"Sitting at the stern and holding the rudder": Teachers' reflections on action in higher education based on student agency analytics

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Abstract Digital technologies in teaching and learning in higher education have the potential to enhance student agency. Student agency is an essential resource to nurture, especially at times when students face challenges emerging from the volatile, uncertain, complex, and ambiguous world. In addition, contemporary policymaking has identified the importance of student agency. Student agency analytics is a process utilizing learning analytics, specifically psychometrics and machine learning to provide teachers insights about the agentic resources of their students. Four teachers in higher education were provided with student agency analytics results of their mathematics courses. The teachers participated in a semi-structured interview where they reflected on their pedagogical actions based on the analytics results. Points of pedagogical reflection-on-action were identified and analyzed using Burke's pentadic analysis. The teachers made diverse reflections relating to their pedagogical actions in the courses. The results pointed out the need to provide teachers with information and research-based tools for reflection. The chapter contributes to the

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knowledge on how learning analytics can facilitate teachers' pedagogical reflection in a practice-oriented manner.

1 Introduction

Digital teaching and learning in higher education can foster students' capacities and purposeful learning in several ways. To mention a few examples, the use of augmented reality could enhance students' self-efficacy and motivation (e.g., Su et al. 2021). Digital tools could be effective in enhancing behavioral and affective engagement (e.g., Bond et al. 2020). Also, digital technologies could facilitate peer support (e.g., Tuhkala et al. 2018). In general, educational technology has the potential to support student agency (Marín et al. 2020).

Our aim is to examine how a learning analytics approach—student agency analytics—could provide a means for teachers to reflect on their pedagogical actions to nurture student agency. Student agency has been described as a compass that guides students in their lives (OECD 2019). To put it another way, student agency is "the capacity and propensity to take purposeful initiative——the opposite of helplessness" (Talreja 2017, 44); as such, it is an essential resource to nurture, especially in those times when we tackle the obstacles emerging from the volatile, uncertain, complex, and ambiguous (VUCA) world (i.e., Perone 2021). However, the possibilities of digital education or digital student-centered learning activities to support student agency should not be taken for granted (Stenalt 2021). Research-based evidence on how digital technology could facilitate both student and teacher agency is strongly needed. At the same time, supportive technology for agency should be based on sufficient theoretical understanding of the key concept—agency—which has been associated with various emphases in the literature (Jääskelä et al. 2017; Jääskelä et al. 2020).

Learning analytics is the use of data and suitable analysis methods to promote learning in different contexts (Conole et al. 2011). Learning analytics should be comprehensible and it should draw from the learning sciences (Saarela et al. 2021). Furthermore, Jørnø et al. (2018) point out that actionable insight in learning analytics should relate to data that enables corrective procedures and feedback loops. However, Tsai et al. (2020, 554) note the tension "between increasing student agency in making learning-related decisions and 'datafying' students" in learning analytics. By utilizing relevant data analysis methods and educational theory, student agency analytics aims to automatize a student feedback questionnaire so that it can provide nonpersonally identifiable information for the teacher as a tool for professional reflection-on-action.

Reflection is a central process in professional thinking and an essential competence for a reflective practitioner (Schön 1983, 300). According to Korthagen (2001, 58), reflection refers to "the mental process of trying to structure or restructure an experience, a problem, or existing knowledge or insight." Specifically, reflection-on-action relates to, for example, "giving reasons for actions taken," "exploring

alternative ways to solve problems in a professional situation," and "thinking about the effects upon others of one's actions" (Hatton et al. 1995, 45). Reflection is a central part of a particular feedback loop—"the spiral of professional development" (Korthagen 2001, 61–62). Thus, learning analytics could be used as a tool for providing actionalble insights through a reflective feedback loop (c.f., Jørnø et al. 2018). This chapter examines how four mathematics teachers in higher education reflect on their pedagogical actions based on a learning analytics process called student agency analytics.

2 Student agency analytics in higher education

In educational context, the roots for the discussion of agency has been linked to the era of the Enlightenment, when fostering autonomous action through education was emphasized (Biesta et al. 2007). In this respect, 'agency' has parralled with 'learner autonomy' because they both include an idea of a person's desire and ability to take control over one's own learning (Benson 2013). However, Hunter et al. (2007) have aptly clarified on the different connotations of these concepts: While 'learner autonomy' include emphases of self-directed and independent learning, 'agency' takes attention to its relationally constructed nature highlighting dependence, interdependence and engagement in a social world.

The debate on agency is multifold and coloured by the approaches and emphases of different disciplines. The concept of agency has roots in the literature of social sciences (e.g., Giddens 1984), philosophy (e.g., Ci 2011) as well as psychology and social cognitive theory (e.g., Bandura 1989). Furthermore, agency has been analyzed in many applied and human sciences, such as education and adult education (e.g., Billett 2008), linguistics (e.g., Ahearn 2001), childhood (e.g., Haring et al. 2019) and aging (e.g., Romaioli et al. 2019). The recent conceptualizations on agency in higher education and professional learning contexts emphasize multidimensional and person-centered approaches (Eteläpelto et al. 2013; Jääskelä et al. 2017; Vähäsantanen 2015; Su 2011). They call for getting knowledge of the actor's experiences (e.g. judgements of their own individual resources of agency) to understand the core of agency and, at the same time, offer a holistic way to analyze agency in the learning context. Agency is seen as dynamic, contextually situated, and relationally constructed in nature (e.g., Edwards 2005; Emirbayer et al. 1998). Starkey (2019) points out the constructivist notion of agency and highlights the meaning of student agency in student-centered learning.

Here, we rely on the conceptualization made by Jääskelä et al. (2020, 2), who synthetize the previous literature and define student agency in higher education as "a student's experience of having access to or being empowered to act through personal, relational, and participatory resources, which allow him/her to engage in purposeful, intentional, and meaningful action and learning in study contexts." As a multidimensional construct, student agency is composed of 11 dimensions (Figure 1) that are measured using the validated psychometric Agency of University Student

(AUS) scale (Jääskelä et al. 2017). Personal student agency resources include the dimensions of competence beliefs and self-efficacy. Relational resources refer to power relations, which include trust in the teacher, support from the teacher, and the experiences of equality among the students. The participatory resources of student agency comprise the dimensions relating to engaged and active participation in learning. The AUS scale is used as a student feedback questionnaire and psychometric measurement instrument in student agency analytics.

Student agency analytics is a process that uses a validated psychometric instrument, robust clustering methods, and data visualization (Jääskelä et al. 2021). In this process, the students first assess their agency in the course context by responding to the AUS scale questionnaire (Jääskelä et al. 2017). After automated analysis, the teacher receives a profile with four distinct profiles of prototypical students (P1–P4) and the general average profile (Figure 1). Previous research has shown that the four prototypical profiles provide a valid and interpretable representation of the different levels of student agency (Jääskelä et al. 2021; Jääskelä et al. 2020). From a privacy and accuracy point of view, the four profiles' results are a trade-off between disclosing the students' identities and providing mere average values of the results, which can suppress essential information.

In addition, high student agency has been found to be associated with experiences of student-centered practices (Jääskelä et al. 2020). Student-experienced high level (strong) personal and relational agency was associated with student-experienced generally positive course satisfaction (Heilala, Saarela, et al. 2020). On the other hand, the students in the lower agency profile can experience a variety of difficulties in their studying, such as lack of prior knowledge and skills, lack of support, or difficulties in time management (Heilala, Jääskelä, et al. 2020).

3 Teachers' reflections-on-action based on student agency analytics

The following analysis and results are based on interviews with four teachers teaching mathematics to engineering students in a Finnish university of applied sciences (ISCED Level 6-7, ISCED-F 08). In 2019, the interviewees, John, Helen, Katie, and Maria (names changed), taught four different degree programs: Bachelor's Degree Programme in Energy and Environmental Technology, Bachelor's Degree Programme in Electrical and Automation Engineering, Bachelor's Degree Programme in Logistics, and Bachelor's Degree Programme in Construction and Civil Engineering. In all degree programs, the course was offered for first-year students as their first mathematics course. The contents of the courses were almost identical. The course contents include elementary algebra, equations, groups of equations, trigonometry, elementary functions, the concept of a complex number, applications to engineering, matrices, geometry, and applications to the business, if necessary, in the degree program.

After each course, the students responded to the AUS questionnaire, and the teachers received the group-level results of their course (the examples of Maria and John are shown in Figure 1). In a semi-structured interview, each teacher reflected on their pedagogical actions in the course using the analysis results. The teachers were not familiar with the student agency analytics beforehand. They were given a brief overview of the concept of student agency and the visualization of the results during the interviews. The interviews can be considered as topic-centered narratives (Riessman 1993, 18; Mishler 1991, 66), in which the teachers used their own words for explaining how they interpreted the results and how they thought their pedagogical actions might have affected the analysis results.

Our analysis aimed to find out *i*) which dimensions of agency the teachers paid attention to when they reflected on their students' group-level results and *ii*) what kind of reflection-on-action the teachers highlighted based on the analysis. We used a top-down content analysis (Krippendorff 2013) to code the interview transcripts using student agency dimensions as theory-based codes. Furthermore, we coded if the teachers' observations were positive, negative, neutral, or comparisons between group profiles or general average profile dimensions. We identified the narrative parts where the teachers' interpretations of the results concerned a reflection-on-action. The parts concerning reflection-on-action were analyzed using a narrative analysis and Burke's dramatistic pentad, which is also called a pentadic analysis (Allen 2017).

A pentadic analysis has been used to analyze narratives in research interviews (e.g., Beck 2020), and it has been suggested as being a useful tool for reflection (e.g., Rutten et al. 2009; Bourgonjon et al. 2011). According to Burke, human actions and motives can be described using the following five terms: "what was done (act), when or where it was done (scene), who did it (agent), how he did it (agency), and why (purpose)" (Burke 1945, p. xv). The pentadic analysis involves identifying the terms and applying so-called ratios, which are ordered pairs of the five terms (e.g., *agent:agency* ratio) (Allen 2017; Burke 1945, 15). The analysis of ratios can be used to identify meaningful structural points in a narrative (Anderson et al. 2001; Riessman 1993, 19). According to Bruner, the balance between Burke's terms is "being defined as a 'ratio' determined by cultural convention," and when the ratio becomes imbalanced, in other words, "when conventional expectation is breached, Trouble ensues" (Bruner 1991, 16). Here, we use Bruner's Trouble (with a capital T) to denote certain occasions in the teachers' narratives where the conventional expectations of student-centered learning are breached. To clarify, we use *agency* to refer to the agency in the pentadic analysis methodology, which is a distinct concept from the multidimensional conceptualization of student agency explained in the previous section.

First, the pentadic analysis aimed to identify the points of reflection-on-action facilitated by the analytics results and then apply the pentadic ratios. Particularly, the *agent:agency* ratio (who did it and what?), *agent:agency* ratio (who did it and how?), and *agency:purpose* ratio (how and what for?) provided information about the teachers' reflections-on-action. We eventually selected the ratio that best described the teacher's narrative or that was the most informative. The ratio was interpreted as imbalanced if it concerned a negative aspect brought up by the teacher. For

example, one teacher reflected—based on the analytics results—that the students were probably passive because the pedagogical arrangements of the course were monotonous. Here, the *agent:agency* ratio provides a meaningful interpretation of the teacher's reflection-on-action. The students (i.e., *agents*, who did it) were studying (i.e., *act*, what was done) in the course (i.e., *scene*, where it was done), and the way they performed their studying was monotonous (i.e., *agency*, how they did it), all of which is based on the teacher's narrative. The *agent:agency* ratio is imbalanced because the common expectation in contemporary learning discourse is that the students should be more active than passive, and the pedagogical arrangements should be more activating than passivizing.

3.1 The teachers and their pedagogy

Most first-year students in a Finnish university of applied sciences come from either a general upper secondary school or vocational institution. Adult students may have a long working history in the field of study. The course's learning objectives aim to ensure that all students have mathematical competencies that are essential in engineering studies, can apply mathematical knowledge to engineering applications, and can assess the results using digital tools. The heterogeneity of the student population in mathematics skills, which can be traced back as far as elementary school, made the teachers feel that they must modify their approach in teaching and the level and scope of the content.

All interviewees were experienced teachers using student-centered pedagogies, and they all shared the view that building a solid routine in calculation techniques makes applying mathematics easier. Throughout the course, to motivate the students, the teachers gave examples of the connections between the course contents and its professional applications in engineering. The mathematics course was offered as contact lessons that included lecturing and supported individual or group work. This enabled teachers to follow students' progress toward the learning objectives and offer individual support, if needed. The interviewees felt that mathematics does not easily lend itself to students' individual choices concerning course contents. However, the students could make some choices concerning the method of passing the course, such as taking a test initially if they felt they were familiar with the content.

Personal resources (i.e., competence beliefs and self-efficacy), relational resources (i.e., teacher support, trust for teacher, and equal treatment), participation activity, and peer support were highlighted in the interviews. The interviews with Maria and Katie concerned all the student agency dimensions. Furthermore, Maria and Katie made more comparisons between profiles and the general average profile when compared with John and Helen. John and Helen mainly dealt with personal and relational resources, while participatory resources received less attention than the other resources. Notably, the teachers paid more attention to the negative aspects of the analysis results than the positive aspects.

Maria especially made extensive interpretations and comparisons between profiles P1–P4. She used a boat metaphor to describe the students in each profile and described how the students in P1 "feel awkward being in the boat." Even though the students in P2 "have not been in a boat before, they are like, 'I have never been rowing, but let's see what happens." The students in P3 "sit in the middle of the boat and row among the others," while the students in P4 go first to the boat—right to the front—and "are the most eager to row." Referring to her purpose and role as a teacher, Maria concluded that "the teacher sits at the stern and holds the rudder."

3.2 Personal resources of student agency

John, Helen, and Katie perceived the students' competence beliefs and self-efficacy as the most important dimensions regarding to learning mathematics. John pointed out the low competence beliefs and self-efficacy of the students in P1 and P2 in his course. There was an *agent:act* ratio imbalance, because some students (*agent*) did not pass the knowledge checks or did not manage to do the assignments, despite several attempts (*act*), which John suspected as hindering the students' experiences of personal resources. As a result, John reflected that the imbalance might have been resolved through teacher action (*agent:act* ratio), more precisely, if the teacher (*agent*) would have designed (*act*) more clear and gradually progressing tests and assignments (*agency*) to enhance students' sense of competence and self-efficacy (*purpose*). Furthermore, he suspected that his decision to follow (*act*) "the traditional way and middle course" (*agency*) might have affected students' personal resources:

> Perhaps, the assignments were considered too difficult. Some students faced the wall because we took the traditional way and middle course ... Some students were hitting their heads against the wall with the mandatory tests required to pass. If you frequently get feedback that you still can't handle something, it can really affect those competence beliefs and self-efficacy. If there would have been more structured and differentiating assignments, then maybe the results would be different.

Much like John, Katie also mentioned that in the beginning of the course (*scene*), the teacher (*agent*) should select (*act*) suitable content and assignments (*agency*). In other words, the teacher's actions (*agent:act* ratio) could foster competence beliefs and self-efficacy by taking into account the students' prior knowledge and adjusting the course content accordingly:

> Just don't select too tricky stuff. Start with easy content. It destroys self-efficacy if you start the course with too tricky stuff. Students need to get far enough so that they feel they get the hang of it. ... Always design assignments so that there is also easy stuff, so students feel that "I can do it."

Katie's reflection reminds us of the Vygotskian view about the zone of proximal development: learning is supposed to happen most effectively when the task is challenging but within reach of the learner's abilities (Vygotsky 1978, 21). Much like Katie, Helen emphasized the importance of timing, more specifically the starting
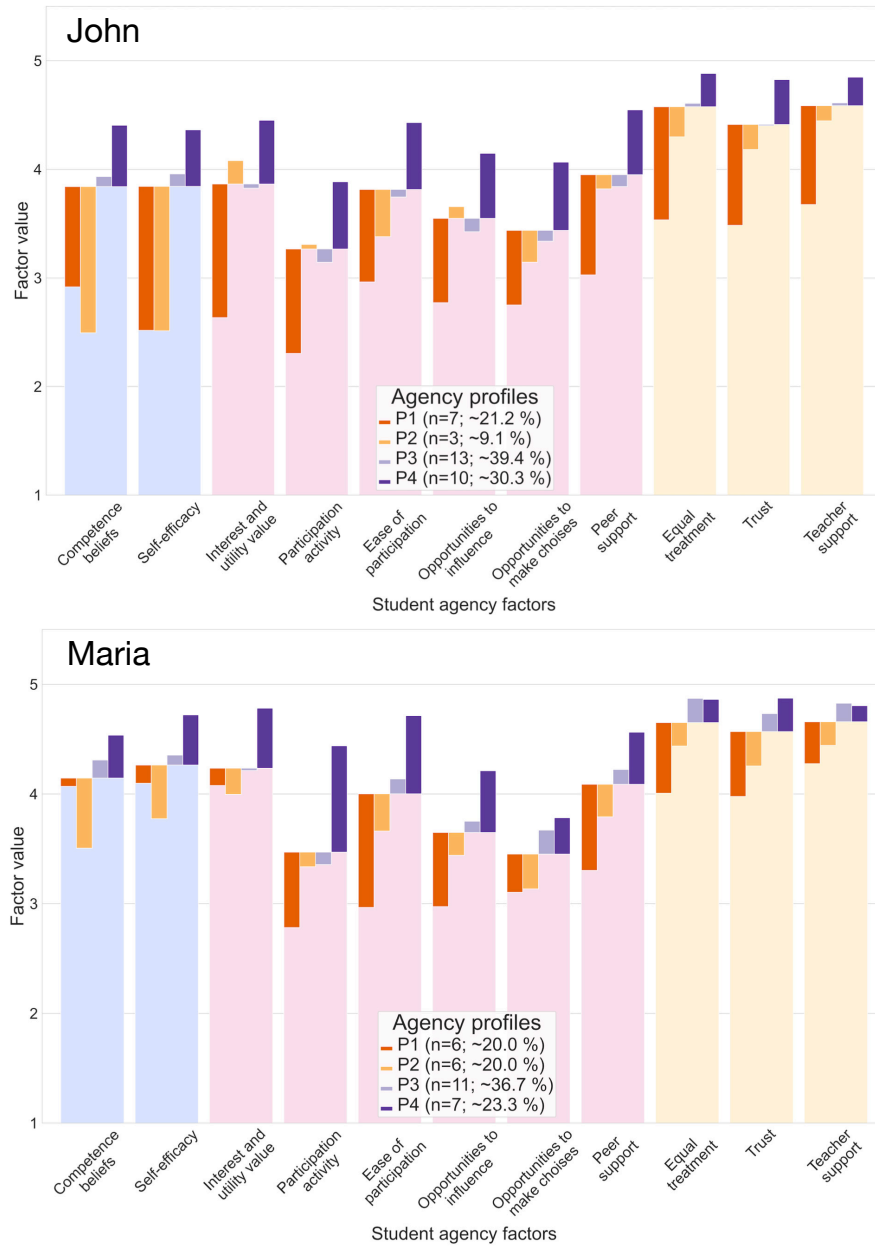
Fig. 1 Student agency analytics profiles of John's and Maria's courses. Maria used a boat metaphor to describe the differences between students in P1–P4.

phase of the studies. She pointed out that there should be enough early support of personal resources for the students with a lack of prior skills and knowledge. Helen reflected on an actionable *scene:act* ratio, stating that at the beginning of the course (*scene*), the teacher should provide timely and effective support (*act*) to those students to prevent them from dropping out. Thus, the scene (i.e., timing, when something was done) becomes an important factor:

> Well, starting the studies is critical. Every time we have a new group of students, some of them drop out. I've always emphasized putting effort to the start that when you get a hold of your students, and the students get a hold of studying— And then enough support measures, especially if students with flimsier knowledge have been taken in. At the beginning, it's also vital to teach learning techniques and how to learn.

Because the questionnaire was provisioned close to the end of the course, Helen also pointed out another temporal aspect of personal resources relating to imbalanced *scene:agency* ratio. When the course progressed toward the end (*scene*), some students might have realized that they have not learned enough, causing problems in future learning (*agency*):

> At that point, when the semester was already progressed, the students surely have noticed what they should already know and be able to do. Indeed, some of them realized that they're going to have problems.

On the other hand, Katie did not think that the low personal resources were necessarily a negative aspect. She observed her course results and pointed out that the students in P2 had the lowest personal resources but also reported the lowest interest and utility value. She thought that "it would be more miserable if the students felt that they don't know and can't, and at the same time, they think it's very important and useful". Katie's observation would suggest that the teacher's reflection on the level of imbalance (or Trouble) in some agency dimension might be contingent on other dimensions. She also presumed that the high experiences of personal resources and the dimension of interest and utility value could reflect the students' actual traits as "certain kinds of students find their ways to this study line" and "they in principle have high characteristics in these dimensions regardless of course or teacher." Katie also suspected that she "could not credit the high first three bars," which represented the personal resources and dimension of interest and utility value. In other words, teachers might also think that some student agency dimensions could be somewhat out of their reach and more because of the students' latent characteristics.

3.3 Participatory resources of student agency

Participation activity was pointed out as an important aspect by all the interviewed teachers. From their students' self-assessment results, they all noticed that the participation activity was reported as lower than other dimensions. According to Maria, collaborating with different kinds of people is an important skill to learn and practice in engineering education. On the other hand, the tendency to participate and both

provide and receive peer support, "to become visible in the group" as she called it, depends on personal characteristics and individual differences. She made an insightful comparison by pointing out that P1 students had the potential for active participation based on their high personal resources but still experienced low participatory resources. Even though a clear balanced *agent:agency* ratio would be one where a teacher would be expected to encourage interactions, Maria reflected that the reason might have been her (*agent*) deliberate emphasis on student collaboration (*agency*), which might have caused an inconvenience for some students. In other words, students might have the potential to act, but the teacher's actions—even for a good purpose—could prevent student agency from actualizing, possibly causing Trouble:

> I invest in and want to foster collaboration between students. It's not natural for all in the group. If you're a new student, it's not easy to say you don't know something. ... On the other hand, one might ask the P1 students if they feel that emphasizing group work isn't a natural way to learn math for them. They have competence beliefs and self-efficacy, on average, relatively high. So it's maybe not about the math itself, but more about working in a group and emphasizing it.

Only John and Katie reflected on students' opportunities to influence and make choices. For example, John recalled that the students in his group were "very passive." He noted that the results showed lower opportunities to make choices and that the students in P1 showed lower resources of interest and utility value. When they were doing the assignments in the classroom, the students were not actively asking questions, and he "had to pry if anyone needed any help." He suggested that perhaps the problem was that the students' (agent) activities were "too monotonous" (*agency*), which did not encourage them to participate, indicating an imbalanced *agent:agency* ratio. As a solution, John suggested that maybe the teacher (*agent*) could guide (*act*) the students more toward working in small groups (*agent:act* ratio) or that the teacher (*agent*) could design more practice-oriented assignments (*agency*) referring to the *agent:agency* ratio. On the other hand, John did not consider the opportunities to influence and make choices as important as the other dimensions:

> When you think of our school, there are precise curricular requirements what the students have to learn. Perhaps, that's why I don't think the opportunities to influence are so important. Now that I say this, I feel bad, but still, the teachers may have a better vision of what the students need. That's why I think it's not so important. On the other hand, if you feel that you can influence, it might increase motivation. Oh, it's tough to say what's important and what's not.

John's reflection can be examined further through a pentadic analysis. John pointed out that the curriculum places some important requirements in the form of aims and, thus playing an influential role in teaching and studying. He also proposed that the teacher (*agent*) exercises agency (i.e., does not necessarily need to provide opportunities to influence) because "the teachers maybe have a better vision," or paraphrasing this: the teachers know something better than the students (*purpose*). John said he felt bad saying such a thing because he also saw the benefits of students having the opportunities to influence and make choices. After reflecting

on the analysis results, John was eventually indecisive about the importance of students' opportunities to influence and make choices. The imbalanced *agent:purpose* or *agency:purpose* ratio could provide fruitful grounds to think about the teacher's purpose and actions. When interpreting his student agency analytics results, John noticed the evident Trouble (i.e., control versus freedom), which manifested as a critical reflection-on-action.

When evaluating the level of peer support, Katie drew from her own past experiences as a student. She recalled that her own experiences as a student was that she felt that peer support was essential. Katie noticed that peer support was assessed as lower than teacher support in her course. She suggested that the peer support network might be more critical for a higher education student than "merely the teacher." She associated the high peer support resources of the P4 students in her course with social skills. Katie said she (agent) had been making efforts to allocate time (act) for collaborative tasks every week (*agent:act* ratio).

3.4 Relational resources of student agency

John perceived that the student agency dimension of teacher support, trust in the teacher, and equal treatment all play important roles for learning (purpose). Also, Helen stated that "creating kind of beneficial atmosphere for learning and providing as much support as you can (*act*) is important for learning (*purpose*)." Reflecting on the results of their courses elicited spontaneous, positive emotional responses from both John and Helen because they felt delighted to see that the students in their courses experienced high relational resources in general. John suspected that it might have something to do with the fact that he (*agent*) had provided time for personal support (*agency*), especially for the "quiet dudes" (*agent:agency* ratio). He noted that some students (*agent*) might not participate as actively (*agency*) as others, indicating an imbalanced *agent:agency* ratio in his view:

> Those three on the right [teacher support, trust in the teacher, and equal treatment] are important for all subjects. Of course, it's nice that the students have experienced it like it's good. I hope it relates to the fact that there was time for practicing and personal support face to face and ask how you are doing. ... Provide help for all, so you don't leave those quiet dudes without attention.

High student agency resources might render the teacher's actions unnecessary, which Katie suggested in her reflection. Depending on the study context (*scene*), she considered that peer support and teacher support (*act*) might not be important for students with high personal resources and a higher experience of student agency resource of interest and utility value. Katie's reflection pointed toward the importance of the context of studying (i.e., *scene* in pentadic term). She reflected on the student agency analytics results toward her image of the modern student type she perceived as independent and autonomic:

> It could be that peer support and even teacher support are not, in fact, at all critical for all students if they are high on those first three bars. Nowadays, people learn independent stuff.

> You don't necessarily need any support, and still— Central is the self-efficacy and interest. Those might be enough.

Maria said that she (*agent*) usually starts a new course by giving a motivational speech (*agency*) to all the students. The following *agent:act* ratio shows us that a seemingly simple act can be meaningful:

> I told them about the boat metaphor and that I feel that we are all here rowing the same boat towards the mutual goal. ... And then, when I looked at them, they all responded to my look. And even the shyest student raised his eyes and looked at me. That's my highlight moment.

4 Discussion

Four teachers in higher education were provided with student agency analytics results of their mathematics courses. The teachers participated in a semi-structured interview where they reflected on their pedagogical actions based on the analytics results. Points of pedagogical reflection-on-action were identified and analyzed using Burke's pentadic analysis (Burke 1945; Allen 2017).

The teachers made several reflections relating to the *agent:act* (what they did?) and *agent:agency* (how?) ratios and a few relating to the *agency:purpose* ratio (why?). The ratios point toward reflection-on-action, indicating what the teachers thought about the connections between their actions and interpretations of the students' agency. Furthermore, the interviews with the teachers pointed toward the complex nature of student agency. For example, the teachers' perceived level of one student agency dimension could be contingent on other dimensions. Also, the teachers' actions could prevent student agency from actualizing. On the other hand, high personal resources were suggested as rendering some of the teachers' actions as unnecessary. In addition, temporal aspects were highlighted in the teachers' reflections-on-action. Timely support is important, and the teacher's effective actions depended on where they were at in in the course. Thus, timely learning analytics could provide information for the temporal planning of pedagogical actions.

Imbalanced pentadic ratios prompted the teachers to suggest tentative actions that might have improved the situation. Interestingly, the teachers were prone to point out more negative than positive aspects from the analysis results. The power of narrative is the point where the traditional cultural conventions are violated (Althouse et al. 2016; Bruner 1991). Perhaps, the educational conventions direct the teachers' observations toward the problematic aspects of the learning, or perhaps, it is the nature of analytics itself that channels the observations toward a quandary. Thus, it might be worth asking if the positive results should receive deliberate emphasis in learning analytics.

A particular indication of reflective thinking was when one teacher interpreted her analysis results using a metaphor. A metaphor can be considered "a heuristic device to increase reflection" (Marshall 1990, 129). As Maria depicted, the students and teacher share the same boat. In fact, there can be multiple boats on the "sea of learning" because not all students share the same location and bearing, let alone weather.

Some students might even be solo sailing. Student agency is about "acting rather than being acted upon; shaping rather than being shaped; and making responsible decisions and choices rather than accepting those determined by others" (OECD 2019, 4). To continue with these naval terms, students will eventually become the captains of their ships. Agency would be their tool for navigating in the volatile, uncertain, complex, and ambiguous environments they face. A challenge for the teacher would be to provide timely and practical support and guidance until the students can sail on their own. As the results of our study propose, student agency analytics could provide data-driven means for the teachers to support student agency through reflection-on-action while protecting the privacy of an individual student.

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