Promoting Long-Lasting Interest in Computer Science: An Analysis of High School Teachers' Perspectives

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Abstract: This study explores the perspectives of high school computer science (CS) teachers on students' interest in the subject. Using structured interviews, we identified factors that may influence students' interest in CS, such as curriculum design, teaching methods, and the use of materials and technology in the classroom. The findings reveal the importance of making CS relevant and exciting to students to increase engagement and understanding and promote acceptance of the subject in society. Additionally, the study highlights the challenges and benefits of interdisciplinary teaching of CS and the value of pre-designed teaching materials in supporting this approach. The presented study provides valuable insights for educators and policymakers looking to promote and sustain students' interest in CS. Overall, the study emphasizes the crucial role of CS education (CSEd) in preparing students for success in a digital world.

1 INTRODUCTION

The field of computer science (CS) has become increasingly important in today's world, with its applications spanning various industries and impacting nearly every aspect of our daily lives. As such, it is crucial for students to understand this subject comprehensively to be well-equipped to navigate and shape the future. However, research has shown that many students, especially those in high school, struggle to maintain a lasting interest in CS (Vidal et al., 2020; Armoni and Gal-Ezer, 2014; Webb et al., 2012).

This study aims to explore the perspectives of high school CS teachers on the factors that may influence students' interest in the subject by answering the following question: *What is the relationship between initial interest, the content of the lesson, and the design of the teaching material in CS lessons with regard to the promotion of long-lasting interest in the subject of CS?*

The study also highlights that CS is more than just programming. It is a broad field that encompasses the study of algorithms, data structures, computer systems and networks, artificial intelligence, human-computer interaction, and more. CS is not only about learning how to code but also about understanding how computers work and how to use them to solve problems and create new technologies. It is a multidisciplinary field that draws from mathematics, engineering, and the sciences and has applications in a wide range of industries.

Given the importance of CS in today's world, interdisciplinary teaching of CS is crucial. It helps students understand CS's real-world applications and implications by connecting it to other subjects, such as math, science, and language arts (Takeuchi et al., 2020). This approach can also break down stereotypes and misconceptions about CS being solely a programming-based field and showcase the wide range of possibilities and career opportunities within the field (Marquardt et al., 2023; Graham and Latulipe, 2003). Additionally, interdisciplinary teaching can also help to attract diverse students to CS, as they may be more likely to see themselves in the field if they can see connections to their interests and passions (Ng and Fergusson, 2020).

However, the study also acknowledges the challenges that teachers face in implementing interdisciplinary teaching of CS (Tytler et al., 2019). Despite the benefits, interdisciplinary teaching of CS can be difficult for teachers. It requires a broad understanding of the subject matter and the ability to connect it to other subjects. Additionally, it may require additional planning and preparation for the teacher and the ability to adapt lessons and materials to the class's specific needs. Furthermore, it may require more cre-

ativity and flexibility in teaching methods and a willingness to incorporate new technologies and tools into the classroom. Moreover, teachers may not be familiar with the other subjects they would be teaching in an interdisciplinary format and may need additional training.

In this article, we intend to identify and examine the opportunities and challenges teachers experience in their classrooms when implementing these measures. Especially the complex interdisciplinary applications are getting very little space in the classrooms, virtual or traditional, because they might be too complex for many teachers, having too many variables to solve effectively within the limited classroom time. Therefore, providing teachers with digital materials ready-to-use, interdisciplinary, and related to the curriculum will help with these issues. However, the acceptance of such materials among teachers is low, and thus, more profound insights on teaching the compulsory CS classes and curriculum will support in-depth planning of online educational resources that take significant time and effort to create.

Overall, this study aims to contribute to understanding how to promote long-lasting interest in CS among students and how interdisciplinary teaching can achieve this goal. By providing insights into the factors that influence students' interest in the subject, this study can inform the development of a more effective curriculum and teaching materials and ultimately help to equip students with the knowledge and skills needed to navigate and shape the future.

2 BACKGROUND

This study is a follow-up to our survey on methods and strategies for establishing an inclusive environment that has the potential to engage a broad and diverse audience in the study of CS (Happe et al., 2020; Buhnova and Happe, 2020; Happe and Buhnova, 2021) and aims to understand what are teachers' perceptions on the most effective strategies for engaging CS teaching identified from existing literature in our comprehensive survey (Happe et al., 2020). The survey found that interdisciplinary context in CS teaching is highly beneficial and has the potential to engage students through the relevance of the application area to their own interests. However, the requirement to teach CS across disciplines leads to an increased amount of preparation required from teachers and adds to the already high workload imposed on them. Since there is a large amount of ready-made material on the internet today that teachers could use to alleviate this burden, we investigated what their requirements are for these materials and what obstacles currently stand in the way of using such materials.

Before designing the study, we formulated the following research questions:

- **RQ_Interest:** With what interest and what expectations do students start their studies on the subject of CS? Do teachers consider taking or need to take special measures to engage and support equal participation of all students in CS classrooms?
- **RQ_Content:** Which topics (e.g. interdisciplinary) interest and engage students most?
- **RQ_Material:** What are the requirements on digital materials to be used by the CS teachers?

Unlike other similar studies, the aim of the study is to understand the perspectives and recommendations for using digital materials in the classroom. In this regard, we respond to recommendations from the academic literature by collecting the perspectives of practitioners, e.g. CS teachers, who report their strategies or problems with digital materials and their use in the context of CS teaching. We have gained rare insights into their experiences as they were compelled to use such digital materials by sheer necessity arising for them during the Covid 19 pandemic.

3 METHODOLOGY

The study aimed to explore the perspectives of high school CS teachers on students' interest in CS. We used a structured interview guide (Zimmerman and Pons, 1986) to elicit information about the teachers' perspectives on factors that may influence students' interest in CS, such as curriculum design, teaching methods, and the use of technology in the classroom.

Two interviews were conducted in person and recorded with the help of an iPad. The remaining five interviews were conducted online via an encrypted connection in a private Jitsi conference room using the integrated recording function. All recordings were saved locally. The duration of one interview was about one hour. Prior to the start of the interview, the teachers were informed of their rights and the purpose of the study. They were also informed that the interview would be transcribed and that the data would be anonymized for the purposes of analysis.

3.1 Participants

We could recruit seven teachers for our interview study (2 female, 5 male) in age from 29 to 53 (see Table 1). All teach at German secondary schools (*Ger-*

Table 1: Participants' gender, age, experience [years], and taught subjects

Code	Gender	Age	Experience	Subjects
A	male	31	2	Informatics, Maths
B	female	53	11	Informatics, Maths
C	male	29	2	Informatics, Maths
D	male	40	9	Informatics, Maths, Physics
E	male	33	6	Informatics, Maths
F	female	30	2	Informatics, Maths, Geography
G	male	47	19	Informatics, Maths, Sports

man gymnasium). The teachers have teaching experiences ranging from two to 19 years.

Five of the teachers are engaged in the field of CS didactics beyond the school context: three are involved in research or teaching computer didactics at universities, and one of them is a trainer at the seminar for teacher training and involved in the state's curriculum commission. One teacher is active in the Chaos Computer Club (CCC) for the promotion and support of young computer scientists. Additionally, five of the teachers are in close contact with the Hopp Foundation, which offers workshops for teachers and/or is involved in the creation of teaching materials. The Hopp Foundation is a foundation that promotes CSEd in schools and works closely with CS teachers. This illustrates, that the interview sample consists of very active and engaged teachers.

3.2 Context

Since all teachers are teaching at German high schools (called *gymnasium*), most of them in the state Baden-Württemberg, we will give a brief overview of the CSEd situation there. The German gymnasium is a school type with the dedicated goal to prepare students for higher education at the university. It is one of the possible educational paths after the 4-year elementary school (grades 1-4, ages 6-9). The gymnasium usually has an 8-year curriculum (grades 5-12, ages 10-18). In the study area, CS is only in grade 7 a mandatory subject (called *informatics*, which is the more common term for CS in Germany), and also only since 2016. The curriculum in this grade includes topics from 'data and encoding' (e.g. binary code, image coding,...)), to 'algorithms' (e.g. conditionals, loops,...), to 'computers and networks' (e.g. internet communication, local networks,...) to 'society and security' (e.g. encryption, copyright,...)[1]. In grades 8, 9, and 10 there is no dedicated subject for CS. Students can choose it only as part of the subject *IMP*, which is a combination of informatics, mathematics, and physics. Only in the last two years (grades 11 and 12) students get the opportunity to choose CS as a dedicated subject again.

[1] see the curriculum (only in the German language): https://www.bildungsplaene-bw.de/,Lde/LS/BP2016BW/ALLG/GYM/INF7

Table 2: Structured Interview Guide

Topic	
T1	Special features of the mandatory CS subject in grade 7
T2	Exciting topics for students
T3	Strategies and Challenges in regard to girls inclusion
T4	Experiences with digital materials (platforms, problems, and requirements)
T5	Experiences with interdisciplinary teaching
T6	Strategies against stereotypes
T7	Strategies for initial interest and early success
T8	Strategies for self-confidence
T9	Atmosphere and personal highlights

3.3 Interview Guide

Our interview was structured by the topics of Table 2. To cover all the topics T1-9, we prepared an interview guide, with seven main questions and two backup (or in-depth) questions. For every leading question, we had backup questions to further direct the conversation. For example, the main question on topic T3 was *"Do you have specific strategies for the inclusion of girls in the classroom?"* and backup questions included the question *"Have you observed challenges in the school in this regard?"*. The seven interviews were then conducted using this interview guide.

3.4 Interview Analysis

The transcripts of the interviews were analyzed using qualitative data analysis techniques (Denzin and Lincoln, 2011). The data was coded and themes were identified Theron (2015). The findings of the study were based on the analysis of the interview data. The interview analysis was conducted systematically, following the steps outlined below.

Due to the different content emphasis in the interview responses, an evaluation was based on meaningful quotations, between which connections were revealed and established. Relevant quotations were marked, extracted, and provided with an ID, resulting in a collection of 198 quotations. The contents of the quotations were assigned to one or more categories using rough coding, with the first differentiation comprising 15 categories, which were later reduced to ten categories.

The quotations were grouped thematically and overarching main statements were formulated. The contents of the quotations, which were coded with "interest", "content" or "material", were each systematically arranged in a separate table, providing an overview of the experiences gathered by the teachers regarding interest development, individual teach-

Table 3: Most mentioned reasons for interest and requirements on the content

Motivation	Description	Mentions
Relevance	General education and life-world relevance to understand the world and everyday things	12
Self-efficacy	Implementing one's ideas and products, and helping oneself to progress with own plans	10
Creativity	Ability to create new things, unhindered creative freedom, artistic freedom and expression	6

ing contents as well as teaching materials or tools. A total of 36 teaching contents and 29 teaching materials/tools were identified.

For the contents of the quotations, which were coded with "motivation" or "material - requirement," a separate tabular overview was also created, showing which motivating circumstances the teachers perceived in learners and which points were considered decisive for the use of teaching/learning materials in class.

A graphical overview of the topics was created, which placed the mentioned teaching contents in relation to the contents of the curriculum and was color-coded according to students' previous feedback on the topics. This provided a clear and comprehensive understanding of the teachers' perspectives on students' interest in CS and the content factors that may influence it.

4 RESULTS AND DISCUSSION

The results of the interview study provide insight into the perspectives of high school CS teachers on students' interest development, lesson content, and usage of pre-designed teaching materials. The following section presents the results for each question, highlighting key themes and insights (see Table 3) that emerged from the interviews. To provide a rich and nuanced understanding of the teachers' perspectives, the results are supported by quotes from the teachers themselves.

4.1 Development of interest in CS

4.1.1 Interest Question 1

INT_Q_1: *With what interest and what expectations do students at secondary schools start the subject of CS?*

The teachers' experiences in this regard indicate that high school students generally have a positive attitude towards CS as a subject and are motivated to learn it. As one teacher stated:

> *Well, what I definitely see is that the students are very motivated. They are very interested in the subject.* (E,1)

The teachers see the origin of the interest among other things in the novelty of the subject, the social presence of information technology topics, the assumption that it is an important subject, and confirm that "*everyone knows that CS is an important topic*" (D,19). The interest of students is therefore presumably not based on the content of the subject, but on the assumption that it is an important subject. Often the relevance is also conveyed by the parental home. Parents have a "*fixed image*" and say that CS is "*important*" and "*good for life*" (B,16). One of the teachers observed in this regard students "*who already get something at home about what CS is*" and remarked: "*actually everyone imagines programming under it*". As a possible reason for narrowing the subject area to the activity of programming, the teacher later reflected:

> *I can imagine that programming is a relatively easy answer, even if that is not the main activity at all. So, that it is something that you can most easily imagine.* (E,23)

The mental focus on programming on the part of the students was noted by all interviewees. One teacher described the students' ideas with the following statement:

> *They don't know what CS is and they imagine something else, namely exactly coding, how to program games, how to use mobile phones, and hacking.* (D,20)

The other teachers describe the expectations in a similar way. On the one hand, this assumption certainly contributes to the fact that, as mentioned above, there is a fundamentally positive attitude towards the subject among the students. On the other hand, some teachers see this as a cause for the differences in behavior between girls and boys. While some of the students, especially boys, often approach the tasks "*briskly*" (B,8) and without fear, because they have already dealt with programming themselves, inexperienced students, who on average include more girls, are skeptical about their future performance in the subject:

> *First of all, the students and especially the female students have great respect for programming. They imagine it to be incredibly difficult and often don't have the confidence to do it.* (F,2)

Some teachers also described that girls increasingly felt an "*initial tension*" (G,7) in addition to the strongly differentiated prior knowledge within a class due to a lack of previous skills in dealing with computers, which is recognized as a problem for teaching.

4.1.2 Interest Question 2

INT_Q_2: *To what extent do students' expectations of the subject of CS match what is actually happening in the classroom and to what extent is their image of CS changed by the lessons?*

The teachers report, that students at the beginning of the 7th school year have a predominantly positive attitude towards the new subject of CS. The reason for this is often the assumption that the main content of the lessons will be programming. In reality, however, programming fills only about one-third of the time in 7th grade. In addition, the topics of data and encoding, computers and networks, as well as information society and data security, are dealt with. Furthermore, only a part of the lessons takes place on the computer, which also does not correspond to students' expectations. This design of the curriculum risks disengaging students who had especially programming in their minds and have to do something else now. One observation of the teachers was that due to the discrepancies between the anticipated image of the students and the actual teaching reality, disappointment on the part of the students quickly became noticeable at the beginning of the school year:

> *The fact that we don't work on the computer for a large part is a bit of a damper for the students because they imagine it to be more exciting on the computer. That is actually a bit of a problem.* (E,4)

It is difficult to get them excited about other topics because the students want to have their expectations fulfilled:

> *So, even the boys who say they are totally preeducated in CS and have a clue and interest, that is actually only limited to programming.* (E,9)

The experience that one's own previous knowledge was overestimated, which tends to occur more with the boys in a class, is less observable with girls who often start the school year unsure of their own ability, but "*then they realize that it is easy to grasp and that it can be done well*" (G,7).

One strategy to arouse interest, especially at this age when the topic of career choice does not yet play any major role, is "*not to open the barrel [to think] about job profiles, but [...] to arouse intrinsic interest in CS. Aesthetically, but also to simply understand the world*" (A,4). Through a sense of achievement in class, students begin to feel enthusiastic about the subject and thus gain advantages. Some teachers were also convinced that with the right tools, lessons can be designed appealingly enough to get over the increased initial disappointment:

> *Well, I have the feeling [...] that if you package it relatively well, in an interesting way, the students will still find it just as interesting. If you work it up methodically and didactically well, it can definitely be effective.* (E,22)

Once this hurdle has been overcome, the students also get involved in the other contents of the lessons, because "*they notice that it is also very cool content that explains a bit of this world that exists around them*" (G,2). Especially those subjects that have a clear connection to everyday life arouse interest. As a result, the students are "*involved for a long time during the school year*" (E,2). According to the assessment of some teachers, the experience of small successes and "*aha moments*" (B,17) is decisive for this and can be achieved much more often in CS lessons than in other school subjects.

In one case a teacher states that due to different approaches, the class should be divided according to gender (or alternatively experience) and taught separately. While boys try things out and approach the tasks quickly, girls are more hesitant and ask for more precise instructions. This makes them feel insecure and gives them the impression that they are not good at the new subject. Separation eliminates the constant comparison with each other and the girls in the class can become more courageous and gain positive experiences:

> *[Girls] do easier on all the topics that are written down, which are more cognitive. But the implementation, I'll say hands-on, many girls have a harder time with that. They simply don't have enough confidence, they are too cautious in their approach. And you have to provide much more support here.* (G,4)

4.1.3 Interest Question 3

INT_Q_3: *Why is it important to start CS education in schools at an early age?*

This question is intended to show arguments for the introduction of the subject of CS in the lower grades of secondary school. From the answers of the teachers interviewed, various reasons can be derived as to why the introduction of CS as a subject is advantageous for students at a young age. A frequent observation is that the young students approach the

subject in a more unbiased way than they would at an advanced age:

> *So 7th grade in CS, that's great, because a lot of people still have no idea and think CS is just hacking. And because they are introduced to it in 7th grade, they get a good picture of CS.* (B,1)

The later the students get to know the subject, the more they are influenced by their environment. It is often the case that by 10th grade they are "*somehow influenced to think that CS is always a boys' thing, for some reason*" (A,2). Later in the life phase of puberty, some girls often decide to distance themselves from the subject.

In 7th grade, two counteracting effects occur instead. On the one hand, the young students are still learning for the teacher and can build up new interests more quickly than at a later point in time when the interests have already been consolidated. They may find a role model in the teacher or through the suggestions in class from other people from the world of CS, which they gladly accept at that age and otherwise look for elsewhere. On the other hand, it is a compulsory subject in 7th grade. This means that students do not have to justify why they are taking this subject and do not have to choose for themselves in which learning group they want to spend their time with more or less. In this way, the view of CS can be shaped positively and create the basis for students to be interested in the subject area in the future. One teacher interviewed concluded the following from her own experiences:

> *I would assume that in 7th grade you can get a good three-quarters of the whole class excited about CS and maybe a quarter not. But that is probably also a quite normal average.* (G,3)

A long-term consequence of interested students gaining a better understanding of the contents of CS through the lessons is the sharpening of the idea about the subject of CS in the broader society. One teacher describes the current situation with the following words:

> *And in my opinion, a comprehensive idea of CS has not yet arrived in society. Something about computers and something about programming. But it's so fuzzy and so woolly.* (F,19)

CS can thus be perceived as part of today's general education. The contents of the subject are becoming increasingly important in order "*to be able to cope in this world*" (G,17).

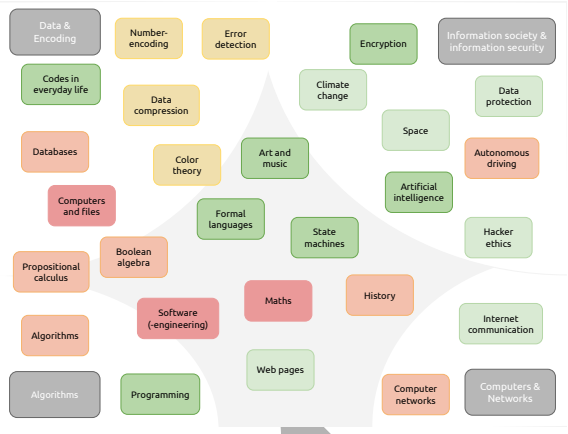

Figure 1: CS curriculum contents mentioned by the interviewed teachers (gray - thematic areas). Color according to teachers' overall experiences about how well the topic is received by students (red - not good, green - good)

4.2 Content of CS lessons

4.2.1 Content Question 1

CONT_Q_1: *What lesson content can strengthen the existing interest of the students and arouse new interest?*

At this point, it will be summarised which topics of CS lessons, according to the experiences of the teachers, capture the interests of the students regardless of their initial ideas about the subject.

At the beginning of the school year in 7th grade, students in the study area are introduced to CS for the first time by looking at common codes they have mostly encountered in their everyday lives (e.g. Morse code or Braille).

> *And they definitely find that exciting, because they can imagine something under it.* (E,6)

The students show interest because they mostly already know the contents and can now look at them in a different way. One teacher mentioned the topic area of encoding is particularly well suited to introduce the subject, as it is "*structured [...], comprehensible and understandable*" (G,6).

For other topics, too, it is of great importance that students can see a connection to the world in which they live. One of the teachers states:

> *I think CS always has the possibility of motivating students through its content. That the students are motivated for it when you make it visible to them that it always has something to do with their own lives. I think this relevance is extremely important.* (G,14)

One possibility is to take up newspaper articles and current topics in class. This works well because

timeliness is one of the things that distinguishes the subject of CS. Some learners "*really enjoy [...] discussing the impact of CS*" (A,7) and are very interested in the social components of the subject.

Since many students mainly associate programming with CS it is crucial to find a suitable didactic reduction that makes it easier for the students to get started: "*Programming languages like Scratch have helped to lower the inhibition threshold much, much, much less*" (B,9). The block-based programming environment of the graphical programming language simplifies the syntax so much that the students do not have to spend a lot of time and energy looking for small errors and inaccuracies and there is more time to deal with the actual problem. In addition, teachers reported that games and animations can be programmed in a simple way, which is a lot of fun for both the girls and the boys in the class.

The teachers report that the topic of cryptology also "*works well*" (D,13), "*creates interest*" (E,7),and "*they definitely [enjoy] it*" (G,9). The contents are inviting because a sense of achievement can be achieved quickly. At first, the students show less interest in the topic of data protection. However, as soon as they see how they themselves are affected by it, "*then it suddenly becomes exciting*" (B,7).

Another topic that has not yet been included in the curriculum of the study area, but is of interest to the students, is artificial intelligence.

Art and languages can be used to inspire girls in particular. Unplugged materials are also suitable for explicitly addressing female learners. They can work creatively while building an understanding of CS topics. Overall, girls at that age seem to be more interested in "*the big picture*" (D,25) and are particularly inspired by far-reaching visions.

4.2.2 Content Question 2

CONT_Q_2: *What kind of lesson content makes students lose interest in the subject?*

The aim of this question is to find out what content of lessons reduces learners' motivation to engage with CS topics. In the study area, it is common, that CS at school starts with the topic area of encoding. One teacher (E,6) reports, that this topic can also weaken motivation, in particular encoding text, numbers, and pictures can be too abstract for some. Programming also holds the potential for failure. Less experienced learners are quickly left behind because the complexity of algorithms increases rapidly. Furthermore, there is hardly any opportunity to look beyond the application of the theory of programming in the lower classes:

> *I can't really teach the concept of software at that age, they can't understand it yet. They can understand hardware because you can say that's what you touch. But that software is nothing other than a certain state of the hardware, that there are zeros in the memory and ones somewhere else, so to speak... the term software is not comprehensible for the grade level, one must say.* (D,17)

The history of CS and the question of how the technologies have developed up to the present time arouses little interest among the learners. They are most likely to be enthusiastic about the emergence of the internet, since the topic is so present in their everyday lives. However, one of the teachers (B,10) also observed that not all of them are eager to learn about the functioning of the internet and the applications in this area. Two other teachers also stated that they had the impression that networks "*quickly become too complicated for many*" (F,6) and "*are not a typical girls' topic*" (G,8).

If the lessons are strongly mathematically oriented, this has "*a rather deterrent effect for some*" (A,5). One teacher (C,7) had the experience of even losing half the class with mathematical tasks.

One of the teachers sees one reason for difficulties in teaching content in the design of the education plan:

> *[. . .] the curriculum is far too full. [. . .] it both burdens the teachers in the subject and also becomes a setting for the students, where perhaps the depth is missing or they are simply put under even more pressure.* (D,4)

4.3 Usage of pre-designed teaching materials

4.3.1 Materials Question 1

MAT_Q_1: *Which freely accessible educational materials and tools are used in CS lessons and why?*

The aim is to determine what added value the materials available on public platforms bring to the classroom in order to provide clues as to which criteria need to be taken into account when creating and publishing new teaching material (see Table 4).

All teachers interviewed use the programming language Scratch for the topic area of algorithms. This language, including its development environment, is also suggested by the state institutions. This becomes clear through the training materials offered on the state's teacher training server[2]. , administered

[2] https://lehrerfortbildung-bw.de/u_matnatech/

Table 4: Most mentioned problems, advantages, and requirements on the teaching materials

	Description	Mentions
Problems		
No-fit	Structure or content does not fit teacher's own teaching plans	6
No-need	Necessary only for beginner teachers or career changers	5
Advantage		
Personalisation	Student independence and personalisation of teaching easier achievable	3
New Topics	Content not usually covered are available, about relevant problems, topics from the students' life	3
Special Needs	Special support is possible, like communication through female role model	3
Requirements		
Structure	It has to be well-structured, small-steps with milestones	3
Curriculum Coverage	Reference to or coverage of educational plan needed	3
Background Information	Technical and didactical background information for teachers is necessary	3

by the Centre for School Quality and Teacher Training (ZSL), which include teaching materials on the topics of the educational plans of many school subjects in the study area.

The teachers use the Scratch environment because the playful environment arouses the interest of the students, the direct feedback lowers the inhibition threshold to try something out and several small feelings of success are possible within one lesson. In addition, the tool offers a lot of freedom for open projects and especially female students are enthusiastic about it. For the design of the lessons, some of the teachers use additional materials that are freely available on the internet. The website `code.org`, for example, offers an introductory module that the students can work on independently. The added value for the teachers is that during the independent work of the learners, individual support can be given, which otherwise there is often not enough time for. Two other teachers (A, C), on the other hand, stated that they only draw inspiration for using the platform from external materials and mainly create their own materials.

In addition to Scratch for programming, the teachers in higher grades use the simulation tool Filius because here results are also directly visible and thus success can be achieved quickly. The didactic tool was explicitly developed for teaching computer networks at German schools and therefore appropriately maps the contents of the education plan. One of the teachers remarks with regard to didactic tools like *Filius*:

> *It gives me the possibility to act didactically, didactically reduced. Not everything is presented. Some things are faded out, specifically faded out. The essentials are pointed out.* (G,22)

Another "*goldmine*" for teaching materials for CS lessons is the website `inf-schule.de` for many teachers. On the one hand, the CS topics are presented by many examples, so that the learners can work independently and at their own pace . On the other hand, the site also provides a good overview of the lesson topics and can serve as a textbook substitute. The lesson topics are structured in particular by supplementing the introductory materials with subject concepts that make connections clearer.

Many materials for teachers can be found on the App Camps website. However, videos and flashcards also provide the students with a predefined structure for independent work. In the materials, explicit attention is paid to female actors who are to act as role models for young schoolgirls.

Learners can work just as independently and only guided by a guidance program with materials from ETH Zurich and `Swisseduc.ch`. In this context, however, one of the teachers directly mentions the difficulties that this form of working entails:

> *It works moderately well, I think. Because it has the difficulty that the teacher then thinks he can lean back and "It's all there". But students don't read everything very intensively and you have to be very, very awake as a teacher and support very, very much.* (G,21)

Many teachers, therefore, use selected materials and do not leave the learners alone with the material for a longer period of time without providing the structure. Other elements such as HOUR OF CODE, LIGHBOT and unplugged materials from `Code.org`, YOUTUBE videos by Alexander Lehrmann and the Finnish website on the topic of artificial intelligence `ElemtentsofAI.com` are integrated in the lessons.

One of the teachers reported using a CORNELSEN textbook in class. However, the contents are not sufficiently prepared there and it is mainly used for structuring.

Important building blocks of CS lessons are so-called digital devices, such as the microcontrollers *Arduino* and *Calliope Mini* and the programmable sewing machine TURTLE STITCH. The special added value of this is to get results that "*you can hold in your*

informatik/gym/bp2016/fb1/2_algorithmen/

hand" (D,49) and thus quickly achieve great effects. One teacher (D) found that working with the *Arduino* appeals more to male learners due to its physical focus and working with the *Calliope Mini* appeals more to female learners due to its artistic focus. The complexity of working with accessories increases rapidly and the challenge can be quickly underestimated.

In summary, the reasons for using pre-designed teaching materials are ease of use (e.g. Scratch), relevance to the curriculum (e.g. Filius), flexibility (e.g. Code.org), support for special needs (e.g. role models in app camps) and variety of topics and activities (e.g. ETH Zurich/Swiss-Educ). However, the teachers also note some problems with using these materials. One issue is that while students can work independently with these materials, they still require guidance and support from the teacher, otherwise, students may not engage with the materials as deeply as needed. Additionally, these materials may not fully cover all aspects of the curriculum and teachers may need to supplement them with additional resources.

4.3.2 Materials Question 2

MAT_Q_2: *What requirements must materials fulfill so that they can be used in the classroom?*

This question complements the previously highlighted criteria for teaching materials. In this context, the reasons for not using external material are also mentioned.

A decisive criterion for materials that present CS topics in an age-appropriate way is the coverage of the curriculum goals. Furthermore, some of the interviewed teachers stated that the material should be easy to integrate into their own lessons. In addition to the goals, the underlying concepts and the structure of the material, should also fit well into their own lessons.One teacher stated that the material should be editable accordingly and should be under a free license so that, among other things, putting adapted or extended content online could not lead to legal problems.

Two of the teachers (A, C) interviewed stated that they were generally reluctant to adopt material and only used other sources for inspiration. The materials usually did not fit the class situation and their own planning and had a software or platform at their core that was unsuitable. One of the teachers added:

> *I think this supports people who don't have a CS didactics background now, for [them] it's good. I think the longer I'm here, I realize I don't need these offers at all.* (A,10)

Other teachers, on the other hand, were in favor of the material, when it is easily accessible and can be used with little time expenditure. An important topic for teachers is data protection when using external materials.

Also with regard to accompanying materials, not all interviewees held the same opinion. While one teacher (D) preferred materials that spoke for themselves and saw no added value in receiving additional information, two others (F, G) stated that background information on the topic and further didactic considerations could be an important help.

5 LIMITATIONS

One limitation of this interview study is that it was conducted with a small sample of teachers, which may not be representative of the larger population of CS teachers. Additionally, the sample consisted mostly of male teachers, which may limit the generalizability of the findings to female teachers. Another limitation is that the study relied on self-reported data from the teachers, which may be subject to bias or inaccuracies. Additionally, the study only focused on the perspectives of the teachers and did not gather data from students, which would have provided a more comprehensive understanding of the factors influencing interest in CS. Furthermore, the study was conducted in Germany, and the results may not be generalizable to other countries or cultures where the education system and attitudes towards CS may be different. Finally, it is important to note that this study is based on the responses of teachers, who may not have an objective view on the topic, and further research would be needed to confirm the findings.

6 CONCLUSIONS

In conclusion, the study found that, according to the interviewed teachers, students in 7th grade have a predominantly positive attitude towards the new subject of CS . However, it was also found that as the students progress in their understanding of the subject, their interest may wane if they do not see a connection to the world in which they live. Students are more likely to be interested in the subject if it is made relevant to their everyday lives and if they can see a possibility to have a relevant impact in their world (Marquardt et al., 2023). Additionally, the study found that the later students get to know the subject, the more they are influenced by their environment, highlighting the importance of starting early.

Pre-designed teaching materials can help teachers with interdisciplinary teaching by providing them

with a framework and resources to integrate CS concepts and skills into other subjects. These materials can include activities, lesson plans, and assessments that are specifically designed to connect CS to other subjects such as math, science, and language arts. Additionally, pre-designed materials can also provide teachers with a variety of teaching strategies and learning activities that can be adapted to different learning styles and abilities. This can help teachers to better differentiate instruction and make the subject more accessible to a wider range of students. Furthermore, with pre-designed teaching materials, teachers can use the materials that are already created and can easily be integrated into lesson plans, and it eliminates the need for teachers to create their own materials from scratch. Thus, pre-designed teaching materials can save teachers time, and allow them to focus on teaching the material rather than creating it, which can make interdisciplinary teaching more manageable.

The teachers noted that the use of pre-designed teaching materials can be beneficial in terms of ease of use, relevance to the curriculum, flexibility, support for special needs, and variety of topics and activities. However, the teachers also noted some problems with using these materials, such as the need for guidance and background information, and the fact that these materials may not fully cover all aspects required by the curriculum. Overall, the study emphasizes the importance of making CS relevant and interesting to students in order to increase their engagement and understanding of the subject and to promote its wider acceptance in society.

CS is not just about computers and programming. It's about understanding the digital world we live in and using that understanding to shape a better future for humanity. The interdisciplinary nature of CS makes it ideal for preparing students to be successful in a wide range of fields. It's a tool that will empower students to shape the future and change the world.

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