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Research article

Paired peer tutoring in higher chemistry education: The tutors' experiences of the tutoring

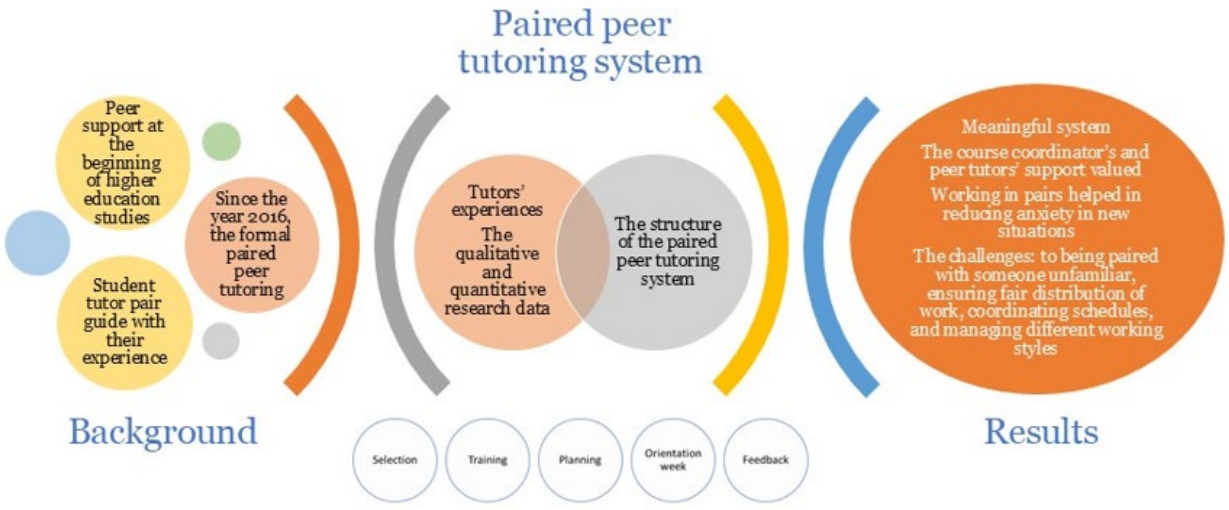
Piia Valto[1] and Piia Nuora[2]

[1] Department of Chemistry, University of Jyväskylä, Finland
[2] Jämsänkoski Comprehensive School, Finland

Abstract: In university education, peer tutoring at the beginning of higher education studies is an important support factor that influences first-year students' overall experience. Since the year 2016, the formal paired peer tutoring in new students' orientation has been used in chemistry education at University of Jyväskylä. In this system, a pair of student tutors guides a group of first-year students, using their own experience to help them overcome the challenges of the first weeks at university. The present study examines tutors' experiences of paired peer tutoring and introduces the structure of the tutoring system. The qualitative and quantitative research data was gathered from 39 tutors using questionnaires from the fall semester 2018 to 2022. Data was analyzed using content analysis and statistical methods. Tutors reported that paired tutoring has been meaningful for them (mean 4,8, a 5-point Likert scale). The course coordinator's and peer tutors' support were valued during the tutoring process. Tutors noted that working in pairs was particularly helpful in reducing anxiety in new situations and in resolving challenging circumstances. The main challenges of paired tutoring were related to being paired with someone unfamiliar, ensuring fair distribution of work, coordinating schedules, and managing different working styles.

Keywords: first-year students, chemistry, paired peer tutoring, higher education

Correspondence: piia.k.valto@jyu.fi



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1 Introduction

Paired peer tutoring is an interesting but relatively little-known research area compared to mentoring. Existing literature on this approach remains limited, particularly within the domain of university-level science education. Furthermore, paired peer tutoring has gained greater importance at research universities following the Covid-19 pandemic. According to Abbot et al. (2018), numerous studies demonstrate the benefits of peer tutoring for students through various roles and practices; however, far fewer studies have asked tutors directly about their experiences (e.g., Skaniakos et al., 2014). Our research focuses on paired peer tutoring in higher education, where tutors were upper-year students. They worked in pairs in the Department of Chemistry, providing mutual support throughout the tutoring process.

In Finnish universities, older students typically support groups of first-year students during the early weeks of their studies (Honkimäki & Tynjälä, 2018). Formal tutoring often includes tutor training, scheduled meeting sessions, and specific matching of tutors to tutees (e.g., Budge, 2006). Tutoring is particularly important at the beginning of first-year studies, as it effectively introduces students to the university's educational culture. In addition, tutoring provides guidance on practical aspects of student life and supports social integration with other students, while simultaneously fostering academic growth.

The transition from school to university is challenging for young people, as it involves many changes (Leidenfrost et al., 2014). Peer tutoring aims to make transition to university as smooth as possible supporting the formation of students' identities. Becoming a member of the academic community is an important process that influences the progression of studies (Wilcox et al., 2005). Many students find the transition to the academic environment challenging, even difficult. Maintaining contact between peer tutors and tutees from the early weeks of study through the later semester is likely to result in successful outcomes by providing support and facilitating the transition (Ghenghesh, 2018).

The Covid-19 pandemic significantly affected students' study processes. Social isolation resulting from distance learning reduced availability of peer support among university students. Both students and teachers had to adjust their counselling and tutoring practices. Many universities used various information and communication technology (ICT)-based orientation methods (De Klerk et al., 2021; Pérez-Jorge et al., 2020). However, ICT based tutoring was not widely used at the University of Jyväskylä. According to Pérez-Jorge et al. (2020) research results, in order to successfully address the diverse needs of the students, it is essential to adapt urgently to these realities. Their research suggests that media and technology can improve the tutoring process. The success of tutoring is particularly important due to the role of peer support. For instance, Sun et al. (2020) emphasize that high levels of perceived peer support are associated with greater positive affect and hope. Van Maaren et al. (2022) have studied the Covid-19´s effects on the effectiveness of distance academic support, focusing on remote tutoring experiences. Their findings indicate that the quality of remote tutoring was comparable to

in-person tutoring. Technology, as well as physical and emotional well-being, did not present major barriers for students. Nevertheless, challenges were observed in areas such as social integration, particularly for first-year students.

Paired peer tutoring in chemistry education at University of Jyväskylä includes collaboration between peer tutor students and tutees in both formal and informal tutor meetings. The peer tutors are senior students within the same field of study. The purpose of this study was to examine tutors' experiences of cooperation with their paired partner within the tutoring system. The research aimed to explore the benefits and challenges associated with paired peer tutoring. For the purposes of this study, peer tutoring in higher education refers to a process in which students tutor other students within the same institution but at a different academic level (see Patton, 2010).

2 Background

2.1 Peer tutoring

Peer tutoring is an old practice. Before, as far as the ancient Greeks, peer tutor was defined as a surrogate teacher where the transmission of knowledge went linearly from teacher to tutor to tutee. Later, peer tutoring evolved into a qualitatively different interaction, no longer limited to the transmission of knowledge from the more able and experienced to the less able (Topping, 1996). They also defined peer tutoring as '*people from similar social groupings who are not professional teachers helping each other to learn and learning themselves by teaching*' (p. 322; e.g., Burgess et al., 2016). According to Thurston et al. (2021), peer tutoring is often referred to as 'tutoring', which is a structured form of peer learning. Peer tutoring involves two students working together in a structured and purposeful manner.

Peer tutoring is a widely used form of guidance during for the early stages of higher education (Kim, 2015; Yale, 2019). It benefits both student tutors and tutees, although the primary purpose is to assist and guide the tutees (Yook & Kim, 2013). Peer tutoring is also an important way for tutees and student tutors to develop their skills and knowledge (Abbot et al., 2018). It can enable a comfortable environment for student peers which can also improve their academic performance (Yook & Kim, 2013). Tutors assist other students by familiarizing them with various campus organizations, such as student support centers. Peer tutoring holds a relatively equal status within higher education, both inside and outside the classroom. It also influences first-year students' study success and overall academic study continuation (Valto & Nuora, 2019).

Abbot et al. (2018) made recommendations on how peer tutors can experience purposeful and successful relationships with students and instructors. According to them, peer tutors appreciate clear expectations about their role. It is important to give tutors opportunities to reflect on their work and to accept some uncertainty and the liminal nature of their position. Both tutors and instructors should recognize that being a tutor is

a learning process. As a conclusion, Abbot et al. (2018) found that tutors value the opportunity to help students through an intermediary role.

Wong & Chapman (2023) have studied student satisfaction and interaction in higher education. Their study provided an in-depth analysis of eight aspects of student satisfaction (such as student support, overall university experience and life as a university student in general). The study suggested that these aspects were associated with the following forms of interaction: 1) formal student-student, 2) informal student-student, and 3) student-instructor. Based on the results, peer tutoring that involves with both formal and informal student-student interaction has a positive effect on student satisfaction. To clarify the meaning of peer tutoring in current study, the term 'peer mentoring' is also introduced and discussed to some extent.

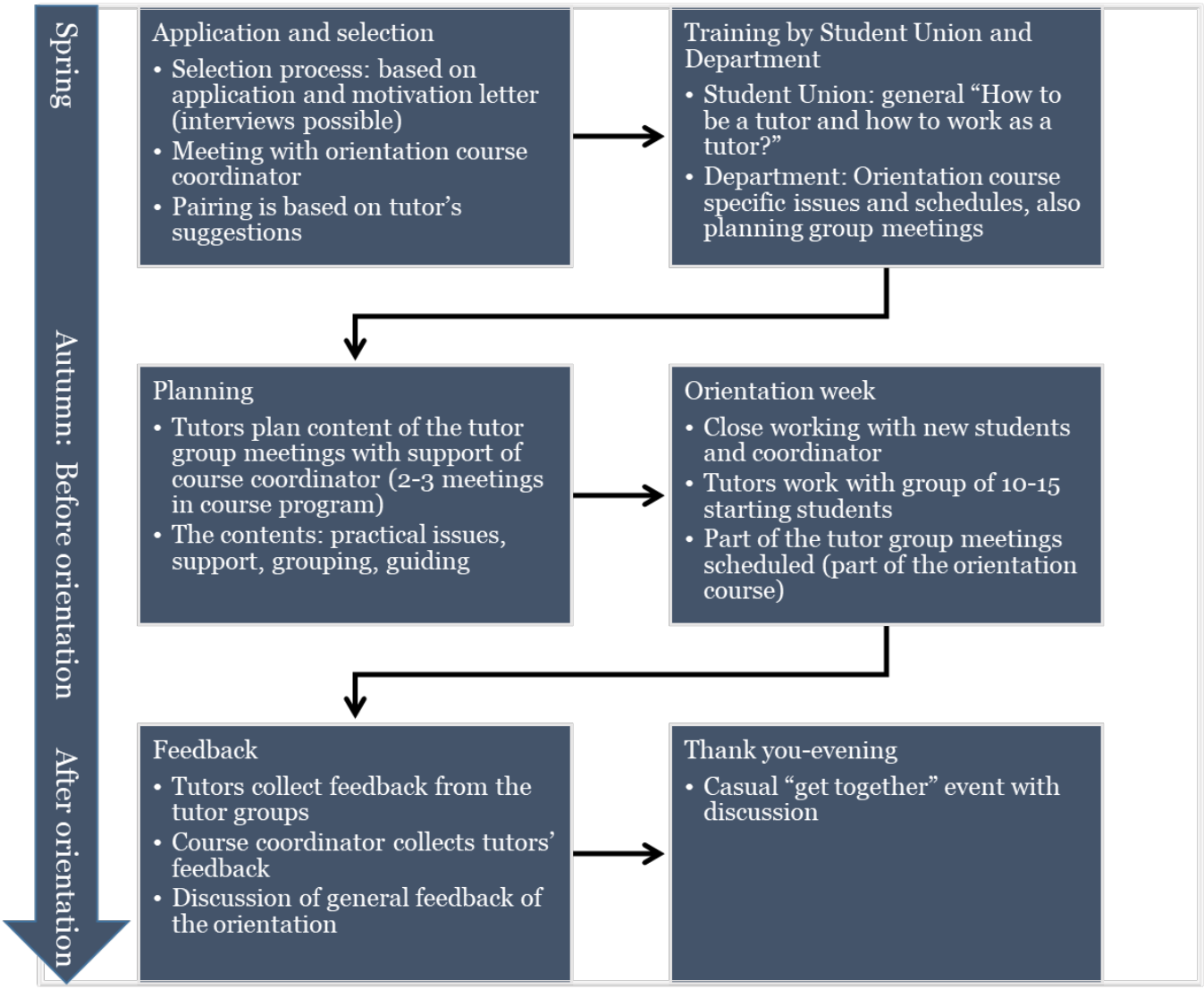
The terms 'peer tutoring', 'peer mentoring' and 'peer coaching' are often used interchangeable because the roles of the tutors can vary depending on their academic position, as these roles are evolving (Kim, 2015). However, in peer tutoring, advanced students typically serve as tutors for less academically prepared tutees, focusing on course content (Colvin & Ashman, 2010). Although peer tutoring often involves more experienced individuals tutoring less experienced peers, it can also occur between students at the same academic level. Tutoring may be described as 'cross-institutional' or 'cross-level' when two institutions are involved (Falchikov, 2003). In the current study, however, tutors and tutees are primarily at different levels within the same field of study.

2.2 The paired peer tutoring system at the Department of Chemistry

The peer tutoring is the most common support system for first-year university students in Finland (Honkimäki & Tynjälä, 2018; Skaniakos et al., 2014). The importance of peer support at the beginning of the studies is evident, and peer tutoring aims to increase study motivation, academic integration and social peer support. Based on our previous research (Valto & Nuora, 2019), peer tutoring in the Department of Chemistry is highly valued by first-year students. Clearly, tutors help first-year students become familiar with both informal and formal aspects of university studying by also introducing them to general student life.

The main features of the paired peer tutoring system are summarised in Figure 1. Tutors (eight/year), who are advanced students in the Department of Chemistry, are selected based on their applications and are trained by both the University and Department. University training (provided by The Student Union of the University) gives tutors general competence to work as tutors while Department training focuses more on practical issues and schedules related to orientation, grouping tutors and tutees, and integrating first-year students into chemistry studies and the department.

Figure 1. Summary of the features of the paired peer tutoring system.



Each first-year student is assigned a peer tutor, and groups of approximately 10–15 first-year students are guided by a tutor pair. Working in pairs provides tutors with greater opportunities to apply different grouping strategies and to provide both advice and peer support. Tutors are also given the option to form pairs themselves.

Tutoring in the Department of Chemistry is closely integrated with the first-year students' orientation course, Appetisers for Beginners (2 ECTS credits) (Valto & Nuora, 2019). The course coordinator also serves as a contact person and provides support throughout the tutoring process. Tutors act as assistant teachers in the orientation course and take part in course events. They receive a small financial reward based on their working hours and can also earn credit points once for tutoring during their studies.

As part of the orientation course, tutors also hold their own tutor groups meetings: 2-3 meetings within the course program and, in addition, other informal meetings with first-year students. The content of the course program meetings is planned by the tutors and depends on the needs of the groups. The course coordinator guides and supports tutors in the planning process. Typically, practical issues, group formation and support in study

planning are the main topics of the tutoring meetings. After the orientation week, tutors also meet their groups regularly later in the autumn to maintain the tutor-tutee-relationship and to ensure the continuity of peer support. Tutoring also provides tutors working-life skills such as experience in planning, scheduling, reporting and evaluating results, which are known to increase the success of the tutoring process (e.g., Skaniakos et al., 2014).

3 Research questions

The purpose of present research was to examine chemistry tutors' experiences of cooperation in a paired peer tutoring system and the relation of these experiences to benefits and potential challenges paired peer tutoring presents to tutors. The study also aims to describe how chemistry students work in pairs as tutors in the Department of Chemistry. Finally, researchers consider how tutoring could be developed in the future, particularly with regard to paired peer tutoring. In more detail, the following research questions were addressed:

What are tutors' experiences of paired peer tutoring?

- What were the benefits of paired peer tutoring?
- What were the challenges of the paired peer tutoring?
- How did tutors distribute the tasks during their tutoring process?
- How did tutors experience the support from their pair and the Department of Chemistry?

4 Methodology

4.1 Research method

A case study approach was adopted for this study. A case study refers to a research method used to gain an in-depth understanding of a real-life phenomenon, taking into account important contextual conditions (Yin, 2009, pp. 18–19). Data collection in case studies is systematic and precise. Defining what constitutes a 'case' can be challenging due to varying perspectives (Patton, 2010, p. 259), which gives the researcher the opportunity to determine its meaning within their own field of study. A case may involve an individual, a group, an institution, or a community (Patton, 2010, p. 259). The focus of this case study was formal paired peer tutoring, examined from the perspective of student.

4.2 Data collection

Survey was chosen as the research method because we aimed to collect data over several consecutive years completely anonymously. This choice was made due to concerns that

the sample size might have been too small for an interview-based study. The survey was tested for functionality and clarity of questions before the start of the study. A questionnaire template was already in use prior to data collection for this research. Before starting this research, data had been collected for the purposes of tutor training and its development. Based on these previously collected data, the questionnaire was further refined for this study, and certain questions were adjusted to improve their functionality. The paired peer tutoring survey consisted of Likert scale statements and open questions.

4.3 Data analysis and quality of the study

The open-ended questions were analysed using content analysis (phase 1) (Patton, 2010). Analysis was guided by knowledge about paired peer tutoring. In the content analysis of the tutors' answers to open questions, qualitative interpretations were structured progressively. In the first phase, the answers were processed and analysed by identifying and listing the words and concepts used. In the second phase, categories were generated to determine the meanings of these concepts. Both authors participated in the content analysis process by independently reading and analyzing the answers, then discussing the results. Any disagreements were resolved through discussion. Finally, the authors arrived at a consensus, which enhances the reliability of the analysis. According to a consensus-based theory of truth, truth can be constructed through agreement (Patton, 2010). To highlight the tutors' own voices, excerpts from their written comments have been included. Respondents are referred to by the survey question number (e.g., Q1) and their respondent number (e.g., T12 for tutor 12). All excerpts were translated from Finnish to English by the authors. Direct quotes retain their colloquial style to preserve authenticity and avoid compromising reliability.

Statistical analysis was used in order to structure the answers from the Likert scale questions (phase 2). All statistical analyses were run using SPSS 27.0 Version. This data was analysed via descriptive statistics including frequency distributions (f), means (M) and standard deviations (SD).

The reliability criteria for content analysis include credibility, transferability, dependability, and confirmability (Tuomi & Sarajärvi, 2018). In this study, credibility was established through a detailed description of the research process. For instance, the analysis categories were illustrated with examples. The research results are also transferable and replicable in other similar contexts. Regarding dependability, all choices made during the research process were documented, and the decisions were justified to enable the reader to follow and evaluate the researchers' conclusions. Confirmability refers to the justification of the decisions and conclusions (Tuomi & Sarajärvi, 2018), which was ensured through a detailed description of the research method. Additionally, confirmability was supported by peer review. The study employed fully anonymous data collection, meaning no personally identifiable information was processed at any stage. This also enhances the reliability of the study from an ethical perspective.

4.4 Participants

This research took place in fall semesters from 2018 to 2022. Responses to the Webropol 3.0 questionnaire (2018) and Microsoft Forms questionnaire (years 2019 to 2022) were anonymous. Webropol 3.0 and Microsoft Forms are internet-based survey solutions. Email invitations were sent to tutors to participate in the online survey. The participants expressed their consent to participate in the study by answering the survey anonymously.

A total of 40 tutors from the Department of Chemistry were invited to participate in the study and the response rate was 97.5%. 20 of the respondents were male students and 19 were female students. From the year 2018 to 2021 there were eight student tutors every year who participated in this study and in the year 2022 there were seven student tutors. Significantly, 53.8% of the respondents (21/39) had previously worked as tutors at the Department of Chemistry and 15 (38.5%) of the respondents were focusing on the chemistry teacher line. The respondents' year of study at the time of tutoring is shown in Table 1. Typically, they had studied two (23.1%), three (30.8%) or four (23.0%) years of chemistry before being selected for the tutoring process.

Table 1. The respondents' year of study at the time of tutoring.

Study years	*f*	Percent (%)
2	9	23.1
3	12	30.8
4	9	23.0
5	6	15.4
6	2	5.1
7	1	2.6
Total	39	100

A further 14 closed questions related to tutors' experience of paired peer tutoring (see Table 2 below) were made via a response with a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=not agree, not disagree, 4=agree, 5=strongly agree). In addition, tutors were asked to answer the following open-ended questions:

1. Describe the benefits of paired peer tutoring.
2. Describe the challenges associated with paired peer tutoring.
3. How did you and your pair organize the division of tasks during tutoring?
4. How did you experience peer support during tutoring meetings?
5. How would you develop tutor training at the Department of Chemistry?

5 Results

During the research period, the structure of the paired peer tutoring process remained unchanged, with only minor adjustments based on annual feedback. In 2020 and 2021, the global Covid-19 pandemic had to be considered, although its impact on the fundamental aspects of paired peer tutoring and its challenges appeared minimal. A separate question addressing the implications of Covid-19 for paired peer tutoring was included in the questionnaire for both years, and the responses are discussed in the Conclusions section. In 2022, this question was removed, as paired peer tutoring had returned to its normal format with face-to-face meetings.

5.1 Open-ended questions (phase 1)

Question 1. Describe the benefits of a paired peer tutoring.

a. Peer support (*f*=34): for example, it helped to resolve challenging situations
   Example responses:

> T23: When working in pairs, tutors complement and support each other. Collaboration makes it easier to plan and implement tutoring activities, and challenging situations feel less demanding when shared.

b. Sharing of information between tutor pairs (*f*=25): includes things like ideas, responsibility, workload
   Example responses:

> T17: One tutor may have more expertise in certain areas than the other, which makes it easier to divide the group into smaller parts—a practice that became particularly important during Covid-19.

c. Informative (*f*=8): includes information shared during orientation course
   Example responses:

> T2: In paired peer tutoring, the guidance provided is comprehensive; first-year students receive a wide range of information about different fields of study, practical matters, events, and other relevant topics.

d. Scheduling (*f*=7): tutor's own schedules are not an obstacle
   Example responses:

> T4: In addition, paired tutoring provides flexibility to schedule meetings according to individual needs, allowing adjustments when important tasks arise.

Tutors felt that the support from their partner as the most significant aspect of paired peer tutoring, and this collaboration also contributed to creating a more relaxed atmosphere during tutoring sessions. Paired peer tutoring provided tutees with more information, as two tutors could offer perspectives on different issues. Tutoring helps orient students to the university's educational culture. Paired peer tutoring introduces practical aspects of student life and supports social integration with other students. In addition, paired peer tutoring offered flexibility in tutors' schedules; for example, if a tutor had academic commitments, they knew that the other tutor could cover the session independently. In 2022, the Covid-19 pandemic did not raise concerns in the tutors' responses, which marked a significant change compared to previous years (cf. Van Maaren et al., 2022).

Question 2. Describe the challenges associated with paired peer tutoring.

a. Chemistry between tutors (*f*=19)

Example responses:

> T4: The greatest challenge may be the forming of pairs. If the chemistry between tutors does not align, collaboration can become difficult. However, this has not been an issue so far. Compatibility between partners, alignment of tutoring styles, and the ability to make compromises are key factors for successful paired tutoring.

b. No challenges (*f*=8)

c. Different working methods (*f*=7)

Example responses:

> T5: I believe the challenges are primarily related to the dynamics between the pair; however, these do not constitute a major problem.

d. Coordinating schedules (*f*=8)

Example responses:

> T7: Challenges arise when one member of the pair is frequently unavailable during the week, which can be particularly problematic with larger groups. Scheduling becomes difficult if one tutor has numerous evening commitments.

e. Equal work distribution (*f*=4)

Example responses:

> T2: In paired tutoring, it is important to avoid stepping on your partner's toes. Ensuring an equitable division of labour is another aspect that requires careful attention.

According to the tutors, the biggest challenges in paired peer tutoring were related to chemistry and interaction between pairs. The no-challenges class is special because there was only one answer in this class between 2018 and 2021. In 2022, all respondents (*N*=7) answered that there were no challenges at all. This might be explained by the background of the tutors. In 2022, five out of seven tutors had previously worked as a tutor, representing 71% of the respondents that year. When this result is compared with the previous years (2018–2021), 17 out of 33 tutors had prior tutoring experience, which accounts for 52% of the entire group of respondents.

Challenges were also mentioned in relation to time management particularly in agreeing on schedules. It is noteworthy that this finding appears to contradict the earlier observation that paired tutoring provided flexibility in tutors' schedules. A few tutors (*f*=4) also reported that ensuring a fair and equal distribution of tasks was challenging.

Question 3. How did you and your pair organize the division of tasks during tutoring?

The tutors (*N*=35) mostly shared the tasks evenly with the pair.

Example responses:

> T3: Things were done quite evenly. At the tutor meeting, the topics to be discussed were divided in half. During the city tour, we split the group in two and both shared information, and so on.

On the other hand, they (*f*=16) also divided tasks according to the situation.

> T1: We didn't plan the division of tasks in advance; instead, we adapted to the situation and gave each other space. Naturally, each of us took the lead on tasks that felt more familiar.
> T33: We worked together, and at times we divided the tasks equally based on what each of us considered important or felt confident doing.

Most tutor pairs distributed their tutoring tasks evenly and in mutual agreement. Tutors generally demonstrated a good understanding of task allocation. However, several responses indicated that tasks were often assigned based on individual expertise; in other words, the tutor most knowledgeable about a subject assumed responsibility for it. This suggests that tutors may have aimed to reduce workload or streamline the supervision process, possibly avoiding challenges when feasible.

Question 4. How did you experience peer support during the tutoring meetings?

a. Meaningful support (*f*=37): it helps to create a spirit of togetherness, it completed the thoughts, encourages, cheer ups.

Examples of responses:

> T2: The pair plays a surprisingly important role in supporting tutoring. When communication flows well between them, it fosters a sense of togetherness.
> T23: Pair support is crucial in a tutoring situation. If one forgets something, the other can help, and vice versa. It also facilitates brainstorming.

b. Eased the excitement (*f*=9):

Example responses:

> T7: You can relax a little, knowing the other person is involved too. In the evening, you can share the day's experiences and feelings and receive peer support from each other.

c. Variably (*f*=1)

Support from the pair in instructional situations was meaningful in most cases. It helped reduce stress and ease the excitement of the new situation. The pair also contributed to creating a sense of community and provided opportunities for mutual support, such as complementing each other's ideas.

Question 5. How would you develop tutor training at the Department of Chemistry?

According to the tutors, there are some aspects of tutor training in the Department of Chemistry that could be improved (*f*=10). For example, tutors suggested that the schedules for the orientation course should be communicated earlier. They also expressed a desire to hear experiences from previous tutors. Additionally, it was considered beneficial to allocate more time for tutors to get to know each other and collaboratively plan tutoring activities. More discussion regarding the tutor pairing process was also requested.

However, the majority of tutors (*f*=27) perceived the tutoring system as a functional and effective package. The system has been actively developed, and currently, selected peer tutors typically include both new tutors and those with prior experience. This approach facilitates a smoother orientation for new tutors, as they can rely on peer support. This may explain why tutors participating in the study view the system as highly functional.

5.2 Likert scale questions (phase 2)

Tutors were asked to respond Likert scale questions related to their experiences with paired peer tutoring. Table 2 presents the means and standard deviations for all variables. Specific results are discussed below.

Table 2. Means (*M*) and standard deviations (*SD*) (a 5-point Likert scale) of the selected questions, (*N*=39), years 2018-2022.

Statement	***M***	***SD***
The Student Union tutor training gave me great tools to work as a tutor.	3.4	0.92
The tutor training of the Department of Chemistry gave me the great excellent tools to work as a tutor.	4.6	0.56
The tutor training of the Department of Chemistry helped me in implementing paired peer tutoring.	4.4	0.76
I would have liked more versatile tutor training.	2.1	0.83
I would rather tutor alone than with a pair.	1.1	0.43
Paired peer tutoring has been meaningful for me.	4.8	0.67
I felt the support from a pair was an important factor.	4.7	0.74
Paired peer tutoring was challenging.	1.7	0.98
In my opinion, the tutorial meetings were very successful.	4.6	0.50
I would like to be a tutor at the Department of Chemistry again next year.	3.8	1.3
I would also like to recommend working as a tutor to my student friends as well.	4.1	0.61
I think tutoring took too much time.	1.9	1.0
Tutees have contacted me too often.	1.4	0.55

When comparing year-to-year differences, only four statements with clear differences in responses were found. Questions were as following:

- The tutor training of the Department of Chemistry helped me in implementing paired peer tutoring.
- I felt the support from a pair was an important factor.
- Paired peer tutoring was challenging.
- I would like to be a tutor at the Department of Chemistry again next year.

Table 3 shows how the means of responses varied from year to year. Based on the results, the appreciation against tutorial training given by the department has increased since the year 2018. Clearly, departments' training helped tutors to implement their pair work by providing the support and guidance they needed.

Table 3. The annual differences of the selected statements between years 2018-2022 (*N*=8 per year, except 2022 (*N*=7), total *N*=39, a 5-point Likert scale).

Statement	Year	2018	2019	2020	2021	2022
The tutor training of the Department of Chemistry helped me in implementing paired peer tutoring.	*M*	4.0	4.4	4.6	4.4	4.6
	SD	1.1	0.52	0.52	0.52	0.79
I felt the support from a pair as an important factor.	*M*	4.9	4.6	4.4	4.9	5.0
	SD	0.35	1.1	0.92	0.35	0.0
Paired peer tutoring was challenging.	*M*	2.0	2.0	1.6	1.1	1.0
	SD	0.93	0.76	1.4	0.35	0.0
I would like to be a tutor at the Department of Chemistry again next year.	*M*	3.5	4.3	3.8	4.5	3.9
	SD	0.93	1.2	1.6	1.1	1.5

Tutors' willingness to work as a tutor again mostly depends on their studies in the next study year. For example, many tutors with chemistry teacher line background will have a teaching internship for the subject teacher line the following year, which will take a lot of time.

The results show that the tutorial training given by the Department is especially meaningful and supports the pair working. At the same time, the statement of the challenge of paired peer tutoring decreased. However, the importance of the support received from the tutor pair decreased significantly (0.5 points) during years 2018 and 2020 but increased to 5.0 (Likert scale) in 2022. This might be due to the Covid-19 situation which highlighted the meaning of pair support again.

6 Discussion and conclusions

This paper focused on tutors' experiences on chemistry paired peer tutoring system. According to Velasco & Stains (2015), it has been established that both tutees and tutors benefit from tutoring sessions. Our interest in this study has focused on tutors' experiences of tutoring and in particular, paired peer tutoring. The existing literature on peer tutoring and peer mentoring is not directly applicable to the context of this study. In general, previous studies have combined peer tutoring with various course settings. In this study, paired peer tutoring was used to introduce new students to the university life and to study chemistry. In addition, the study examined paired peer tutoring in a context for which no related studies have previously been conducted.

Based on the results of this research, paired peer tutoring is a functional system (cf. Colvin & Ashman, 2010). The tutors found working with another pair rewarding because it made their own work easier, among other things, by providing the support they needed in challenging situations (*M*=4.7, *SD*=0.74). In addition, working together made it easier to plan tutoring. They saw paired peer tutoring as a pleasant working method and felt that

the support from a pair was an important thing. Tutors supported each other by sharing the tasks and responsibilities, so tutoring benefits not only tutees but also tutors (e.g., Yook & Kim, 2013; cf. Kim, 2015). Also, they felt that another tutor relaxed the guidance situations by supporting uncertain situations. In paired peer tutoring, the guidance is quite complete as first-year students receive a wide range of information about different fields of study and practical matters. Grouping and planning tutors' own schedules were also seen easier in pairs.

The tutors identified their greatest challenges as collaboration with a previously unfamiliar pair, fair work distribution, coordinating schedules and different working methods. At this point, it was interesting to note the discrepancy in the respondents' answers. Tutors felt that it was easy to plan schedules with another tutor, but on the other hand, it was difficult to make them fit both schedules. In the future, it would be useful to explore how students experience the presence of two tutors. It is also interesting to compare this result with, for example, the findings of Colvin & Ashman (2010). According to their research, all participants reported challenges in maintaining a peer mentor relationship. Although we are now discussing different concepts, tutoring and mentoring can be seen as virtually interchangeable.

During the tutoring process, tutors shared and distributed their task fairly evenly with their pair, but they also divided tasks according to the situation without making specific plans beforehand. According to Abbot et al. (2018), peer tutors face challenges related to inadequate preparation. For example, the relational nature of tutoring creates challenges around role clarity. Wilson & Arendale (2011) reached similar conclusions in their research: role clarity is a significant challenge for peer tutors.

Tutor training provided by the Department of Chemistry was highly valuated (M=4.6, SD=0.56) and its importance, for example in implementing paired peer tutoring remained a good level throughout research period (see Table 3 above). Most of the tutors did not identify any areas for improvement in tutor training and felt that support from the Department was sufficient to guide them through orientation of first-year students. For instance, tutors 'responses indicated that they considered the training versatile enough (see Table 3 above). According to Abbot et al. (2018), peer tutors value clear examples of tutor practices. Thus, while peer tutoring aims to support and guide first-year students in their academic and social integration process, support from academic staff is also essential (cf. Abbot et al., 2018) .Continuous interaction between tutors, the course coordinator, and other academic staff clearly is highly valued in the overall paired peer tutoring process (e.g., Abbot et al., 2018). In conclusion, it is important to note that peer tutors need clarification of roles and training on developing, maintaining, and managing relationships. Furthermore, understanding the expectations of all parties is crucial (Colvin & Ashman, 2010).

The years 2020 and 2021 were exceptional for universities worldwide due to the global Covid-19 pandemic. Overall, the importance of available peer support was emphasized as being crucial for mental health and emotional well-being in general (Sun et al., 2020). At the University of Jyväskylä, the situation was taken into account when organizing teaching

and the main effort was focused on new students' orientation at the beginning of the semester. The main differences in the Department of Chemistry included safety rules, reduced group sizes and limited interaction between tutoring groups. Formal small-groups activities were preferred, and tutors' responsibilities increased due to their role in supporting the wellbeing of first-year students (cf. Wong & Chapman, 2023). However, tutors were relieved that despite the acute Covid-19 situation, the orientation week and its events could be organized in different ways. Safety rules and group size restrictions significantly limited interaction and opportunities to get acquainted between tutoring groups, but despite this, tutors felt that tutoring was organized well. Due to the safety rules, planning tutoring events and moving around the campus required more time. The course coordinator's and peer tutors' support were highlighted during the tutoring process. Support from a pair was especially meaningful during this time, and its importance reflected in the results, showing a 0.5 point (*M*) increase in Likert-scale questions from 2020 to 2021 (see Table 3). It is important to note that the Covid-19 pandemic caused social isolation, which increased the risk that the necessary peer support was not as readily available as before the pandemic. On the other hand, Van Maaren et al. (2022) concluded in their study that the quality of distance tutoring was comparable to face-to-face tutoring. Despite the pandemic situation, the overall structure of the tutoring process could remain the same as before (see Figure 1).

In the future, it would be beneficial for tutors to be supported, for example, by an online version of the tutor's manual. This would assist them in providing guidance, especially in situations where they have to tutor alone. The handbook could also help reduce planning time for tutors, although this was not found to be particularly time-consuming in this study. Alternatively, the research could be implemented more extensively within chemistry departments at other universities, thereby fostering broader scientific collaboration and knowledge exchange.

7 Limitations

The study has some limitations. The lack of control group remains a methodological challenge in this study. Further research is needed to examine the influence or paired peer tutoring in a rigorously controlled setting. Also, this study used a questionnaire to measure the competencies of paired peer tutoring. It would be worthwhile to examine the effect of paired peer tutoring through objective observation of these competencies. Individual interviews would bring in-depth knowledge of this phenomenon. Also, the findings may not be easily generalizable since the data set is too small to empirically represent what may be observed in a larger population. Thus, the study fulfils the function of offering important evidence to complement experiments (Yin, 2009).

Research ethics

Author contributions

P.V.: conceptualization, investigation, methodology, visualization, writing - original draft preparation, writing - review and editing

P.N.: conceptualization, investigation, methodology, validation, writing - original draft preparation, writing - review and editing

Both authors have read and agreed to the published version of the manuscript.

Artificial intelligence

M365Copilot has been used for language checking purposes.

Informed consent statement

The participants participated in the study completely anonymously.

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