From Beliefs to Intention: Mentoring as an Approach to Motivate Female High School Students to Enrol in Computer Science Studies

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ABSTRACT

We present the mentoring program *make IT* which was designed to motivate female high school students to study computer science. The measures of the program address different factors which have been shown to hinder a decision of girls to study a STEM[1] subject. First empirical results of a mainly qualitative evaluation of the program show that the program is rather promising. To gain deeper insights in the respective effects of the different components of our program, we developed a questionnaire based on the Theory of Planned Behaviour (TPB). In this way, we want to provide a theoretical foundation to the positive evaluation we gained for this project starting in practice. We instantiated the TPB to reveal the impact of *make IT* on attitude, subjective norms, and perceived behavioural control and, in consequence, the impact of these constituents on the intention to enrol in a CS program.

CCS CONCEPTS

• **Social and professional topics** → **Computing occupations**; *CS1*; *Employment issues*; Computer and information systems training; Information systems education;

KEYWORDS

computer science mentoring; questionnaire; theory of planned behaviour

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1 INTRODUCTION

The likelihood for choosing an IT career is lower for female than for male high school students. As women are not less qualified than men to study computer science (CS), the lower proportion is not caused by a lack of competence in female students [17]. Instead, the presence of gender stereotypes, negatively connoted self-perception in girls and the absence of female role models are considered to be reasons for a smaller number of female students in CS [27].

Various measures to increase the number of female students in STEM subjects have been investigated [27]. Existing measures mainly cover information events or one-day workshops that aim to trigger interest in female students. Interest in CS is an important prerequisite to developing the intention to take this career path. However, it might not be sufficient to determine the choice of CS as a course of study.

Mentoring programs have been shown to be effective in providing support for protégés (*mentees*) with respect to psycho-social functions as well as for career development [31]. Based on previous research we claim that mentoring can also be a suitable measure to create positive beliefs in female high school students. Therefore, we assume that mentoring can trigger the intention to study CS in female high school students and that it increases the likelihood for enrolment in CS accordingly. Effectiveness of mentoring with respect to positive beliefs can be measured and explained by combining qualitative and quantitative approaches. Evaluations should not only examine the quality of a program and of the mentoring relationship, but also the mentee's beliefs and changes in the long-term [5, 16].

This paper contributes to the research body in that way, that we present a mentoring program, that showed promising results in interviews as well as in a quality-oriented questionnaire. The program is currently reassessed based on a theory-driven questionnaire, which we present in this paper and which complements our existing evaluation measures. We implement the theory-driven questionnaire in order to test the effectiveness of *make IT* in the long-term, meaning whether our mentoring program can positively influence girl's beliefs, and thus the intention of female high school students to enrol in CS.

In the following, we first introduce literature, explaining how beliefs in young women evolve and how mentoring can motivate female high school students to enrol in CS accordingly. Afterwards, we will present our program *make IT* together with first evaluation results. Based on our experience with the mentoring program, we finally propose a questionnaire based on the Theory of Planned Behaviour (TPB) from Fishbein and Ajzen [1, 20]. This questionnaire will be applied at the beginning and at the end of our current mentoring round. This way, we try to obtain a theoretical basis for

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the positive evaluation we got regarding our program in practice. Thereby we hope to get deeper insights in how the different aspects of the mentoring program influence high school students beliefs and their intention to enrol in CS studies.

2 MENTORING AND BELIEFS

In this section, we will give a review of literature relevant to the design of a mentoring program engaging female high school students in CS. That is, we focus on findings on mentoring that is carried out within the phase of study decision. This phase is usually undergone by students during their last school years. There is plausible empirical evidence that beliefs in this stage have a strong impact on their career choices [27, 38].

2.1 Gender-specific attitudes towards computer science

According to findings in previous research, girls show less interest in STEM than boys at the end of high school [18, 34]. For instance, in a retrospective cohort study of Sadler et al. with more than 6000 students, male students showed high interest in technical fields, whereas girls preferred medicine and health-oriented subjects [34]. This result aligns with findings of other researchers that report a higher interest of girls in humanities and social subjects [27, 42]. One of the major findings of the retrospective cohort study was, that the overall interest of girls in STEM declined during the high school years (from 15,7% to 12,7%). For boys the interest remained stable (from 39,5% to 39,7%). Studies performed by Bitkom show that for CS the amount of female university students is far behind the amount of males (around 14%) in Germany [6].

The reasons behind these differences are diverse and multiple factors have been identified to influence young girls' attitude towards CS. Comparing girls and boys, there is no evidence for differences in talent and giftedness. More common are differences in self-perception, interests, goals as well as environmental influences [42]. In the subsequent paragraphs currently discussed factors are presented with respect to female high school students and CS.

Stereotypes: One important factor that influences the study decision is **self-perception** which is highly related with the perception of sex stereotypes. Especially during and in the first years after puberty, girls and boys try to comply with stereotypes which they think they belong to [27]. As summarised by Schmid et al. [35] different studies reveal, that CS study and occupation is linked with stereotypes, which do not match with the classical female role model. The traditional role model refers mainly to taking care of a family and behaving socially acceptable [26], whereas the stereotype for computer scientists implies for example being technology-oriented and highly intelligent, focussed at the computer and having limited social competencies [11]. In addition, research interviews showed that girls who are interested in CS are judged by peers to be less attractive [33].

That indicates that the environment has a great influence on girls' beliefs about implicit and explicit norms. In case girls do not fulfil expectations it is very likely that they will get negative feedback. As a consequence girls are more likely to act according the norms. For example teachers that expect girls to perform worse in mathematics might not only create negative beliefs in girls about their capabilities but they might even make the girls show the expected behaviour [27]. Thus, certain beliefs about norms have the potential to determine the career path a high school student takes. Existing literature confirms that girls enrol in social science and humanities rather than in STEM as these fields align with gender stereotypic education and expectations [23]. To overcome those gender stereotypic norms, **role models** (see section 2.3) can serve as examples that differ from the norm.

Experience and goals: Since many girls do not develop interest in STEM or loose it during the years, they set their goals lower compared to boys, leading to less success and experience in this field [18, 42]. However, even girls that are interested in STEM might have difficulties to identify career options best suited to their talents and goals. Since humans have different goals they try to achieve, like living in a secure environment, working in a field they like, never being unemployed or earning a lot of money, they need to negotiate the alternatives in order to make a decision about suitable career paths that align with their goals. For example, empirical findings show that female students are more likely to choose a study subject based on their interest rather than based on financial and career related aspects which is more likely for male students [35, 36].

Especially at the end of high school, students are situated at a point in life at which they decide about further directions. However, if they are not aware of their talents and future goals as well as which study fits best to them, and if relevant information about certain fields of study or job descriptions are not available, it might be hard for high school students to make a reasonable decision.

Giving relevant **information** about the subject of CS and careers in this field can help to overcome gaps in experience and to ease complex decisions. Services, such as counselling can be offered to female high school students (see section 2.3). Counselling might alter behavioural beliefs and can help to identify desirable actions that comprise the individual goals. For example, it would be interesting to see, whether the girls' viewpoint on financial and career related aspects changes through *counselling* offers.

Perceived skills: Girls are found to show less confidence in their capabilities and skills [37]. In order to motivate female students to study CS as an alternative to social science and humanities, personal beliefs about skills need to be addressed. It is crucial whether girls believe that they are able to achieve or accept new skills [13] or whether they think their skills are part of their fixed abilities, which are difficult to influence. Therefore, in order to develop a positive self-perception and good skill performance, it is important that a person considers her own effort to be the cause of success and the lack of effort to be the cause of failure instead of the lack of ability [41]. Furthermore, realising that one is responsible for own achievements is a prerequisite to success [39]. Accordingly the study decision is concerned with the question of whether success is expected in a field of study which, as mentioned before, depends on perceived skills in this domain. Along with the perceived likelihood of success, girls and boys choose a study field based on their personal fit to a particular environment.

For boys MINT seems to be an appropriate environment in comparison to girls [42]. In this regard Ziegler et al. describe an actiotope model, which refers to (1) the environment, (2) the repertoire of developed as well as accessible skills and actions and (3) to the goals

that a person has [42]. This actiotope can be altered or analysed by a mentor in order to support a mentee. Usually appropriate actions are taken to reach goals within a certain environment. However, Ziegler et al. showed that the repertoire of actions differs in girls and boys. They hypothesise that one reason for the smaller amount of girls in STEM might be that girls and boys perceive their actiotope differently. Boys are found to often overestimate their skills, whereas girls are more likely to underestimate them, especially in STEM [35, 36]. Furthermore girls less often take opportunities that are accessible in their environment, such as participating in a voluntary STEM workshop although this would increase their skills [42]. We therefore claim that female high school students who experience **acceptance and confirmation** of their skills, will gain positive beliefs about their skills and change perception regarding their actiotope. This could be supported by providing opportunities for skill development combined with encouraging **feedback** on efforts.

Finally, the girls' environment has a significant impact on their beliefs. Therefore, mentoring programs should not only address stereotypes, career related content and goals as well as perceived skills. Additionally, mentoring needs to consider the girls' gatekeepers, such as parents, peers and teachers [32]. Therefore our theory-driven questionnaire considers gatekeepers (see section 4). The following paragraphs give a short overview on existing literature and relevant topics regarding mentoring.

2.2 Mentoring

In mentoring, a relationship between a mentor and a mentee serves the personal development and support of the mentee with respect to a certain environment, field or profession [29]. Depending on the setting, the mentor is the more experienced person or the person with desired characteristics, and the mentee in turn benefits from the experience or tries to adopt characteristics of the mentor. Great efforts have already been put into research on mentoring. Various theories, application fields and settings influenced the creation of models describing important aspects of mentoring relationships.

Theories come mainly from the fields of training for skill and personal development [28, 29] as well as from the field of socialisation and social learning [15]. Application fields that are predominantly present in the literature are youth mentoring [40, 42, 43], academic mentoring [12, 14, 24] as well as workplace and organisational mentoring [16, 25]. Relationships between mentors and mentees can take place in various settings, such as informal mentoring [2, 25] and formal mentoring [4]. Informal mentoring does not follow a predefined program within an organisation, whereas formal mentoring is embedded into a program with a clear structure and has a specific goal. Moreover classical mentoring [22], blended mentoring [40, 42], cross-mentoring [14], reverse mentoring [22], one-to-one mentoring [14], peer-mentoring [10, 12] as well as group mentoring settings [10] are distinguished.

The computer science mentoring program *make IT*, we present in section 3, is aiming at female high school students (youth), it follows a formal setting and it is implemented as group mentoring. In the following we describe classical functions of mentoring which we assume to positively affect the beliefs in girls who participate in our program.

2.3 Functions of Mentoring

According to Kram's theory [28, 29], which belongs to the most cited in the mentoring research area [5, 16], mentoring has two important functions. Besides a career oriented function, which is geared towards boosting visibility of mentees within an organisation, mentoring has also a psychosocial function. This function affects the mentoring relationship through four aspects: *role modelling*, *counselling*, *acceptance-and-confirmation* as well as *friendship*. In the following, we do not consider friendship for further analysis. We acknowledge that friendship increases the sympathy which is needed for a mentoring relationship, however we assume that appropriate role models, high quality counselling and confirmatory feedback can be provided by persons who are not in a closer relationship to mentees as well.

Role Modelling: The term *role model* can be addressed from two perspectives [21]: First, it describes the tendency of individuals to identify with other people that hold important social roles in order to increase the similarity between them by imitating desirable attitudes and behaviour [9]. Second, a role model can be utilized in terms of social learning, whenever individuals try to meet certain expectations. Thus, role models can be helpful to influence gender related self-perception in mentees and to support learning of new tasks and skills that align with these gained perceptions [7].

In mentoring relationships for female high school students, mentors can provide role models. For instance, they can offer information about women that are successful in the field of CS or they can even act as role models themselves, for example, if they have good mathematical abilities or good grades in their study [7, 43]. A female mentor can show that women are capable to gain valuable experiences in the field of CS and thus can show that stereotypes are not insurmountable. They can provide information about how women can be successful in a men's domain and might communicate aspects of reconciling family and professional career [8]. Mentors can even represent the future-self of the mentee if they generate in them the desire to achieve equal goals and to pursue competencies even under challenging circumstances [23, 39]. It is worth to mention that the relationship between the mentor and the mentee needs to be based on sympathy. Otherwise, role models might not be influential [7, 43].

Counselling: Mentoring serves the exchange of information and we consider it to be of great importance in counselling. The mentor provides new information and can give instructions on which steps to take with respect to the study decision and future goals [8]. This might include for example information about job and salary perspectives as well as the work environment in CS. We think that, the more relevant information is provided by mentors to mentees, the better the mentees can orientate in the field and set their own goals and beliefs about desirable behaviour accordingly.

Acceptance and Confirmation: Mentees are not just influenced by stereotypes and their desired goals, but also by their own performance and success expectations. As mentioned before, female high school students might not enrol in CS, although they are interested in this field, if they think that they do not have the necessary skills to successfully study CS. However, a mentor can assure and encourage mentees in that they already have relevant competences to be successful, respected and accepted in a new field.

By offering skill developing measures, such as workshops, a more supportive environment concerning the study decision and new application areas can be created. This means that the mentee gets the chance to explore new topics and skills [42]. If a mentee does not believe in her own capabilities, a mentor can show acceptance towards the mentee and thus resolve doubts by communicating and confirming positive expectations [27].

To sum it up, mentoring can influence the self-perception towards less stereotypic fulfilment of expectations. It can help mentees to find actions that are appropriate to achieve certain goals and it seems suitable to strengthen positive beliefs about capabilities and success in mentees, concerning themselves and the study of CS.

Nevertheless, during the mentoring relationship, certain deficiencies can occur, such as ambiguous goals, insufficiently qualified mentors, a low quality of the relationship between mentor and mentee and a duration for the mentoring that is not appropriate to the needs of mentees. The listed deficits can be controlled by thoroughly selecting and training mentors [30], by carefully choosing the mentor-mentee pairs [19], by selecting an appropriate duration for the mentoring program according to wishes of the mentee as well as aspects that need to be communicated [3] and by the implementation of measures to promote the quality of the relationship [29]. These measures help to ensure that the study decision is not made based on good or bad quality of the program, but rather based on presented role models, provided counselling and given acceptance and confirmation feedback.

3 THE MENTORING PROGRAM MAKE IT

In this section, we present the mentoring program *make IT* that was implemented and evaluated based on the mentioned quality aspects and that is subject of our further theory-driven analysis. Starting in 2005, at the University of Bamberg a variety of measures have been implemented to help girls to discover their possible talent and interest in CS [35, 36]. The latest of these measures has been the introduction of the mentoring program *make IT* in 2014. The initiative of this program originated in a long standing cooperation with a girls' school: One of the 11th grade girls in a course addressing study and career choices proposed that mentoring might be helpful. In consequence, we developed the first round of *make IT* in cooperation with a seminar course of this school.

3.1 Components of the Program

The program addresses high school students aged between 16 and 18 years who are in 10th and 11th grade, that is about two years before they gain their higher education entrance qualification. The program was designed to include measures specifically considering the concepts discussed above: First, self-concept and gender-biased stereotypes correlated with a negative image of women in CS should be addressed by involving the mentees with **role models** with whom they interact over a longer period of time. Second, the mentees should have the possibility to gain more **information** about CS, concerning content matter, study programs, career paths together with factors concerning expected salary and work-live balance by providing them with specific informations. Third, participants in *make IT* should be supported in achieving a more realistic assessment and a positive **confirmation** of their own abilities and skills by giving them hands-on opportunities to gain experience with different aspects of CS, including programming, involving informal but explicit individual feedback about their performance.

The *make IT* program is supervised by the project leader (female professor of CS with an additional background in psychology) together with a student with background knowledge in mentoring and empirical research. The program has been iteratively developed over three years with three groups of high school students (see Table 1): In the **first round**, only girls from the cooperating girls' school participated in the program and the program was open to girls already interested in CS as well as girls with other interests. Four female students of different CS degrees, offered at the University of Bamberg, participated as mentors. The mentors and the girls were involved in the design of the measures of the first round as well as in the evaluation. Furthermore, both groups contributed to the design of the web page, of flyers and in an information evening advertising the program.

Instead of a tandem between one mentor and one mentee, we decided that about three mentees are associated with one mentor. An interest profile of each mentee is assessed in the first meeting and the group composition is based on a best match policy. In general, the program involves several meetings of mentees and mentors as well as joint sessions.

In the **second round**, the mentoring program was advertised in nine high schools – specifically addressing girls in grades 10 and 11 who were in principle interested in studying CS. The mentors again were female students of CS, about half already were involved in the previous round. Due to feedback from mentors and mentees, we decided that encouraging girls to study CS should take place in mixed gender settings, at least partially. This allows to construct a more realistic impression about male CS students who typically have a negative image which might create another barrier for girls to select CS as a study degree. Consequently, in the **third round**, we opened the program to boys and girls and we involved male and female students as mentors. The mentees were free to specifically choose a female or male mentor.

Please note that from the second round onwards, the program is always advertised in all nine regional high schools. However, interest is distributed unevenly and will be open to variation over the rounds. Due to capacity restrictions, the program is offered for 18 high school students per round who apply with a motivational letter.

After three completed rounds, in our opinion the program has gained a suitable maturity. For the current fourth round, the measures of the previous round are kept. Now we also will start a systematic assessment of the effect of the various aspects of *make IT* on the attitudes of the high school students and their intention to study CS. An overview of the measures is given in Table 2.

In its current design, the *make IT* program provides regular contact to the female and male CS students who serve as mentors. In addition, mentees experience tutors and lecturers of both sexes when visiting CS classes. The visit of these classes is restricted to times when there is no school. Typically, one or two lectures are visited together with the mentor. One of these lectures might be outside of CS study, depending on the interest profile of the mentee. Moreover, mentees are informed about general aspects of studying at a university. Furthermore, they receive specific information

Table 1: Participants of *make IT* (each round started in fall and spanned 6 months).

Round	Mentees	Mentors
2014/2015	9 girls, grade 11, one high school for girls not exclusively interested in computer science	4 female students of computer science
2015/2016	17 girls, grades 9, 11, three high schools all interested in computer science	7 female students of computer science
2016/2017	3 girls, 3 boys, grades 9, 10, 11, three high schools	2 female and 3 male students of computer science

Table 2: Measures and their assumed effect on mental barriers to study computer science.

Mentors as role models	Changing the gender-related conceptualization of computer science as un-female towards a gender neutral concept
Specific information about computer science studies and occupational profiles	Providing a rational basis for a study and career decision
Hands-on experience and explicit feedback addressing underestimation and negative beliefs	Realistic assessment of own talents and skills

about different CS programs, showing the variety of the domain ranging from bioinformatics over engineering informatics to media informatics and information systems. The attractive job market with a very low unemployment rate and high salaries is also illustrated in talks and with an optional visit to a software development company.

Mentees are encouraged to participate in the CS workshop program offered by the university for high school students. Furthermore, at least one Saturday is spent with different projects where mentees experience applications such as design and implementation of a webpage, as well as computer programming. Mentors are trained to observe the high school students during these workshops and to give explicit encouraging feedback. Of course, it can happen that a mentee realized that he or she has problems to grasp the introduced CS concepts. In this case, nevertheless, feedback will be encouraging, trying to offer alternative perspectives more adequate to the talents and interests of the mentee.

3.2 Empirical Evaluation

During the first three rounds, the program was evaluated based on qualitative feedback and a sample of simple yes/no questions. Questions covered motivation as well as goals about the participation in *make IT*, how good the program conveyed different aspects of CS study programs, occupational features, and whether the program had an impact on the decision to study CS. Furthermore, participants were asked about the quality of the mentor-mentee relation as well as whether they prefer a mentor of the same sex.

Overall, the high school students rated the program very positive (100 percent rated their satisfaction with the program as very good or good). 79 percent of the mentees rated the relation to their mentor as very positive or positive. 47 percent rated their mentors as role models (43 percent had no opinion on this, 9 percent answerded no). The function of the mentors as role models and as counsellors can be seen in the following answer:

> *Yes, because she is open, had an appropriate answer for every question and is a friendly, communicative and helpful person. With her the mentoring was a lot of fun!* (Ja, da sie offen ist, für jede Frage eine passende Antwort hatte und generell ein freundlicher, aufgeschlossener und hilfsbereiter Mensch ist. Mit ihr hat das Mentoring sehr viel Spaß gemacht!).

Mentees seem to be more open to learn about CS study and occupation when presented by a student than in the context of school as documented by one typical answer:

> *It was not enforced but more relaxed. If a teacher had told me all this stuff I probably would have fallen asleep.* (Es war nicht erzwungen, sondern eher lockerer. Bei einem Lehrer wäre ich vermutlich eingeschlafen, hätte er mir das alles erzählt.)

Another important point is that the mentees were able to discover some aspect they liked during the program regarding the field of CS. As can be seen in figure 1, more than half of the mentees found some point in the field of CS they liked.

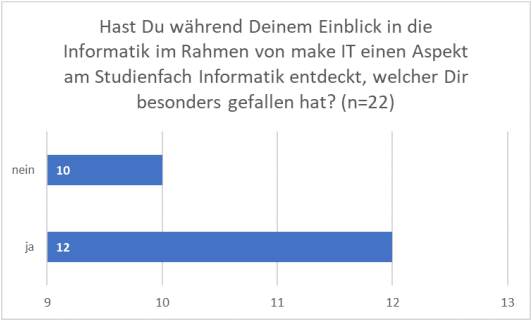

Figure 1: Did you discover a specific aspect in the field of computer science that you liked during the make IT project?

When we asked for specific aspects, a typical response was:

> *Not one special aspect, but the diversity of the study course computer science I liked.*(Nicht genau ein bestimmter Aspekt, aber die Vielfalt des Studienfachs Informatik hat mir gefallen.)

Another frequently mentioned positive aspect, that illustrates the mentoring's function regarding skill development, was:

> *Programming, mathematical basics.* (Programmieren, mathematische Grundlagen.)

Furthermore, mentees corrected their initial image about CS as an area where mostly male persons work mostly alone and sit the whole day in front of a computer. One typical answer in this context was:

> *I learned that computer science is not only about computers and programming but about many other topics. There are very interesting minor subjects.* (Dass es nicht nur um Computer und Programmieren geht, sondern auch sehr viel anderes beinhaltet. Und, dass es spannende Nebenfächer gibt.)

4 SYSTEMATIC ASSESSMENT OF THE IMPACT OF MAKE IT ON STUDY INTENTION

Based on the encouraging impressions gained during the first three rounds of the mentoring program, we now plan to perform a more systematic empirical study to assess the relative influence of the different measures of the program. We propose a model of the impact of different attitudes and beliefs on the intention to study CS. The empirical study is based on the Theory of Planned Behaviour which is shortly introduced in the following. Based on this model, we designed a questionnaire which will be presented afterwards. This questionnaire will be applied at the beginning as well as at the end of the current round of the *make IT* program which starts in November 2017.

4.1 Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB, see figure 2) was proposed by Ajzen (1991) [1]. It is one of the most established theories which link subjective attitudes and beliefs to behaviour with many applications in fields such as healthcare, pro-social behaviour, and advertising. Basic assumption of the TPB is that human behaviour is based on *normative*, *behavioural*, and *control beliefs*. For example, quitting smoking might depend on perceived social norms such as that the partner does not like smoking (normative belief), on the belief that quitting to smoke will reduce health risks (behavioural belief), and the conviction that one can execute this behaviour (control belief).

These beliefs are typically reflected by several underlying aspects (e.g., quitting smoking might not only be believed to have a positive effect on health but also save money, or make one more attractive). They are aggregated to a *subjective norm*, an *attitude* towards the behaviour, and *perceived behavioural control*. The combination of these concepts leads to a behavioural *intention* which is the precondition that a given *behaviour* really is executed.

We use the TPB as foundation to model the impact of our mentoring program and its functions on the intention to study CS. We assume, that providing female high school students with role models can positively change their normative beliefs about how family, peers, or society in general perceives females in CS. Furthermore, we propose that counselling and giving specific information about CS studies and occupational profiles will affect behavioural beliefs such as expectations about salary, or work-live-balance. Finally, getting explicit feedback in the context of hands-on experience with CS activities should have a positive impact on control beliefs of the high school students, that is, their assessment about their probable success in a CS program. The resulting model is illustrated in figure 2.

4.2 Design of a Questionnaire

We constructed a questionnaire which allows us to analyse the effects of mentoring based on the proposals from TPB as introduced above. The new questionnaire will be briefly explained in the following paragraphs.

As mentioned before, there are three levels of interest in the TPB. The forth level – *behaviour* – is not considered here, as it is not possible to measure this behaviour (starting a CS study) properly. All in all, the questionnaire consists of 27 questions that are presented to the participants at the beginning and the end of the project.

The main goal of this questionnaire is to investigate the effects that mentoring might have on the intention building according to the TPB. All items are formulated as statements. The participants are asked to judge, based on a 7-point-Likert-Scale, how much they agree or disagree with the given statement (1 = totally agree, 7 = totally disagree) (as used in Ajzen 2006, [20]). For items where these linguistic anchors are not adequate we used alternative anchors. The first and second levels are both examined with one question for each concept. Starting with level one, the **intention**, the used item is:

- *I plan to study computer science: totally agree - totally disagree* (Ich habe vor Informatik zu studieren: stimme sehr zu - stimme überhaupt nicht zu).

The aim of this item is to measure the intention by showing the intended behaviour, in this case, the plan to study CS. The second level consists of three concepts: attitude, subjective norms, and perceived behavioural control. These influence the intentions towards the behaviour. For investigating the **attitude** the item

- *To study computer science would be for me personally: very good - very bad)* (Informatik zu studieren fände ich persönlich: sehr gut - sehr schlecht)

is proposed. This item is formulated to examine the attitude a person has towards their behaviour, which in this case reflects the opinion a person has about him-/herself studying CS. The second item refers to **subjective norms**, for which the item

- *If I study computer science, people who are important to me will appreciate this: totally agree - totally disagree* (Wenn ich ein Informatikstudium absolviere, finden das die mir wichtigen Menschen: sehr gut - sehr schlecht).

is presented. Subjective norms are thoughts a person has about the opinions other persons have about a special behaviour ('studying computer science'). The last item on this level is **perceived behavioural control**, which is measured by the item

- *I am able to complete a computer science study successfully: totally agree - totally disagree* (Ich kann ein Informatikstudium

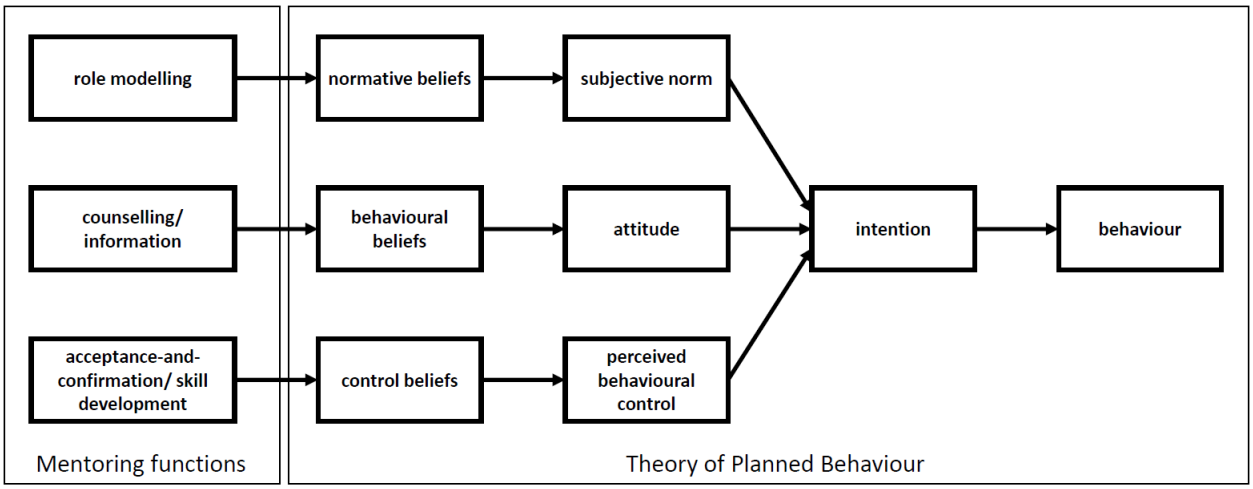

Figure 2: The Theory of Planned Behaviour and its instantiation with mentoring effects.

erfolgreich absolvieren: stimme sehr zu - stimme überhaupt nicht zu).

The perceived control a person has about his/her behaviour is of great importance when investigating the likelihood to which a person will perform one special behaviour. Furthermore, assuming being successful in study is essential as well.

The factors on the third level are assessed by more than one item. Each aspect assessed on this level has to be captured by two items – measuring the expectation that the aspect can be fulfilled together with the value this aspect has for the person. As already mentioned, **behavioural beliefs** influence the attitude. To examine this, four item pairs are used. Examples of these include the item pair

- *If I study computer science I will earn a lot of money: totally agree - totally disagree* (Wenn ich Informatik studiere, werde ich später viel Geld verdienen: stimme sehr zu - stimme überhaupt nicht zu) and
- *To earn a lot of money is for me: not at all important - very important.* (Viel Geld zu verdienen ist mir: gar nicht wichtig - sehr wichtig.).

The first item in each pair is used to measure whether a person has any specific expectations about the result of one behaviour. For example, an expectation about the behaviour 'to study computer science' might be 'to earn a lot of money'. The second item evaluates the value a person gives to the expected outcome of the behaviour. With respect to the example above, that means that participants would be asked to judge how important it is to them to earn a lot of money during their professional career. The basis of these assumptions is, that the participants who have certain expectations about a behaviour and who value those expectations, are more likely to perform the stated behaviour to reach the expected outcome. Furthermore, the following items are used to examine the **behavioural beliefs**:

- *If I study computer science this will make me attractive: totally agree - totally disagree* (Wenn ich Informatik studiere, macht mich das attraktiv: stimme sehr zu - stimme überhaupt nicht zu) and
- *To be attractive is for me personally: very important - not at all important* (Attraktiv zu sein ist mir: sehr wichtig - überhaupt nicht wichtig).
- *If I study computer science I will have a rewarding job: totally agree - totally disagree* (Wenn ich Informatik studiere, werde ich später einen erfüllenden Job haben: stimme sehr zu - stimme überhaupt nicht zu) and
- *To have a rewarding job is for me personally: very important - not at all important* (Einen erfüllenden Job zu haben, ist mir: sehr wichtig - überhaupt nicht wichtig).
- *If I study computer science I study a popular course of studies: totally agree - totally disagree* (Wenn ich Informatik studiere, studiere einen angesagten Studiengang: stimme sehr zu - stimme überhaupt nicht zu) and
- *To study a popular course of studies is for me personally: very important - not at all important* (Einen angesagten Studiengang zu studieren ist mir: sehr wichtig - überhaupt nicht wichtig).

Normative beliefs that influence subjective norms which in turn influence the intention to perform a behaviour are addressed as well. For investigation of the **normative beliefs** four item pairs are used. One of these item pairs is:

- *If I study computer science my mother thinks this is: very good - very bad.* (Wenn ich Informatik studiere fände meine Mutter das: sehr gut - sehr schlecht)
- *What my mother expects from me is to me: not at all important - very important.* (Was meine Mutter von mir erwartet ist mir: gar nicht wichtig - sehr wichtig.)

In addition, there is one item each to investigate the influence of father, teachers and friends on normative beliefs. These items have the same structure as the presented one.

With an impact on perceived behavioural control, control beliefs will also be examined in this questionnaire. For this, three item pairs are used. Serving as an example of **control beliefs** the item pair is used:

- *Whether I study computer science depends on whether I think that I am able to study computer science: totally agree - totally disagree* (Ob ich Informatik studiere, hängt davon ab, ob ich mir das zutraue: stimme sehr zu - stimme überhaupt nicht zu)
- *I think I am able to study computer science: totally agree - totally disagree* (Ich traue mir ein Informatikstudium zu: stimme sehr zu - stimme überhaupt nicht zu).

The first item asks about the degree to which an external or internal factor (here confidence in ability) is influencing the behaviour (study CS). The second item evaluates how strong this factor is with respect to a certain person. Besides this item pair the following item pairs are presented:

- *Whether I study computer science depends on my monetary situation: totally agree - totally disagree* (Ob ich Informatik studiere hängt von meiner finanziellen Situation ab: stimme sehr zu - stimme überhaupt nicht zu) and
- *My monetary situation is: very good - very bad* (Meine finanzielle Situation ist: sehr gut - sehr schlecht)
- *Whether I study computer science depends on the possibility to study computer science in my favourite city: totally agree - totally disagree* (Ob ich Informatik studiere hängt davon ab, ob ein Informatikstudium an meinem Wunschstandort möglich ist: stimme sehr zu - stimme überhaupt nicht zu) and
- *To study computer science in my favourite city is possible: stimme sehr zu - stimme überhaupt nicht zu* (Ein Informatikstudium ist an meinem Wunschstandort möglich: stimme sehr zu - stimme überhaupt nicht zu).

To evaluate the data gained from the questionnaire, weighted sums are calculated for the item pairs contributing to each of the three concepts subjective norms, attitude and perceived behavioural control. Afterwards, the correlations will be computed. These correlations are then used to show whether there is a relation between two concepts (e.g., attitude and intention) and the direction of this relation (positive/negative).

After the mentoring project, the high school students shall answer the questionnaire again. By comparing the scores of the correlations before and after the mentoring, the effects of mentoring on the concepts of attitude, subjective norms and perceived behavioural control on intention shall become visible. To guarantee valid results the questionnaire is given to the high school students before and after the mentoring program (pre-/post-design).

4.3 Discussion

The chosen approach has some limitations. It is important to note when examining the TPB that it is not possible to measure the real behavioural outcome properly with a questionnaire, since this behaviour will take place in the future, thus usually a certain amount of time after the questionnaire is completed. This is a general problem while investigating the TPB. For investigating the effects of the mentoring program on the behaviour ('studying computer science'), it might be an option to question the high school students again after they have finished school. This is possible because of the relationship the high school students have with their mentors. Due to this interpersonal relationship, the students might be available for further contacts and questioning in the future. Therefore, it might be possible to gather information about the real behavioural outcome.

Another concern is the possibly low external validity, which means the results might not be generally valid. This is a consequence of the sample not being randomly selected. The sample is constrained in terms of consisting of a rather specific group of high school students (mainly female, German, young students with sophisticated social background). As these are personal factors, a random allocation to the project is not possible (quasi-experimental design). Though the results of our study are not ambiguous, therefore the observed constraints within our sample do not seem to restrain the stated scientific outcome.

Another weak point of our approach could be the non-availability of a control group to ensure that the differences between the measures are due to the mentoring program and not due to other environmental or personal factors. Regrettably, at the moment it is impossible for our group to acquire voluntary high school students for the control group.

We as well want to point out some enriching factors within our approach. First, the number of items as well as the structure of the questionnaire is oriented towards the proposals of Ajzen (2006), which have been successfully applied in many different areas of application. Furthermore, the item statements are clear and well understandable formulated which will support our study in delivering reliable results. Moreover, the questionnaire is developed on a strong theory based approach. Resulting from the fact, that there are female and male high school students as well as female and male mentors participating, it might be interesting to investigate on whether there are gender effects within the effects of mentoring. Lastly, the quality of the mentoring program, which is measured by an extra evaluation-questionnaire is held on a high level. As proposed in the theory part this is important for effects of mentoring on behaviour.

5 CONCLUSIONS

We presented the mentoring program *make IT* which has been designed to motivate female high school students to consider studying CS as a possible option. The design of the program is based on findings about barriers for girls to engage in STEM or more specifically in CS and findings about the impact of mentoring on psycho-social factors. After three rounds with encouraging evaluation results, we consider the program as consolidated. Most promising is that all girls who participated in the third round, stated that they plan to study CS.

To gain deeper insight in the impact of the different measures of the program on girls beliefs and attitudes towards CS as a possible study course, we related our measures to the Theory of Planned Behaviour. We presented a questionnaire based on this theory which we will apply in the new round of the mentoring program.

While there exist other programs which use a combination of information and hands-on experience to engage girls in CS (e.g., [23]) and while there exist some more long term E-mentoring approaches (e.g., [40]) we believe that our program is the only one in Germany which accompanies girls personally in a group mentoring

setting and in the context of an university over a longer period of time.

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