Saving Bees with Computer Science: a Way to Spark Enthusiasm and Interest through Interdisciplinary Online Courses

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ABSTRACT

In computer science education (CSEd) it is a well-known challenge to create learning environments in which everyone can experience equal opportunities to identify themselves with the subject, get involved, and feel engaged. Especially for underrepresented groups such as girls or not computer enthusiasts, CSEd seems to lack sufficient opportunities at its current state. In this paper, we present a novel approach of using interdisciplinary online courses in the context of bee mortality and discuss the possibilities of such courses to enhance diverse learning in CSEd. We report summarized findings from a one-year period, including 16 workshops where over 160 secondary school students (aged 10-16) have participated in our online courses. Pre-test-post-test surveys have been conducted to gain insights into students' perceptions and attitude changes. The results show the potential of such interdisciplinary approaches to spark interest in computer science (CS) and to rise positive feelings toward programming. Particularly striking are the results from differentiated analyses of students grouped by characteristics such as low initial self-efficacy, coding aversion, or less computer affinity. We found multiple significant effects of our courses to impact students of those groups positively. Our results clearly indicate the potential of interdisciplinary CSEd to address a more diverse audience, especially traditionally underrepresented groups.

CCS CONCEPTS

• Applied computing → Education; • Social and professional topics → Gender.

KEYWORDS

Interdisciplinary curriculum, interest, gender, diversity, beginner, e-learning, STEM

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1 INTRODUCTION

The field of computer science education (CSEd) and computer science (CS) itself has been facing a persistent challenge of low diversity and participation of underrepresented groups, particularly in terms of gender [37]. One possible reason for this is that diverse learners' needs, interests, and non-stereotypical skills may not feel adequate, valued, or supported enough in traditional CS classes [e.g. 22, 36, 39]. Therefore, there is a need to explore alternative approaches to teaching CS that can appeal to more diverse students.

Interdisciplinary education, in which CS is taught in the context of other disciplines, is one such approach. One of the main reasons why interdisciplinary courses can be beneficial for motivating diverse students to study CS is that they provide context for the material being taught. When CS is taught in isolation, it can be difficult for students to see the relevance of the material to their lives and interests. However, when incorporated into other fields, it becomes more relatable and meaningful to students [22, 29, 32].

RockStartIT is an initiative offering various interdisciplinary CS courses. These courses provide context for the material being taught, break down stereotypes about who can succeed in the field, and open up a wide range of career opportunities. Through these courses, students can develop the skills and knowledge they need to succeed in the field of CS while also pursuing their passions and interests. In this study, we investigate the effectiveness of an interdisciplinary curriculum called the *Save the Bees Expeditions* by *RockStartIT* [23] that aims to raise interest in CS among students. The curriculum consists of online courses integrating CS with other subjects, such as biology and environmental studies. To identify effective strategies, our research is guided by the following research questions (RQs):

> **RQ1:** Can the interdisciplinary curriculum of the *Save the Bees Expeditions* raise interest for CS?

Here, we first want to investigate the overall effect (for all), and then, if there are any gender-related differences. Next, we want to dive deeper into the enthusiasm potential of different groups of students:

> **RQ2:** Can the interdisciplinary online courses positively impact groups of students that initially showed less self-efficacy, low computer affinity, and coding aversion?

Our study aims to contribute to understanding how interdisciplinary education can be used to improve diversity in CS. By exploring the effectiveness of the *Save the Bees Expeditions* curriculum, we hope to provide insights that can inform the development of other interdisciplinary CS education programs and help make CS more accessible to a broader range of students.

2 BACKGROUND

In recent years, there has been growing interest in the potential of interdisciplinary education to promote greater engagement and inclusion in CS. It is well known that students have different demands on learning contexts to unfold their potential and to feel engaged [7, 25, 40].

Previous research has also shown that interdisciplinary education can help promote greater self-efficacy and motivation among students, particularly those who may be less confident or experienced in CS. For example, previous studies [11, 17] indicated that women and programming-inexperienced students tended to prefer *people*-related activities over *things*-related activities. Especially in terms of gender, there is much evidence that girls do prefer real-world inquiry-based open-ended learning approaches with social impact [9, 22]. A recent study about *dramatists* and *patterners* learning styles emphasized girls' preference for *dramatists* learning patterns, which are featured by storytelling learning approaches [4]. Other studies indicate the potential of programs motivated by doing something for *social good* to impact self-efficacy and perception of CS in underrepresented groups positively [8, 16]. Strengthening self-efficacy [5] and broadening the perception of CS against negative stereotypes or negative/unrelated experiences with programming are essential for sparking enthusiasm and fostering interest [1, 22].

In our courses' design, we do expressly incorporate those findings from previous studies: we do not focus on the *things* (e.g. "programming for the purpose of programming"), but more on the *people* (e.g. "How can we make the computer do something useful for *us*?") and on the impact for *social good* ("How can we *save* the bees?"). Also, we provide a narrative context supporting *dramatists* learning styles but also differentiated task types and difficulties to meet the needs of rather *patterner*-associated students. In addition, our online courses address the benefits of e-learning, such as immediate, personalized feedback to encourage students [18] and providing a safe space where students can progress at their own pace without competitive pressure [14].

3 RESEARCH METHOD

In this paper, we shed light on findings from summarized data of one year of workshops where secondary school students participated in courses part of the *RockStartIT* project. In every workshop, students did choose courses (called *expeditions*) from the *Save the Bees Expeditions*. The courses connect topics from biology and geoecology about *bee mortality* with CS in such a way that students explore how CS can help solve big problems and make impactful contributions. All courses are freely available online (rockstartit.com). To capture changes throughout the workshops and the potential of our interdisciplinary online courses to impact students' perception and interest in CS positively, we used an experimental pre-test-post-test study design [13]. Therefore, students were asked to complete a survey at the workshop's beginning and end.

3.1 Course Design

In a total of six online courses (called *expeditions*), forming the *Save the Bees Expeditions*, students can explore the utility and joy of CS to solve big problems such as bee mortality. This way, the courses support a growth mindset, and students can experience CS as an essential tool to make impactful changes for social good, both factors that showed potential for addressing underrepresented groups in CS [6, 15]. Additionally, every course is explicitly designed so that no previous knowledge is required at any time. This should make the courses more accessible to a broader audience, especially to those students who could not identify themselves with the subject through prior experiences and thus did not spend as much time with the subject as others. The expeditions then provide a safe space where participants can progress at their own pace and choose their depth and difficulty based on their needs. The duration of one expedition is about 60 to 90 minutes.

The six expeditions cover CS topics from web development to data science, artificial intelligence (AI), to project management. Each *expedition* starts with a problem statement under the grand goal to *"save the bees"*. The given problem raises food for thought about alternative solutions. Early in the process, students will experience technology as a helpful and fun tool to achieve such big goals. This way, CS is no longer introduced as an end in itself, but with a broader purpose, and in this particular case, with a personal, relevant touch through the higher-ordered goal of saving the bees. A variety of interactive elements (e.g. H5P elements, the interactive database DB Fiddle, the Teachable Machine by Google,…) guide the students on their journey, providing different levels of detail and difficulty to ensure active participation.

In an introductory expedition, a short introduction to the interdisciplinary topic of bee mortality is given with some background from biology. In the *Web Expedition*, students face the question "How can we inform as many people as possible about the problem?" and find homepages as a great solution. They learn essential web technologies and build their own homepage using HTML and CSS. In the *Data Science Expeditions*, students investigate how bee populations change in different areas and how they can help local beekeepers find an optimal location for their bee hives. They learn about suitable storage strategies and how to use database technologies such as SQL to find new knowledge in big datasets. The starting point for the *AI Expedition* is whether all bees leaving the bee hive will also return. The students experience that counting bees alone is very dull. They learn about possibilities to train the computer with machine learning to recognize and count bees. Therefore they experiment with models in the Teachable Machine by Google (TM) and are encouraged to train their own AI. The last expedition *Team Expedition* is about requirements for starting an own initiative. First, they learn about the basic principles of project work. Then they go through a hiring process where they choose fictive people for their initiative on provided characteristics. At the same time, this is a recap illustrating that big problems involve interdisciplinary collaboration, often including many very different fields of CS, highlighting the broad spectrum of CS.

3.2 Context

Since the workshops were conducted in Germany, we will shortly illustrate the CSEd situation in the study area. The KIT has, with more than 2700 active students in the CS degree program, one of the largest programs in Germany. Still, just less than 13% of the students are female, illustrating the diversity problem. Since the ratio of females under new registrations is also just roughly 15%,

Figure 1: Students working on online courses of the *Save the Bees Expeditions* by *RockStartIT* in a computer lab at the KIT

CSEd in secondary school might be an important set screw. In the study area, CS is a mandatory subject in grade 7 (ages 12-13) of secondary school (the *gymnasium*), but only in that grade and only since 2016. For grades 8, 9, and 10 there is no dedicated subject for CS. CS is then only selectable in a trade-off with a second foreign language as part of the subject IMP, a combination of informatics (the more common term for CS in Germany), maths, and physics. This drives CS in a challenging situation. CS in this educational level has big pressure to glance at a high level to attract as many students as possible in order that they are not lost here. This highlights the need for innovative CSEd approaches.

3.3 Workshops

We collected data from 16 different workshops from January to December 2022. All workshops were in German and conducted by scientific staff familiar with the project. The workshops were conducted in either one of the following setting types: a face-to-face (F2F) setting in a computer lab at the KIT (see Fig. 1) or an online setting via conference tools (*Zoom*, *BigBlueButton*). In both settings, participants enrolled in online courses of the *Save the Bees Expeditions* and could ask for support at any time during the workshop. In the online setting, the scientific staff was always present with video and voice turned on. The duration of the workshops varied from 2-to-3-hour day workshops to 6-hour day workshops, to repeating 2-hour workshops for six weeks. In the day workshops, students usually completed one or two expeditions (excluding the introductory expedition). Student groups of the six-week program usually went through all expeditions (except for the *Team Expedition*).

3.4 Participants

Over 160 students participated in the workshops. We had 164 valid responses in the pre-test and 131 in the post-test. Invalid cases were responses with 5-star (or 1-star) ratings only, identified through negatively formulated control questions in the survey. For validity purposes, we excluded all cases from our analysis without transparent allocation between the pre-test and post-test data. The final dataset included responses from 130 students (79 female, 50 male, and one non-binary) from German secondary schools. The mean age is 13.14, ranging from 10 to 16 years. All participants were informed about their rights to participate in the survey study and confirmed a written declaration of consent. Participation in the survey was voluntary.

3.5 Survey

We asked the participants to fill out a survey at the beginning and end of the workshop. In the case of the six-week program, this was done only once at the beginning of the first workshop session and once at the end of the last workshop session. We used a previous study questionnaire to access our courses' enthusiasm potential [28]. The questionnaire consists of 28 items, most scaled on a Likert scale from (1)-*"Strongly disagree"* to (5)-*"Strongly agree"*. The questionnaire is used to measure enthusiasm potential based on the cognitive constructs *interest*, *positive feelings*, and *future intents* from the person-object theory of interest (POI) [26]. The value for one construct is then calculated for responses to multiple items related to the specific construct. The questionnaire also includes items to perception such as students' *interdisciplinary preferences* and *self-efficacy*. In addition, we collected sociodemographic data for gender (choices: *"female"*, *"male"*, *"not listed"*), age, grade level, and average time spent on a computer daily.

3.6 Analysis

First, we performed an exploratory analysis with descriptive statistics (means and effect sizes) to estimate the potential impact of our approach on different groups [19]. Then, we used paired t-test and independent t-test analyses with 95% confidence intervals (CIs) and Cohen's d for effect sizes to compare pre-test and post-test results (within-subject analysis) as well as differences between different groups (between-subject analysis) [20, 27].

4 FINDINGS

Next, we will present the results related to our RQ1 (*"Can our interdisciplinary courses raise interest for CS?"*), followed by the results related to our RQ2 (*"What is the effect on different sub-groups?"*). Figure 2 depicts the distribution of students by groups and according to their scores in the three constructs positive feelings, future intentions, and interest in the pre-test (x-axis) and post-test (y-axis). All cases above the diagonal represent an increase from the pre-test to the post-test. Table 1 contains a summary of the t-test results.

4.1 Can the Interdisciplinary Courses raise Interest in CS (RQ1)?

A quick examination of Figure 2.A reveals that interest and future intents in CS were already high at the start of the study. Still, the t-test analysis indicates that the interdisciplinary courses have the potential to further increase general interest in CS (see Table 1:Interest-all). Although positive feelings and future intentions did not show statistically significant change, the responses on the item *"Coding is fun for me"* suggest an increased acceptance for coding t(121)=-3.00, d=-0.27, p=.004, and responses on the item *"I can see myself doing something in the field of CS later on after school"* indicate a positive effect on future intentions t(122)=-2.15, d=-0.19, p=.033. Additionally, the results indicate a statistically significant effect

Table 1: Paired t-tests for pre-test (1) to post-test (2) results by group

Construct (related survey-items)	Group	N	M_1	M_2	SD_1	SD_2	Cohen's d	95% CI Lower	95% CI Upper
Interdisciplinary preferences	all	126	3.91	4.13	0.85	0.85	-0.32^{***}	−0.50	−0.14
(*"I like to combine knowledge from*	girls	77	3.84	4.10	0.89	0.90	-0.37^{**}	−0.60	−0.14
different domains to solve problems")	boys	48	4.00	4.15	0.77	0.77	−0.24	−0.52	0.05
	coding aversion	16	3.56	3.88	0.89	0.89	-0.44^{1}	−0.95	0.08
	low initial self-efficacy	12	3.50	3.58	1.00	1.08	−0.16	−0.73	0.41
	low computer affinity	40	3.73	3.85	0.99	0.98	−0.19	−0.51	0.12
Self-efficacy	all	125	3.64	3.77	0.98	0.99	−0.16	−0.34	0.02
(*"I know I can do well in CS"*)	girls	77	3.49	3.65	0.96	0.94	-0.19^{1}	−0.42	0.03
	boys	47	3.89	3.96	0.98	1.04	−0.08	−0.37	0.20
	coding aversion	15	3.07	3.73	1.44	0.96	-0.74^{*}	−1.31	−0.16
	low initial self-efficacy	12	1.67	2.83	0.49	0.94	-1.05^{**}	−1.74	−0.32
	low computer affinity	40	3.40	3.43	1.00	0.99	−0.07	−0.38	0.24
Positive feelings	all	123	3.77	3.80	0.86	0.82	−0.05	−0.23	0.12
(e.g. *"Coding is fun for me"*, *"Learning*	girls	73	4.08	4.16	0.79	0.76	−0.13	−0.36	0.10
about what computers can do is fun")	boys	44	4.50	4.53	0.59	0.52	−0.06	−0.35	0.24
	coding aversion	15	3.84	4.18	0.97	0.75	-0.59^{*}	−1.13	−0.03
	low initial self-efficacy	11	3.27	3.61	0.65	0.83	−0.44	−1.05	0.19
	low computer affinity	35	3.97	4.22	0.79	0.80	-0.38^{*}	−0.72	−0.03
Future intents	all	118	4.24	4.30	0.74	0.70	−0.10	−0.23	0.12
(e.g. *"I can see myself doing something in*	girls	75	3.66	3.70	0.79	0.76	−0.07	−0.29	0.16
the field of CS later on after school",	boys	47	3.94	3.95	0.89	0.78	−0.02	−0.31	0.26
"I do not want to deal with coding in my life")	coding aversion	15	2.69	3.31	0.67	0.95	-0.94^{**}	−1.54	−0.31
	low initial self-efficacy	10	2.90	3.03	0.82	0.51	−0.16	−0.78	0.47
	low computer affinity	39	3.61	3.61	0.82	0.85	0.00	−0.31	0.31
Interest	all	122	4.07	4.18	0.65	0.66	-0.21^{*}	−0.38	−0.03
(e.g. *"Computer scientists deal with*	girls	76	3.99	4.08	0.70	0.70	−0.17	−0.40	0.06
interesting topics", *"What I learn in CS*	boys	45	4.18	4.32	0.56	0.56	-0.26^{1}	−0.56	0.04
I know I can put to good use later on")	coding aversion	16	3.60	4.04	0.86	0.69	-0.74^{*}	−1.28	−0.17
	low initial self-efficacy	11	3.40	3.75	0.80	0.89	−0.45	−1.06	0.18
	low computer affinity	37	3.97	4.10	0.62	0.69	−0.20	−0.52	0.13

^{1}p<.1, *p<.05, **p<.01, ***p<.001

of the courses on positively impacting students' interdisciplinary learning preferences (d=-0.32, p<.001).

When considering the gender of participants, the results show no statistically significant difference between girls and boys regarding the courses' impact on positive feelings, future intentions, and interest in CS (|d|<0.1, p>.6). However, an independent t-test analysis showed that the initial positive feelings t(111.60)=-3.38, d=-0.59, p<.001, future intentions (t(96.52)=-2.20, d=-0.41, p=.030), and interest (t(110.36)=-1.92, d=-0.34, p=.057) in CS for boys were significantly higher than for girls. For girls, the courses seemed to have a small to medium effect on their perception of the personal use of programming (*"Coding skills can help me in my everyday life"*) t(75)=-2.51, d=-0.29, p=.014. The results were particularly striking in girls' interdisciplinary learning preferences (d=-0.37, p=.002) and also indicated an improvement in girls' self-efficacy (d=-0.19, p=.096).

Observation 1: Interdisciplinary learning contexts have the potential to increase students' interest in CS regardless of their gender. Experiences with interdisciplinary learning even increase students' preferences for this type of learning.

4.2 How do the Interdisciplinary Courses affect Students depending on Initial Conditions (RQ2)?

In this section, we focus on sub-groups of students who initially displayed values that indicate hindering factors for a positive relation to CS.

Coding Aversion. The first sub-group we analyzed is the group of students who initially had a hesitant attitude towards coding (N=18, f=14), as reflected by a rating of four or five on the item *"I do not want to deal with coding in my life"* in the pre-test. Results show that after participating in the online courses, this group had significantly

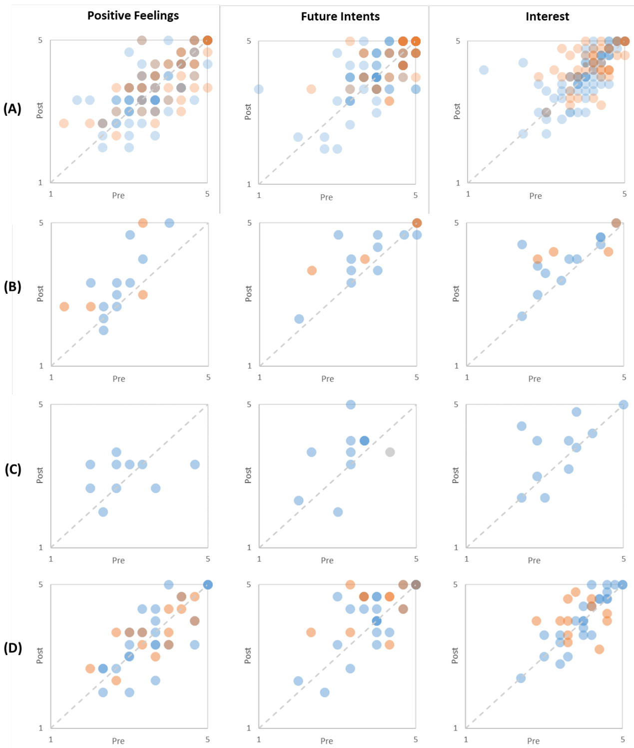

Figure 2: Scatter plots for responses in the survey and by groups (rows). The x-axis represents pre-test values and the y-axis post-test values. Blue cases are female students, and orange ones are male students. (A)-all, (B)-coding aversion, (C)-low initial self-efficacy, (D)-low computer affinity

higher positive feelings (d=-0.59, p=.038), future intents (d=-0.94, p=.003), and interest (d=-0.74, p=.010). At the same time, there was a significant increase in their self-efficacy (d=-0.74, p=.012). The scatter plots for this sub-group (Figure 2.B) clearly demonstrate the positive impact of the courses on this group of students.

Low Self-efficacy. Self-efficacy is considered an essential factor in strengthening underrepresented groups in CS [1, 5]. In this paragraph, we investigate the effect of our courses on a sub-group of students (N=12, f=9) who initially displayed lower self-efficacy, as indicated by a rating of two or one on the item *"I know I can do well in CS"* in the pre-test. The courses did not have a statistically significant impact on these students' attitudes towards CS according to the three constructs of interest, but there was a medium effect on their positive feelings (d=-0.44, p=.167) and their interest (d=-0.45, p=.165). Furthermore, their increased interest is highlighted by the large effect on the item *"What I learn in CS I know I can put to good use later on"* t(10)=-3.07, d=-0.93, p=.012, and the medium effect on the item *"Computing jobs are boring"* t(11)=1.82, d=0.53, p=.096. Figure 2.C illustrates that the courses positively impacted most of the students in this group. The most prominent effect of the courses was on their self-efficacy, which increased significantly from the pre-test to the post-test (d=-1.05, p=.004), but at the same time, the variance increased a lot (SD_1=0.49, SD_2=0.94).

Low Computer Affinity. This sub-group includes all students who reported spending on average less than one hour per day on the computer (N=40, f=26). The results indicate that participation in the study had no significant effect on the future intentions or interest in CS of this group. However, there was a small to medium statistically significant effect on the positive feelings of this group (d=-0.38, p=.032), particularly in the results of the item *"Coding is fun for me"* t(36)=-2.75, d=-0.45 p=.009.

Low Interdisciplinary Preferences. As a control group to the previously mentioned sub-group, we were interested in determining whether our courses had a negative impact on students who did not express a preference for interdisciplinary learning (N=39, f=27). This sub-group includes all students who in the pre-test did rate the item *"I like to combine knowledge from different domains to solve problems"* with a three or lower. The results indicate that the courses had no significant effect on this sub-group's positive feelings, future intents, or interests. However, the courses did have a positive impact on the students' interdisciplinary learning preferences, which increased from pre-test (M_1=2.85, SD_1=0.37) to post-test (M_2=3.36, SD_2=0.81) with a highly significant medium to large effect (t(38)=-4.23, d=-0.68, p<.001).

> **Observation 2:** Interdisciplinary learning contexts have a high potential to positively influence students' attitudes towards CS (positive feelings, future intents, interest, and self-efficacy), particularly of students with initially low self-efficacy or coding aversions.

5 DISCUSSION

Our findings support the claims of previous studies that interdisciplinary education can be an effective approach for increasing interest, and engagement in CS, and addressing diversity in CSEd [e.g. 3, 22, 29, 32, 33]. Our results also indicate, that the majority of students in the sub-groups identified as having coding aversion and low initial self-efficacy are female, which highlights the importance of promoting a positive image of coding and strengthening self-efficacy to make students feel comfortable and confident in the field of CS [1, 34]. This observation is further supported by findings presented in [21], which indicate that girls' first contact with CS typically happens in the presence of more experienced learners, typically boys who tend to have a one-year head start in computer usage due to their strong focus on one discipline. As a result, girls often struggle and feel uncomfortable, leading to aversion towards typical CS course activities, such as coding, and low self-efficacy.

The results of our study also show that the courses had a striking effect in increasing girls' interdisciplinary learning preferences. This could suggest that some students may not have had a clear understanding of what interdisciplinary learning means, and may have initially viewed it as rather negative, because combining knowledge may be considered something more difficult in general. Nevertheless, participation in interdisciplinary courses increased their preference for this type of learning. This aligns with previous studies that have shown the benefits of learning environments that embed topics into a broader context and involve creative and problem-solving skills, particularly for underrepresented groups in STEM [12, 30, 35].

Our work also responds to the challenge identified recently by Tellhed et al., who found an essential interaction between interest in CS and programming self-efficacy: "To attract more women to IT, we thus need to find ways to not only to make girls think 'Sure I can code', but also 'and I want to!' " [34, p. 9]. Our courses increased the willingness to program, particularly among students who were not initially programming enthusiasts. Since programming was not a primary focus of our courses, our approach of communicating programming as a tool to achieve something more remarkable may be an alternative pathway into CS, and the ones taking this way gain self-efficacy and collect success experiences by having a relatable impact in the area of their interest.

Even though we did not find indications of a significant adverse effect on a specific group in our current study (e.g. courses had, on average, at least as a positive effect on boys as on girls), in an earlier study, we found the potential of such courses to polarize [2]. Thus, we want to point out that it is still necessary to carefully consider the diverse needs of students and that polarization is avoided when developing an interdisciplinary CS curriculum. This adds an additional layer of complexity to the already challenging task of preparing interdisciplinary material and communicating across disciplines [35]. The need for further research in this area is highlighted by the importance of identifying the potential and sustainability of different interdisciplinary approaches to CS education.

> **Recommendation:** Incorporate more interdisciplinary contexts in the CS curriculum. This might help underrepresented groups build self-confidence and develop a better relationship with CS without neglecting other learners' needs.

6 LIMITATIONS AND THREATS TO VALIDITY

Overall, while the study provides valuable insights into the potential of interdisciplinary education to impact student attitudes and perceptions towards CS positively, it is important to consider these limitations and threats to validity when interpreting the results.

Firstly, the results presented in this paper are based on data collected from multiple different workshops, which may introduce validity threats arising from the potential impacts of different settings. To address this, we have used a repeated case study design [38] to generalize our findings beyond a single case, and we plan to investigate the influence of different environments further in future studies. Also, if we want to transfer our findings into recommendations for traditional CSEd, a settings variety might be substantial since classroom settings also vary greatly. Still, we plan to investigate the influence of different environments in the future.

Secondly, the answers provided by students in the survey are subjective and may be influenced by their surroundings, which may not accurately reflect reality. Especially for Likert scales, the perceived distances between two ratings might vary depending on the student, and a change from a four-point rating to a five-point rating, for example, might be more unlikely than the other way around [24], so results might underlay a tendency to underestimate the effect since interest was already at the beginning at a surprisingly high level. Additionally, how we sub-grouped students using a single item could raise threats to validity, as it may not necessarily reflect the actual probability of belonging to the identified sub-groups. Nevertheless, on the one hand, it is also problematic to include additional items in the survey, which might affect the reliability of students' responses negatively. On the other hand, our goal for the current study was to identify tendencies of which the selected items can be assumed to be good indicators.

Thirdly, our sample size is relatively small, and more studies with larger sample sizes and different sub-groups are needed to validate our findings. For the validity purposes of our pre-post comparison, we did limit our study to pre-post-matching responses resulting in a total of about 130 students. Furthermore, pre-test-post-test studies like ours are closely related to the concept of *situational interest*, which may be influenced by factors other than the courses themselves, such as a novelty effect. While situational interest is necessary to develop long-lasting interest [31], it is still important to note that this is a limitation that must be considered when interpreting our findings.

7 CONCLUSION

The presented study highlights the potential of interdisciplinary education in raising interest and engagement in CS and addressing diversity in the field. We were able to demonstrate the effectiveness of our interdisciplinary *"Save the Bees"* curriculum by *RockStartIT* in increasing interest and engagement in CS for all students, with particularly positive effects for sub-groups of students who initially showed less interest, less self-efficacy, and coding aversion. By breaking down the barriers between disciplines, we can tap into a broader range of skills and perspectives, resulting in a particularly impactful approach to addressing the underrepresentation of certain groups, such as women, in CS. When CS is incorporated into other fields, it becomes clear that there are many different ways to use and understand CS and that anyone can succeed in the field. This can help remove barriers and open the field to a more diverse group of students, including girls. The results of this research can inform educators and policymakers on how to design and deliver CSEd in a way that addresses the diverse needs of students. It is essential to continue exploring and developing interdisciplinary approaches to CSEd to promote greater inclusion and engagement in CS. This can also help to make the field more accessible and inclusive, as it shows that there are many different paths to success in computing, as summarized by a quote from Cheryan et al. [10, p.6]:

> *"By broadening the mental picture of what it means to be a computer scientist or engineer, we may not only attract more women to these fields, but also be more accurate about what computer science and engineering are like and what they have the potential to become."*

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