for their project work. By the time of preparing this manuscript, 10 participants responded with their reflective writings in the first wave, 8 in the second wave, and 1 responded in the final wave. The data was analysed through inductive coding (Braun & Clarke, 2006), identifying salient challenge episodes and their corresponding coping strategies within each of the dimension of the conceptual framework. In a second step, we grouped the identified challenge episodes into larger themes based on their proximity. With the challenge episodes and coping strategies identified, we used an inductive approach to identify episodes of socially regulated learning similar to Järvelä et al. (2013) when they identified regulated learning using challenge episodes.

FINDINGS

In this section, we present the observed challenges, solution strategies and episodes of SoRL that we extracted from the reflective writings of the students. We thereby follow the applied conceptual framework of Planning, Monitoring/Performance and Evaluation as the main categories. However, at the time of writing, data from the evaluation phase was still being collected and we had only access to a single response. Therefore, this category is excluded at the moment.

Planning phase

Regarding planning the group work, we identified three frequent challenges: (1) Scheduling time for meetings in an interdisciplinary group, (2) Navigating the initial steps (3) Organising the ongoing work.

Almost all groups reported difficulties to *find time to meet and work together*. While this might be a challenge for group work in general, it became clearly more problematic in interdisciplinary projects in Tracks as students were bound to different study programs with different schedules to be coordinated. Solutions were different for different groups and involved moving the interactive parts out of regular study times to evenings and weekends, being more flexible with meeting times e.g., by meeting online or moving meeting times on short notice, and/or trying to minimize the necessity to meet by dividing the work and defining tasks that could be executed individually.

Secondly, in all courses, groups reported difficulties to *navigate the initial steps and tasks* in the projects. Groups struggled in the initial planning stages through a combination of unfamiliarity with the interdisciplinary nature of Tracks, the requirement that groups choose their own project topic/focus, and the nature of the projects, i.e. wicked problems. Some groups felt the information or instructions they received at the beginning of the project was vague or unclear. To address this challenge, groups reported different strategies. Most importantly, the majority of groups met physically and had discussion and brainstorming sessions in order to jointly delimit the scope of the project. Some contacted the instructor for clarifications and help. At least one group reported to that they “just began working” and open questions would clarify over time.

Lastly, groups had to find solutions for how to *organise and plan their work*, including the assignment of tasks where applicable. Meetings and group discussions were the favoured option for organising and planning work. At least one group worked in iterative cycles where the results from a task would be discussed by the group, and they would then decide on what direction to take next. The use of technology, WhatsApp or chat channels, were used by some to ensure group members were kept abreast of any new developments or emergencies. Several groups elected to assign tasks to individual members based on different criteria, e.g., disciplinary backgrounds or simply availability.

In terms of regulation, most groups used scheduled meetings as their dominant way of discussing and planning each group members behaviours with some using technology to employ more flexible and asynchronous ways of communication. Group discussions,

brainstorming, meetings, and working together suggest instances of SSRL when consensus is formed. However, depending on the group dynamics within such meetings, discussions etc there may be instances of CoRL when one of more group members take a lead position. While some groups expressed a preference or desire to work together as a group, assigning tasks to individuals appears to be the more popular strategy, sometimes chosen due to necessity. We pose that the assigning of tasks are instances of CoRL. In sum, all groups practiced some form of SoRL during the planning phase(s).

Monitoring/performance phase

When categorizing the challenge episodes for the monitoring/performance phase we identified four challenges that appeared frequently: (1) Monitoring the group's progress (2) Challenges when performing a task (3) Managing the group's motivation (4) Lack of knowledge on a topic.

One aspect of managing a project is *monitoring the progress of the work*. A common strategy was the use of weekly meetings to set targets for the following week, to check on individual members' progress, and to set deadlines which for one group proved to be a challenge in and of itself. One group reported that they did not perform such weekly checks and instead trusted that they knew what work needed to be done and progress could determine their progress based on how far they had come in their work.

Groups and individuals would sometimes face *challenges when performing a task* including times when they would become mired in a task or need help. Solutions varied and depended on what had gone wrong and to whom. Groups would try to provide help to individuals and discuss the problem with some then turning to their supervisors for help or to the larger class/other groups. One group simply found solutions to problems if they "sat on it long enough", while another group had simply allowed for such delays in their original planning. Some challenges required the groups to rethink their project and make changes e.g., making a different type of battery cell. Some problems were the result of lab equipment not working or issues with components, for these issues groups had to seek other alternative methods or components.

Managing the group's motivation was a challenge as groups had to deal with members not contributing, different ambition levels and maintaining a positive spirit. For one group this meant giving reminders to an unproductive member to finish their work. One participant noted a variety of ambition levels in their group and speculated it was possibly related to the individual team members' previous knowledge and backgrounds. However, they noted that the groups planning still worked well in their chat channels. One group experienced low levels of motivation and did not employ any strategy to change this.

The projects were interdisciplinary which inevitably led to participants experiencing knowledge gaps or a *lack of knowledge on a topic* or tasks as they fell outside of their discipline, experience, or comfort zone. This was felt at both the individual and the group level. Individuals that felt they lacked knowledge took the approach of asking questions during lab sessions, through working in labs where they could combine theory and practice, and from working with PhDs/tutors in labs. One group realised that they lacked knowledge at the group level, their

solution was to focus on what they felt was achievable and to work from there. They also tried to not worry about not having the right background for the work.

The regulation across these challenges varied significantly. Once again meetings featured significantly as groups would use them to monitor progress, set deadlines, and help when individuals were stuck on tasks. While these meetings are a form of SoRL, which specific type would depend on the meeting objectives and the group dynamics in the meetings. As previously mentioned, meetings where consensus is sought suggest SSRL. However, meetings and discussions where an individual is seeking help on a task, or where tasks and deadlines are set, which individuals must adhere to, would indicate CoRL as would instances of groups or individuals turning to supervisors or lab assistants. CoRL was also observed when a group had to send reminders to a member that had not completed their work on time. The instances of groups working together on solutions to problems with tasks strongly suggest SSRL as the regulation was not started by nor led by an individual and the group work as a whole.

DISCUSSION AND CONCLUSIONS

This study is set out to identify challenges students experience during interdisciplinary group work in Tracks courses, the coping strategies they mobilise in the face of those challenges as well as the how the groups regulated their learning. In the following, we will discuss the preliminary findings against the backdrop of prior work in the area.

First, the fundamental importance of creating opportunities for collaboration through meetings and group discussions was widely recognised and was used for numerous purposes throughout the projects including organising planning and assigning tasks, monitoring the group's progress, setting deadlines, and as a way for individuals to get help when they face difficulties in a task. This preference for cooperative coping strategies is consistent with previous work (e.g., O'Connell et al., 2021). Such strategies are intrinsically linked to SoRL in that groups favoured and appreciated the need to engage in co- and shared regulation in all phases of the project. However, from the data we also see that while all groups engaged with *planning* as a socially shared regulation activity (e.g., through discussion), this appeared to have varied with regard to *monitoring* and *performance*. Some students did not see the need to collaboratively monitor progress and jointly decide on adaptations. And interestingly, students tended to deal with knowledge gaps individually as opposed to seek help within the group (O'Connell et al., 2021). This shift from CoRL to SRL is interesting, we can only speculate that perhaps the groups involved lacked members with the necessary backgrounds or knowledge to help, these groups may have had poor cohesion, or these individuals may simply prefer to utilise SRL.

With the above considerations in mind, our results also suggest that finding opportunities for collaborative meetings was experienced as particular difficult. This is due to the interdisciplinarity of the groups coming from different, unaligned study programs and making scheduling conflicts difficult to overcome. This consistent finding separates this study from other literature on SoRL and we could observe that students tended to approach this problem by either meeting at unusual times or, more importantly, reduce the necessity to meet by

attempting to divide the work in small tasks that could be solved individually and will less need for coordination. From an SoRL perspective, even though some groups found ways to regulate their learning via asynchronous communication, this can be interpreted as reducing the amount and opportunities for SSRL and engage in self- and co-regulation of learning instead. This tendency is problematic from a learning perspective as it counteracts the intended learning processes in collaborative learning. We follow Hadwin et al. (2017) in their call for have numerous opportunities to collaborate and see the unaligned study programs as a major barrier to the educational success of initiatives such as Tracks that build on interdisciplinarity as a major cornerstone of the learning experience. Other universities with similar efforts report the same challenge (e.g., Crawley et al., 2018). To solve this, higher education institutions that systematically work with interdisciplinary programs are therefore asked to find ways to align their different study programs. The Norwegian University of Science and Technology, for example, has a dedicated day that is reserved in all first-year master programs for interdisciplinary project courses under the Experts in Teamwork umbrella (Wallin, 2017).

Further, students appeared to struggle to formulate a project idea or problem statement in the context of interdisciplinary group work. This finding is in line with similar research on open and unstructured projects (e.g., O'Connell et al., 2021). We speculate that this can be attributed to a lack of experience and 'tools' to approach interdisciplinary, open-ended or even wicked problems. Even though those challenges caused frustration for some of the students, most groups were able to develop effective collaborative coping strategies, leading to progress and learning. This finding point towards an understanding of challenges as not inherently good or bad in terms of learning. Borrowing from the concept of "desirable difficulties" (Bjork & Bjork, 2011) once could make the distinction between "desirable challenges" and "undesirable challenges" and teachers should strive to find the right amount and type of "desirable challenges" together with support for appropriate coping strategies (O'Connell et al., 2021; Wallin, 2017).

Our results show that some groups experienced motivation (or various levels of motivation) within the group as a challenge. The role of emotional and motivational challenges in regulatory processes is increasingly highlighted by the literature (e.g., Rogat & Adams-Wiggins, 2015; Järvenoja et al., 2019). How group members interact with each other can have a significant effect on a group's regulation. Groups that experience positive socioemotional interactions engage more in regulatory processes such as planning, monitoring, behavioural engagement over groups that have negative ones (Rogat & Linnenbrink-Garcia, 2011). However, the students in this reported very few strategies to overcome motivational issues apart from setting reminders.

We were able to observe an extensive number of instances of SoRL, both CoRL and SSRL. Examples include a group helping an individual (CoRL), getting support from supervisors (CoRL) or consensus-building (SSRL) and more directive (CoRL) discussions. We saw several connections between different modes of regulation for example SSRL leading to CoRL as groups assigned tasks to individuals or sought external help. Bakhtiar & Hadwin (2020) were able to find multiple instances of CoRL leading to both SRL and SSRL and vice versa through challenge episodes. However, identifying the specific mode of regulation proved to be challenging at this stage of the analysis. Looking ahead, we therefore plan, apart from a more

in-depth analysis of the complete data, to conduct interviews with students from the different groups to be able to better interpret the collected data from the reflective writings.

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