Journal of Innovation in Psychology, Education and Didactics
ISSN: 2247-4579, E-ISSN: 2392-7127
http://www.jiped.ub.ro/
Covered in : EBSCO, CEEOL, ProQuest, DOAJ, Scipio,
International Innovative Journal Impact Factor, CiteFactor,
EuroPub database, Open Academic Journals Index, ResearchBib,
Universal Impact Factor
2023, Volume 27, Issue 2, pages: 191-210, doi:10.29081/JIPED.2023.27.2.05

Stepping into the Role of a Teacher – Challenges and Opportunities of Cross-Age Peer Tutoring

Jonas TILLMANN [1]*, Anne-Maria SCHMER [2], Claas WEGNER [3]

Received: 15 September 2023/ Accepted: 25 October 2023/ Published: 03 November 2023

Abstract

This study investigates the challenges and potential of a cross-age peer tutoring program in the satellite laboratories of the teutolab-robotic out-of-school laboratory for the participating tutors based on six guided interviews, which were analysed using Mayring's summarising content analysis. The categorisation focused on the challenges associated with the new role as a teacher, the tutors' self-assessments of their generic competencies, and the potential of the satellite labs to promote these competencies. The results show that the tutors especially perceive challenges in classroom management and their relationship with the younger students and that they respect their work as tutors, particularly at the beginning of the project. Furthermore, they recognise the opportunity to contribute their strengths to the satellite laboratories and the potential of the project to promote weaker skills and abilities.

Key words: Competencies; computer science; content analysis; interviews; peer-tutoring

How to cite: Tillmann, J., Schmer, A.-M., & Wegner, C. (2023). Stepping into the Role of a Teacher – Challenges and Opportunities of Cross-Age Peer Tutoring. *Journal of Innovation in Psychology, Education and Didactics*, 27(2), 191-210. doi:10.29081/JIPED.2023.27.2.05.

[1] PhD Student, Bielefeld University, Bielefeld, Germany, Email: jonas.tillmann@uni-bielefeld.de
[2] M.Ed. Student, Bielefeld University, Bielefeld, Germany, Email: anne-maria.schmer@uni-bielefeld.de
[3] PhD, Professor and lecturer, Bielefeld University, Bielefeld, Germany, Email: claas.wegner@uni-bielefeld.de
* Corresponding author

1. Introduction

The shortage of teachers is a far-reaching problem affecting the education system in North Rhine-Westphalia. In recent years, this shortage of qualified teachers has become increasingly severe and represents a significant challenge for schools, students, and parents (Köller et al., 2023). Particularly in computer science instruction, a patchy and understaffed picture is evident throughout Germany (Schröder et al., 2022). The compulsory nature and availability of computer science instruction at the lower secondary level vary widely among the states in Germany. Currently, there are about 10,000 computer science teachers in the country. More than twice as many teachers would be needed to reach the level of the leading states of Mecklenburg-Western Pomerania and Saxony concerning teaching provision in school computer science (Schröder et al., 2022). The introduction of a compulsory subject in computer science in the 5th and 6th grades in North Rhine-Westphalia will also increase the additional demand in this respect. The teacher shortage in NRW is the product of a combination of factors such as demographic trends and teacher retirements (Köller et al., 2023). Another important aspect is the attractiveness of the teaching profession. High workloads, lack of opportunities for promotion and development, and comparatively low pay contribute to the fact that many graduates from other disciplines do not consider a career as a teacher (Koch, 2023). The shortage of qualified teachers has various implications for the education system in NRW. One of the most obvious consequences is the loss of instructional time; this affects students' progress and can have long-term effects on their education and future opportunities (Köller et al., 2023). In addition, the shortage of teachers leads to an increased workload for the remaining teachers. They often have to work overtime and have less time for individual attention and support for students. This can lead to a deterioration in the quality of teaching and harm teachers' motivation. Comprehensive measures are needed to address the shortage of teachers in NRW. First, it is essential to increase the attraction of the teaching profession and to provide prospective teachers with realistic career ideas. In addition, greater efforts should be made to attract more young people to the teaching profession. This is where peer tutoring can come in and give students a first insight into the work of a teacher so that career aspirations in the teaching profession can be sparked or strengthened.

In peer tutoring, the nature of tutor-tutee interaction differs significantly from teacher-student interaction. Tutors and tutees interact at eye level and are peers. They share socialisation experiences, perspectives and concerns similar to students. In contrast to the hierarchical relationship between teachers and students, the tutor-tutee interaction is based on a friendly relationship. Research shows that this interaction is a two-way give-and-take between learning partners (Fogarty & Wang, 1982). The fact that tutors still need formal training in pedagogy does not necessarily mean that their interaction with tutees is less effective (Korner, 2015). However, Topping (2005) and Cohen (1982) emphasise that structuring tutoring programs is extremely important. According to Topping, results are very good when tutoring is carefully organised, and the method is precisely tailored to the context being addressed. The structuring should consider various aspects such as the content, the materials and methods, the time and space frame, and the selection of tutors. In addition, the hurdles for tutors should be kept low, and the programs should be made attractive. In this sense, the study examines the challenges that peer tutoring poses for tutors as well as the potential of peer tutoring concerning the promotion of interdisciplinary competencies.

In the following, the categories derived from the summary content analysis are first defined and theoretically considered. The focus is mainly on the presentation of the challenges posed by peer tutoring as well as the definition of the generic competencies. These are collected in the context of tutors' self-assessments of their strengths and weaknesses, as the non-cognitive components of competencies cannot be measured sufficiently (Guggemos, 2016). Finally, the qualitative content analysis allows a systematic and rule-guided comparison between the

statements of the tutors and the theoretical assumptions. This comparison and the elaboration of commonalities and differences, facilitates the control of the theory in practical everyday life.

2.

2.1. Cross-Age Peer Tutoring in Satellite Laboratories

The satellite laboratories are (autonomous) branches of the teutolab-robotic out-of-school laboratory, which are carried out at schools. They aim to stimulate the discussion of technical and computer science topics and increase interest (Tillmann & Wegner, 2023b). The hardware and software components of a physical computing platform allow for a connection of different disciplines and offer learners the option to construct, program, and design. The teaching approach used in the satellite labs is cross-age peer tutoring. In this type of cooperative learning, while peers work together, knowledge is imparted through the interaction of tutors and tutees, as well as promoting understanding among the participants (Cockerill et al., 2018). While in cooperative learning, responsibility is shared among the involved stakeholders, in (cross-age) peer tutoring, there is an imbalance between the knowledge of tutors and tutees in a learning unit, which is equalised during that unit with the help of tutors (Ali et al., 2015; Topping et al., 2017). Since tutors are closer in age to tutees compared to teachers, they are more responsive to tutees' needs and expressions. This increases the willingness of the tutees to ask questions and reduces the fear of making mistakes, so that self-confidence and self-assurance increase (ibid.). In addition to the positive effect on the tutees, the tutor's organisational skills, as well as their knowledge and understanding, are strengthened (Tillmann et al., 2021) as they respond to the tutees' questions, resulting in a deeper engagement with the topic, increasing their confidence in their abilities (Moliner & Alegre, 2020; Ali et al., 2015). Through the individualised but trained feedback of the tutors, knowledge building is also achieved and communicated (Topping, 2017; Ali et al., 2015). In addition to the positive effects for the individual participants, general positive effects are attributed to peer tutoring. As a result of increased communication, not only are relationships between peers strengthened, but heterogeneity within groups can be addressed, too (Topping et al., 2017). In addition, teachers present can provide support and contribute to the exchange of experiences in the tutor groups (Topping et al., 2017). For the peer tutoring approach to run smoothly, training in content preparation and classroom management of the tutors is essential (Ali et al., 2015). At teutolab-robotic, tutors are prepared at regular intervals. In the tutor training sessions, skills and abilities for classroom and class management are trained since, in addition to the technical content, sufficient preparation for teaching is also essential (Scharfenberg & Bogner, 2013). Which skills the prospective tutors already bring with them, which skills they consider particularly important in the context of their work, and which skills are promoted by participation in the project will be considered in the context of the study presented here.

2.2. Concept of competence

Over the years, the concept of competence has not shown a unique definition, although it is increasingly used (Maag Merki & Grob, 2003; Röhr-Sendlmeier & Käser, 2017). In the meantime, it has also found its way into schools; educational standards and curricula specify which competencies students acquire in the respective subjects (KMK, 2009; MSB, 2019). Here, the competencies represent skills and abilities that can be learned and are based on knowledge (KMK, 2009). In addition, motivation, social skills, and attitudes should enable one to successfully cope with challenges (ibid.). Weinert (2001) attempted a general definition of competencies. According to this, competencies conclude on abilities and skills that occur in dealing with different circumstances, whereby these are necessary for the achievement of a goal (ibid.). As a result, the inclusion of effects such as motivational or social aspects is omitted. Extending this definition, the acquisition of competencies, according to Klieme (2004), represents

a process whereby the linking of knowledge and skills is placed in the foreground. Regarding educational standards, the ability is based on knowledge (Klieme, 2004; KMK, 2009). While Röhr-Sendlmeier and Käser (2017) take up the aspect of knowledge, which is combined with action to form skills, Maag Merki and Grob (2003) again take up action by defining competencies both as the ability to act in concrete situations and as characteristics of people that are necessary to cope with challenges. Thus, affective traits such as interest are also considered so that competencies in this understanding include human experience and expertise (Röhr-Sendlmeier & Käser, 2017). For a clear definition of competencies in this paper, there should be a balancing of necessary factors, with action being a crucial aspect to measure competencies (ibid.). Nevertheless, the definitions presented have commonalities that allow for further narrowing. On the one hand, competencies serve to deal with challenges and tasks and thus to achieve specific goals. On the other hand, people are attributed based on competencies and possibilities to deal successfully with certain situations. In addition to knowledge, the systematic development of skills is added to the definition. Especially concerning the German Qualifications Framework (DQR), the necessity of integrating skills into the definition becomes visible as competencies are defined underneath (BMBF, 2013).

2.3. Interdisciplinary competences

A clear definition of generic competencies is complex. When considering the change from competencies to generic competencies, it is necessary to examine which prerequisites competencies must fulfil to be considered generic (Rychen, 2003). When switching, it should be noted that generic competencies, on the one hand, are found in variable overarching situations and describe the ability to cope with them, and on the other hand, allow coping in interaction with other individuals, whereby both interaction partners gain an advantage by doing so (Rychen, 2003; Maag Merki & Grob, 2003). For these requirements, in addition to dealing with mentally complex situations, dealing with attitudes is considered (ibid.). While the effects of generic competencies cannot be identified, there is the possibility of developing reference systems as a framework for determining individual competencies (Maag Merki & Grob, 2003). In addition, the need for such a framework becomes apparent when considering the rapid change of the individual components of life, making (generic) competencies necessary to deal with change (CoEU, 2006). Like the classification of subcategories according to Weinert (2001), the German Qualifications Framework (DQR) or European Qualifications Framework attempts to categorise competencies and make them transparent across educational systems (Weinert, 2001; BMBF, 2013). The DQR differentiates between professional competence and personal competence (BMBF, 2013). While professional competence is subdivided into knowledge and skills, which include both the knowledge and the application of these, personal competence describes the ability of one's further development in different contexts (ibid.). The subdivision of personal competence into the subcategories of social competence and independence, as well as their further subdivisions, are visualised in Figure 1.

In the definitions of the individual categories, competencies are equated as abilities attributed to a person (ibid.). More broadly, social competence is considered a function of a social situation in which interaction with fellow human beings takes place. A dutiful and rational interaction with others influences one's environment (ibid.). Social competence can be complemented by interpersonal competence, according to Maag Merki and Grob (2003), as these also assume abilities that include cooperation with others, assumption of responsibility, and communication, which are integrated with the subcategories of team ability and communication.

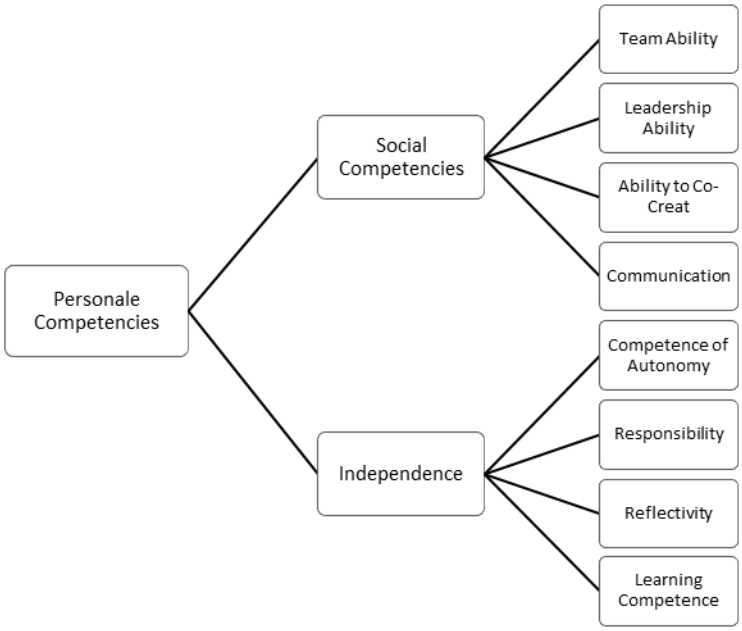

Figure 1: Classification of personal competencies into social competence and independence as well as their subcategories (according to BMBF, 2013).

Team ability refers to an individual's ability to work with other individuals cooperatively toward a common goal. Cooperative working includes a mutual exchange of knowledge in addition to making joint decisions and respectfully incorporating opinions (CoEU, 2006; Rychen, 2003; BMBF, 2013). In addition to the classification of this ability in interpersonal competence, it can also be found in the category of interaction in heterogeneous groups, according to Rychen (2003), whereby the latter assigns the team ability to an individual instead of an entire group (Maag Merki & Grob, 2003; Rychen, 2003). In the Official Journal of the European Union (CoEU) (2006), team ability is not explicitly described. Instead, individual aspects of the above definition are found in competencies such as learning to learn social competence (ibid.). Across the country, this competency is of high importance in the education system, and it is also essential in satellite laboratories. Here, the challenge lies mainly with the tutors in that they must make an agreed-upon lesson progression with different role assignments, and each member must be included and respected (Rychen et al., 2002). Tutees also face such challenges when they take on different roles in cooperative work phases and work toward an expected outcome, requiring them to share their insights and make joint decisions.

Leadership ability is used to describe the ability of an individual to exert an influence on other individuals in a group and thus influence their behaviour. In the group, in addition to dealing with conflicts and their solutions, there is a prioritisation of the central conflict issues as well as the identification of new opportunities (CoEU, 2006; Rychen, 2003; BMBF, 2013). While this ability, according to Rychen (2003), is assigned to interaction in heterogeneous groups, in whose category, among other things, the ability to work in a team also falls, the Council of the European Union sees it as an independent competence (Rychen, 2003). The latter also includes risk-taking, which is less of a challenge in satellite laboratories than dealing with conflicts, such as classroom disruptions, in which tutors must act (CoEU, 2006).

Dealing with different evolving circumstances, both in the cultural context and technology, describes the **ability to co-create**. In addition to being proactive, this ability is attributed to recognising opportunities contributing to co-creating the environment (CoEU, 2006; BMBF,

2013). While the cultural and technological aspects are gathered in this definition, the Council of the European Union (2006) divides it into digital literacy and initiative and social literacy. All aspects together form a crucial challenge in the satellite laboratories because the tutor's initiative requires, in return, the involvement of the tutees in a new environment with teaching students. Tutors are confronted with the integration of their ideas and their distribution of tasks within their groups, whereas tutees are confronted with new methods of teaching.

Communication, as the last subcategory of social competence, describes the ability to exchange information and communicate in native and foreign languages and digital environments such as social networks. The exchange of information always takes place during interaction between individuals so that language is mastered and used according to the situation on the one hand, and information is interpreted and integrated according to the context on the other (CoEU, 2006; BMBF, 2013). While Maag Merki and Grob (2003) classify communication as an immanent component of interpersonal competence, the Council of the European Union (2006) distinguishes between digital, native language, and foreign language competence. Internationally, communication also shows a high value, but native language and communication competence are considered separately (Rychen et al., 2002). In the school environment, communication is crucial and forms a separate (process-related) area of competence, essential for developing other competencies (MSB, 2019). In the context of satellite laboratories, communication presents a particular challenge because tutors must convey information in an age-appropriate manner, while tutees must interpret it. Conversely, tutees must be able to clearly express questions and problems so that tutors can offer appropriate assistance.

Another area of competence in addition to **social competence** is **independence**, which is understood to mean one's ability to act, independence, and reflection on actions (ibid.).
The ability to make independent decisions and to defend one's interests is expressed in the **competence of autonomy** (Rychen, 2003; BMBF, 2013). Decision-making describes both autonomous information gathering with appropriate sources in variable situations and organising own learning processes (CoEU, 2006; Rychen, 2003). The latter enables one to make appropriate decisions in different settings, such as choosing the appropriate amount of a learning unit on the weekend to strike a balance with free time (CoEU, 2006). In addition, this ability expresses, besides one's acceptance, the handling of different feelings (Maag Merki & Grob, 2003). Thus, a consumed judgment by negative feelings will lead to losing autonomy, so dealing with such feelings is crucial. In particular, the organisation of one's learning processes becomes clear concerning the preparations of the tutors, who, in addition to the training days, independently repeat the contents before the respective satellite laboratories.

Furthermore, **responsibility**, as the following subcategory of autonomy, describes one's ability to show a willingness to participate in social activities, which take place due to the assessment of possible risks, in addition to a risk assessment about the environment but also digital media (CoEU, 2006; Maag Merki & Grob, 2003; BMBF, 2013). Risk assessment is particularly evident in digital literacy, where users must question the safety of the Internet and its possibilities (CoEU, 2006). According to Maag Merki and Grob (2003), the competence of responsibility is seen as a component of society-related competencies. Especially according to Rychen (2003), when using tools, responsible and effective handling is needed. While responsibility is a challenge for the tutees in the satellite laboratory since they increasingly work with digital systems and have to assess the risks in the event of deviations, the challenge for the tutors is to check the tutees' systems and assess the consequences of incorrectly assembled components, for example.

Reflectivity describes the ability to take a critical stance about one's thoughts and actions, whereby changes and their effects on one's goals and future are reflected upon and learned from (CoEU, 2006; Rychen, 2003; BMBF, 2013). To ensure reflection, dealing with change is assumed as much as understanding norms (Rychen, 2003; BMBF, 2013). The critical stance is increasingly visible in the Council of the European Union's competence of learning to learn (CoEU, 2006). In

the satellite laboratory, tutors are required to reflect, critique, and learn from the lesson and possibly unplanned situations for the next lesson to facilitate a smooth lesson process.

The last category examined here includes **learning competence**, which describes the ability to engage with the acquisition of competencies (CoEU, 2006; BMBF, 2013). The examination consists of realistic assessments of one's strengths and weaknesses with the respective competence, the development of learning opportunities, and the use of knowledge to achieve goals and improved competencies (ibid.). Due to the learning process, which is constantly progressing, this competence is assigned to lifelong learning (Rychen et al., 2002). While the tutors in the satellite laboratory have a reflective attitude of their competencies in dealing with a group of tutees and their attention, in connection with their role within the satellite labs, they can open further possibilities for increasing competencies. This includes, among other things, concluding the methods used on the learning behaviour of others and the resulting consequences for their handling of the method.

The Satellite Laboratories project works according to the design-based research approach and tries to include as many practitioners as possible in the evaluation process. While previous studies focused on the participating students (Tillmann & Wegner, 2023a, 2023b), the present study focused on the attitudes of the tutors active in the project in the context of an interview study. The analysis of the interview data focuses on the following research questions:

- What challenges do the tutors perceive when teaching within the satellite laboratories?
- How do the tutors rate their competencies in teaching within the satellite laboratories?
- Which competencies do the tutors perceive to be fostered by participating in the satellite laboratories?

3. Methods

3.1. Participants

Students in grade 9 of a secondary school participated in the project. The selection of the students was influenced by legal factors (e.g., signed consent of a parent or guardian) as well as the voluntary nature of the participation. Table 1 provides information about each participant and describes the code for the interview quotes.

Table 1. Participants' gender, age, grade level, and code.

Participant	Gender	Age	Grade	Code
1	F	15	9	P1F15
2	M	14	9	P2M14
3	F	15	9	P3F15
4	M	15	9	P4M15
5	F	14	9	P5F14
6	M	15	9	P6M15

Data Collection

As part of this survey, guided interviews were conducted with six students in April 2022. All interviews took place in a private room at school with the same interviewer to ensure comparability. Interviews were recorded as *.mp3 files using the Olympus LS-14 recorder and

lasted between 23 and 28 minutes. The interviews were then anonymised using the MAXQDA program and transcribed according to the standards described by Rädiker and Kuckartz (2019). The transcripts were analysed using qualitative content analysis by two independent coders by Mayring (2015). The summary method was used, as it compresses the transcripts to the essential statements, and categories are formed inductively on the material. For this purpose, Mayring (2015) describes three macro-operations: Paraphrasing, generalisation, and category formation. To test the quality of the analysis, the intercoder reliability of the two independent coders was calculated at the segment level. The percentage of the overlapping area of two coders was used as a criterion. The calculation of the intercoder reliability at a 75% agreement resulted in $\kappa = 0.77$. According to Landis and Koch (1977), this can be considered a substantial agreement.

4. Results

Summary content analysis aims to systematically work through and analyse text documents to capture important information. In several condensation steps, the statements are condensed, and categories are inductively formed. This finally results in a category system or the coding guide with the naming of the main and subcategories. The results of the summary content analysis are described in Table 2.

Table 2. Result of the summary content analysis with presentation of the central and subcategories as well as the frequency of the code assignments.

Main Categories	Subcategories		Code
Motives (K1)	Commitment (Certification)	(n = 2)	K1.1
	Interest (Vocational)	(n = 5)	K1.2
	Interest (Technical)	(n = 10)	K1.3
	Role change	(n = 8)	K1.4
	Teaching Teams	(n = 2)	K1.5
	Knowledge transfer	(n = 8)	K1.6
Challenges (K2)	Classroom-Management	(n = 18)	K2.1
	Expertise	(n = 6)	K2.2
	Group size	(n = 3)	K2.3
	Tutor-Student-relationship	(n = 9)	K2.4
	Nervousness	(n = 12)	K2.5
	Knowledge of participants	(n = 6)	K2.6
	Expenditure of time	(n = 7)	K2.7
Tutor Skills Social Competences (K3)	Empathy	(n = 2)	K3.1
	Leadership Ability	(n = 2)	K3.2
	Communication	(n = 5)	K3.3
	Presentation competence	(n = 5)	K3.4
	Team Ability	(n = 6)	K3.5
	Tolerance	(n = 4)	K3.6
Tutor Skills Independence (K4)	Resilience	(n = 2)	K4.1
	Technical Knowledge	(n = 3)	K4.2
	Creativity	(n = 2)	K4.3
	Organisation	(n = 4)	K4.4

	Knowledge transfer	(n = 7)	K4.5
Promotion of competencies (K5)	Resilience	(n = 1)	K5.1
	Decision-making ability	(n = 4)	K5.2
	Technical Knowledge	(n = 2)	K5.3
	Critical faculties	(n = 2)	K5.4
	Presentation competence	(n = 1)	K5.5
	Team Ability	(n = 4)	K5.6

The analysis of the data material inductively resulted in the main categories of motives, challenges, social competencies of the tutors, independence of the tutors, and promotion of competencies. The main categories were subdivided into subcategories, e.g., the main category challenges were subdivided into the subcategories classroom management, expertise, group size, tutor-student-relationship, nervousness, knowledge of the participants, and time expenditure. Table 3 shows an example of the creation of a subcategory using the tutor-student relationship as an example. Paraphrasing refers to the rephrasing of text statements to make them more precise and more concise. This allows the content to be presented more understandably and avoids unnecessary redundancy. In summarising, long passages are often paraphrased to streamline the text and focus on the essentials.

Table 3. Paraphrasing of interview statements on the subcategory tutor-student relationship.

Category	Subcategory	Quote	Paraphrase
Challenges	tutor-student relationship	"[...] I sometimes had the fear that you would not get along with the fifth graders, so to speak, that you would then come across as not so exciting or not so good a teacher, [...]" (P1F15, Pos. 25)	**P1F15:** How do I get through to the students?
		"[…]We didn't have much respect, so we were a bit annoyed when no one listened and so on." (P2M14, Pos. 38)	**P2M14:** Different types of students
		"[…]Some of the students there just didn't listen to you at all and answered very, I'll say // okay, maybe insulting would be too much to say, but very sarcastically and so on. […]" (P2M14, Pos. 38)	**P2M14:** Partially challenging students
		"At first, I found it a bit (.) difficult to understand somehow (.) how we should relate to the fifth graders. Or how we should deal with them, […]" (P3F15, Pos. 26)	**P3F15:** Relationship between tutors and tutees not clear at the beginning
		"[…]So first you had to get to know the pupils and (.) but you already noticed in the first lesson that there were some (.) troublemakers." (P4M15, Pos. 24)	**P4M15:** Different types of students
		"[…]especially because you're not much older than, um, the fifth graders, so it's not so teacher-student-like, […]" (P5F14, Pos. 16)	**P5F14:** Do the pupils perceive me as a teacher, even if I am not much older?
		"[…]And I was especially also, um, a little worried, c// also a little worried about how the fifth graders might find me or perceive me." (P6M15, Pos. 20)	**P6M15:** How do I get through to the students?
		"[…]And um, then there's this, because I'm not an adult, I don't have the same authority for them as a (.) teacher. […]" (P6M15, Pos. 22)	**P6M15:** Do the pupils perceive me as a teacher, even if I am not much older?

5. Discussion

In the following, the categories found and statements of the tutors will be discussed concerning the formulated questions and the theoretical explanations concerning the generic competencies.

What challenges do the tutors perceive when teaching within the satellite labs?

The tutors perceived challenges on three levels. On the one hand, this concerned their abilities and skills and, on the other hand, those of the participating students. In addition, the tutors considered the interaction with the students and the relationship with the students in the satellite lab.

Regarding their abilities and skills, one tutor feared: "that I myself will not understand this and will not be able to explain this to the fifth graders" (P3F15, Pos. 20). In addition, the statement indicated nervousness before the first lessons, which was cited by other tutors in the interviews:

> **P5F14:** […] That's why I was definitely excited and nervous too.
>
> (P5F14, Pos. 16)

> **P4M15:** So first of all, it was a bit exciting, and I was very nervous.
>
> (P4M15, Pos. 24)

The tutors also wondered how time-consuming participation in the project would be, "I also wondered at the beginning whether it would take up so (.) much time" (P3F15, Pos. 18). A structured preparation and training concept for the tutors is therefore of particular importance (Ali et al., 2015) and is also explicitly called for by some authors (Fogarty & Wang, 1982; Robinson et al., 2005). In the preparation of the satellite laboratories (Tillmann et al., 2021), the tutors were prepared for the lessons in terms of content, "[n]aturally, we first dealt with the material ourselves and did these tasks that the fifth graders did later" (P3F15, Pos. 70), and their technical and pedagogical knowledge was trained, "we also talked about the lessons, i.e. how to deal with the fifth graders" (P3F15, Pos. 70). In this context, it was also about how specific contents could be conveyed to the pupils using the technical equipment. Overall, the tutors feel sufficiently prepared by the training days so far:

> **P3F15:** So I actually think (.) we were taught everything very well.
>
> (P3F15, Pos. 68)
>
> **P4M15:** But otherwise, I thought it was actually quite good, even the worksheets were, um, very well structured and the presentation led you (.) super through the lessons.
>
> (P4M15, Pos. 68)

However, the tutors stated that they needed more intensive training in dealing with the younger pupils:

> **I:** Um (.) What would you have to be taught so that everything works even better?
>
> **P2M14:** (in.) Sounds or works even (in.) //
>
> **I:** Works (in.). Works even better.

> **P2M14:** So what you could perhaps do more intensively is things like communication skills or similar things. [...] But maybe, even more, something like, um, how you can deal directly with the pupils or so (.) in this area so that it would work even better.
>
> (P2M14, Pos. 77-80)

This desire for support was also expressed in other statements made by the tutors about taking on the role of teacher. In addition to the concern about the tutor's effect on the students and his or her ability to convey the lessons in an exciting way (cf. P1F15, Pos. 25), for some tutors the challenge was to gain the attention of the students - "to make oneself heard when the class is not paying attention" (P5F14, Pos. 20) - and to take the lead in the lessons - "Then (.) um, to teach there as well, that is not always easy. And also (.) um, (to say) then to take the lead in the lessons" (P4M15, Pos. 8). This showed that the tutors first had to grow into their new role as teachers. Teaching was a new experience for the tutors, in which they were tested by the younger pupils, who tested their limits and observed and evaluated the reactions of the tutors (Tillmann & Wegner, 2023a).

To overcome these challenges, tutors need a permanent on-site contact person (Topping et al., 2017). In addition to supporting the tutors under challenging situations or organising the satellite labs at the respective project schools, they can act as external experts and intervene in conveying or consolidating misconceptions (Ding & Harskamp, 2011) and support the tutors in cases of uncertainty. In the interviews, one tutor said that she lacked certainty as to whether all students understood what she had explained:

> **P5F14:** It is, um, difficult to assess, um, whether you have explained something enough, for example, um, or so, whether everyone has understood it or whether you have to explain it again or how much you have to do on a specific topic. (P5F14, Pos. 26)

In this context, the tutors mentioned difficulties due to the lack of (prior) knowledge of the students, but also the communication of knowledge in the "language of the other person". It could have been clearer to the tutors what knowledge they presupposed from the students or what knowledge they could build on.

Table 4. Interview statements on difficulties regarding (pre-)knowledge and knowledge transfer

(Prior) knowledge of the younger students	**Transfer of knowledge to younger students**
“Um, another fear was that, um, they might not understand directly or (.) some need more help than others." (P4M15, Pos. 26)	„[…],that you have to know somehow how (.) how to explain it in their world“ (P2M14, Pos. 54)
“Well (.) fifth graders don't have the same understanding as (.) I do now, for example." (P6M15, Pos. 24)	"That you can convey it to the other person's world, so to speak […]“ (P2M14, Pos. 60)

Communication between tutors and tutees is a crucial factor for successful cross-age peer tutoring (Tillmann & Wegner, 2023a) and should be trained in advance if possible (Ding & Harskamp, 2011). Galbraith and Winterbottom (2011) suggest that some tutors in their study reflected on their learning process to set appropriate understanding anchors for the tutees and help them find the answer without telling them.

How do the tutors rate their competencies in teaching within the satellite laboratories?

During the interviews, the tutors were first asked which skills and abilities they consider to be particularly important when it comes to guiding a group of pupils or children and young people. The central skill they identified was imparting knowledge or explaining:

> **I:** And if you had to single out the most important skill of all, what would it be?
> **P2M14:** Explaining.
> **I:** Okay (.) Why?
> **P2M14:** Because, as I said, um, it is simply this ability or these characteristics, a piece of information (..) that is perhaps somehow packaged in a way that I don't directly (understand) // um, others would understand [...] That you convey this in such a way, quasi into the world of the other, [...] So that you make it accessible for them, so that they can then build on it, um, further things. That's why I would say that explaining is the most important thing.
>
> (P2M14, Pos. 57-60)

In another interview study with tutees (Tillmann & Wegner, 2023a), the quality of the tutors' explanations was assessed very differently. While some students stated that the tutor's explanations were entirely accurate, others thought that the explanations could be even better. They also stated that the tutors did not digress from the topic but got more to the point than the regular teachers. The other statements regarding essential skills can be assigned to the following areas:

Table 5. Interview statements about essential skills and abilities of teachers and tutors.

Social Competencies	Team Ability	”And (...) you should definitely be able to work in a team, especially when you have to clarify who does what and who helps whom and so on" (P3F15, Pos. 44)
		“Um, what is also important is that you are cooperative with the pupils, that you don't say, um, you do it now and leave me alone with it. But that you really, um, help them when they need help" (P6M15, Pos. 50)
	Communication	“[…]The most important thing is to be able to explain somehow or other. That you can, yes, roughly, I would say, present something without having to interrupt all the time or something like that. (.) Yes, that is definitely very important. Then also (.) not only being able to explain yourself but also to understand what the children might mean or something. I would say to put yourself in their shoes" (P2M14, Pos. 44)
		“Um, in any case, um, about // in any case, expressiveness. You have to be able to express yourself well and not somehow mumble or something. You have to be able to speak out loud” (P4M15, Pos. 36)

Independence	competence of autonomy	"You should be organised [laughs]. You should be able to prepare (I: Why?) well, um, because you have to prepare the lessons and if you don't do that, you have problems. Um, I also noticed that" (P1F15, Pos. 57) "Um, also that you (...) just have to have a good, I don't know what it's called, well, that you time the lessons in such a way that you get on and that you don't get lost in it [...], that you just (...) continue the lessons in such a way that everyone understands it at the end and that you keep to the schedule" (P5F14, Pos. 34)

These are also characteristics that Hattie (2009) characterises as significant in his meta-study about the influence of the teacher on the learning success of the students and attributes great effect strengths to them. The three most substantial influencing factors are described as micro-teaching, teacher clarity, and the teacher-student relationship. Following the Hattie study, the popular science magazine sofatutor-magazin asked 1530 teachers in November 2017 what they thought makes a good teacher. The conclusion was:

> *"A good teacher is always prepared and structured and knows whether to react with severity or humour in every situation. However, he or she also regularly questions him- or herself and asks for student feedback. In addition, a good teacher always communicates clearly, is empathetic and is perceived by students as a confidant, [...]"* (translated by Sofatutor magazine teachers, 2023)

In addition to the factors mentioned above, reflexivity and learning competence are two further characteristics that are also important in the satellite labs. The tutors sometimes have to deal with very variable conditions in the organisational framework of the school – "[...] the PC or something was defective or the beamer was newly installed" (P4M15, Pos. 50) - and had to master the teaching challenges - "Some students just didn't listen to you at all" (P2M14, Pos. 38) –, they are called upon in the tutor training sessions to reflect on demanding situations and to develop joint approaches to solutions. This requires, on the one hand, an objective assessment of teaching situations, which is difficult for most tutors but can be supported by outside observations, and, on the other hand, realistic assessments of their strengths and weaknesses. This reflexive attitude was also required in the interviews, as the tutors were asked to assess their abilities concerning teaching a group of students in the satellite lab. For this purpose, the tutors were able to select two skills from a series of cards in which they saw their strengths and weaknesses.

Table 6. Interview statements on the tutors' strengths and the benefits of the activity in the satellite laboratory.

Stärken	Nutzen für die Arbeit als Tutor:in
Creativity	"Creativity, um, I think that is important because we have to (.) design the lessons creatively// creatively, so that it is most exciting for fifth graders, because I think fifth graders need that (.) um so that they can concentrate and also pay attention." (P1F15, Pos. 79)

	"So maybe a little bit of lesson planning and so on, you can be a little more creative sometimes. But (.) otherwise (.) I wouldn't say that it had a big influence on the preparation for the lessons" (P3F15, Pos. 64)
Independence	"[…]on preparing for the lessons. Um, first of all, you could prepare yourself all by yourself, or is it easier for me to prepare myself? And also in the lessons, it was, um, sometimes easier to work independently// independently." (P4M15, Pos. 62) "So the independent work, as I said, especially in the preparation, because in the labs themselves // actually teamwork is always needed and that's why (.) there is just not so much needed. (P5F14, Pos. 48)
Team Ability	"So teamwork in any case, because you are a team of student lecturers [...]. Um, because you should be able to (..) integrate (..) all opinions (..) have to (..). [...] So who introduces it, who introduces it, who wants to do what, and so on. And also divided up, i.e. the pupils (.) if there were questions, for example, one took care of it, the other took care of it" (P1F15, Pos. 79) "Being a team player definitely helped me. So (.) I was also able to get along better with the other student lecturers, I think. And I think it also worked quite well with the fifth graders, yes" (P3F15, Pos. 62)

The statements reflect individual strengths, which the tutors relate to their work as teachers in the satellite lab. Commonalities between the desired/demanded skills and the self-assessed strengths of the tutors are already apparent. The tutors see weaknesses particularly in presentation skills (cf. P1F15, Pos. 67; P3F15, Pos. 54), decision-making skills (cf. P2M14, Pos. 64; P4M15, Pos. 49) and critical faculties (cf. P2M14, Pos. 64; P6M15, Pos. 64). However, they also recognise the potential of the satellite laboratories to promote as well as strengthen these abilities.

> **I:** […] Um, do you think you can, um, in the Sattelor// um, satellite labs, so do you have the opportunity to, um, improve the skills, and if so, how?
> **P5F14:** So I think, yes, definitely. Um, first of all, because they are simply challenged there, and if you need them and use them, they probably get better and better overall.
>
> (P5F14, Pos. 39-40)

In their study of peer tutoring in higher education, De Smet and colleagues (2008) characterised three types of tutors - motivators, informers, and knowledge constructors - using cluster analysis, with individual tutors' skills reflected in the types. In addition, they note that tutees' behaviour depends on the tutor and reflects the tutor's preferred style.

Which competencies do the tutors perceive to be fostered by participating in the satellite laboratories?

For the tutors, the satellite laboratories represent an offer outside their everyday life (cf. P5F14, Pos. 40). Acting as a tutor requires different skills and abilities, which, according to the tutors, can be improved through regular use:

> **P3F15:** It gets better the more often you do it, so to speak. (P3F15, Pos. 58)

Within the framework of the training days, the tutors acquire (new) specialist knowledge and establish links to different subject areas (cf. P2M14, Pos. 74; P3M15, Pos. 58). Topping (2005) confirms that peer tutoring programs lead to an increase in academic performance in the targeted subject areas if they are organised appropriately. Finally, in satellite labs, age-appropriate content delivery to younger students ensures a deeper understanding and more sustained learning (Zinn, 2008). To implement the lessons, the tutors deal more intensively with the subject matter and the learning content to make it accessible to the students (Tillmann et al., 2021). About the organisation of their own learning and preparation processes for the lessons as well as the structuring of the actual lessons, the independence – "In lessons, when you, um, have to know [...] when to go on with the (.) teaching, with a question or something" (P5F14, Pos. 42) - and decision-making ability – "in the satellite laboratory you have to make many decisions, for example also at short notice" (P4M15, Pos. 50) – of the tutors is also promoted. Furthermore, the training promotes the ability to reflect as the tutors become aware of their actions and critically question them. This ultimately leads to moments of realisation, with one tutor noting that "(it) [e.g., disrupting lessons, not listening, JT] is not only the smaller ones who do it but also oneself" (P2M14, Pos. 66). This also strengthens their critical faculties, as the tutors give each other feedback - "because we always helped each other out with what we could do better and so on" (P1F15, Pos. 85) – and discuss situations from the lesson together and with guidance. From this, the tutors derive alternative courses of action for concrete teaching situations, returning them to the satellite laboratories.

Even though tutoring programs were initially conceived to improve the skills of the tutees (Kroner, 2015), Topping (2005) states that tutors and tutees can benefit from the programs. It is already known from some studies that tutors benefit more (Fogarty & Wang, 1982; Robinson et al., 2005; Topping, 1996). Social and communicative skills and affective functions are addressed (Cohen et al., 1982; Rohrbeck et al., 2003). In the interviews, the tutors expressed the influence of their work in the satellite laboratory on the following areas in particular:

1. Presentation Competencies

> **P1F15:** So you have learned how to make it more exciting, and you can simply apply it. And what you yourself find (..) exciting or successful in your presentation, you also apply yourself. (P1F15, Pos. 75)
>
> **P3F15:** I do believe that the fact that we now (..) hold lessons almost every Friday [...] (...) already brings something. So, after a while, you realise that you don't always have to make presentations so complicated and that if you get to grips with it well enough, it's actually relatively simple.
>
> (P3F15, Pos. 58)

2. Cooperation capability

> **P3F15:** Because you not only have to be prepared to learn these things that you have to learn in (..)half of computer science, but you also have to learn how to deal with the students (P3F15, Pos. 52)
>
> **P3F15:** And (..) yes (..) maybe also still a bit of dealing with the fifth graders. Well, I mean, somehow you're still learning (..) so yes.
>
> (P3F15, Pos. 54)

3. Team Ability

> **P1F15:** The ability to work in a team because you have to agree and [...] not have to keep an eye on everything, but because you have to be aware that you are not alone.
>
> (P1F15, Pos. 85)

> **P4M15:** Yes, in any case, because until now, we had always done it in such a way that each of us took over a part of the lesson. Um, maybe we could, um, do it in such a way that we work together more, so that not, um, while one of us is talking at the front, the others are sitting next to them.
>
> (P4M15, Pos. 52)

6. Limitations and implications

The interview study examined cross-age peer tutoring in the fixed setting of satellite labs with a small sample of tutors. It is, therefore, difficult to make generalised statements that apply to all settings, which is different from the aim of the study as qualitative research. Instead, it can be seen as an individual case analysis of the development of the tutors involved in the project. In their role as tutors, the students adopt a reflective attitude towards their abilities and skills and recognise individual opportunities to use their strengths profitably as well as to promote their weaknesses through participation in the project. The results presented here confirm the statements of the pilot study conducted by Tillmann and colleagues (2021), in which prospective tutors were asked what increase in skills and abilities they expected through participation and whether participation would influence their future school or professional decisions. Furthermore, it confirms the potentials of peer tutoring, which are already known from other subject contexts (e.g., biology (Galbraith & Winterbottom, 2011); chemistry (Ding & Harskamp, 2010); mathematics (Topping et al., 2003); physics (Zinn, 2008)) and underlines that tutors can act, even in content areas that are entirely new to them, if they are sufficiently prepared in advance.

Furthermore, the challenge remains to objectively measure the interdisciplinary competencies of the participants. Guggemos (2016) clarifies that non-cognitive components of competencies can still be measured inadequately and are, therefore often, as in the context of this interview study, assessed with the help of self-assessments. Finally, there was evidence from the interviews that cross-age peer tutoring promoted the tutors' metacognition, as many thought about how they could support the tutees' learning and teach content in the tutees' world. It would also be exciting, following De Smet et al. (2008), to examine whether the tutors in this project could be categorised as having a particular tutoring style, or developed a particular tutoring style when accompanying the interaction and learning processes in the satellite labs. These areas could provide exciting approaches for further research.

References

Ali, N., Anwer, M., & Jaffar, A. (2015). Impact of Peer Tutoring on Learning of Students. *Journal for Studies in Management and Planning, 1(2),* 61-66.

Bundesministerium für Bildung und Forschung (2013). *Handbuch zum Deutschen Qualifikationsrahmen: Struktur - Zuordnung - Verfahren - Zuständigkeit*. https://www.dqr.de/dqr/shareddocs/downloads/media/content/dqr_handbuch_01_08_2013.pdf?__blob=publicationFile&v=2.

Cockerill, M., Craig, N., & Thurston, A. (2018). Teacher Perceptions of the Impact of Peer Learning in Their Classrooms: Using Social Interdependence Theory as a Model for Data Analysis and Presentation. *International Journal of Education and Practice*, *6*(1), 14–27.

Cohen, P. A., Kulik, J. A., & Kulik, C.-L. C. (1982). Educational Outcomes of Tutoring: A Meta-analysis of Findings. *American Educational Research Journal*, *19*(2), 237–248. https://doi.org/10.3102/00028312019002237

Council of the European Union (2018). Council Recommendation of 22 May 2018 on key competences for lifelong learning Text with EEA relevance. *Official Journal of the European Union*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0604(01)

De Smet, M., van Keer, H., & Valcke, M. (2008). Blending asynchronous discussion groups and peer tutoring in higher education: An exploratory study of online peer tutoring behaviour. *Computers & Education*, *50*(1), 207–223. https://doi.org/10.1016/j.compedu.2006.05.001.

Ding, N., & Harskamp, E. G. (2011). Collaboration and Peer Tutoring in Chemistry Laboratory Education. *International Journal of Science Education*, *33*(6), 839–863. https://doi.org/10.1080/09500693.2010.498842

Fogarty, J. L., & Wang, M. C. (1982). An Investigation of the Cross-Age Peer Tutoring Process: Some Implications for Instructional Design and Motivation. *The Elementary School Journal*, *82*(5), 451–469. https://doi.org/10.1086/461281

Galbraith, J., & Winterbottom, M. (2011). Peer-tutoring: what's in it for the tutor? *Educational Studies*, *37*(3), 321–332. https://doi.org/10.1080/03055698.2010.506330

Guggemos, J. *Modellierung und Messung von Kompetenz im externen Rechnungswesen* [Dissertation, Verlag Dr. Hut]. GBV Gemeinsamer Bibliotheksverbund.

Hattie, J. (2010). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement* (Reprinted.). Routledge.

Jambunathan, S., Jayaraman, J. D., Jayaraman, A., & Jayaraman, K. (2021). Is peer-led discovery based learning effective in promoting leadership skills among middle school children? Evidence from India. *Education 3-13*, *49*(4), 422–432. https://doi.org/10.1080/03004279.2020.1733041.

Klieme, E. (2004). Was sind Kompetenzen und wie lassen sie sich messen, *6*, 10–13.

Koch, M. (2023, 6. März). *Bildungsnotstand: Warum immer mehr Lehrkräfte in NRW aussteigen*. https://www1.wdr.de/nachrichten/landespolitik/bildungsnotstand-lehrkraefte-ueberlastung-100.html.

Köller, O., Thiel, F., van Ackeren-Mindl, I., Anders, Y., Becker-Mrotzek, M., Cress, U., Diehl, C., Kleickmann, T., Lütje-Klose, B., Prediger, S., Seeber, S., Ziegler, B., Kuper, H., Stanat, P., Maaz, K., & Lewalter, D. (2023). *Empfehlungen zum Umgang mit dem akuten Lehrkräftemangel. Stellungnahme der Ständigen Wissenschaftlichen Kommission der Kultusministerkonferenz*. SWK : Bonn. https://doi.org/10.25656/01:26372.

Korner, M. (2015). *Cross-Age Peer Tutoring in Physik: Evaluation Einer Unterrichtsmethode*. *Studien Zum Physik- und Chemielernen Ser: v.186*. Logos Verlag Berlin.

Kuckartz, U., Dresing, T., Rädiker, S., & Stefer, C. (2008). *Qualitative Evaluation: Der Einstieg in die Praxis* (2., aktualisierte Auflage). VS Verlag für Sozialwissenschaften / GWV Fachverlage GmbH Wiesbaden. https://doi.org/10.1007/978-3-531-91083-3.

Landis, J. R., & Koch, G. G. (1977). The Measurement of Observer Agreement for Categorical Data. *Biometrics*, *33*(1), 159. https://doi.org/10.2307/2529310.

Maag Merki, K., & Grob, U. (2003). Überfachliche Kompetenzen. Zur Validierung eines Indikatorensystems. *Empirische Pädagogik*, *17*(2), 123–147.

Mayring, P. (2010). Qualitative Inhaltsanalyse. In G. Mey & K. Mruck (Eds.), *Handbuch Qualitative Forschung in der Psychologie* (pp. 601–613). VS Verlag für Sozialwissenschaften / Springer Fachmedien Wiesbaden GmbH, Wiesbaden.

Mayring, P. (2015). *Qualitative Inhaltsanalyse: Grundlagen und Techniken* (12., überarb. Aufl.). *Beltz Pädagogik*. Beltz.

Mey, G., & Mruck, K. (Eds.). (2010). *Handbuch Qualitative Forschung in der Psychologie*. VS Verlag für Sozialwissenschaften / Springer Fachmedien Wiesbaden GmbH, Wiesbaden. https://doi.org/10.1007/978-3-531-92052-8.

Ministerium für Schule und Weiterbildung des Landes Nordrhein-Westfalen (MSB NRW) (2019). Kernlehrplan für die Sekundarstufe I Gymnasium in Nordrhein-Westfalen Biologie. https://www.schulentwicklung.nrw.de/lehrplaene/lehrplan/197/g9_bi_klp_%203413_2019_06_23.pdf.

Moliner, L., & Alegre, F. (2020). Effects of peer tutoring on middle school students' mathematics self-concepts. *PLoS ONE*, *15*(4). https://doi.org/10.1371/journal.pone.0231410.

Nawaz, A., & Rehman, Z. (2017). Strategy of Peer Tutoring and Students Success in Mathematics: An Analysis. *Journal of Research and Reflections in Education, 11*(1), 15-30.

Robinson, D. R., Schofield, J. W., & Steers-Wentzell1, K. L. (2005). Peer and Cross-Age Tutoring in Math: Outcomes and Their Design Implications. *Educational Psychology Review*, *17*(4), 327–362. https://doi.org/10.1007/s10648-005-8137-2.

Rohrbeck, C. A., Ginsburg-Block, M. D., Fantuzzo, J. W., & Miller, T. R. (2003). Peer-assisted learning interventions with elementary school students: A meta-analytic review. *Journal of Educational Psychology*, *95*(2), 240–257. https://doi.org/10.1037/0022-0663.95.2.240.

Röhr-Sendlmeier, U., & Käser, U. (2017). Kompetenz. In *Bonner Enzyklopädie der Globalität* (pp. 235–248). Springer VS, Wiesbaden. https://doi.org/10.1007/978-3-658-13819-6_19

Rudeloff, M. (2019). Kompetenz: Grundlagen und Begriffsbestimmung. In *Der Einfluss informeller Lerngelegenheiten auf die Finanzkompetenz von Lernenden am Ende der Sekundarstufe I* (pp. 13–48). Springer Gabler, Wiesbaden. https://doi.org/10.1007/978-3-658-25131-4_2.

Rychen, D. S. (2003). Key competencies: Meeting important challenges in life. In D. S. Rychen & L. H. Salganik (Eds.), *Key competencies for a successful life and a well-functioning society* (pp. 63–107). Hogrefe & Huber.

Rychen, D. S., & Salganik, L. H. (Eds.). (2003). *Key competencies for a successful life and a well-functioning society*. Hogrefe & Huber.

Rychen, D. S., Salganik, L. H., & McLaughlin, M. E. (Eds.). (2003). *Contributions to the second DeSeCo symposium: Geneva, Switzerland, 11-13 February 2002; definition and selection of key competencies*. Swiss Federal Statistical Office.

Rychen, D. S. (2016). *Key Competencies for a Successful Life and a Well-Functioning Society*. Hogrefe Publishing. http://elibrary.hogrefe.de/9781616762728/1.

Scharfenberg, F.-J. & Bogner, F. X. (2013). Instructional Efficiency of Tutoring in an Outreach Gene Technology Laboratory. *Research in science education*, 44(3), 1267–1288.

Schröder, E., Suessenbach, F., & Winde, M. (2022). Informatikunterricht Lückenhaft und unterbesetzt: Informatikunterricht in Deutschland – ein Flickenteppich auch hinsichtlich der Datenlage. POLICY PAPER, 04. https://informatik-monitor.de/fileadmin/GI/Projekte/Informatik-Monitor/Informatik-Monitor_2022/02-Policy_Paper_Informatikunterricht_Lueckenhaft_und_unterbesetzt_FINAL.pdf.

Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland (Ed.). (2010). *Konzeption der Kultusministerkonferenz zur Nutzung der*

Bildungsstandards für die Unterrichtsentwicklung. https://www.kmk.org/fileadmin/veroeffentlichungen_beschluesse/2010/2010_00_00-Konzeption-Bildungsstandards.pdf

sofatutor-Magazin Lehrkräfte. (2023,). *Was Lehrkräfte glauben, was eine gute Lehrkraft ausmacht*. https://magazin.sofatutor.com/lehrer/was-lehrkraefte-glauben-was-eine-gute-lehrkraft-ausmacht/

Thurston, A., Cockerill, M., & Chiang, T.-H. (2021). Assessing the Differential Effects of Peer Tutoring for Tutors and Tutees. *Education Sciences*, *11*(3), 97. https://doi.org/10.3390/educsci11030097

Tillmann, J., & Wegner, C. (2021). Weiterentwicklung eines klassischen Schülerlabors – Darstellung des aktuellen Forschungsstandes. *Progress in Science Education (PriSE)*, 4(2), 5-39. https://doi.org/10.25321/PRISE.2021.1076

Tillmann, J., & Wegner, C. (2022). „Satellitenlabore“ – ein Projekt zur Förderung informatischer Bildung an weiterführenden Schulen. *Informatik Spektrum*, *45*(3), 146–151. https://doi.org/10.1007/s00287-022-01449-0.

Tillmann, J. & Wegner, C. (2023a). Students teaching students: investigating teaching quality in an out-of-school laboratory peer tutoring program – ‘I think it's exciting when older students do it, and it's usually more fun, too’ [Manuscript submitted for publication]. Faculty of Biology / Didactics of Biology, Bielefeld University.

Tillmann, J. & Wegner, C. (2023b). ‘When I started, I wasn't really interested in such things [...] And now I think it is [...] more exciting’ – Catching and holding interest in computer science and technology [Manuscript submitted for publication]. Faculty of Biology / Didactics of Biology, Bielefeld University.

Tillmann, J., Wegner, C., & Schmiedebach, M. (2021). Lernen durch Lehren – Satellitenlabore zur MINT-Förderung am Gymnasium. *Journal of Technical Education (JOTED)*, *9*(2), 34–58. https://doi.org/10.48513/joted.v9i2.203

Topping, K., Buchs, C., Duran, D., & van Keer, H. (2017). *Effective peer learning: From principles to practical implementation*. Routledge.

Topping, K. J. (1996). The effectiveness of peer tutoring in further and higher education: A typology and review of the literature. *Higher Education*, *32*(3), 321–345. https://doi.org/10.1007/BF00138870.

Topping, K. J. (2005). Trends in Peer Learning. *Educational Psychology*, *25*(6), 631–645. https://doi.org/10.1080/01443410500345172.

Topping, K. J. (2017). Peer Assessment: Learning by Judging and Discussing the Work of Other Learners. *Interdisciplinary Education and Psychology*, *1*(1). https://doi.org/10.31532/InterdiscipEducPsychol.1.1.007.

Weinert, F. E. (2001). Concept of competence: A conceptual clarification. In *Defining and selecting key competencies* (pp. 45–65). Hogrefe & Huber.

Zinn, B. (2008). Physik lernen, um Physik zu lehren: Eine Möglichkeit für interessanteren Physikunterricht. Zugl.: Kassel, Univ., Diss., 2008. Studien zum Physik- und Chemielernen: Vol. 85. Logos-Verl.