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"When I started, I wasn't really interested in such things" – Catching and Holding an Interest in Computer Science and Technology

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Abstract

Satellite laboratories, designed to ignite interest in technical and computer science topics, employ cross-age peer tutoring and physical computing platforms. Catering to students from 5th grade onwards, these laboratories are led by tutors from 9th grade onwards. Employing a design-based research approach, the project aims to comprehensively understand teaching and learning dynamics and address well-founded problems. This study investigates the impact of satellite laboratories on (situational) interest and subsequent course choices, recognizing the decline in STEM interest as students age, particularly in computer science. To combat this trend, early stimulation of STEM interest is deemed crucial. Thirteen students were interviewed, revealing that many already held STEM interests before participating. The data, analyzed through structured content analysis, demonstrates alignment with the four-phase model of interest genesis, highlighting situational epistemic and emotional interest. Students view satellite laboratories as valuable introductions influencing future course selections. This research underscores the significance of initiatives fostering early STEM interest to sustain engagement and combat declining interest in computer science.

Introduction

Encouraging pupils' interest in computer science and technology is a critical challenge in today's educational landscape. In an increasingly digitalised world, understanding computer science fundamentals and technological developments is becoming more critical (Bergner et al., 2017). Nevertheless, educators need help getting pupils interested in these subject areas. This is because various aspects make access to computer science and technology more complex, ranging from a lack of qualified teachers (Schröder et al., 2022) to outdated teaching methods and stereotypical gender images (Bergner, 2016). These challenges require innovative approaches and a targeted approach to the needs and interests of students to generate sustainable enthusiasm for these critical areas, as fostering interest and enthusiasm for computer science and technology among students is crucial for the future development of science and technology (Bergner et al., 2017).

In this context, extracurricular educational opportunities such as out-of-school laboratories play a crucial role by offering pupils the opportunity to delve deeper into the world of science, computer science and technology through practical experience (Euler & Weßnigk, 2011). Establishing school laboratories enables pupils to deepen their theoretical knowledge through practical applications. Through independent experimentation and creative problem-solving, pupils develop a deeper understanding of scientific principles and gain an early insight into the fascinating world of technology. This hands-on approach can sustainably strengthen interest in STEM subjects by allowing students to awaken their curiosity and develop creative thinking.

Innovative approaches such as cross-age peer tutoring expand the possibilities of out-of-school laboratories by creating a dynamic learning environment in which older students act as tutors for younger students. This form of knowledge transfer promotes collaboration and social skills (Tillmann et al., 2023) and enables a differentiated approach to the subject matter (Ali et al., 2015). Older students can pass on their experience and enthusiasm, while younger students can learn from their older classmates and thus identify better with STEM topics (Moliner & Alegre, 2020). In this context, the question arises about how such approaches can increase pupils' interest in STEM subjects.

The satellite laboratories research project presented here combines the cross-age peer tutoring approach with the idea of out-of-school laboratories. The design-based research approach forms the basis of the research process, so the satellite laboratories go through several evaluation loops. The interview study examines how participation in the satellite laboratories affects the three dimensions of current interest and influences future course selection decisions.

Research Project Satellite Laboratories in Design-based Research

The design-based research (DBR) approach strives to link practical educational processes with scientifically obtained findings to counteract a central criticism of teaching-learning research: the lack of practical application and practicability of scientifically obtained findings (Reinmann, 2005). Thus, it is not about purely researching an intervention but rather about accompanying a design process towards an intervention suitable for everyday use, which stands up to the demands of a concrete educational practice (Edelson, 2002). Particularly in school contexts, variable conditions and significant interpersonal interactions make it challenging to establish innovations (Euler & Sloane, 2014). Didactic designs, therefore, aim to record and design as many variables as possible that influence the effectiveness of an intervention in concrete application situations (Reinmann, 2005) to be able to transfer an effective intervention from an experimental classroom to an average classroom. In doing so, it is essential to look at the match between what is required of the user and the capacity of the schools and teachers to use it (Fishman & Krajcik, 2003). This is where the DBR approach comes in, trying to find a unified solution to the gap between research and educational sectors.

Satellite laboratories aim to provide lasting technical and computer science support in lower secondary schools using a physical computing platform and to test a cross-age peer tutoring approach in schools. For this purpose, students from the 9th grade onwards are trained as tutors and teach 5th and 6th-grade students. In the future, these satellite laboratories will act as autonomous branches of the teutolab-robotic out-of-school laboratory. The peer tutoring approach will thus prevent the "silting up" of many school development projects, which has been criticized in many places (Jäger, 2009). To be able to address the associated problems in a well-founded manner and thereby gain an overarching understanding of teaching and learning in generalizable school contexts, the DBR approach by Shavelson et al. (2003) formed the basis for the research process of the satellite laboratories (Tillmann & Wegner, 2022). This type of DBR can be divided into three main phases: preliminary testing, prototype development, and assessment.

Following the preliminary review phase of the DBR research cycle, an extensive systematic literature review (Tillmann & Wegner, 2021) was conducted to review the current research state and anticipate potential problems. Based on the findings of the systematic literature review on research on out-of-school laboratories, the second phase of the research cycle aimed at developing appropriate interventions or teaching projects as well as suitable survey instruments. In this phase, the prototypes of the teaching concepts with the physical computing platform using a cross-age peer tutoring approach, as well as the survey instruments of the different stakeholders, have thus been developed. The (preliminary) teaching concepts have already been piloted at two schools, allowing the initial experience to be gained regarding the organization and practical implementation of the satellite laboratories. Since the project depends on the recruitment of tutors at the project schools because of the cross-age peer tutoring approach, possible motives for participation and framework conditions of the project were additionally investigated using guided interviews (Tillmann et al., 2021).

Finally, the prototypes are evaluated in the assessment phase of the DBR research cycle and refined based on the insights gained by iteratively applying the steps of implementation, evaluation and revision. Starting in the second half of the 2021/22 school year, it was thus possible to conduct two interview studies with the participating students at the project schools in addition to the practical implementation of the teaching concepts. For the first study, 5th-grade students participating in the laboratories were assessed. Study 1 is divided into two sub-studies: On the one hand, the quality of teaching within the satellite laboratories was analysed (Tillmann & Wegner, 2024), and on the other hand, the promotion of situational interest and its influence on future voting decisions were examined. The latter will be presented in the following.

Theoretical Framework

This sub-study focused on promoting (situational) interest by satellite laboratories and their influence on future course selection decisions. To this end, the following sections define the interest construct according to Krapp (1998) and present a model of interest genes. Finally, according to Eccles (2005), the expectancy-value model is used as an explanatory approach to the student's course selection decisions.

Situational Interest

Interest theory examines how object-specific interests arise and their influences on learning and individual development (Krapp et al., 2014). The concept of object here refers to concrete objects and abstract topics, ideas or activities (ibid.). According to Krapp (1998), interest is not assumed to be an attitude or personality trait but rather an interaction between individuals and their representational living environment. The person-object theory assumes that specific preferences for areas of action and knowledge are formed during a person's development

(Krapp, 1992). Thus, content or object specificity is one of the most critical features of interest. The person-object relationship can be characterized by combining two subjective evaluative tendencies. These are high subjective appreciation of the object domain of interest and positive experiences during the interest action. They are summarized under the determinants of value-related and emotional valence. In the school setting, learners gain new experiences and competencies, knowledge about certain content is supplemented and reclassified, and skills are optimized. Krapp (1998) identifies two types of interest in contemporary interest research: current or situational interest as well as dispositional or individual or personal interest. The latter constitutes a person's already pronounced interest (Pawek, 2009). It is based on motivational dispositions and forms a relatively stable personality trait representing personal values and willingness to act. Individual interest influences actions, especially when the individual can freely dispose of them (Krapp, 1992). In this way, the person acquires knowledge about the subject matter and the associated possibilities for action because he or she wants to deal with it without needing external influences.

The situational interest is a short-term motivational state (Kunter & Trautwein, 2013). This form of interest is generated by the appeal of individual situations, learning environments, or the materials used in class (Habig, 2017). This generates motivation to learn on the part of the students, which in turn leads to a current increase in attention and improved cognitive processing. Krapp assumes that certain stimuli of the learning object trigger interest. In this context, the exciting concept of situational interest can be characterized by three determinants: the epistemic, emotional, and value-based components (Priemer et al., 2018). The epistemic component of situational interest is defined by a person's need to expand competencies and skills concerning an object of interest (ibid.). Emotional-situational interest is a pleasant emotional aspect that arises during engagement with the object. The value-related component is developed when an object of interest displays an elevated subjective meaning for a person. Compared to the epistemic interest, the value-based and emotional interest components are more relevant in the context of out-of-school laboratories (ibid.).

Over the last 20 years, the effectiveness of out-of-school laboratory visits in terms of interest genesis has been investigated in several studies (Tillmann & Wegner, 2021). The central results show that one-time and multiple visits can promote students' current interests in the short term (Engeln, 2004; Guderian, 2007; Pawek, 2009; Simon, 2019). Pawek (2009) found that 91% of the students displayed a strong current interest. In addition, Guderian (2007) proved with his study that multiple visits to the out-of-school laboratory repeatedly reignite interest. Engeln (2004) and Pawek (2009) also examined the individual components of current interest and found that the value-based component did not decline over time. The influence of laboratory variables on interest has also been examined by various studies (Engeln, 2004; Pawek, 2009). Pawek (2009) proved that comprehensibility, atmosphere and everyday relevance correlate with current interest. Simon (2019) investigated the relationship between the tutors' characteristics and the out-of-school laboratory's objectives in more detail. He confirmed that the characteristics of the tutors influence the objective variables.

Four-phase Model of Interest Genesis

Various models have illustrated and empirically confirmed interest development (Mitchell, 1993; Hidi &

Renninger, 2006). Common to all of them are, on the one hand, factors that stimulate interest through learning conditions; they are called catch factors or ‘triggered’ (Hidi & Renninger, 2006). Hidi and Renninger’s (2006) four-phase model not only represents the development of interest in four phases but also describes the process for long-term interest genesis. The phases are distinguishable from one another and can be viewed as a sequence in which interest development is characterized as accumulative and progressive. Stimulation can occur through instructional methods such as peer tutoring or the use of technology (Mitchell, 1993). Second, the current interest must be stabilised for the long-term development of some personal interests. For this, the importance of the content must be made clear, and the learner's inner involvement must be maintained. In the literature, this process is also called the hold component (Mitchell, 1993) or 'maintained' (Hidi & Renninger, 2006). These factors can eventually lead to developing a type of personal interest. If external support is not given (any longer), interest genesis may stagnate, regress to the previous phase, or disappear. In particular, the early phases of interest development are characterized by focused attention and positive emotions. In addition to such positive emotions, the later phases are characterized by gained knowledge and value references. The phases differ in effort, self-efficacy, goal setting and the learners' self-regulating ability.

Course Selection Motives

Teaching STEM subjects has a decisive influence on students' later course selection decisions and career decisions. Eccles' (2005) expectancy-value model provides an explanatory approach to performance-based task choice. It attributes decisions to the individual expectation of success as well as the subjective task value (Krapp et al., 2014). It assumes that the two components influence individuals' performance, persistence, and course selection decisions. This, in turn, means that the expectancy and value components are shaped by task-specific beliefs such as perceptions of competence, social identity, long- and short-term goals, and the difficulty level of individual tasks (Eccles & Wigfield, 2002). According to Dresel and Lämmle (2011), success expectancy refers to individuals' beliefs about their abilities to complete a task successfully. These arise from experiences in the relevant areas and the interpretation of these experiences (Eccles & Wigfield, 2002). The value component distinguishes between intrinsic value, utility value, attainment value, and relative costs (Grassinger et al., 2019).

The first component, intrinsic value, is very similar to intrinsic motivation (Köller et al., 2000) and describes the incentive inherent in the action (Grassinger et al., 2019) to engage in a (future) task, object or subjective interest in a specific domain. The correspondence of an action with a person's self-concept can be found in the attainment value (ibid.). Ability self-concept refers to the cognitive representations of one's capabilities (Dresel & Lämmle, 2011). It describes the degree to which a task or subject is essential to a person's self-concept (Eccles, 2005). The utility value of an action describes the degree to which the consequences of the action are helpful for other short- and long-term goals (Grassinger et al., 2019). This value component includes all aspects that are influenced by extrinsic motives. The costs include, on the one hand, the limitation of the possibility to perform other activities and, on the other hand, the necessary efforts but also emotional costs (ibid.).

Many studies on course selection decisions show that interest is a crucial factor influencing students' choices (Abel, 2002; Merzyn, 2010). In addition, personal attributes such as ability self-concept and school performance influence course choice (Abels, 2002; Cleaves, 2005). In her study, Hülsmann (2015) showed that students who took a science differentiation course in lower secondary school were more likely to choose an advanced course in this area later on, with students interested in science being more likely to choose a differentiation course or advanced course in STEM. Negative experiences in STEM classes in grades 5 and 6, as well as a perceived irrelevance of the content, negatively impact students' science competencies as well as interest and lead to opting out of/non-choosing STEM subjects (Cleaves, 2005; Merzyn, 2010). To what extent do satellite laboratories influence students' (situational) interest and choice decisions regarding differentiation areas? This is investigated in the present study.

Methodology

The common goal of the out-of-school laboratories is to promote interest and openness to science and technology among children and young people. These factors also strongly influence course choices in the middle and upper school. The satellite laboratories as branches of the out-of-school laboratory are analysed in the interview study presented here to determine how they can promote interest in STEM subjects, particularly computer science and technology, and influence later course choices. To this end, the interview transcripts of the participating students are analysed using qualitative content analysis, which provides insight into the student's interests and perceptions as well as their individual experiences and backgrounds.

Research Questions

This study investigates the promotion of situational interest by satellite laboratories and their influence on future course selection decisions. The two research questions and their rationales are presented below.

I. How do satellite laboratories impact the three dimensions of current interest?

Interest in STEM subjects decreases with age (Anderhag et al., 2016); additionally, computer science as a subject has low appeal (Bergner, 2016). Getting students interested in STEM subjects at an early age is essential to spark and maintain interest in these subjects as early as possible. This is where the satellite laboratories come in. Their physical computing approach links computer science topics with other STEM subjects. The combination of hardware and software components makes it possible to establish direct links between computer science and physics. Pupils are involved in programming microcontroller boards and assembling small circuits with electrotechnical components such as LEDs and resistors. In biology, differences between control and regulation processes are determined using natural examples such as temperature regulation in warm-blooded animals and humans. Similarly, various sensors are compared with human sensory organs. In addition, mathematical concepts such as the binary system and the map()-function will also be introduced to understand how microcontroller boards work. Finally, project-based work in small groups enables students to familiarise themselves with operational processes and develop their prototypes from planning to presentation. In addition, the cross-age peer tutoring approach creates early and lasting support within the computer science and technical areas.

II. What impact do satellite laboratories have on future course selection decisions?

Interest and the ability to self-concept have a crucial influence on students' future course choices (Abel, 2002). Therefore, the influence of satellite laboratories on these choices needs to be investigated to analyse their potential to influence long-term course choices positively. The evaluation of the project will reveal various potentials for development and thus support the future implementation of the project to increase the sustainability of interest promotion, among other things.

Data Collection and Analysis

The research questions were investigated using guided interviews with 13 secondary school students in 5th grade. The selection of students was influenced by legal factors (e.g., signed informed consent from a parent or guardian). Qualitative interviews, especially semi-structured ones like the guided interview, provide in-depth insights into students' opinions and experiences. They use open questions to conduct flexible, dialogue-oriented conversations. The semi-structured interview form used here can be characterised as a focused interview. Focused interviews concentrate on specific experiences and allow a detailed analysis of subjective meanings. This interview form aims not to generalise but to systematically evaluate information according to categories. They are particularly suitable for children and young people, as they allow short time intervals between the situation and the interview. The interview guide allows for flexible qualitative interviews by outlining topics that can be adapted. It is orientated towards openness, processuality and communication and uses understandable everyday language to give the interviewees space for their ideas. In the interview study presented here, all participating students were asked the same narrative impulses or guiding questions (see Table 1). However, the questions to maintain the flow of speech may vary depending on the students' answers.

Table 1. Information on Gender, Age and School Class of the Participants

Participant	Gender	Age	Class	Code
1	F	10	5c	P1F10
2	F	11	5c	P2F11
3	F	11	5c	P3F11
4	M	10	5a	P4M10
5	F	11	5a	P5F11
6	M	11	5a	P6M11
7	M	11	5b	P7M11
8	F	11	5b	P8F11
9	F	10	5b	P9F10
10	M	10	5b	P10M10
11	M	10	5a	P11M10
12	M	11	5a	P12M11
13	M	11	5a	P13M11

All interviews took place in a private room at school and were conducted by the same interviewer to ensure comparability. At the beginning of the interview, a narrative impulse was set to generally learn about the lessons and the perception of the tutors in the satellite laboratories ("You voluntarily decided to participate in this project. Tell me, how did you like having older students from your school do the teaching?"). This stimulus had several sub-prompts asking about different dimensions of current interest (e.g., " How did you find the satellite laboratory experience compared to regular classes?"). Another stimulus dealt with differentiation course choices in 7th grade ("Let's move forward two years; in 7th grade, you can choose between different differentiation courses. Considering your experience in satellite laboratories, could you envision opting for a science or computer science course, and what factors contribute to this consideration?"). Further questions were asked about the reasons for the course choice ("Did the inclination to choose a course in this field exist prior to your participation in satellite laboratories?", "How has your perspective on science, particularly computer science, evolved as a result of your experiences?"). Finally, the students were asked to evaluate the teaching in the satellite laboratories, particularly the cross-age peer tutoring approach ("Between you and me, if you had to choose, would you rather be taught by your regular teacher or tutor?").

The interviews were recorded as *.mp3 files using the Olympus LS-14 recording device and lasted between 10 and 17 minutes. Subsequently, the interviews were anonymized with the program MAXQDA and transcribed according to the standards described by Rädiker and Kuckartz (2019). The transcripts were analysed using qualitative content analysis by Mayring (2015). Structuring content analysis filters out a particular structure from the material. This structure is applied to the material using a category system so that certain content and aspects are filtered out and summarized (Mayring, 2015). First, the structural dimensions and their characteristics are theoretically derived and summarized in a category system. For the application to the material, three steps follow: 1. definition of the category, 2. anchor examples and 3. coding rules. The definition should specify which text components can be assigned to a particular category. For this purpose, concrete text passages are given as anchor examples. They serve to illustrate the essence of a category. The coding rules enable an unambiguous assignment in case there is the danger of two or more categories overlapping and thus causing ambiguity in the coding process (ibid.). With the category system created this way, two material runs occur. In a first rehearsal run, text passages in which the categories are addressed are worked out, depending on the goal of the structuring (Mayring, 2015). This usually results in a revision of the category system, and after that, the primary material run-through is started. The results of this run-through must then be summarized and processed, depending on the type of structuring (ibid.).

Quality of the Analysis

In the context of qualitative research, existing quality criteria are controversially discussed. Often, a mere transfer of the quality criteria of quantitative research needs to be revised (Mayring, 2015). This study tried to follow the general quality criteria described by Mayring (2016). Additionally, the intercoder reliability was calculated. For this purpose, it was tested on the segment level to see whether the codings of two independent coders match. This variant was chosen because the coders deviate minimally from each other when assigning the codes, e.g. because one word is coded. However, this deviation usually is irrelevant in terms of content. The percentage of the overlapping range of two codings is used as a criterion. Our calculation of intercoder reliability at 75% agreement yielded κ = 0.79, thus indicating substantial agreement (Landis & Koch, 1977).

Results

To answer the two research questions presented, the interviews were analysed for aspects regarding situational interest and its manifestations, as well as the student's course selection motives. The statements are summarized in the main categories*:* individual interest, situational interest, and course selection motives. While the first two categories address the first research question, the latter focuses on students' future elective choices, particularly regarding differentiation course choices in 7th grade. Since the interviews were conducted in German, direct quotes were translated into English without changing the content or correcting grammatical errors to give an accurate impression of the students' expressions. Situational interest includes statements about individual valences, divided into emotional, epistemic, and value-related components (Table 2).

Table 2. Description of the Three Subcategories of Situational Interest

Category	Subcategory	Description	Anchor examples
Situational interest	Epistemic component	Considers the needs of the learner to expand competencies and skills concerning an object of interest	"[…] I want to learn to develop my games about other things and not only about Roblox" (P5F11, Pos. 75)
	Value-related component	The object of interest and the possibilities of action connected with it have enormous subjective meaning for the person.	"I just thought it was cool that you could do something yourself" (P8F11, Pos. 74)
	Emotional component	Interest is associated by learners with predominantly positive qualities of experience	"Yes, that was such mega much fun" (P11M10, Pos. 98)

How do satellite laboratories impact the three dimensions of current interest?

Many participants already displayed a (pronounced) individual interest in the STEM fields of technology and computer science before the satellite laboratories. Statements on this could be attributed primarily to the following influencing factors:

1. **General interest in STEM topics**
   P10M10: […] because I also like technology or so […]. (P10M10, Pos. 22)
   P5F11: […] And because I also find Science quite exciting. (P5F11, Pos. 63)
2. **Social environment**
   P13M11: My father also installed an app like this on his PC. It was called 'Programming with the Mouse', and then I programmed [...] (P13M11, Pos. 62)
   P4M10: Above all, I can now do this with my father. He's a computer scientist, so I can generally

program something at home every day in theory. (P4M10, Pos. 84)

3. **Recreation**

P2F11: But I also find the topic of robotics exciting in general, and I also have two toy robots at home. (P2F11, Pos. 12)

P7M11: Yes, I have one of those robots you can program, and I spend hours programming it. That's fun. (P7M11, Pos. 68)

In addition to a general interest in STEM topics, some students deal with (programmable) robots and software applications in their free time or mention other offers they have perceived. In this context, the influence of the social environment was frequently mentioned. In particular, the parents, the parent's profession, and the peer group determined the affinity for STEM topics. Some statements indicated that students were interested in something other than this field beforehand.

I: […] Or was the interest already there [...] before [...]?
P4M10: It was not.
I: Wasn't it? And did the satellite lab produce some interest in you?
P4M10: (Nods). (P4M10, Pos 75-78)

Overall, the participants of the satellite laboratories can be assigned to different phases of interest genesis (Table 3).

Table 3. Statements on the Individual Phases of Interest Development by Hidi and Renninger (2006)

Phase	Examples
Triggered situational interest	"Well, when I started, I wasn't really interested in that yet. Not so much yet. And now I think it is even more exciting" (P9F10, Pos. 26)
	"Only since the satellite lab. I wanted to try it out first [...] because the proof of the pudding is in the eating" (P8F11, Pos. 56)
Maintained situational interest	"[…]I was also interested in how to connect such an Arduino board with LEDs and then so just" (P13M11, Pos. 60)
	"Well, I have already dealt with technology. Now not so much, but I had a bit of interest before" (P3F11, Pos. 68)
Emerging individual interest	"So I've built something with it before [...], and that's why I signed up, because I'm interested in technology" (P6M11, Pos. 16)
	"It [interest already existing, JT] has already increased a bit" (P13M11, Pos. 106)

While some students' situational interest was first stimulated by their participation in the satellite laboratories, some students' interests emerged. This mainly builds on current interest (cf. P13M11, Pos. 106), triggered in elementary school or at home.

If the individual dimensions of situational interest are considered, the participants' statements can more frequently be assigned to epistemic and emotional components (see Table 4).

Table 4. Statements on the Respective Dimensions of Current Interest

Dimension	**Example**
Epistemic (n = 33)	"That you also must save on electricity, for example, because it takes much effort to turn on a light like that. And if you imagine who invented it and what he must have been thinking, you have to take something like that into account, I think“ (P9F10, Pos. 66)
Value-related (n = 23)	"Yes, because if I have prior knowledge, it's easier for me, and that means less stress“ (P9F10, Pos. 62)
Emotional (n = 34)	"And that's also just exciting, looking at the part that has to go there so that the LED part lights up” (P1F10, Pos. 10)

Statements regarding the emotional component referred primarily to the teaching materials, such as "for example, the equipment with the Arduino board, I thought that was really cool" (P10M10, Pos. 36), which are usually not that frequently used in regular lessons. In particular, the students described the independent work with the materials and programs as fun and exciting, accompanied by positive experiences and successes.

> **P10M10:** First, I didn't know how to do that, and now I already know how to build a whole circuit. (P10M10, Pos. 36)
>
> **P11M10:** […] but you can also try out several things. I particularly enjoy that. (P11M10, Pos. 52)

In addition, one student stated that the content of the satellite laboratories is not likely to be covered in the fifth grade "because that is more likely to come a few grades later and that has already given me an insight into what that might be like" (P13M11, Pos. 30). In the satellite laboratories, the students hope to expand their technical and computer science knowledge (cf. P11M10, Pos. 98; P13M11, Pos. 60); they can make use of this prior knowledge in the future (cf. P9F10, Pos. 62). One student also expressed, "[...] I just think it's cool that I can do something like this that not everyone else can always do" (P8F11, Pos. 18).

Cross-age peer tutoring also has an impact on how students feel. One student felt that the interaction with the tutors was fun because they could learn with and from each other. "That's funny then, that sometimes you can still teach them something" (P11M10, Pos. 28). One student finds "it exciting when older students do it, and it is usually more fun" (P2F11, Pos. 64). Many students would choose to participate in the satellite laboratories again. In the future, they also see themselves as tutors, as they would like to take the knowledge gained at the satellite laboratories with them and pass it on to the younger generations.

> **P5F11:** The younger students, as they get older, could pass on computer stuff that way. (P5F11, Pos. 15)
>
> **P7M11:** (…) I think they do it to teach us what they do so that when we're the same age as them that, we can then bring the others up to speed on the experience we've gotten from them. (P7M11, Pos. 12)

In this context, students were asked whether they would prefer to be taught by the tutors or their regular teachers if they had the choice. 10 out of 13 students would decide in favour of the tutors and give different reasons. Regular classes are characterised by limited resource access, exam pressure and hierarchy. In contrast, classes in the satellite laboratories are characterised by hands-on experience, efficiency and direct contact with the equipment and the experiments. Students appreciate the relaxed learning environment, the cooperative work in small groups and the tutors' ability to explain at eye level. Nevertheless, the students also emphasise the expertise of the regular teachers, especially when it comes to explaining more complex issues, and would even like to see more assertiveness from the tutors, as they are used to from their regular teachers.

What impact do satellite laboratories have on future course selection decisions?

For the students interviewed during the study, the first choice for the differentiation courses will be made in the 7th grade. The students' statements regarding future course choices can be attributed to various motives similar to the influencing factors described above. Thus, interest in and for STEM topics also plays a decisive role in the choice of a differentiation course (cf. P10M10, Pos. 22; P5F11, Pos. 63). Other factors were:

1. **Influence of the social environment**

   I: […] And now I would like to know whether you would choose a differentiation course in the STEM area with the experiences from the satellite laboratory.

   P10M10: […] I would definitely take it because my brother also took it.

   (P10M10, Pos. 73-74)

   I: And now I would like to know if you would choose a STEM differentiation course with the experience from the satellite lab.

   P12M11: […] See where my friends go because I don't want to go into a course all by myself.

   (P12M11, Pos. 69-70)

2. **Influence of the satellite laboratories**

   I: Would you feel more encouraged to go in because of the satellite lab?

   P13M11: Yes, I would, I would already feel more encouraged [to choose a differentiation course in STEM, JT].

   (P13M11, Pos. 99-100)

   I: [...] And now, with the experience of the satellite lab, could you imagine choosing a differentiation course in STEM?

   P1F10: Yes. Definitely. That was also a very good introduction to it […]

   (P1F10, Pos. 29-30)

In addition to interest, the social environment is another essential influencing factor. Siblings, as well as classmates, are mentioned as a reference so that the decision to choose is based on the experiences of others (cf. P10M10, Pos. 74). The decisions of friends influence their own decisions (cf. P12M11, Pos. 69). However, taking part in the satellite laboratories also had an impact on students' future decisions. Some feel encouraged and described the satellite laboratories as a "very good introduction" (P1F10, pos. 29). However, many participants are still unsure and report needing more specific information about the topics covered in each differentiation course. One student said that he could already imagine working in the IT sector in the future.

> **P11M10:** Yes, I can imagine it later. I can already imagine programming video games or things on the computer later because Dad also made his own video game once. (P11M10, Pos. 102)

Discussion

The analysis of the interview statements has shown that students' situational interest could be fostered with the help of the satellite laboratories. Catch factors are the independent work in small groups and the teaching materials characterized by the physical computing platform (Mitchell, 1993).

> **I:** What was so different?
> **P10M10:** That you didn't have any books on the table, that is. That you could only work with electronic things. (P10M10, Pos. 39-40)

However, getting to know and focusing on the object of learning only constitutes the first developmental step in generating interest. If the individual dimensions of current interest are considered, the statements regarding girls' and boys' epistemic and emotional interests do not differ. Both genders want to expand their knowledge and see a future benefit in the contents of the satellite laboratories. Furthermore, they enjoy the satellite laboratories. They justify this not only with the teaching materials and contents but also with the peer tutoring.

> **P2F11**: […] I find it exciting when older students do it, and it's usually more fun. (P2F11, Pos. 64)

Regarding the value-related dimension, differences between the genders can be identified. At the same time, the boys particularly emphasize independent work with their friends and technology, and the girls hope to gain more knowledge than their classmates by participating in the satellite laboratories.

Table 5. Statements of the Boys and Girls of the Value-related Dimension of Situational Interest

Boys' statements	Girls' statements
"The one with the Arduino boards and Tinkercad" (P10M10, Pos. 86)	"[…] but not everyone can do that" (P1F10, Pos. 32)
"You do more things with the PC. You can say things freely. Yes. You can work freely with friends in group work. Yes. And there is not so much teacher-centred work" (P4M10, Pos. 24)	"[…] but I think it's cool that I can do something that not everyone else can do. Then maybe I'm a little better than others because they're usually better than me" (P8F11, Pos. 18)

Although various studies (e.g., Fechner, 2009; Habig et al., 2018) mainly refer to emotional and value-related aspects of situational interest, the epistemic component is essential from a practical point of view, particularly regarding out-of-school laboratory research. After all, according to Lewalter and Willems (2009), for the development of (new) individual interest, value attributions towards the object of interest and an epistemic orientation of the action of interest must take place (Krapp et al., 2014). Many students reported being interested in STEM fields before the satellite laboratories, which can be attributed to various influencing factors. They see the satellite laboratories as a suitable opportunity to pursue their interests and expand their knowledge.

> **P3F11:** Well, I have already been involved with technology. Not so much now, but I had a bit of interest before. (P3F11, Pos. 68)

Here, the first epistemic orientations emerge, reflected in the interview statements' frequent assignment to the epistemic component of situational interest. Pronounced situational epistemic interest can provide information about how much instructional content appeals to students (Priemer et al., 2018). However, Pawek (2009) emphasizes that the situational pathway from generating to stabilizing current interest occurs frequently and is a prerequisite for long-term interest development. Ongoing optional engagement with the object of interest occurs much less frequently. Continuous offerings and multiple visits represent a way to maintain the elicited interest (Guderian, 2007) and stabilize it over a more extended period. In the satellite laboratories, students can gradually expand their skills and knowledge and learn new ways of working with the teaching materials. However, the analysis cannot answer to what extent this leads to an emerging individual interest. It would be interesting to interview such students who participate in the project for an extended period. Additional influencing factors that could impact the students' situational interests should be investigated in this context. In his study, Pawek (2009) showed that comprehensibility, support and atmosphere correlate with situational interest.

By choosing an additional subject or a combination of subjects, the introductory differentiation lessons offer the possibility of setting a focus that meets the student's interests. Students can choose either a STEM focus - e.g., mathematics/physics, technology/computer science, or science - or a third foreign language - e.g., French, Spanish, or Greek. As described in Eccles's (2005) expectancy-value model, an individual's characteristics, such as interests, skills, and abilities, influence course choice behaviour. In contrast to the shaping of interest, which is initially triggered by close persons such as parents or close relatives, parents have less influence on students' future course selection decisions. This decreases with age, whereas peers' influence increases (Wieder, 2010) so that friends' decisions become increasingly crucial to their own (Harring et al., 2010). This is also found in the interviewees' statements. In addition, the lessons in the satellite laboratories influence the assessment of different STEM subjects, at least for some students.

> **P11M10:** At the beginning, I thought: 'Natural sciences. Yes, that sounds exciting, but mathematics, no.' Then, in the satellite lab, my opinion changed completely. (P11M10, Pos. 94)

However, it must be considered that the participants in this study were interviewed at the end of the 5th grade. This means that their voting decisions are still far in the future. Many students would like to gather more information and experience before deciding. Their differentiation course choices should be considered to strengthen the students' statements. The statements of some students that they see themselves as tutors in the future (cf. P5F11, Pos. 15; P7M11, Pos. 12) were quite surprising in this context. This shows the interest in the satellite laboratory content. Furthermore, the students recognize the relevance of the topics, which they would like to pass on to the younger generations. In the 2022/23 school year, the first former participants of the satellite laboratories became active as tutors.

Conclusions

The study with 5th-grade students has a qualitative focus to explore the potential of peer tutoring for long-term out-of-school laboratory courses and sustainable use for the school setting. Sub-study 2 presented here examines the impact of satellite laboratories on students' situational interests and course selection decisions. The analysis of the transcripts shows that the satellite laboratories influence the participants' interests and future course choices. Many students already had an increased interest in STEM subjects before participating in the project. However, participation in the satellite laboratories awakened and strengthened their situational interest, with epistemic and emotional components being expressed. The positive learning experiences with the materials and the peer tutoring contributed to this. As a result, some participants can now imagine choosing STEM differentiation courses or considering a future career in STEM fields. The satellite laboratories serve as dynamic, hands-on learning environments that can increase student interest and engagement in STEM disciplines, particularly engineering and computer science. By providing hands-on experiences and real-world applications, these laboratories bridge the gap between theoretical knowledge and practical skills, making STEM subjects more accessible and appealing to students. In addition, the interactive nature of satellite laboratories encourages collaboration, critical thinking, and problem-solving skills, essential competencies in STEM fields. Through interaction with peers and tutors, students can develop a deeper understanding of STEM concepts and gain confidence in their abilities, increasing their likelihood of pursuing careers in STEM-related fields. Additionally, satellite laboratories can help address disparities in STEM participation by providing access to resources and opportunities for schools with limited funds.

In future longitudinal studies, it would be interesting to investigate whether the students choose a differentiated course in the STEM field, which advanced course choices are chosen in the upper school and whether the students accept vocational training or a place at university in the STEM field in the long term, to examine the influence of the satellite laboratories on the course selection decisions and to support the results described. In addition, it should be considered whether the participating 5th and 6th-grade students are subsequently involved as tutors and whether their work as tutors influences their career and study choices. The results of a study with the tutors indicate that some tutors are interested in the teaching profession and would like to gain initial experience in teaching through their tutoring activities (Tillmann et al., 2023).

Using interview surveys offers valuable insights into students' perspectives and educational experiences but also harbours some limitations. A primary limitation is the subjectivity of the answers, as individual perceptions, memories, and interpretations characterise them. Students may tend to optimise or distort their answers to meet social desirability or specific expectations. Furthermore, students (especially Year 5 students) may need help to fully reflect on or articulate their experiences, especially when it comes to complex concepts. Their self-reflection might be influenced by limited knowledge or lack of experience, which can lead to incomplete or inaccurate answers. In addition, social norms can influence self-assessments, leading to bias. It is important to critically question the extent to which the students' statements are characterised by external influences and to what extent they reflect their authentic experiences. However, careful planning, questioning and interpretation can maximise the validity and reliability of the data collected. Interview surveys can provide valuable insights into subjective experiences and opinions that cannot be captured by quantitative data alone. In this study, the use of guided interviews as a survey instrument has proven to be fundamentally suitable for identifying the potential of peer tutoring regarding various aspects, such as teaching quality or interest. Reasons for this include small cohorts - also due to the coronavirus pandemic - which would have made quantitative studies challenging to implement and of little significance. The evaluation using qualitative content analysis is particularly suitable within the implementation phases of the project and for the first scientific discussion. Deductive categorisation enables the evaluation of the project from the subjective point of view of the participants. It provides insight into problems and opportunities of the peer tutoring approach for long-term student laboratory courses at schools. Qualitative content analysis allows a systematic and rule-guided comparison between theoretical assumptions and accurate student responses, facilitating theory control in practical everyday life. Nevertheless, in line with the DBR approach, quantitative survey instruments should also be considered to support the qualitative findings. Furthermore, dependencies between the considered categories could be worked out this way.

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