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Promoting career choice competence and self-efficacy of women in STEM: A case study of the 'Niedersachsen-Technikum' and the application of Social Cognitive Career Theory

Svenja Folkerts* & Judith Bräuer

Hochschule Osnabrück, Germany

Corresponding Author* Contact: s.folkerts@hs-osnabrueck.de
ORCID: Folkerts & Bräuer

ABSTRACT
The social cognitive career theory (SCCT), developed by Lent, Brown and Hackett in 1994, has become a popular foundation for vocational research all over the world (Brown & Lent, 2019). The first three connected SCCT models describe interest development, career choice, and performance achievements in a certain career domain. The following variables play the most important roles in all models: self-efficacy, outcome expectations, and choice goals (Sheu & Bordon, 2017). These variables form the guidelines for the best practice project "Niedersachsen-Technikum", which is a cooperation project between universities and companies that offers young women orientation in STEM fields. In 2010, "Niedersachsen-Technikum" was initiated by the Hochschule Osnabrück and was extended in 2012. Today, nine universities and more than 130 companies in Lower Saxony are participating. Participating companies finance an internship of six months.

During this period the participants gain practical experience in engineering. Besides seeing different departments, they apply new knowledge into an independent project. Once a week the participants attend first semester lectures and laboratory visits at one of the participating universities. Evaluation of the single-sex orientation project "Niedersachsen-Technikum" shows its positive effects on the vocational choice competence of female graduates and strengthens their self-efficacy and self-awareness.

KEYWORDS: STEM, gender, vocational orientation, career choice, self-efficacy, Social Cognitive Career Theory

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INTRODUCTION

The underrepresentation of women in STEM subjects remains a persistent global challenge despite numerous initiatives to promote gender equality in education and the workplace. Numerous studies have shown that gender stereotypes, social barriers, and a lack of role models are major factors in why many women do not consider a career in STEM professions, despite having the appropriate qualifications. Social Cognitive Career Theory (SCCT) shows how self-efficacy, outcome expectations, and choice goals influence individual career decisions. Programs that take these factors into account can have a decisive influence on reducing gender differences in technical and scientific professions.

Against this background, the 'Niedersachsen-Technikum' was launched in 2010 as an innovative orientation program for female school leavers in Lower Saxony, Germany. By combining practical and academic experiences in STEM companies and universities, the program enables participants to gain insights into technical and scientific career paths, develop a stronger sense of self-efficacy, and explore their professional interests in a supportive environment.

This case study examines the Niedersachsen-Technikum through the lens of the Social Cognitive Career Theory. It explores how the program specifically enhances self-efficacy beliefs, promotes positive outcome expectations, and supports participants in setting clear career-related goals. By linking theory and practice, this study highlights the effectiveness of the Niedersachsen-Technikum as a best-practice model for fostering gender diversity in STEM and demonstrates its contribution to dismantling barriers that continue to limit women's career opportunities in technical fields.

NIEDERSACHSEN-TECHNIKUM

History

The program was developed at Osnabrück University of Applied Sciences in 2010 for a target group of female students interested in mathematics and science in their final year of school. The first iteration of the program included an in-depth career orientation phase at companies and universities after leaving school and made use of networking with regional companies and chambers, university lecturers, equal opportunities officers and employment agencies. Today, the Niedersachsen-Technikum is run at a total of nine universities, funded by the Lower Saxony Ministry of Science and Culture as well as the Dr. Jürgen und Irmgard Ulderup Stiftung and is supported by the Niedersachsen Metall Foundation. In 2010 the project included seven participants and enrollment increased year by year. More than 1000 women have participated between 2010 and 2025. The growing number of participants proves the success of the concept.

"Study STEM? Just give it a try!"

The program is aimed at young women who have an interest in mathematics and science but are still undecided about their choice of study, training and career. Formally speaking, the Niedersachsen-Technikum is a preparatory study program of the participating universities[1], which have formally anchored it as a preparatory course in their university regulations since 2016.

Participation in the Niedersachsen-Technikum is intended for female school graduates with the purpose of providing them with career guidance. With the Niedersachsen-Technikum, female school graduates can test whether a career in a STEM profession is an option for them during a 6-month trial phase. Through practical experience in companies and at universities, uncertainties about their self-competence and self-efficacy for such professions can be transformed into new knowledge and experience about their own abilities and enables them to anticipate the environment of a future STEM profession. Through this knowledge and experience, the Niedersachsen-Technikum leads to a secure career decision.

Program schedule

School graduates or soon-to-be graduates who have or will soon receive their Abitur[2] apply to one of the participating universities. At each university, the Niedersachsen-Technikum is organized and implemented regionally by a coordinator. The coordinators organize the placement process between the participant and the company, as well as the trial study period at the university. Each location has a large number of cooperating companies from various STEM sectors and specializations. If the application is successful, the participants start a paid six-month internship at the company four days a week in September. They receive in-house support from a contact person at the company and are initially instructed in general industry-relevant activities. This often takes place together with the company's trainees in a training workshop. The participants then pass through various departments. An essential part of the internship is working on their own project. Here are some examples of such projects from the 2024/25 cohort:

- Shelf-life validation of fried potato slices
- Development of a manual adhesive coating in comparison with a pilot plant
- Development of a training board for mechatronics engineers
- Integration of a chatbot with artificial intelligence

In addition to these four internship days, the participants take part in a taster course at the university one day a week. This includes first semester lectures, excursions, seminars and laboratory tours. The program is newly created for each round of the Technikum in consultation with the curriculum managers and lecturers at each university. Participants can choose a lecture according to

[1] In the German education system, the term "university" generally refers to all types of academic educational institutions, including universities and universities of applied sciences. A university is usually research-oriented with a broad, theoretical range of courses and the aim of training young scientists for doctoral studies. A university of applied sciences focuses on practice-oriented courses with a closer connection to professional application, often with practical semesters and smaller seminar groups. The university degree (bachelor's, master's) is formally equivalent.

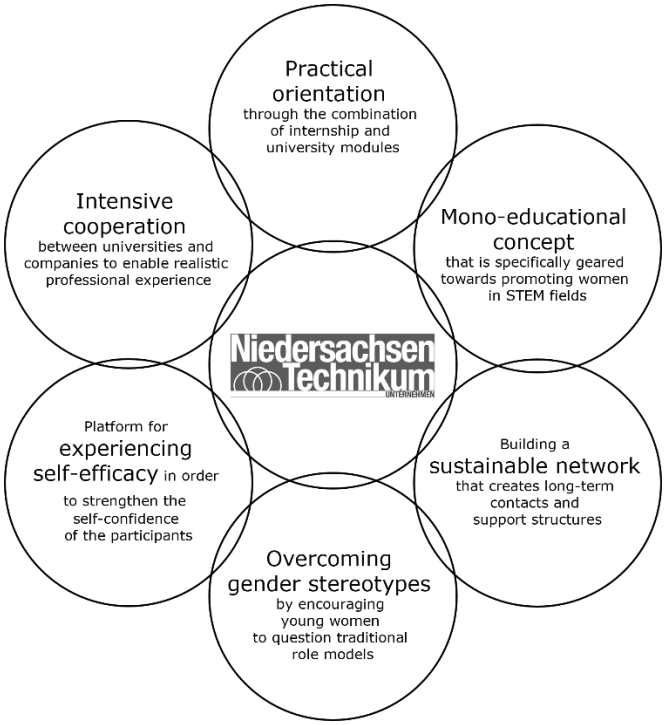
[2] Abitur is the general qualification for university entrance in the German education system.

their individual preferences. As far as the schedule of the university day allows, there is the option to "get a taste" of other lectures.

At the end of the six months, the Technikum participants present their experiences at a final event at the university. They receive an internship certificate from the company and a certificate from their university. Figure 1 shows the key elements of the Niedersachsen-Technikum.

The current and former participants often return as mentors and role models within the program. They reduce barriers for forthcoming women. The Niedersachsen-Technikum can therefore continue to change the perception of STEM professions in the future.

Figure 1. *Key Elements Niedersachsen-Technikum*



Alumnae survey 2023

The sustainability of the program was proven through various evaluation procedures[3]. An alumnae survey in 2023 provides further evidence for the positive effects of the program. The survey provided key insights into the careers and satisfaction of former participants of the Niedersachsen-Technikum. The target study population comprised 850 women who participated in the Niedersachsen-Technikum between 2010 and 2023. Data were collected using a computer-based online survey via Limesurvey. A total of 380 people took part in the survey, which

[3] The sustainability of the program was proven through various evaluation procedures such as an evaluation by ZEVA in 2020. Further information about the evaluation can be found here: https://www.niedersachsen-technikum.de/rund-ums-technikum/evaluationen

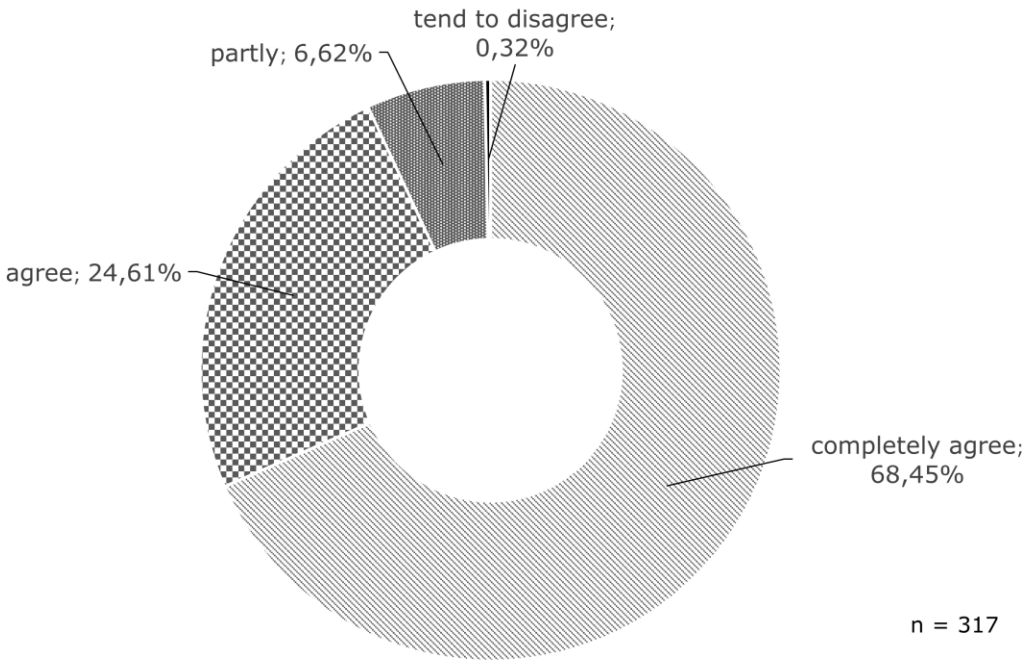
corresponds to a response rate of 54%. The evaluation of the results is based on the 317 (45%) complete data sets.

The central focus of the survey was the question about the graduates' future educational and career paths. According to the results, 83.54% of participants decided to study after completing the program, and 87.37% of this subset chose a STEM subject. This high rate demonstrates the effectiveness of the program in promoting women in technical and scientific disciplines. In addition, 13.92% of those surveyed opted for an apprenticeship, with 85.33% of this group choosing a STEM apprenticeship. This shows that the Niedersachsen-Technikum not only facilitates access to academic careers but also promotes practice-oriented professional careers.

Participants' satisfaction with the program was also examined. The results show an exceptionally high level of approval: 9 out of 10 participants stated that they were either satisfied or very satisfied with their participation (see Figure 2). 93% would recommend the Niedersachsen-Technikum to others. This speaks to the lasting positive effect of the program on the personal and professional development of the participants. The following quote from the survey exemplifies this:

> *Even though I didn't go on to study a STEM subject, the technical internship really helped me to recognize where my interests and strengths lie.* (Alumna Niedersachsen-Technikum)

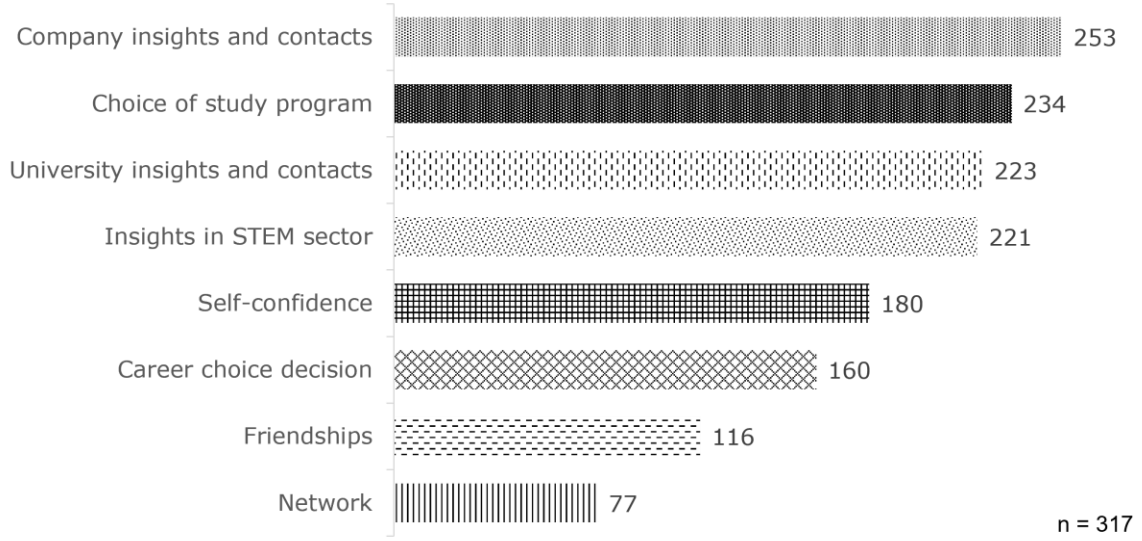
Figure 2. *Recommendation rate of program*



The survey also highlighted the direct benefits that the participants had gained from the program (see Figure 3). In response to the survey question "Can you

name one or more immediate benefits?", the most frequently mentioned positive aspects were company insights and contacts (253 mentions), support in choosing a course of study (234 mentions) and insights into everyday university life (223 mentions). These points make it clear that the program not only contributes to vocational orientation but also provides participants with valuable networks that help them in their future career decisions. Another important finding is the strengthening of self-efficacy through the Technikum. Many participants reported that they felt more confident in their decision after completing the program and were less afraid of studying STEM subjects or pursuing a corresponding apprenticeship.

Figure 3: *Immediate Benefits Niedersachsen-Technikum*



One interesting aspect of the survey was the analysis of the graduates' career paths. At the time of the survey, 50% of the program participants were still studying: 40% were undertaking a regular degree course and 10% a dual degree course. Of the remaining 50%, 32% were already working, 6% were studying for a doctorate, and 12% are taking temporary measures to bridge a vocational transition. This shows that the Technikum is not only a springboard for degree courses, but also for further academic careers. Of the respondents who opted for an apprenticeship, most chose professions such as electronics technician for automation technology, industrial mechanic, or IT specialist, which illustrates that the program helps girls to feel supported to enter technical professions. The majority of those who took up a degree course opted for mechanical engineering, industrial engineering and electrical engineering— classic STEM subjects with high relevance for industry and in which women are underrepresented. The following quote from the survey encapsulates this positive impact of the program:

> *I always tell everyone how grateful I am to have done the Technikum! It gave me enough self-confidence to start studying computer science.*
> (Alumna Niedersachsen-Technikum)

In summary, the alumnae survey shows that the Niedersachsen-Technikum has a considerable influence on the career paths of its participants. The Niedersachsen-Technikum facilitates entry into STEM professions, promotes academic and professional development and contributes to increasing the proportion of women in technical disciplines. The high level of satisfaction among female participants and the high recommendation rate underline the effectiveness of the program.

The alumnae survey was the first comprehensive data collection across cohorts with the aim of understanding the alumnae's vocational status and development after the program. This is the rationale behind the primary descriptive nature of the case study and analysis provided above. Subsequent surveys will concentrate on the examination of cognitive constructs utilizing multivariate analysis. The results of these analyses will be used to enhance the efficacy of the program in the future.

SOCIAL COGNITIVE CAREER THEORY

Social Cognitive Career Theory (SCCT) was developed by Lent, Brown and Hackett in 1994. It contains three interrelated models of career and academic interest development, career choice, and achievement. These models serve to explain the conditions under which people develop vocational interests and predict how they make decisions and achieve success at work and school (Brown & Lent, 2019). The model is essentially based on three relevant social-cognitive predictive factors: self-efficacy beliefs, outcome expectancy, and personal goals. Prior research has shown that these three interrelated variables largely predict a person's career behavior (Brown & Lent, 2019; Hirschi, 2008).

Self-efficacy belief is a person's own conviction that they have the appropriate skills to achieve desired outcomes in certain subject areas (Brown & Lent, 2019; Hirschi, 2013). Self-efficacy belief is not to be equated with self-confidence but is a dynamic collection of beliefs associated with specific subject areas (Hirschi, 2008). It motivates appropriate actions, encourages effort and perseverance in the face of difficulties and facilitates achievement in relevant areas. It is important to note that self-efficacy beliefs are domain-specific, such that, for example, self-efficacy in mathematics is not transferable to other subject areas (Brown & Lent, 2019).

Outcome expectations are another important theoretical construct in all five SCCT models. Outcome expectations refer to a person's beliefs about the positive, negative or neutral consequences of their actions. The difference between outcome expectations and self-efficacy beliefs is that the latter focus on perceived abilities, whereas outcome expectations refer to the expected consequences of actions taken relating to said abilities. These expected consequences can be, for example, material rewards, social recognition or rejection; they can also be intrinsic in nature, such as pride (Brown & Lent, 2019; Hirschi, 2008). Similar to self-efficacy beliefs, outcome expectations are individual cognitive assumptions of likely outcomes. They may or may not correspond to the actual results that a person achieves (Brown & Lent, 2019).

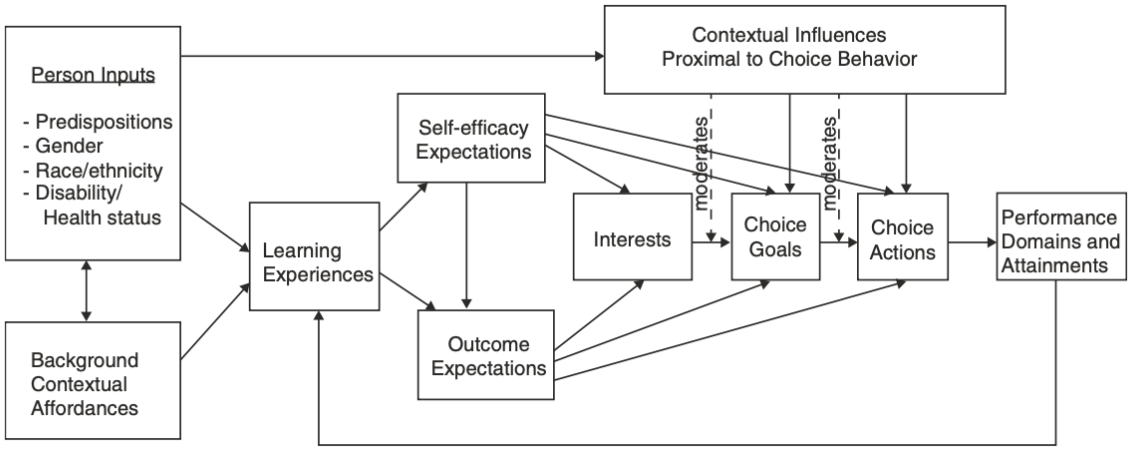
Goals are the third central social-cognitive construct in all SCCT models. Goals refer to the intention to engage in an activity or to achieve a specific outcome. Goals help

people to organize, direct and maintain their behavior even when there are no external rewards or difficult and unsupportive circumstances. According to the interest and choice model, individuals with stable self-efficacy beliefs and positive outcome expectations in a particular performance area (e.g., math, job search) develop goals for further activities (e.g. taking additional math courses, conducting a job search) (Brown & Lent, 2019; Hirschi, 2008).

Interest & choice model

According to the SCCT, interest is directly influenced by self-efficacy expectations and outcome expectations. This means that a person develops an interest in a certain area if they believe that their own abilities are sufficient to carry out this action successfully and they evaluate the expected result as desirable (Hirschi, 2008). As shown in Figure 4, one's own learning experiences serve as the basis for the development of self-efficacy expectations and are always subject-specific. At the same time, they influence outcome expectations and are the basis for interest and the development of personal goals (Rübner & Höft, 2019).

Figure 4. *Lent & Brown, 2019, p. 153*



Interest in a particular subject area is more likely to develop if the person perceives themselves as competent (self-efficacious) in this area and expects their actions to lead to more positive than negative results (outcome expectancy) (Brown & Lent, 2019). Interest is not stable over time, and this change is dependent on changes in self-efficacy and outcome expectations and can also be triggered by new experiences (Brown & Lent, 2019; Hirschi, 2008).

The central statement of the model is that interest depends more on a person's subjective beliefs than on their actual abilities and on subjective outcome expectations than on simple learning experiences. The model also contains a feedback loop which states that demonstrated performance as a learning experience has an influence on self-efficacy expectations and outcome expectations (Hirschi, 2008). The theory also hypothesizes that, under optimal circumstances, a

person will choose an occupation that matches their interests. Personal goals are an important link between interests and actions. Interest alone is therefore not sufficient: goals are necessary for a person to choose an occupation. In reality, people are influenced by personal and environmental variables that make this choice easier or more difficult or limit it. These moderation effects mean that the relationship between interest and choice is stronger under supportive conditions than under less supportive conditions (Brown & Lent, 2019; Hirschi, 2008).

To summarize, the Social Cognitive Career Theory (SCCT) by Lent, Brown and Hackett (1994) states that career interest results from self-efficacy expectations and outcome expectations and are also related to choice goals. These factors are significantly influenced by past learning experiences. This is precisely where the program Niedersachsen-Technikum comes in, by breaking down structural barriers and creating targeted experiences that strengthen the self-beliefs of young women in the STEM field.

EFFECTS OF NIEDERSACHSEN-TECHNIKUM

In the following sections, we detail the rationale for the positive effects of the program on participants. We use alumnae feedback to support these conclusions.

Niedersachsen-Technikum Effects on Self-Efficacy

The Niedersachsen-Technikum plays a crucial role in fostering the self-efficacy beliefs of its participants, particularly in the fields of STEM. By providing hands-on experiences in technical and scientific environments, the program enables young women to develop confidence in their abilities and strengthen their conviction that they possess the necessary skills to succeed in these domains. Through practical work in companies and the insight at universities, participants gain firsthand experience and thus strengthen their competence beliefs. This increased self-efficacy motivates them to actively engage with technical subjects, and tackle challenges with resilience, ultimately enhancing their long-term career success.

> *In my opinion, the main reason why many women don't consider a STEM career is that they simply don't think they are smart/good enough for it. At some point I realized that men are much quicker to say they know something (e. g. programming languages (men have used them once and say they can do it. While women haven't done anything else for 6 months and only then say they can)).* (Alumna Niedersachsen-Technikum)

Niedersachsen-Technikum Effects on Outcome Expectations

The Niedersachsen-Technikum supports its participants in developing positive outcome expectations regarding their engagement in STEM fields. By providing insights into technical careers and academic opportunities, the program helps young women anticipate the potential benefits of their efforts, such as career prospects, financial stability, and professional recognition. Through hands-on experiences in companies and universities, participants see firsthand that their involvement in STEM can lead to meaningful achievements and personal fulfillment. In addition, they get to know role models who set an example and talk about their

positive experiences associated with a STEM career. While self-efficacy beliefs shape the participants' confidence in their abilities, positive outcome expectations reinforce their motivation to pursue and persist in STEM careers, despite potential challenges.

> *My future has turned 180 degrees and improved thanks to the Niedersachsen-Technikum.* (Alumna Niedersachsen-Technikum)

Niedersachsen-Technikum Effects on Choice Goals

The Niedersachsen-Technikum plays a key role in helping participants set and pursue meaningful goals in STEM fields. Through hands-on experiences in companies and academic exposure, the program enables young women to develop clear intentions regarding their educational and professional paths. As participants strengthen their self-efficacy and form positive outcome expectations, they are more likely to set ambitious goals, such as pursuing a technical degree or applying for a job in a STEM-related field. Moreover, successful role models in companies and universities help them to see what is possible for themselves. These goals help them stay motivated and persist in their efforts, even in the face of challenges or a lack of external encouragement.

> *Without the Technikum, I would never have started a technical degree. It reduced my fears and showed me my own strengths.* (Alumna Niedersachsen-Technikum)

In conclusion, the Niedersachsen-Technikum creates supportive conditions for young women so that they can pursue their own interests in STEM and make a suitable career choice with lots of support.

CONCLUSION

The low representation of women in STEM degree programs and professions is not due to a lack of interest, but rather to structural and social barriers. The SCCT theory makes it clear that self-efficacy experiences and supportive environmental influences are decisive in promoting interest in STEM professions. This is precisely where the Niedersachsen-Technikum comes in, using practical experience, single-sex educational contexts, role models and networks to specifically strengthen the factors that make a STEM career more attractive for women. In this way, it actively contributes to breaking down gender-related barriers and attracting more women to STEM professions in the long term.

ENDNOTES

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