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Finnish university students' views of different relationships in first-year engineering mathematics courses

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ABSTRACT

Integration is seen as a main factor for students to stay in university and eventually graduate. In conventional lecture-based teaching, students might avoid asking for academic help from teachers, which weakens the student–teacher relationship and distances students from the faculty. To decrease distance and ease integration, more student-centred methods are widely adopted. This article concerns the use of specific tutors and a learning space called Math Shack in engineering mathematics teaching and learning at Tampere University in Finland. The aim of this study was to examine how students experience relationships and roles within first-year engineering mathematics courses and determine if Math Shack affected their experiences. The analysis was based on the material from a drawing assignment ($N = 695$) which was collected from first-year engineering mathematics students. Drawings were categorized as data-driven. The results showed that Math Shack tutors were experienced as more approachable than assistants; however, assistants were experienced as middlemen. Though there were no major differences in experiences whether students had been in Math Shack or not, assistants were experienced slightly differently.

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Roles; integration into faculty; engineering mathematics; Math Shack

1. Introduction

By beginning studies in university, students' journey to become academic experts in a specific field of study begins (Thompson, 1984). However, it is not as simple as that; there is a widely indicated gap between secondary and tertiary education both in general (e.g. Coertjens et al., 2017; O'Keeffe, 2013) and in mathematics specifically (e.g. Brandell et al., 2008; Engelbrecht & Harding, 2015). For example, there has been a noted curriculum gap between secondary mathematics' goals and tertiary mathematics assumed skills in Finland (Silius et al., 2010).

In addition, the gap phenomenon has been studied from various viewpoints (e.g. Gruenwald et al., 2004; Hong et al., 2009; Hourigan & O'Donoghue, 2007), including the students' point of view. For instance, for individual students, transition has also been viewed as a chance for becoming independent and mature, both emotionally and mentally (Hernandez-Martinez et al., 2011). However, there is a still a chance for an unfortunate

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failure. Consequently, when successful, students transform from a passive pupil to an active student, but when the transition and development of a new identity are unsuccessful, even successful students begin being alienated from teaching–learning community (Solomon, 2007; Solomon & Croft, 2016).

Another phenomenon is 'students' developing loss of interest in mathematics due to a combination of cognitive and affective factors with a focus on the persistence of their mathematical beliefs' (Daskalogianni & Simpson, 2002, p. 1), which is referred to as 'cooling-off' by Daskalogianni and Simpson (2002) and can be seen as a result of the failed transition from secondary to tertiary mathematics. Furthermore, the cooling off phenomenon can potentially be reduced by peer-assisted learning (Duah et al., 2013). Internationally, support communities and centres have also been seen as means to reduce cooling off (Solomon et al., 2010; Waldock et al., 2017). However, it is not self-evident that students make use of these opportunities to get assistance (Inglis et al., 2011). Eventually, students may even drop out (Daskalogianni & Simpson, 2002; Tinto, 1975). Thus, we will determine in this study whether specific tutors and a learning space applying student-centred methods helped students with integration into university by reducing distance between the students and the teachers.

2. Integration with faculty

It might appear that studying is more about the ultimate performance than learning itself because universities pressure students to graduate (Barnett, 1994). Instead, universities should support students in their studies and try not to pressure them excessively to graduate (Merenluoto, 2005, 2009). Integration with faculty is one of key means to help students eventually graduate from universities (Berger & Lyons, 2005; Tinto, 1996). However, particularly in the field of natural science and mathematics, integration is weak, and that is why it is important that universities support students and make it easier for them to integrate with faculty (Lähteenoja, 2010). Also, within mathematics-related fields, such as technology and engineering, there are difficulties in faculty integration (Giannakos et al., 2017; Vogt, 2008).

As previously mentioned, in the Science, Technology, Engineering and Mathematics (STEM) related fields, students have had difficulties in integrating with faculty. According to Tinto (1975, 2006) and his model about factors that make students quit their university studies, the reason for quitting is the unsuccessful integration with faculty that does not support students' education goals and commitment to studies. The integration at universities happens in two areas: social and academic. Academic integration consists of how the teacher pays attention to students and how the studies correspond to students' intellectual needs. Social integration is a result of positive contacts with other students and with university staff (Lähteenoja, 2010).

To help students to integrate, universities can facilitate the integration in both the social and academic areas. In normal classrooms or lecture halls, where there is neither a specific supporting atmosphere nor intrinsic reasons for the arrangement that teachers teach individually instead of lecturing at the front, the optimal environment to encourage students to ask for help does not exist (Ryan et al., 1998). For instance, students might avoid asking for academic help, at lectures because the environment and atmosphere do not encourage them to ask questions, and the lecturer might not have time to answer everyone's questions

(Berger et al., 2017; Karabenick, 2003). However, the phenomenon of avoidance of asking for academic help is not only environment-dependent but also depends on the students themselves (Ryan et al., 1998). Furthermore, avoidance might be an acquired response and help-seeking should be learned (Herring & Walther, 2016). Students also might be concerned how help-asking affects their social or academic image (Herring & Walther, 2016; Ryan et al., 2001). By offering encouraging situations and places, this kind of student could make contact more easily with teachers, and they would not hold back with their questions considering their studies (Herring & Walther, 2016). Universities should also offer students formal opportunities to discuss with other students, because students ask questions of each other more often than of teachers (Ryan et al., 1998; Ryan et al., 2001; Wirtz et al., 2018). Thus, by offering encouraging and formal opportunities to have contact with teachers and also with other students, integration, not only in the academic area but also in the social area, is supported.

3. Roles at the university

University teachers might experience the student–teacher relationship as being better than how students experience it. The importance of interactions between students and teaching staff should be emphasized to make student–teacher contact easier because the teacher in his or her role as just a lecturer might not be enough from the students' point of view (Asikainen et al., 2018). Furthermore, students expect that teaching staff members not only have good teaching skills, but that they are also approachable. Hence, the approachability of teaching staff should be improved since, if faculty members are experienced as being difficult to approach and, therefore, as distant, students do not obtain the support they may need from teaching staff (Sander et al., 2000; Vogt, 2008). This can result in students eventually accepting their peers' help in place of that of a teacher, even if it is somewhat incomplete (Wirtz et al., 2018). One of the key components in teacher–student interaction is the trust that students have in teachers. By meeting the expectations of students, teachers can gain trust from students, and in this way, teachers are considered to be more approachable (Pawiak, 2018). Unfortunately, for teachers, this kind of trust is hard to gain because only a few students make contact with teachers outside of lectures or even during lectures and prefer, for example, peers or assistants to lecturers (Hagenauer & Volet, 2014; Wirtz et al., 2018). Although the student–teacher interaction and relationship are still understudied subjects at the university level as Hagenauer and Volet (2014) have argued, approachability seems to be one of the key components.

To improve the student–teacher relationship, a new teaching model known as Extreme Apprenticeship (Rämö et al., 2019) was introduced at the University of Helsinki in Finland. In this teaching and learning model, students take part in meaningful activities, which require considerable effort from the students. In Extreme Apprenticeship, the importance placed on lectures is limited, and assignments and exercises play more significant roles. Nevertheless, Extreme Apprenticeship also requires support from teaching staff; that is, students do not need to solve all the problems on their own. This is where these teachers' and tutors' roles become important. Teachers provide individual help and instructions for students when they need it. Teachers have a closer relationship with students, and it is easier for students to ask for help. With this kind of method, students can solve more challenging problems because they can ask for help if they face obstacles (Lahdenperä et al., 2019;

Rämö & Vikberg, 2014). By implementing this kind of student-centred teaching method, where students can ask for assistance, both the academic and social areas of integration are supported.

In conclusion, to support students' integration with faculty, universities need to concentrate on supporting both academic and social integration. Both can be supported by using such methods as Extreme Apprenticeship in which students have a chance to think problems through with each other and, when in need, have the possibility to get help from teaching staff. In this method, teachers are approachable and ready to help when circulating among students. Thus, in Tampere University we created a place called *Laskutupa* (Math Shack, in English) primarily for students studying first-year engineering mathematics.

4. Math Shack

At University X, there are different types of learners among the technology students (Pohjolainen et al., 2006; in English, see Huikkola et al., 2008). According to Pohjolainen et al. (2006; as well Huikkola et al., 2008), there were five groups of students among engineering mathematics students: Surface Oriented Learners, Peer Learners, Students Needing Support, Independent Learners, and Skilful Students. Moreover, not everyone will learn through lectures and by reading (Mannila, 2018). As mentioned previously, there has been a gap between secondary and tertiary mathematics in Finland. Consequently, various methods have already been developed to support students (Silius et al., 2010), such as Mathematics Clinic for students struggling with mathematics, and the development of similar methods is still in progress. Additionally, Math Shack was created with the broader aim of supporting all types of learners in their mathematics studies and to give them alternative ways to learn.

Math Shack consists of a large classroom space which is open for students during the daytime almost every day of the week. In Math Shack, students can freely do their mathematics exercises and get help from Math Shack tutors. It is important to note that these *tutors* are not *assistants* who assist teachers with particular courses by holding exercise sessions, but are competent individuals with mathematics experience and knowledge of how mathematics can be learnt. In Math Shack, there are two kinds of tutors helping with exercises. There is the *koutsi* (coach, in English) who usually is a research assistant with pedagogical experience, and the *tsemppari* (encourager, in English) who is pre-service teacher. Encouragers are in Math Shack as part of a pedagogical course. This way, Math Shack also provides an initial teaching experience for the encourager, and encourager also supports the coaches on guiding students. Reciprocally, coaches guide encouragers and give them feedback. At the University of Helsinki, there have been guidelines for Extreme Apprenticeship guiding (Rämö et al., 2020) which was adapted for Math Shack. For students, Math Shack is completely voluntary, and those students who think they need help can drop in anytime it is open. In Math Shack, students can also access mathematical literature, computers and whiteboards to support their learning.

Other universities in Finland also have a Math Shack type of support for students. For instance, at Aalto University, there is a similar method known as the Mathematics Tutoring Lab which influenced the design of our Math Shack. The Mathematics Tutoring Lab has a fixed timetable, and the weekly timetable is the same over the whole semester. Just as it is here at Tampere University the tutoring lab is meant for students to come freely to do their exercises and ask questions of coaches, or in the case of Aalto, tutors, considering their mathematics courses. The Mathematics Tutoring Lab also supports some more advanced mathematics courses, not just first-year courses (Radnell, 2019). The biggest difference between Math Shack and the Mathematics Tutoring Lab is the encourager at Tampere University. As mentioned, our Math Shack does not only help first-year students in their courses but also provides the first experience of teaching mathematics to the encouragers. Of course, at the University of Helsinki, there is Ratkomo ('a place for solving', in English) with its tutors (Rämö et al., 2019). In addition, there are also Extreme Apprenticeship tutors for particular Extreme Apprenticeship courses at Helsinki (for more details, see Rämö et al., 2019). In comparison, our tutors (i.e. especially coaches) are more like the Ratkomo tutors as both are working with several courses.

5. Research questions

Because integration with faculty influences students' studies and can ultimately affect whether or not they graduate, we wanted to determine in this study whether Math Shack helped students with this integration. A key means to examine integration is students' expressions about how distant or approachable faculty members are, that is, how students experience roles, relationships and interactions. The research questions for this study were the following:

(1) How do university students experience the assistant's role in first-year engineering mathematics courses?
(2) How do university students experience the coach's role in first-year engineering mathematics courses?
(3) How does Math Shack affect university students' experience of assistants and others' roles?

6. Methods

6.1. Context

Surveys which are reported in this paper were taken during the first term of the academic year 2018–2019. In engineering sciences, the present Tampere University grants undergraduate degrees of Bachelor of Science and Master of Science both in Technology and in Architecture. As recommended, bachelor's studies take three years and master's studies two years.

Table 1. Degree programmes and sign-ups of engineering mathematics courses at Tampere University.

Course	Degree programmes	Sign-ups
Engineering Mathematics A	Construction Engineering, Electrical Engineering, Knowledge Management, Information Technology, Industrial Engineering and Management	389
Engineering Mathematics C	Automation Engineering, Mechanical Engineering, Materials Engineering, and Environmental and Energy Engineering	252
Mathematics	Bioengineering, Science and Engineering	115
Engineering Mathematics 123	For engineers in various master's degrees	114
Total		870

For all technology students at Tampere University, there are compulsory service mathematics courses which are recommended to be taken during the first year. In that particular period when the surveys were made, the courses were about the basics of vector and matrix algebra. Previous (i.e. the first engineering mathematics course) courses had been conventional analysis courses about sets, proofs, and elementary functions with limits, continuity and derivatives. In Table 1, separate course implementations of the second course are listed. In addition, programmes and sign-ups (in the academic year 2018–2019) with respect to courses are listed.

Notice that there is also a course for international students, but in this listing, it was not included; all the courses in Table 1 are taught in the Finnish language. Furthermore, sign-ups are actually those students who had previously done some exercises (i.e. worked for a grade) but had not necessarily passed the course.

There were six hours of lectures and two or three hours of exercise sessions per week except in Engineering Mathematics 123. In Engineering Mathematics 123, there were only two hours of lectures and two hours of exercise sessions; however, there was the possibility to complete the exercises without attending exercise sessions. Lectures were conducted by teachers, and exercise sessions were mainly held by teaching assistants; however, in certain courses, teachers held exercise sessions as well.

6.2. Participants and data collection

The target group for this study was technology students at Tampere University who were studying first-year engineering mathematics courses. For collecting data, we administered a questionnaire during the second period after two months of studying engineering mathematics. The questionnaire was referred to as a drawing assignment and was held in the exercise sessions. In the drawing assignment, students had to draw how they experienced different roles and interactions within the current mathematics course. The roles to draw were (1) teacher, (2) teaching assistant, (3) coaches, (4) encouragers and (5) students. Each role group had its own specific colour to be drawn with so that analysing the drawings would be easier. Teachers, teaching assistants and coaches also participated in this drawing assignment. The instructions for the drawing assignment were the following:

- How do you see the role of teachers, assistants, coaches, encouragers and students in Tampere University engineering mathematics courses?
- You have five (5) coloured pencils; each colour represents one group:
  - Blue: teacher
  - Green: assistant
  - Red: coach
  - Yellow: encourager
  - Grey: student.
- Draw these groups on the paper so that your drawing shows how you experience the interaction between the groups.
- Write the name of the group you are drawing with the colour designated for that group.
- You may draw multiple members of one group.
- You do not need to draw a member from all of the groups.
- You may draw arrows and lines between groups and write a few of words to specify interactions between groups.
- Everyone has to complete this assignment independently.

This drawing assignment was used to collect data because network analysis is simple to do via layout of groups with respect to each other and the graphs which show connections between the groups. Visual representation of relationships between groups is important for understanding the whole network and to gather data (Freeman, 2000; Johanson et al., 1995).

We ensured that the answers could be used for the study. Enquiry had a fact sheet explaining how the answers would be used in the future and that answering them was voluntary. Thus, the European General Data Protection Regulation was observed.

6.3. Data analysis

For the drawing assignment, we got 695 answers from students and 13 from teachers, teaching assistants and coaches ($N = 22$) working with the engineering mathematics courses in the first and the second period. There were two separate groups of students: those who were seen in Math Shack and those who were not seen in Math Shack (henceforth, 'SiM' and 'not-SiM', respectively).

The frequencies of students who answered and the courses they were enrolled in are listed in Table 2; percentages are of sign-ups within course (see Table 1) instead of the total of students.

Students' answers to the drawing assignment were categorized via content analysis that was mainly data-driven. Drawings were categorized by three members of the Technology-supported Mathematics Education Research Group, one of whom is not an author of this article. First, preparatory categories were formed by two authors. Next, preparatory categorization was revised by the rest independently. After that, categorization was discussed by all three. Lastly, after finalizing the categorization, example drawings were chosen. Categorization was directed by the following questions:

(1) How is the assistant's role seen compared to other roles?
    (i) Are there differences in the views about roles between students who have visited Math Shack and those who have not?
(2) How is the coach's role seen compared with other roles?

In both cases, categorization was done similarly. When focusing on the assistant's role and differences between SiM and not-SiM, categories were cross-tabulated to check the relation between SiM and not-SiM with respect to the role categories. After cross-tabulation, chi-square analysis was made using SPSS software and p-value with a significance level of

Table 2. Student distribution in the various courses.

Course	Drawing assignment f (% of sign-ups)
Engineering Mathematics A	326 (83.8%)
Engineering Mathematics C	223 (88.5%)
Mathematics	107 (93.0%)
Engineering Mathematics 123	39 (34.2%)
Total	695

Table 3. Frequencies of students who had visited Math Shack and those who had not and the courses they were enrolled in, and also SiM–Sign-ups ratio for the courses.

Course	SiM f (% of 203)	Not-SiM f (% of 592)	$\frac{f(\text{SiM})}{\text{Sign - ups}}$
Engineering Mathematics A	73 (36.0%)	273 (46.1%)	18.8% (of 389)
Engineering Mathematics C	67 (33.0%)	172 (29.1%)	26.6% (of 252)
Mathematics	16 (7.9%)	96 (16.2%)	13.9% (of 115)
Engineering Mathematics 123	47 (23.2%)	51 (8.6%)	41.2% (of 114)
Total	203	592	23.3% (of 870)

5% (i.e. $\alpha = 0.05$). When focusing on coach's role, only the drawings from SiM were categorized because not-SiM did not have the experience from Math Shack. In other words, not-SiM were not supposed to know what coaches are.

7. Results

Firstly, in Table 3, frequencies of SiM and not-SiM are listed with respect to courses; percentages are of totals on the last row. On the last column, frequencies of SiM are compared with sign-ups (see Table 1).

In Table 3, we can see that two-thirds of SiM were taking either Engineering Mathematics C or Engineering Mathematics A. Nevertheless, only 18.8% of Engineering Mathematics A students had visited Math Shack. For Mathematics, the percentages for both the SiM (7.9%) and the SiM–Sign-ups ratio (13.9%) were quite small; in fact, they were minor. However, 41.2% of Engineering Mathematics 123 students had visited Math Shack, which amounted to 23.2% of all SiM. Overall, 23.3% of those who signed up ($N = 870$; see Table 1) had visited the Math Shack.

7.1. Roles of assistant and coach from the perspective of students

From the drawing assignment data ($N = 695$), we were interested in determining how students experienced the assistant's role and how students in the Math Shack experienced coaches compared with assistants. First, the answers to the drawing assignment were categorized by how the role of assistant had been experienced. The categories were the following:

(1) Everyone is equal.
(2) Assistant as a teacher.
(3) Assistant among students.
(4) Assistant as a middleman.
(5) Student-centred view.
(6) Assistant's role is small.

Figure 1 displays an example drawing for each of the six categories. Despite that there were no coaches or encouragers in the example drawings, answers with coaches and encouragers were also categorized with respect to assistants. Thus, we can compare not-SiM with SiM.

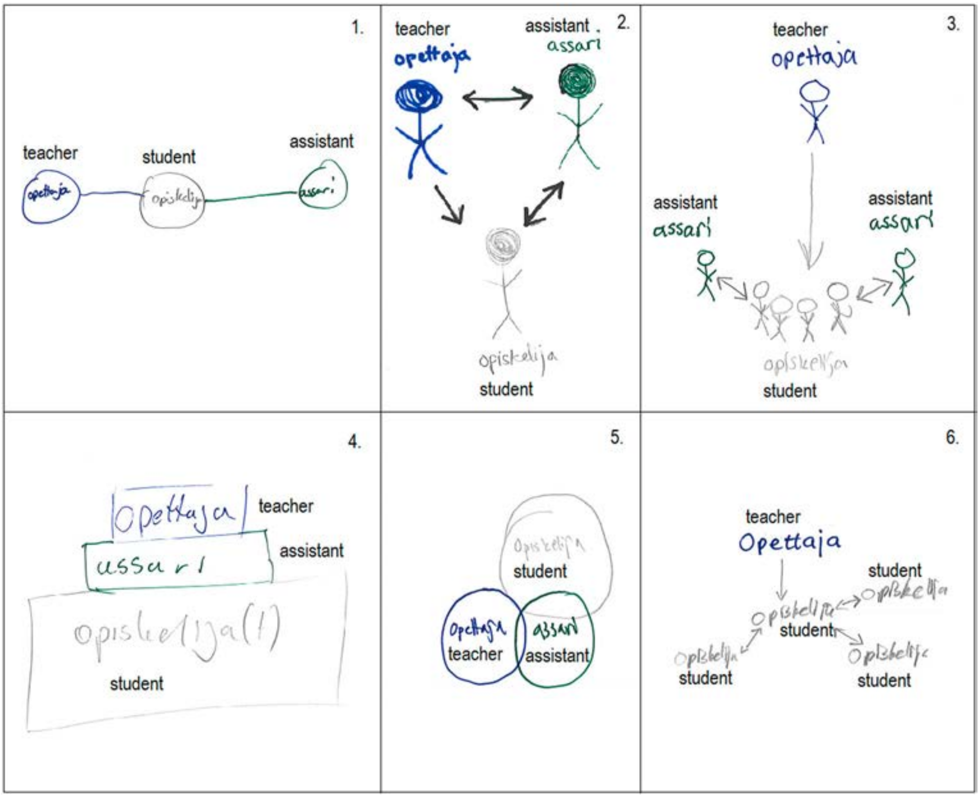

Figure 1. Example drawings of all categories: (1) Everyone is equal; (2) Assistant as a teacher; (3) Assistant among students; (4) Assistant as a middleman; (5) Student-centred view; and (6) Assistant's role is small.

In example drawing 1 of Figure 1, we can see that teacher, student and assistant are all in the same horizontal line. In addition, there are no arrows for representing one-way relationships. Hence, they are hierarchically equal. In contrast, the rest of the categories are somewhat hierarchical. In example drawing 2, assistant and teacher are not only on the same level above student but also, they are equal; we can see that there is a two-way relationship between them. In example drawing 3, despite the assistants being vertically slightly higher than students, the relationship between assistants and students is two-way. In addition, there is no particular interaction between teacher and assistants. Thus, we can interpret that the assistant is among students. Clearly, example drawing 4 is purely hierarchical; more importantly, there is no direct interaction between teacher and students. Consequently, the assistant mediates between students and teacher. In example drawing 5, assistant and teacher are equal, similar to example drawing 2. However, the set-up is upside down; the student is on the top. In addition, the circle around the student is bigger than the corresponding circles, which again represents greater power or responsibility. As we can see from the last example drawing, there is no assistant at all. For this sixth category, the lack of (two-way) interactions between students and assistants was a common characteristic.

Results of the categorization are displayed in Table 4; percentages are of totals on the last row.

Table 4. How students and teaching staff see the assistant's role compared with that of the teacher and students in the first-year mathematics course.

Categories	SiM *f* (% of 168)	Not-SiM *f* (% of 527)	Teachers and assistants *f* (% of 13)
1. Everyone is equal	1 (0.6%)	19 (3.6%)	0 (0.0%)
2. Assistant as a teacher	37 (22.0%)	113 (21.4%)	5 (38.5%)
3. Assistant among students	5 (3.0%)	32 (6.1%)	0 (0.0%)
4. Assistant as a middleman	105 (62.5%)	311 (59.0%)	6 (46.2%)
5. Student-centred view	13 (7.7%)	19 (3.6%)	2 (15.4%)
6. Assistant's role is small	7 (4.2%)	33 (6.3%)	0 (0.0%)
Total	168	527	13

When comparing (i.e. cross-tabulation and chi-square analysis) the answers from SiM and not-SiM with the significance level of 5%, we can say that there was a statistically significant difference ($\chi^2(5) = 12.280$; $p = 0.031$). From Table 4, we can see how views of assistant roles vary between SiM ($n = 168$) and not-SiM ($n = 527$). There are some differences in categories, but the major role views are the same for both SiM and not-SiM, assistant as a middleman (SiM: 62.5%; not-SiM: 59.0%) and assistant as a teacher (SiM: 22.0%; not-SiM: 21.4%). For comparison, teachers and assistants ($n = 13$) themselves also experienced these two roles as two major roles (46.2% and 38.5%, respectively). In addition, 15.4% of teachers and assistants experienced that students are in the centre, whereas the assistant is simply an extra. While 7.7% of SiM experienced teaching as student-centred, only 3.6% of not-SiM had this view. However, while 6.3% of not-SiM experienced that the assistant's role is small, 4.2% of SiM experienced it that way. Also, only 3.0% of SiM experienced that the assistant is among students, while 6.1% of not-SiM shared the same view. For both the SiM and not-SiM, the category of *everyone is equal* had low percentages (0.6% and 3.6%, respectively), although there were differences in percentages.

The answers from SiM were also categorized by how students experienced the role of coaches compared with that of assistants. These categories were the following:

(1) Coaches as assistants
(2) Coaches are closer to students than assistants are
(3) Assistants are closer to students than coaches are
(4) Coaches among students.

In Figure 2, we can see an example drawing of each of these four categories.

In drawing 1 of Figure 2, we have an example of how a coach can be seen as an assistant; moreover, assistants and coaches should be drawn vertically on the same hierarchical level or with similar interactions (i.e. arrows). More clearly, as in example drawing 2, coaches are closer to students than assistants are if coaches mediate between assistants and students, or if coaches are otherwise represented (e.g. with a two-way arrow instead of a one-way arrow) as being closer. In category 3, there is hardly any interaction (e.g. no arrows at all or only dashed lines) between students and coaches, or coaches are drawn on the periphery. In drawing 4, the coach and student are on the same horizontal line. In addition, coaches were usually experienced as independent from teachers and assistants; thus, they were basically considered as older students.

Results of the categorization are displayed in Table 5.

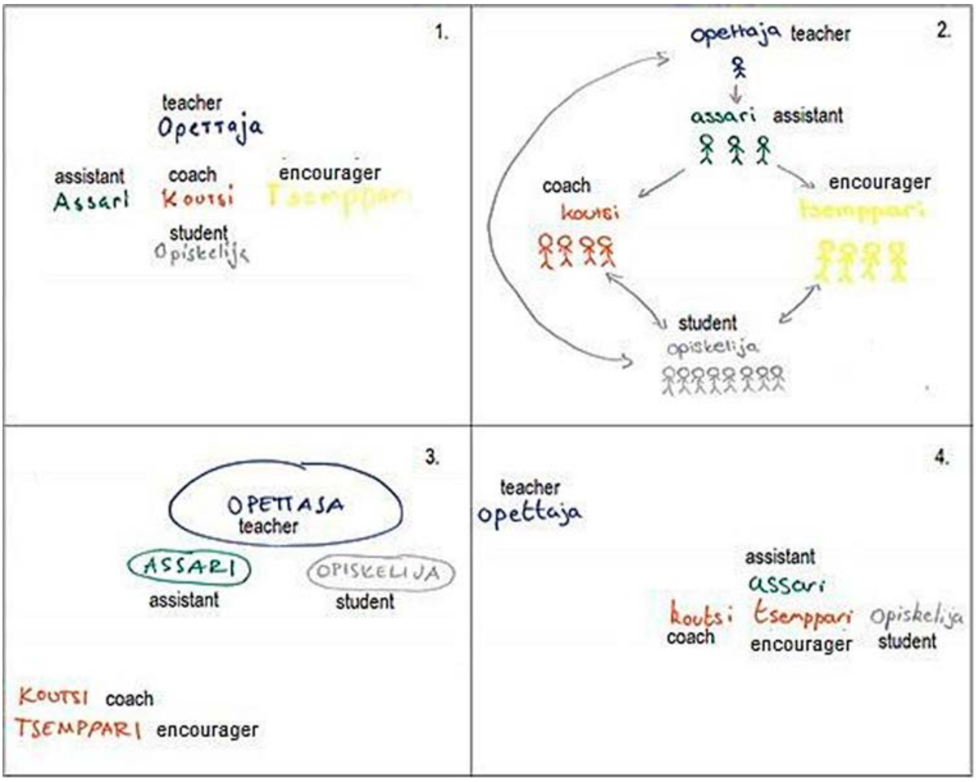

Figure 2. Example drawings of categories: (1) Coaches as assistants, (2) Coaches are closer to students than assistants are, (3) Assistants are closer to students than coaches are, and (4) Coaches among students.

Table 5. How students in Math Shack saw coaches compared with assistants.

Categories	Count *f* (% of the total)
Coaches as assistants	55 (32.7%)
Coaches are closer to students than assistants are	78 (46.4%)
Assistants are closer to students than coaches are	12 (7.1%)
Coaches among students	23 (13.7%)
Total	168

From Table 5, we can see that nearly half (46.4%) of SiM experienced that coaches were closer to them than assistants were, whereas only 7.1% shared the opposite view. More importantly, *Coaches are closer to students than assistants are* was a major and *Assistants are closer to students than coaches are* was a minor perception. A third of SiM experienced coaches and assistants as equal. In addition, even 13.7% of SiM experienced coaches as a student among them.

8. Discussion

In this study, we analysed how students experienced the role of assistants and coaches in Math Shack and how Math Shack affected students' views of the assistant's role. These questions are interesting since students' views tell us how approachable or distant teaching staff were experienced to be, which, in turn, tells us how we could better support student integration with faculty.

In the first research question, we explored how do university students experience the assistant's role in first-year engineering mathematics courses. According to the drawing assignment and Table 4, most of the students saw assistants mediating between students and teachers, but generally assistants were seen to be closer to teachers than students. For comparison, assistant's role was seen similarly by teaching staff.

The second research question explored how do university students experience the coach's role in first-year engineering mathematics courses. In this question, we focused on SiM and their drawings, because not-SiM were not supposed to know what coaches are. Students who visited Math Shack mostly saw coaches between them and assistants or, at least, closer than assistants, as we can see from Table 5. For instance, Wirtz et al. (2018) argued that, in principle, students first seek assistance from a most approachable resource, at first from peers and after that, from assistants. Similarly, according to our present findings, coaches were considered more approachable than assistants.

In the third research question, we expanded on how does Math Shack affect university students' experience of assistants and others' roles. Although the two majority categories for both SiM and not-SiM were *Assistant as a middleman* and *Assistant as a teacher*, as we can see from Table 4, there was a statistically significant difference ($\chi^2(5) = 12.280$; $p = 0.031$). This difference can be seen in respect to categories *Everyone is equal* and *Assistant among students* in Table 4. Moreover, while coaches were mainly seen as being closer to students or equal to assistants, as we can see from Table 5, not-SiM more frequently experienced assistants as closer than SiM, several of whom had experienced how approachable other teaching staff (i.e. coaches) could be. Coaches in Math Shack do not necessarily push assistants farther away, but they do affect the experience of 'closeness'.

Since approachability was an important factor in faculty integration (Hagenauer & Volet, 2014), coaches facilitate students' help-asking and integration. Coaches in Math Shack did not significantly affect how other roles were seen: major views of hierarchy between assistant and teacher were exactly the same with similar percentages for both SiM and not-SiM. Coaches in Math Shack primarily affected the student-centred view. In Math Shack, students learned to see that they themselves had a central role in their learning.

Math Shack helped students' integration with faculty. Students had a chance to communicate and discuss with each other and with coaches who were seen as approachable. Because Math Shack offered both student–student and faculty member–student interactions, it supported both social and academic integration. However, it was difficult to change how students viewed the teaching staff's roles in the lecture form of teaching. One of the main ideas was to offer students more approachable personal and targeted teaching by making the coaches' role closer to that of the students. In a study on how to retain students, Korhonen et al. (2019) recommended some potential means of inhibiting alienation and dropping-out. Based on their findings, alienation and dropping-out could be inhibited by increasing students' participation and belongingness. Thus, they cautiously proposed 'that if one wants to prevent experiences of alienation and support engagement and feelings of belonging, it is necessary to create such educational environments for teaching and learning where it is natural to participate and work together' (Korhonen et al., 2019, p. 12). Our present study results support this assertion.

We were able to verify the validity of this study. The drawings of the views of the roles in the mathematics course, revealed how the roles of assistants and coaches were seen by students. Also, through these drawings, we could see how coaches affected the students' view of assistants. Overall, the drawings together with network analysis are valid way to visualize relationships between groups (Freeman, 2000). In addition, categorization was done by three of the authors with researcher outside the authors. Of course, the reliability of this study would be improved if the data were gathered with several methods.

There are some limitations to this study. In parts of the courses, the lecturer had also been an assistant. More importantly, every course had its own lecturer with specific practices, and lecturers are obviously, individuals which affects students' experiences. In addition, exercise sessions could be different; for instance, there may have been possibilities to do exercises while still in the sessions when assistants circulated around the classroom helping students with the exercises, and coaches likewise could have done this in Math Shack. In Table 1, we can also see that, in Engineering Mathematics A, there were a significant number of sign-ups, while in Engineering Mathematics 123 and Mathematics, there were slightly over a hundred sign-ups. One should also note that only one-fifth of the students in Engineering Mathematics 123 completed the drawing assignment; as mentioned, there was the possibility to return exercises without visiting exercise sessions. Since drawings were collected in the sessions, only those present had an opportunity to submit them, which was an unfortunate misunderstanding. Otherwise, the sample was representative. Overall, the findings merely concerned Finnish engineering students at Tampere University.

In the future, we will continue doing studies considering Math Shack. It will be insightful to determine how Math Shack affects course grades and course passing percentages. Also, it will be interesting to see how encouragers experience Math Shack and if they benefit from it in their own studies. Moreover, Math Shack would be a particularly suitable context for investigating if engineering and teaching identities are conflicting. Furthermore, categorization should also include the concept of how encouragers and teacher's roles are experienced. Although students know they will get precise academic help from lecturers, as Wirtz et al. (2018) emphasized, they seek help only after all other recourses. Thus, if Math Shack can be used for decreasing the distance between students and lecturers, we might ask if there is a need for lectures at all.

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