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International students in Germany

Psychological study success factors in STEM versus non-STEM subjects from an intersectional perspective

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Psychological study success factors in STEM versus non-STEM subjects from an intersectional perspective

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International students in Germany: Psychological study success factors in STEM versus non-STEM subjects from an intersectional perspective

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DANKE

Content

List of Tables

List of Figures

Abstract

Background: International students require core interest, particularly in Germany as the fourth largest host country (12% of the student population). Numerous challenges faced by bachelor students studying abroad, as evidenced by high estimated dropout rates (41% of international bachelor students vs. 28% of domestics), were of particular concern. The dissertations' objective was the study success of international STEM students, particularly focusing on psychological (belongingness, expectations and values), and sociodemographic predictors from an intersectional perspective.

Methods: Beside contingencies at the study start, developmental effects of expectancies and values (SEVT) over the study course, were analyzed with latent growth curve models. Intra- and inter-individual dynamics of study success and its predictors were examined via random-intercept cross-lagged panel models and elucidated overall effects of socio-demographic factors beyond gender and their intersections, which may hinder the international STEM students' study success. The dissertations' data based on a panel study on international students in Germany (*International Student Survey*). The (longitudinal) analyses were constrained to bachelor students (N = 1,486) in the first five semesters.

Results: Findings indicated disadvantages for first-generation students, for students outside of Western Europe, both partly qualified by gender, but no disadvantages for all females in STEM. Only a few differences between STEM and non-STEM students showed significance.

Conclusion: The findings offer insights into international (STEM) students' study success, its predictors, and developmental effects of expectancies and values. They provide indications for tailored interventions, particularly by the intersectional perspective, to support study success for the heterogeneous group of international students in Germany.

Keywords: study success, international (STEM) students, sense of belonging, expectancy-value-theory, intersectionality

1 Introduction

"The benefits of studying abroad are almost endless." – Michelle Obama –

Exploring ways to make these almost endless benefits of studying abroad available to international STEM students in Germany and to provide better support for their study success is the overarching theme of this dissertation. Michelle Obama described the aforementioned benefits of going abroad e.g., becoming marketable in the labor market due to cultural sensitivity competencies, more easily transitioning to new environments, improving language proficiency, developing compassion by stepping out of comfort zones, and acknowledging the advantages of diversity (CNN, 2025). First of all, international students, holding a foreign citizenship and obtaining their university entrance qualification outside of their country of studies (Federal Statistical Office, 2020), constitute a significant population within higher education institutions. The support of their success in higher education is a core educational issue on an international level (Sneyers & De Witte, 2018). Moreover, in 2020, approximately 4.4 million international students were enrolled in the OECD which represents about 7% of the higher education students in 38 OECD states (OECD, 2022). About 369,000 international students study at German universities, i.e., 12% of the student body (OECD, 2022). This ranks Germany as the fourth largest recipient of international students and the most popular non-English-speaking host country (DAAD & DZHW, 2024). Approximately 53% of the international students in Germany were enrolled in STEM subjects (DAAD & DZHW, 2024).

Further, international students make a significant contribution to the economic development of Germany, because the contribution made by each year's cohort of international students to the revenues of the public purse is eight times greater than the total amount invested in them by the state. That finding is supported by a study conducted by the Cologne Institute of the German Economy (IW) and on behalf of the German Academic

Exchange Service (DAAD) by Geis-Thöne et al. (2025). This IW report states that the approximately 80,000 international students who began their studies in Germany and would graduate in 2022 might contribute almost 15.5 billion euros more in taxes and fees during their lifespan than they might receive from the German state. Should the rate of student retention remain stable, this effect will be repeated with each new cohort of international students (Geis-Thöne et al., 2025). International students could also help mitigate the shortage of skilled workers in STEM fields (e.g., in Germany: Hoffmeyer-Zlotnik & Grote, 2019), because it has been demonstrated that particularly, engineering students intend to reside in Germany following the completion of their studies (Koenings et al., 2021; Thies, 2022).

But unfortunately, many international students struggle with their studies as the high estimated drop-out rates of 41% in the bachelor’s and to 28% in master’s programs (compared to 28% (bachelor) and 21% (master) among domestic students) indicate (Heublein et al., 2022) and in that way, do not seem to benefit from the advantages of studying abroad (see Interview with M. Obama, CNN, 2025). Therefore, understanding the (psychological) prerequisites like study motivation (expectations and values) and belongingness of international STEM students’ study success and its indicators is essential.

Moreover, the need-to-belong theory (Baumeister & Leary, 1995) and the expectancy-value theory (Eccles et al., 1983) both provide a prominent theoretical framework for possible impacts on study success. In this dissertation, these frameworks were used to explore characteristics that may shed light on the lower study success of international (STEM) students. Thus, the present dissertation, which was composed as part of the InterMINT project (International STEM students in Germany), focused on the study success of international STEM students and its psychological predictors. First, the psychological success factors of international students in STEM and non-STEM and differences by sociodemographic characteristics and cultural resources and their interactions were investigated at their study start (*Study 1* and *2*). Besides, the developmental effects of the motivational predictors (SEVT) were considered over the study course, which spanned five semesters (*Study 3*). To conclude, the present dissertation focused on the intra- and inter-individual dynamics of study success and motivational predictors and effects of socio-demographic factors beyond gender and their intersectional interplay (*Study 4*). In all studies of this dissertation, differences in the study variables regarding gender, parental academic and cultural background and their interaction were considered to identify possible disadvantages of specific student groups in the sense of intersectionality (Cole, 2009; Crenshaw, 2017).

This Chapter 1 offers an introduction into the topic of this dissertation, international (STEM) students in German and the relevance of the research on the conditions of their study success. In Chapter 2, the theoretical background of this dissertation and its framework is described, the used definitions, models and theories were introduced. Chapter 3 provides a comprehensive overview of the dissertation and its four associated studies, whilst also delineating the distinctive research aims that define each individual study. In the method section (Chapter 4) the data set this dissertation is based on, as well as the analytic strategies of the four studies were introduced. Further, the dissertation concludes with a discussion in Chapter 5. Chapter 5 presents the overarching findings of the four studies, discusses the differences and similarities between these results, provides limitations of the dissertation and resulting implications for future research, as well as recommending implications for practice to promote the study success of international (STEM) students. In the appendix, the declaration on the scope of the own contribution and the contribution of the other authors, the affidavit of the author and the four studies this dissertation includes were provided (pp. 120ff).

2 Theory

As shown in the introduction, the objective of this work is multifaceted. In this chapter, I will first present the sample of this research, as well as the main concepts of the dissertation (study success, its psychological predictors and related sociodemographic characteristics) and the (theoretical) models, that explain possible relationships between them in the population of international students in Germany.

2.1 International STEM students

International students are defined as students who held a foreign citizenship and obtained their university entrance qualification (HEEQ) outside of their study country (Federal Statistical Office, 2020; OECD, 2023) or an equivalence of their HEEQ with the German abitur at a preparatory college (Studienkolleg) in Germany (Federal Statistical Office, 2020).

In international student mobility (ISM) research there is a distinction between degree-seeking and credit-seeking international students. Accordingly, degree-seeking students go abroad with the intention to obtain their degree in the host-country, here Germany. Further, international students who study in the host-country only for a semester or two, e.g., Erasmus students, were defined as credit-seeking international students (Thies & Falk, 2024). In this dissertation the focus was on degree-seeking students due to the relevance for the German (STEM) labor marked (e.g., Hoffmeyer-Zlotnik & Grote, 2019; Koenings et al., 2021) and their development of study success in Germany. Further, the present dissertation's sample focused on bachelor students, as master students may potentially perceive distinct and more heterogeneous (study) experiences what could lead to biases and reduce generalizability. Moreover, the dropout rates of the bachelor students differ highest between international and domestic students in Germany (41% in the bachelor's versus 28% of the domestics, but 28% in master's programs compared to 21% among domestic students; Heublein et al., 2022) than in the master program. Thus, the international bachelor students will benefit most from tailored interventions to promote their study success.

The abbreviation STEM reflects the research or subject areas of science, technology, engineering and mathematics (OECD, 2024). All other study subjects are non-STEM subjects regarding this definition. Each discipline is characterized by its own theoretical frameworks, methodological approaches, and unique challenges. Additionally, they diverge in terms of their academic curricula and the intellectual insights they impart to their students (e.g., Janke & Dickhäuser, 2019; Ylijoki, 2000). Thus, studying in STEM might differ in the higher education culture and its challenges, particularly for international students as we will see in section 2.4. Therefore, it is important to consider who comes to study STEM subjects at German universities and to explore these students' (psychological) predictors for study success that may influence who stays and who leaves during the study course and hopefully implies, who stays after their degree.

There is evidence for some specific patterns of equitable participation regarding sociodemographic differences within the context of STEM careers. To illustrate this point, considering the fields of engineering and computer science, which are often perceived to be more strongly associated with "brilliance" in comparison to the life sciences. These disciplines are also commonly viewed as offering fewer opportunities for assisting others (Cheryan et al., 2017; Leslie et al., 2015; Su & Rounds, 2015). Hence, some STEM careers are more likely to suffer from stereotypes. Patterns of equity in US among STEM careers varied: Women were under-represented in computer science, engineering and physics, but over-represented in life sciences and were more likely to change or adapt their STEM career plans due to competence-related expectancies or beliefs (Rosenzweig et al., 2025). Disadvantages also point to e.g., parental academic background, cultural background and their intersections (e.g., Good et al., 2012; Parker et al., 2020; Seo et al., 2019).

2.2 Study success

The term *study success* has not been subject to consistent definition; rather, there exist multiple ways of defining it. In my dissertation, based on the InterMINT project, the definition is in accordance with the definition as an individual subjective study success from the student's perspective, as defined by Heinze (2018), who categorizes success as process-related objective and subjective indicators.

The varying definitions reflect the perspectives of diverse interest groups, such as politics, higher education level, universities, and the personal view of students as individuals. It is a broad topic, encompassing retention, employability, access, widening participation and student satisfaction. Study success also depends on strategic decisions made by political leaders, e.g., the *2017 Higher Education Act* operationalizes study success as each study year being completed and a degree being obtained, simplifies the complexity of study success considerably (Department for Education, 2017, as cited in Lowe, 2024).

On the one hand, it can be conceptualized in a bureaucratic sense as the completion of the standard period of study with at least an “adequate” grade on the final certificate, or in a subjective interpretation, as a personal development that is experienced as enriching and empowering (Huber, 2009). Another perspective theorizing study success based on the relevant success criterion reference point with three levels (Rindermann & Oubaid, 1999): Study course, graduation and after graduation. On these levels, research distinguishes between objective and subjective success indicators. However, there are alternative defined success indicators, including process-related and subjective indicators, which have been considered by far fewer authors in the German research area, yet were positioned as noteworthy for that framework (Heinze, 2018). Examples for objective indicators for the process level were number of (failed) examinations (Heinze, 2018) or the end-of-semester grade (Glass & Westmont, 2014; Rienties et al., 2012; Wisniewski et al., 2020). As examples for subjective measures study satisfaction (e.g., Heinze, 2018; Heise & Thies, 2015; Westermann et al., 1996) or the individual process of (subjective indicated) dropout-intention (Heublein et al., 2017) could be mentioned.

The present dissertation primarily considers subjective study success factors regarding the definition of study success by Heinze (2018) and their predictors, because subjective study success factors like study satisfaction and dropout-intentions, were the strongest predictors of objective study success factors, such as factual dropout of the university program (Thies & Falk, 2024).

One process-related subjective indicator of study success was mentioned by Westermann (2006) and refers to (self-assessed) student satisfaction as the perceived fit between the individual and their study circumstances. It is not considering a homogeneous construct but rather consists of three different facets: Satisfaction with study content, study conditions, and coping with study stresses are studied as subjective indicators of study success at the process level (Heinze, 2018; Heise & Thies, 2015; Westermann et al., 1996). Study satisfaction (with the context) is significantly related to academic self-efficacy (Kryshko et al., 2022; Lent et al., 2007). A study using BintHo data indicated that the main reasons international students in Germany wanted to stay were satisfaction with their studies, good career prospects and the duration of stay (Petzold, 2022). Further, the results of discrete-time competing risk analyses by Thies and Falk (2024) amongst international students in Germany (N = 3,660) showed that satisfaction with the degree program's content is the most relevant predictor of decreasing the risk of major change and factual university dropout based on the first three semesters of the data set this dissertation based on (*International Student Survey*; Falk et al., 2021).

Another subjective study success factor is described by the students' intention to drop out of their study program. "Overly frequent thinking about dropping out of studies" is the dropout-intention's definition in the National Educational Panel Study (Blossfeld & von Maurice, 2011; NEPS, 2018), but dropout-intention is not only described as the quantity of thought but moreover includes the quality of those thoughts of dropping out, by accessing the degree of agreement to the extent to which students are seriously considering dropping out of university. This dropout-intention showed evidence in predicting the successful completion of a study program and is similarly part of behavior, persistence and is considered as a sufficient proxy for the factual dropout from university (Bäulke et al., 2021; Blossfeld & von Maurice, 2011; Brandstätter et al., 2006; Heublein et al., 2017; Suhlmann et al., 2018; Thies & Falk, 2024). This factual dropout from university is defined by Tinto (1993) as leaving the university in which the student was enrolled without obtaining a formal degree. In addition, dropout-intention is considered an early indicator for factual dropout of university (Brandstätter et al., 2006) and is often used as a measurement instrument for surveying dropout behavior (e.g., Bäulke et al., 2021; Suhlmann et al., 2018).

2.3 Psychological predictors of study success and the SeSaBa Model

The following theories and models used in this dissertation offer approaches to predict subjective study success as study satisfaction and dropout-intention and were base for these (subjective) indicators and self-related attitudes: The Self-Determination Theory (SDT, Ryan & Deci, 2000) regarding belonging and motivation, and the (situated) expectancy-value theory ((S)EVT; Eccles et al., 1983; Eccles, 1994; Eccles & Wigfield, 2023). Within the SeSaBa Model these theories offer the theoretical base for the psychological predictors, whereas the SeSaBa model framed the examination of the *International Student Survey* (Falk et al., 2021) in this secondary data analysis.

2.3.1 SeSaBa Model

This dissertation is based on the dataset of the International Student Survey (Falk et al., 2021) conducted in the project *Academic Success and Withdrawal Among International*

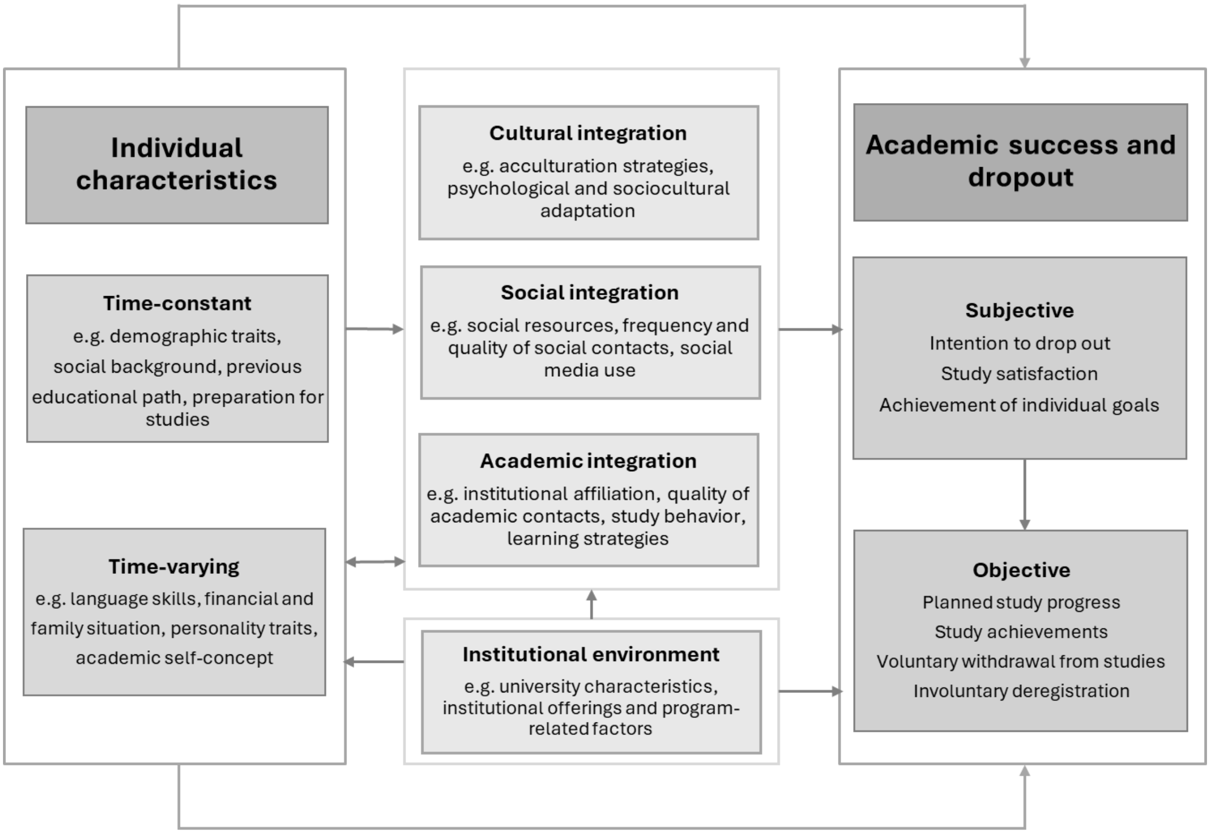
Students in Germany in Bachelor's and Master's Programs (SeSaBa) and further explores as a following project InterMINT the panel data on international students with regard to STEM that were collected as part of the SeSaBa project. For the SeSaBa project, a new model describing study success particularly for international students was necessary (Falk et al., 2021). This new model is an interdisciplinary conceptual framework to categorize predictors of study success. With three new advantages beyond the existing frameworks of study success (e.g., Heublein et al., 2010; Reason et al., 2006; Tinto, 1975), the SeSaBa model offers a differentiation between subjective and objective indicators of study success (see section 2.2 study success), the integration of cultural integration (Figure 1) and the longitudinal perspective. A substantial number of studies have examined specific predictors of study success and attrition (e.g., Bean, 1983; Tinto, 1975). However, Pascarella et al. (2004) stated, that in the context of international students' study success, some additional significant variables need to be considered, including but not limited to gender, social group affiliation, and social background. They were necessary to include the diverse effects of some interventions to reduce the rate of attrition on individuals. Furthermore, there is a possibility that interaction effects may exist, whereby the absence of social integration can be mitigated by academic integration, and vice versa. This represents a progression from Tinto's original additive model (1975) to an interactive model, in which the impact of individual factors is determined by the characteristics of the other variables (Pascarella & Terenzini, 1983). The time component is of particular significance, as the integration into the social and academic systems is a long-term process that is not accomplished immediately upon the transition from secondary to tertiary education (Tinto, 1993). In 1990, Ethington posited that students' expectations of success and the subjective value they attribute to a university degree have a direct influence on the persistence of their studies. However, they often do not enable them to make comprehensive conclusions regarding the interactive effects among different groups of variables (e.g., Reason et al., 2006). Moreover, Heublein et al. (2010) developed an integrative and procedural model of the dropout process. The model distinguishes between the preliminary study phase, the current study situation, and the decision phase. The integrative character of the model is especially evident in the current study situation phase, as sociological factors, including academic and social integration, study and living conditions, and financial situation are integrated with psychological explanatory factors, such as psychological resources, performance, and motivation to study. In the current study situation phase, sociological and psychological factors are integrated. A paucity of academic integration, financial issues, and reduced motivation to study have been shown to constitute the principal reasons for attrition, as demonstrated in the survey of exmatriculated students (Heublein et al., 2010).

Nevertheless, it is necessary to integrate results and theories from both sociological and psychological orientations to achieve a comprehensive understanding of the characteristics and procedures associated with study success and dropout of international students, and to develop the field of research accordingly. The panel study, theoretically based on the *Integrative Explanatory Model on Academic Success and Dropout of Foreign Students* presented below (Figure 1), was extended to the basic *Comprehensive Model of Influences on Student Learning and Persistence* (Reason et al., 2006). For this purpose, the model was adapted to the previous findings on relevant predictors and criteria for the current research interest and the specific study group of international students in Germany.

The SeSaBa model (Figure 1) includes individual characteristics (left bar), which were distinguished int time-constant and time-varying characteristics, which affect directly the study success and withdrawal (right bar). These success factors were differentiated into subjective and objective study success measures.

Figure 1

The conceptual framework of the SeSaBa model of study success



Note. Adapted from "Accompanying international students in Germany to academic success Results and recommendations from the SeSaBa project" by Pineda et al. (2022), DAAD studies, section 2.1 Conceptual framework of the study. Copyright 2022 by DAAD.

In the middle bar, there is one block of integration: Cultural, social and academic integration. These are influenced by the time-constant individual characteristics, whereas the time-varying individual characteristics describe a reciprocal influence on the integration factors. Hence, integration affects the study success factors. In the middle, there is an additional field at the bottom of the integration bar: the institutional environment as contextual factors. That influences all factors, individual characteristics, integration and study success factors directly.

The development of a new model in the SeSaBa project appeared necessary, as the existing models either did not adequately consider the specific situation and (cultural) challenges of foreign students or were based on case studies from the US context, which study conditions were not transferable to the study situation of international students in Germany (Pineda et al., 2022). It can thus be concluded that the model is appropriate for studies on international students, but it could also be used in future research to examine German students.

The current focus of predictors of study success in this dissertation was on sense of university belonging and study motivation, such as expectancies and value beliefs, conceptualized as time-varying individual characteristics in the SeSaBa model, that were shaped by academic, social and cultural integration.

2.3.2 Sense of university belonging

Baumeister and Leary defined belongingness in their *"need to belong"-Theory* as a basic fundamental need to have enduring, positive, meaningful interpersonal relationships and to let this relationship persist (1995). The importance of belonging is also supported in content by the *Self-Determination Theory* (SDT, Ryan & Deci, 2000). This educational environment frequently applied theory suggests that motivation (both intrinsic and extrinsic) for a particular behavior (e.g., learning behavior) depends on if the three basic psychological needs (competence, social relatedness, and autonomy) are encountered with the behavior (Deci & Ryan, 1993; Ryan & Deci, 2000). Thus, according to Ryan and Deci (2000), individuals engage in certain goals in that way to satisfy their inherent needs. However, it is important to note that the three needs do not necessarily have the same meaning for everyone but should be considered in terms of their subjective and culturally formed relevance.

The *sense of university belonging* reflects students' relatedness to the campus community respectively to the students of the own higher education institution (Locks et al., 2008). As well, sense of university belonging is one of the most cited predictors for psychosocial development, well-being, study success, and student persistence (Hausmann et al., 2007; Osterman, 2000; Yildirim et al., 2021). Hence, sense of university belonging was shown to be related to the study success of international students in Germany. Yildirim et al. (2021), showed positive (longitudinal) effects of sense of university belonging on well-being and study satisfaction, as well as a negative effect on dropout-intentions during international students' first two semesters of higher education. Additionally, previous studies emphasize the relevance of the sense of belonging to the university for study success or as a resource against dropout (-intentions). Further, Suhlmann et al. (2018) showed a negative relation of sense of university belonging and dropout-intentions at a German sample. Walton and Cohen (2011) indicated decreasing academic and social stressors in the higher education context through a higher sense of university belonging. As university belonging is important for the well-being and study success of (international) students (e.g., Yildirim et al., 2021), a thorough understanding of its conditions is crucial. Hence, social belongingness and value of the degree program to the labor market were also important factors for the intention to stay in Germany after the completion of their study program. Significant interaction effects of the importance of career prospects with the degree program's characteristics were also identified (Petzold, 2022), what necessitates investigating those characteristics.

Due to the relevance of sense of university belonging for consideration of the (lower) study success of STEM students, possible socio-cultural predictors of the sense of university belonging and possible differences in the relation between STEM compared to non-STEM students are considered in a differentiated way. In particular, students who belong to a minority group in their study program (by virtue of being female, having an academical background as a first-generation graduate, or being of a different cultural background) showed lower levels of sense of university belonging (Good et al., 2012; Harackiewicz et al., 2016; Rainey et al., 2018; Walton & Cohen, 2007; Walton et al., 2015).

2.3.3 Expectancy and value beliefs of success

As posited in the EVT by Eccles et al. (1983), study success could be explained by expectancy and value components, which, in turn, are influenced by the person's experiences, cultural norms, and the environment, such as family and peers (Eccles, 1994). Individuals' expectancy of success and subjective task values are postulated as the most relevant psychological predictors of task choice, performance, persistence and effort in the chosen tasks (e.g., Eccles et al., 1983; for value beliefs: Ethington, 1990). Furthermore, Eccles and Wigfield (2020) extended the EVT to the *situated-expectancy-value theory (SEVT)*. In this extension, Eccles and Wigfield (2020, 2023, 2024) introduced situated and cultural influences into the EVT model, thereby highlighting the significance of environmental conditions or the cultural background for the expansion of individuals' expectancy and values.

The *expectancy* component is one of the key factors within the SEVT and integrates a variety of theoretical conceptions of self-beliefs, as outlined by Eccles and Wigfield (2002), such as (academic) self-concepts (Dickhäuser et al., 2005; Marsh, 2007), and (academic) self-efficacy (Bandura, 1997; Pajares, 1996). In this thesis, the focus was on the latter expectancy component, the academic self-efficacy of international (STEM) students. According to Bandura's social cognitive learning theory, general self-efficacy is defined as a person's trust in his or her abilities to be able to master tasks and challenges or to achieve goals (1986, 1997). He identified four facilitators of positive development: mastery experience, role model learning, social support and physiological reaction to challenging situations (1986, 1997). While self-efficacy can be regarded as a generalized construct, it can also be interpreted in a more specific context, such as academic self-efficacy. Academic self-efficacy is defined as students' confidence that they feel able to control their own learning behavior, to reflect, understand and successfully process the learning material and to meet academic requirements (Bandura et al., 1999).

The expectancy component was enhanced in the longitudinal analyses of this dissertation by students' self-perceived *study-related language skills* in the specific sample of international students, regarding their ability to master study-related language requirements. Despite this, study-related language skills similarly might serve as a mitigating factor for international students, particularly the ones, who do not feel to belong to due to self-perceived minority categorization (e.g., female STEM students, students from different cultural backgrounds, first-generation students; Cena et al., 2021; Kunyu et al., 2021; Ryan et al., 2008). Thus, study-related language skills in this dissertation were considered on the one hand in the cross-sectional studies as a cultural resource (see Section 2.4.5), and on the other hand in longitudinal inquiries as a further expectation component.

The second factor in the (S)EVT, *value beliefs*, is commonly differentiated into four value components: *attainment value* (personal importance of success, identification with the subject or school/university in general), *intrinsic value* (interest and enjoyment in the task), *utility value* (usefulness for short- and long-term personal goals), and *cost value* (potential costs of investing time and effort in this study rather than another).

The assumption that the components of the (S)EVT, i.e., expectations and value beliefs, influence individuals' educational decisions, and study success both consciously and unconsciously is supported by accumulated findings from more than 40 years of research (Eccles et al., 2004; Eccles & Wigfield, 2024; Wigfield & Eccles, 2000, 2020). In relation to STEM choices, earlier research demonstrated that individuals with higher self-efficacy and self-concept of ability were more likely to pursue STEM studies (Eccles & Wang, 2016; Oppermann & Keller, 2018). Likewise, STEM-related expectations and value beliefs of school students, as well as their interactions, have been shown to predict STEM subject choices in high school and seven years later in college (Jiang et al., 2020). Their validities have been confirmed in numerous studies and meta-analyses on predicting achievement success in school and higher education (Breetzke & Bohndick, 2024; Breetzke et al., 2023; Gaspard et al., 2015; Honicke & Broadbent, 2016; Huang, 2012; Jiang et al., 2020; Messerer et al., 2023; Schnettler et al., 2020; Wigfield et al., 2021). Considerable empirical research has been dedicated to the investigation of expectancy-value theories over the course of several decades (Eccles & Wigfield, 2020, 2023). The onset of this research has been observed from as early as first grade (see Eccles et al., 1983), persisting through secondary school (e.g., Gaspard et al., 2015) and extending into higher education (e.g., Schnettler et al., 2020). In SEVT research among higher education, there are three approaches of research: Mostly, research on the relationship between expectancies, values and outcomes as study success constructs; a few findings with regard to research on the longitudinal development of expectancies and values over time (e.g., Benden & Lauermann, 2023; Schnettler et al., 2020); and research on contextual factors that influence expectancies and values to explore on the situated component of the SEVT. Expectancies and value beliefs were also relevant to changes in STEM career plans related to mostly positive attraction-related values, with different patterns by some sociographic characteristics (Rosenzweig et al., 2025). The students cited the attractive aspects related to the attainment, utility, or intrinsic value of their new career as the most relevant influence on their decision to alter their STEM plans. Also, most students cited numerous motivational factors associated with both their new and old careers. Slight disparities based on gender, ethnicity, year in school, and subject group were identified (Rosenzweig et al., 2025).

2.4 Sociodemographic diversity characteristics and their intersectional interplay in STEM and non-STEM students

In the literature, there is evidence that some sociodemographic predictors seemed to influence the psychological prerequisites (sense of university belonging and the SEVT components – expectancies and value beliefs) as well as the subjective study success factors. Therefore, it is of core interest to identify different groups in the heterogeneity of international students to implement suitable interventions, and it is imperative to refrain from neglecting potentially disadvantaged groups within the international student population to promote the study success of all international students. Hence, differences by gender, studying in STEM or non-STEM subjects, parental academic background, and cultural background were included in this dissertation as potential factors of disadvantages, particularly in intersection with gender.

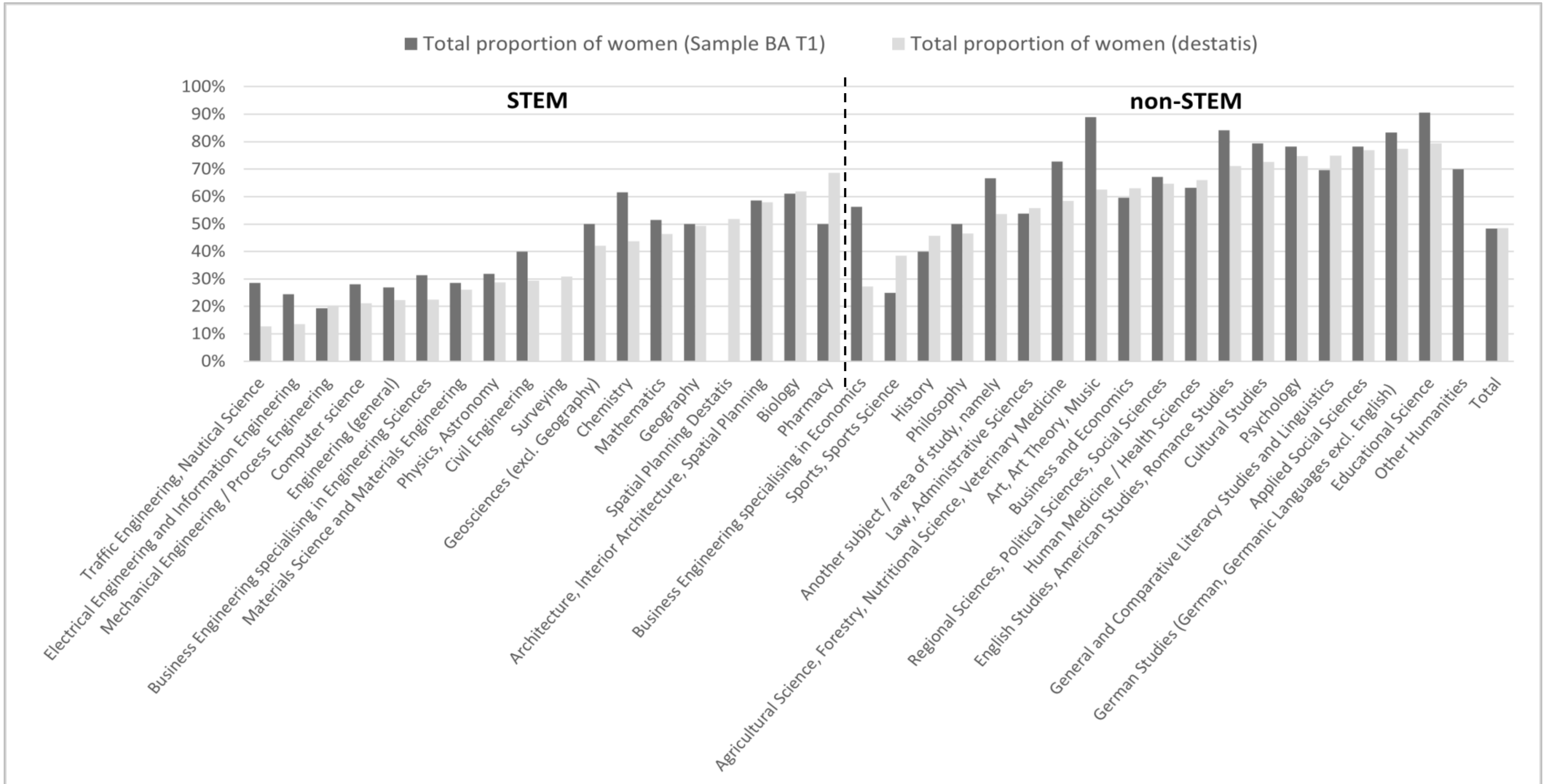
2.4.1 Gender

Female students continue to be underrepresented in STEM subjects, even when controlling for achievement (Else-Quest et al., 2013), apart from some subjects, where the proportion of women is higher (Federal Statistical Office, 2018). A persistent gender imbalance is still evident in the United States, with a proportion of 35% female students across all STEM subjects (OECD, 2023). In 2019, a similar situation is observed in Germany: 35% of first-semester bachelor’s students in STEM subjects were female (Federal Employment Agency, 2019; Federal Statistical Office, 2018). The gender-distribution of the International Student Survey’s sample (Falk et al., 2021) compared to the destatis data (Federal Statistical Office, 2018) of the same study year is provided in Figure 2. In this dissertation, gender was handled as binary: male and female. Gender differences have been identified in the psychological predictors of success in STEM subjects, particularly in self-related attitudes and sense of belonging (Else-Quest et al., 2010; Goldman & Penner, 2016), as well as among students (MacPhee et al., 2013). Furthermore, the psychological mechanisms of action (e.g., the effects of belonging on dropout-intention; Hilts et al., 2018) and the effects of interventions to promote study success in STEM subjects, which were intended to strengthen students' self-related attitudes or sense of belonging, also differed by gender (Harackiewicz et al., 2016; Walton et al., 2015). According to sense of belonging, gender has been mainly discussed as an important dimension regarding the university belonging of female students in STEM subjects. In 1991, Flam was one of the first who proclaimed, "a chilly climate for women in STEM". Most research on gender differences in study motivation was conducted in the context of STEM subjects, particularly related to study conditions. The EVT (Eccles et al., 1983) was developed, among others, to explain the mechanisms underlying the observed gender differences in academic attitudes and decisions related to STEM subjects, including subject choice and study success. A preceding meta-analysis identified gender disparities in academic self-efficacy, moderated by subject area, with males exhibiting higher levels of self-efficacy in maths, computer science and science than females (Huang, 2013). An additional meta-analysis by Parker et al. (2020) revealed gender differences in all expectancy-value components but costs (primarily due to the limited availability of studies) across diverse subject domains. Furthermore, Rosenzweig et al. (2025) showed, that in the US disparate patterns of equitable participation are evident across various STEM career pathways, i.e., women exhibit a disproportionately lower representation in computer science, engineering, and physics careers, compared to life sciences careers and showed a higher likelihood to change or adapt their career plans within STEM due to competence-related beliefs or expectancies (Rosenzweig et al., 2025).

In the SeSaBa model, gender depicts a time-constant individual characteristic, due to the only measurement at the end of the first semester in Germany.

Figure 2

Distribution of the thesis sample proportion of female students compared to the destatis data by subject-group



Note. The distribution of the thesis panel (dark grey) was nearly equal to the proportion of females in subjects in Winter semester 2017/18 according to destatis data (light grey).

2.4.2 Intersectionality

The term *intersectionality* is grounded by the Critical Race Theory by Kimberlee Crenshaw (2017) and is defined as interplay between multiple characteristics across various dimensions like race, gender, ethnic minorities, which can serve as the basis for discrimination or the experience of disadvantages (Crenshaw, 2017; Ferree, 2010). The effects of these dimensions in the sense of intersectionality are theorized to interact, not just to be added up (Cole, 2009; Knapp, 2012). The simultaneous presence of various characteristics leading to minority status (such as gender, ethnicity, and low socioeconomic status, measured by income and parental education) is associated with reduced academic achievement, as US-American studies on student populations indicated (MacPhee et al., 2013; Riegle-Crumb et al., 2010). Further studies provided an intersectional perspective on these phenomena as they assessed the interaction effects between different characteristics. These findings highlight structural and cultural features of universities, as well as STEM curricula and pedagogy, that continue to privilege white males.

To date, research on the intersection between characteristics such as gender, educational background, and ethnic or cultural background (also known as intersectionality) has primarily been conducted in the United States. Persistent gender effects on predictors of STEM success among students in the U.S. were moderated by ethnic or cultural background (Riegle-Crumb et al., 2010; Seo et al., 2019). As well, there is some research on the effects on the psychological predictors of study success. For example, in 2018, Rainey et al.'s results showed that students from underrepresented groups (being black and female) are less likely to feel they belong. In that vein, for example, Good et al. (2012), among others, showed that female students in STEM fields reported a lower sense of belonging than male students, as well as students of color. Parker et al.'s (2020) meta-analysis is currently the most comprehensive in considering intersectional perspectives on students' expectancy and value beliefs in different academic domains. They stated that gender does not influence the expectancy-value components alone, but gender interacts with multiple characteristics, particularly social class (socioeconomic status) in maths, and the gender effect size was highest in high socioeconomic status samples. Similar patterns were found for science expectancy. Additionally, a study of samples from 65 US universities revealed that female first-generation students reported lower levels of self-efficacy than their continuous-generation peers and male students (Blaney & Stout, 2017). Contrary, Else-Quest et al. (2013) reported slight various gender gaps in self-beliefs and value beliefs in science and maths between Latin, Asian American, and Caucasian 10th grade students, but these differences did mostly not yielded significance. Seo et al. (2019) used a similar but nationally representative sample of US 10th graders; male adolescents indicated a more positive math self-concept than females among Whites and Latinxs.

In Germany, intersectionality was mainly examined in higher education contexts descriptively (Lörz, 2019). Most studies grounded in European data beyond Germany mainly focus on the school sector (Else-Quest et al., 2010; Goldman & Penner, 2016). Mostly, former studies used a cross-sectional design. Further research is therefore required to provide specific intervention measures to support (international) students in STEM subjects at German universities. Currently, no intersectional findings have been reported on differences in the influencing processes of study success over the study course. The intersectional perspective facilitates a more precise assessment of the dropout risks of certain student groups (in Germany) and, concomitantly, provides a basis for the development of specifically tailored intervention measures. Moreover, the focus on study success in the context of STEM degree programs is predominantly oriented towards gender effects, while also considering effects arising from educational, ethnic, and cultural background (Else-Quest et al., 2010; Harackiewicz et al., 2016; MacPhee et al., 2013). Consequently, the impact of sociodemographic characteristics should be observed not solely in the function of distinct predictors but also in the context of their intersectional effects in multiplicative interactions. Against the background of the theoretically postulated gender differences in STEM choice, motivation, and success, the intersectional perspective of this dissertation focused on intersections of gender with parental academic and cultural background.

2.4.3 Parental academic background

First-generation students are students where none of their parents gained an academic degree, whereas continuous-generation students are defined as students where at least one parent has obtained an academic degree. Students, being the first in the family at a higher education institution face challenges in academia and perceive several potential disadvantages, that include the feelings of not fitting in, a lack of role models and missing knowledge about campus life (Harackiewicz et al., 2016; Padgett et al., 2012; Pascarella et al., 2004). Numerous studies indicated that continuous-generation students, both with and without an immigration background, perform better in German universities regarding objective and subjective success factors (Ebert & Heublein, 2017; Heublein et al., 2017; Janke et al., 2017; Lörz, 2019).

A small number of studies have examined the relationship between parental academic background and child expectancies and values. Previous research with German secondary education students in their final year of education (13th grade, mean age 19.9 years) showed significant correlations between socioeconomic status, encompassing parental academic background, and expectancy-value components; expectancy, attainment, intrinsic and utility value were all positively associated. However, a negative relationship was identified between cost value and the study variables (Meyer et al., 2019). Later, first-generation college students reported higher levels of cost value, which increased during the semester (Goldman et al., 2022). Against that background, the prediction of the parental academic background was included in both longitudinal SEVT studies, too. In the SeSaBa model, parental academic background could be located as an individual time-constant characteristic.

2.4.4 Cultural background

In my dissertation, culture is defined by the term ‘national cultures’, assuming that national cultural boundaries correspond to geographical boundaries. This perspective benefits constantly from considerable sources of cultural variations. Institutions such as higher education institutions, families and political and societal systems have a latent normative value system. Therefore, individuals' beliefs and values are influenced by these institutions. In this thesis, the categorization of countries or nations by clustering into country groups is also used. However, one negative aspect of this definition is a lack of consideration for the cultural variations present within countries, as living in the same country is not the only way to share a culture, but cultures can also be defined by region, gender, generation or social class (Hofstede & Hofstede, 2004). Empirical research indicates cultural values vary more within countries than between them (Fischer & Schwartz, 2011). Thus, the definition as ‘national cultures’ represents cultures as static and independent, since borders hardly ever change (Agnew, 2008) but could also be dynamic and change (Kannike & Tasa, 2016).

The transition from school to university implies multiple challenges for all students and include, but are not limited to, the new study requirements, a possible change of residence and the separation from family and friends that may come with it, and the need to make new friends and integrate into the new social environment (O'Keeffe, 2013; Sussman, 2002). Additionally, to the aforementioned challenges, international students are obliged to negotiate the process of cultural adaptation. This involves the possibility of challenging language barriers and navigating cultural differences (e.g., Bethel et al., 2020; Greischel et al., 2019; Jindal-Snape & Ingram, 2013). Besides the language barriers, which will be mentioned in the section of cultural resources (2.4.5), there was evidence for differences in study success and its psychological predictors for differences between students from different regions of origin.

Former studies indicated that the effects of interventions to promote study success were moderated by students' cultural background (Walton & Cohen, 2011), who explained this with the feeling of a lack of fit. In addition, study success and effects of (psychological) predictors of study success differed among groups of international students by region of origin (Rienties et al., 2012) and students who identified as belonging to a minority group in relation to their academic or cultural background described lower levels of sense of university belonging (Harackiewicz et al., 2016; Rienties et al., 2012).

Cultural norms, such as individualism and collectivism, shape expectations and value beliefs (Eccles, 1994; Eccles et al., 2004; Eccles & Wigfield, 2020; Tonks et al., 2018; Wigfield & Eccles, 2002). A study of US undergraduate students revealed that cultural norms predicted intrinsic values (Donohue, 2021). Similarly, associations between cultural norms and the perceived utility value of degree programs amongst international students in Germany were described by Mok et al. (2021). Further studies revealed that gender differences in attitudes towards and success in STEM fields varied significantly between European countries, the authors explained these differences with reference to cultural norms (Else-Quest et al., 2010; Goldman & Penner, 2016). The cultural background as regions of origin describes a time-constant individual characteristic, in the SeSaBa model.

2.4.5 Cultural Resources

Acculturation orientation. As posited by Berry (2006) and Ward and Kennedy (1993), acculturation orientations are crucial factors in determining how migrants perceive those challenges, such as cultural adaptation, associated with migration. In intercultural psychology, acculturation is defined as a continuous process of direct contact between different cultures that occurs, for example, when individuals live outside their home countries and is described as changes in behaviors and attitudes in the context of intercultural contacts (Berry, 1997). These cultural changes of international students during their transition to the new host culture (e.g., Bethel et al. 2020; Geeraert & Demoulin, 2013; Greischel et al., 2019; Jindal-Snape & Ingram, 2013) are highly relevant to students' experiences, and thus necessitate the use of (additional) cultural resources (Le Roux & Groenewald, 2021; Pekerti et al., 2020; Ryan et al., 2008).

These orientations were defined as two independent dimensions of acculturation orientations (Arends-Tóth & Van de Vijver, 2004; Berry, 2006). On the one hand host-culture orientation, what means how much a person is interested in getting in touch with people and their culture of the host culture and on the other hand there is home-culture orientation, what reflects how much a person is interested in getting in touch with people and their culture of the home culture. Both orientations showed positive associations with adjustment and successful adaptation (e.g., Berry, 2006; Bierwiaczonek & Kunst, 2021). A recent study among immigrant high school students from six different countries with the PISA data revealed positive associations between host- and home-orientations and school belonging (Schachner et al., 2017).

Further, Taušová et al. (2019) examined the acculturation process of international students in the Netherlands (N = 319 from 62 countries), using the model developed by Arends-Tóth and Van de Vijver (2004). Their results underscore the necessity of examining the acculturation of international students in the context of their other socio-cultural characteristics. Significant direct and indirect effects of acculturation on adaptation were identified, i.e., a lower perceived cultural distance was related with higher adaptation, while host-culture orientation showed a positive correlation with adaptation. Conversely, home-culture orientation was negatively associated with adaptation (Taušová et al., 2019). This suggested that host-culture orientation could serve as a valuable resource, especially at the start of the study program, when students need to adapt to new higher education systems and culture. Until now, this has barely been researched on international students. To close this research gap, one aim of this dissertation was to examine whether the results from school context could be transferred to our sample of international bachelor students.

Against this background, home- and host-culture orientations were also included in this dissertation, in *Study 1 and 2*, which focused the study start, as they could serve as resources for motivation and sense of university belonging in order to diminish the demands by struggling to “arrive” in the host-country, which were especially important at the start abroad. Acculturation orientations were deemed as time-varying cultural characteristics, in the SeSaBa model.

Study-related language skills. Another challenge faced by international students beside the above-mentioned in the acculturation process, includes potential language barriers, whereas language skills were relevant to the international students’ academic and social integration (e.g., Bethel et al, 2020; Jindal-Snape & Ingram, 2013; LaCosse et al., 2020; Le Roux & Groenewald, 2021; Ward & Kennedy, 1993; Wisniewski et al., 2022). The capacity to communicate in one’s host country’s language fosters engagement in campus life and networking with fellow international and host national students, even by contributing some sense of university belonging (Thies & Falk, 2023). In this context, enhanced study-related language skills might serve as a mitigating factor for international students, in particular the ones, who feel not to belong to due to some self-perceived minority categorization, e.g., female STEM students, students from different cultural backgrounds, first-generation students, by augmenting their social integration through interaction with their peers (Cena et al., 2021; Kunyu et al., 2021; Ryan et al., 2008). But it is important to consider the specific sample of international students’ needs and to enhance the expectancy component regarding their ability to master study-related language requirements. For this reason, the study-related language skills in this dissertation were considered on the one hand in the cross-sectional area as a culture-related resource, and on the other hand in the longitudinal inquiries as an additional component of expectations. Thus, the developmental effects in *Study 3* and *4* might vary by sociodemographic characteristics and their intersections.

Study-related language skills (as a cultural resource as well as an expectancy component) in the SeSaBa model could be positioned as a time-varying cultural characteristic.

2.4.6 Subject group: STEM- versus non-STEM

The categorization of the study subject groups into STEM and non-STEM subjects in this dissertation was based on the specification of the Federal Statistical Office for the 2017/2018 winter semester (Federal Statistical Office, 2018) and the statistics of the Federal Employment Agency (2019), as this was when the survey for the International Student Survey began. According to the EVT (Eccles et al., 1983), a person will choose the field of study with which they expect the greatest success compared to others and associate the highest subjective values. Over time, these beliefs were shaped by experiences with the subject content and the evaluation of these experiences and were influenced, among other things, by the subjective assessment of ability (ability self-concept) as well as the expected difficulty of the subject (self-efficacy; Eccles, 1994). To address the potential gender imbalance, some repetitive analyses categorize STEM subjects according to *the proportion of women* to scrutinize the robustness of the results. In that vein, an occupation is considered to be gender-segregated, if the proportion of the other gender is below 30% (Dressel & Wanger, 2008). The proportion of women enrolled in the respective degree program was retrieved from the higher education institution statistics (Federal Statistical Office, 2018) for all students (i.e., German, migrants, other nationalities, mobile students, bachelor’s and master’s students, and all university semesters) to depict the general climate in the degree program.

The distribution of the winter term 17/18 per subject in the dissertations sample compared to higher education institution statistics (Federal Statistical Office, 2018) was provided in the gender section (Figure 2).

In Germany, the higher education system emphasizes independence and self-study in STEM subjects, there is often no mandatory schedule but a lot of autonomy, in contrast to the former school system with guided learning environments. This might be challenging, especially when language or cultural barriers hinder asking peers or teachers for support. Hence, adapting to the different higher education cultures requires time and effort, even to persist in all seminars and tests per semester (Apolinarski & Poskowsky, 2013; Pineda, 2018). Further, the exams per semester are highly competitive, there is a high failure rate (i.e., > 60%; Federal Statistical Office, 2025). Thus, many individual characteristics might have a relevant influence on the international students' study success in Germany and seem to be important to be considered.

In the SeSaBa model, studying in STEM or in non-STEM subjects could be located as a contextual variable, because the participants indicated their subject at the first measurement occasion, at the end of their first semester in Germany.

3 The present dissertation

Despite the established importance of international students at universities worldwide (DAAD & DZHW, 2022; OECD, 2022) and their increasing numbers (in Germany), there is a paucity of research on international students' study success, their important predictors of study success like sense of university belonging and expectancies and value beliefs and its sociodemographic predictors (Eccles et al., 2004; Flam, 1991; Good et al., 2012; Harackiewicz et al., 2016; Walton et al., 2015; Wigfield & Eccles, 2000, 2020). However, it is important to notice that many international students encounter challenges in their academic programs (e.g., Bethel et al, 2020; Jindal-Snape & Ingram, 2013; Morris-Lange, 2017). Therefore, in this dissertation I did not only want to fulfil the essential need to develop a nuanced (intersectional) understanding of the psychological conditions and inter-individual differences that underpin study success at the start of the international students' stay abroad but aimed to investigate the longitudinal development of motivational factors such as expectancies and value beliefs over the study course. Moreover, the importance of examining differences in the development of these factors by gender, as well as the interplay between gender and subject group (STEM vs. non-STEM), parental academic background, and cultural background, is imperative. Yet only few studies have investigated the longitudinal development of motivational factors like expectancy and value beliefs over the study course, and in particular, non with a sample of international students in Germany. Addressing this research gap provides a more comprehensive understanding of the motivational heterogeneity of international bachelor students and a foundation for the development of interventions to foster distinct components of study motivation, and to implement tailored interventions, addressing all groups in the heterogeneity of international students.

My research offers novel insights into potentially disadvantaged groups regarding the predictors of study success, the development of the expectancies and value beliefs (SEVT components and study-related language skills) over the study course and influences by (the interplay of) individual characteristics as determinants of higher education students' expectancies and values, particularly for international bachelor (STEM) students in Germany. Moreover, I investigated the associations between people and within people over time, revealing few incidents of expected intra-individual associations and emphasizing the need for research on motivational components and indicators of success at this level. I used RI-CLPM models to include the relations between time-independent socio-demographic characteristics and stable conditions of motivational and study success. There is substantial evidence for the central postulates of the SEVT, i.e., associations between motivational characteristics and intentions to drop out of university as well as study satisfaction. Contrary, there are barely any studies on the development of motivational conditions and study success over time as well as on the reciprocal relationships between changes in motivational characteristics and dropout-intentions or study satisfaction on an intra-individual level over time, for international bachelor students in STEM. Further, the intersectional perspective thus allowed us to gain a more nuanced picture of the heterogeneous group of international students (in Germany). Hence, this dissertation might provide indications for tailored interventions and information on possible resources to foster sense of university belonging, expectancies and value beliefs and an adaptive motivational development and study-related language skills as well as to reduce psychological costs over the study course in order to support the study success of international bachelor STEM-students in Germany.

To sum up, the following three research aims were pursued across the four quantitative studies (*Study 1–4*) in this dissertation. A general overview of the four studies in this thesis is provided in Table 1. The whole theoretical background and the detailed hypotheses, results and discussion of *Study 1–4* can be seen in the appendix (pp. 123ff).

Research aim 1:

First, this dissertation wanted to investigate from an intersectional perspective the relation of gender, parental academic background, cultural background and cultural resources (i.e., study-related language skills and acculturation orientations) with sense of university belonging (*Study 1*), academic self-efficacy and value beliefs (*Study 2*) of a large sample of international STEM students at the beginning of their studies at the end of their first semester in Germany. Additionally, while focusing on STEM students, the design allowed us to compare the pattern of results between STEM and non-STEM subjects and thus to infer whether any findings are indeed specific to the situation of international STEM students or reflect a more general pattern.

To answer research aim 1, in *Study 1*, there was investigated how gender, first-generation student status, cultural background and acculturation orientations as well as their (intersectional) interplay related to the sense of university belonging of international students in STEM subjects:

- *Study 1* requests to investigate the gender differences on the sense of university belonging.
- It is crucial to examine the influence of parental academic and cultural background as region of origin, and cultural resources (study-related language skills, and acculturation orientations), on the sense of university belonging. And do these influences vary between genders?
- Does the influence of gender, parental academic background, cultural background and cultural resources vary between STEM and non-STEM subjects?

In *Study 2*, it was assessed how gender, parental academic background, and cultural characteristics (i.e., cultural background, study-related language skills, and acculturation orientations) are related to the academic self-efficacy and value beliefs of a large sample of international STEM students, to answer research aim 1.

- In *Study 2* the relationship between gender and study motivation were explored, i.e., if female international (STEM) students showed lower levels of academic self-efficacy, attainment, intrinsic, and utility values, but higher levels of cost value than male international STEM students.
- *Study 2* was to investigate the association of parental academic and cultural background with academic self-efficacy and value beliefs of international STEM

students, and whether there is variance in the influence of these factors according to gender, in the sense of intersectionality.

- *Study 2* seeks to answer the question, how cultural resources (study-related language skills, host-culture orientation and home-culture orientation), were related to academic self-efficacy and value beliefs of international STEM students.
- *Study 2* was to ascertain whether there are any differences between STEM and non-STEM subjects in all these questions.

Research aim 2:

The second research aim was the investigation of the longitudinal development of motivational factors such as expectancies and value beliefs over the study course with five measurement occasions over five semesters on the sample of international students in Germany (*Study 3*). Moreover, the study focused on differences in their development by gender and their interaction with subject group (STEM vs. non-STEM), parental academic background and cultural background.

In order to respond to research aim 2, in *Study 3* the longitudinal development of motivational factors like expectancy and value beliefs of international students in Germany over time were investigated. Differences in their development by gender and their interplay with subject group (STEM vs. non-STEM), parental academic background and cultural background as region of origin were examined. While gender, parental academic background, cultural background and, to a certain extent, the subject group represent time-invariant characteristics that may explain inter-individual differences, study-related language skills may change over the course of the study, like the other motivational components. Therefore, the differential longitudinal development of study-related language skills amongst international bachelor students in Germany were exploratively addressed.

- The purpose of *Study 3* was to ascertain the longitudinal relationships between study motivation and process indicators of study success during the study course. I. e., how do academic self-efficacy and study-related language skills as expectancies and attainment, intrinsic, utility and cost values develop over the study course of international bachelor students in Germany?
- *Study 3* seeks to explore the impact of gender, subject group (STEM vs. non-STEM), parental academic background and cultural background as region of origin on the observed effects of development of expectancies and values among international students.
- In *Study 3*, I explored from an intersectional perspective, if potential gender differences in the development of expectancies and values interact with subject group (STEM vs. non-STEM), parental academic background and region of origin (cultural background).

Research aim 3:

Furthermore, I considered the inter- and intra-individual dynamics between expectations, value beliefs and dropout intentions as well as study satisfaction in the sample of international STEM students in Germany. In addition, inter-individual differences by gender, parental academic background and students' cultural background in these constructs were analyzed. In the sense of intersectionality, the interactions of gender with parental academic and cultural background in relation to the motivational constructs, study satisfaction and dropout-intentions over the study course were also assessed.

To address research aim 3, in *Study 4* of this dissertation the focus was on the sample of international STEM students in Germany and their inter- and intra-individual dynamics between expectations, value beliefs and dropout-intentions as well as study satisfaction, using Random-Intercept Cross-Lagged Panel Models (RI-CLPM; Hamaker et al., 2015). Moreover, the inter-individual differences in these variables were analyzed regarding gender, parental academic background and students' cultural background as well as the intersectional interplay (e.g., Cole, 2009; Knapp, 2012) of gender with parental academic and cultural background relate to the motivational constructs, study satisfaction and dropout-intention over the study course.

- *Study 4* in this dissertation examined if inter- and intra-individual dynamics are evident between expectations (i.e., academic self-efficacy, study-related language skills), value beliefs, dropout-intentions and study satisfaction among international STEM students.
- Secondly, *Study 4* wanted to investigate if there exist any inter-individual differences in expectations, value beliefs, and dropout-intention, as well as student satisfaction, amongst international STEM students based on gender, parental educational background, and cultural background as region of origin.
- A further objective of *Study 4* was to ascertain whether inter-individual differences by parental educational background and cultural background as region of origin vary between genders, from an intersectional perspective.

Moreover, *Study 4* proceeded with further exploratory inquiries into cross-lagged effects.

Table 1

Description of the studies in this dissertation

Study	Method	Sample	IV	T1	T2	T3	T4	T5	DV	Reference
1	Multigroup-regression model	STEM vs. non-STEM	Gender Parental academic background Country groups Study-related language skills Host- & Home culture Intersections with gender	X					Sense of university belonging	Preuß, J. S., Zimmermann, J., & Jonkmann, K. (2025). Intersectional perspectives on the university belonging of international STEM students. Social Psychology of Education, 28, 59. https://doi.org/10.1007/s11218-025-10017-9
2	Multigroup-regression model	STEM vs. non-STEM	Gender Parental academic background Country groups Study-related language skills Intersections with gender Host- & Home culture	X					EVT: academic self-efficacy, attainment, intrinsic, utility and cost value	Preuß, J. S., Zimmermann, J., & Jonkmann, K. (2023). Academic self-efficacy and value beliefs of international STEM and non-STEM university students in Germany from an intersectional perspective. Education Sciences, 13(8), 786. https://doi.org/10.3390/educsci13080786
3	LGCM	STEM vs. non-STEM	STEM/non-STEM Gender Parental academic background Country groups Intersections with gender	X	X	X	X	X	EVT: academic self-efficacy, study-related language skills, attainment, intrinsic, utility and cost value (t1 – t5)	Preuß, J. S., Zimmermann, J., & Jonkmann, K. (2025). The development of expectations and value beliefs among international students in Germany over the study course: Effects of sociodemographic characteristics, subject groups and their intersectional interplay. *Manuscript submitted for publication*.
4	RI-CLPM	STEM	*Time variable:* EVT: academic self-efficacy, study-related language skills, attainment, intrinsic, utility and cost value *Time constant:* Gender Parental academic background Country groups Intersections with gender	X X	X	X	X	X	Dropout intention, Study satisfaction (t1 – t5)	Preuß, J. S., Zimmermann, J., & Jonkmann, K. (2025). International STEM students in Germany: An intersectional perspective on the longitudinal dynamics between expectations, value beliefs and study success. *Manuscript submitted for publication*.

Note. LGCM = Latent growth curve model, RI-CLPM = Random intercept-cross-lagged panel model, IV = independent variable, DV = dependent variable, t1, t2, t3 etc. reflect the measurement occasion at the end of the 1st, 2nd, 3rd etc. semester in Germany.

To answer the research aims of this dissertation, data from a large and heterogeneous panel sample of international students in Germany International Student Survey (Falk et al., 2021) were used that endorsed students with different cultural backgrounds, studying in a broad range of different subject groups and at different higher education institutions all over Germany. This data set also provided me with the great advantage of a large control group of an international non-STEM student (more information on the data base is provided in section 4). Potential effects of age (Parker et al., 2020) and previous residence in Germany (Glorius, 2016; Zimmermann et al., 2021a) were controlled in all studies of this dissertation.

The dissertations sample was restricted to bachelor students to ensure that the participants are more comparable regarding previous experiences at the higher education institution and in their field of studies and because bachelor's students were more likely to drop out compared to domestic students (e.g., Heublein et al., 2022).

4 Method

In the method section first the general data base, which is used for the secondary data analyses in this dissertation, is described. Second, the analyses were introduced briefly. The detailed information of the particular data sets the studies, the operationalization of the constructs, the used instruments in the studies and the analytical strategy of each study could be seen in *Study 1–4* in the appendix (pp. 123ff).

4.1 Data base

This dissertation is part of the interdisciplinary project InterMINT (International STEM students in Germany) as a cooperation of the FernUniversität in Hagen representing the psychological perspective and the Bavarian State Institute for Higher Education Research and Planning (IHF) representing the sociological perspective. InterMINT was funded by the

BMBF (Federal Ministry of Education and Research) as part of the funding line "Study success and withdrawal II" by a research grant awarded to Dr. Julia Zimmermann (grant number 16PX21018A). With a duration from 01.08.2021 to 31.07.2024, the project directly continues the preceding interdisciplinary research project SeSaBa (*Academic Success and Withdrawal Among International Students in Germany in Bachelor's and Master's Programs*) and further explores the panel data on international students that were collected as part of the SeSaBa project.

Thus, the data base for this dissertation is the panel study on international students in Germany (International student survey; Falk et al., 2021). The SeSaBa project constituted a significant contribution to the extant literature concerning international students. This was because, until that time, no comparable data sets were available. The International Student Survey was the first to generate longitudinal data on the study success and development of international students in Germany with comprehensive, multifactorial data. The advantages of this data base is the large and heterogeneous panel sample of international students from 135 higher education institutions which provides information on international students in Germany and thus enabled us the possibility to explore effects of different regions of origin and across different higher education institutions. In contrast to former studies, this data base provides a large control group of non-STEM students and offers the opportunity to investigate if potential effects of gender and/or academic and cultural background are specific to the STEM context or apply to all international students.

As Table 2 shows, the data collection enclosed six measurement occasions over the course of three years. The questionnaires were distributed by the end of each semester and were in German and English language available. In this dissertation, the longitudinal analyses were restricted to the first five measurement occasions, to take account potential biases by the different situation due to the beginning pandemic situation (i.e., Covid-19) at the sixth measurement occasion. Further, it was also decided to exclude students from universities of music and art from the survey due to their specific study conditions, which were substantially different from those at other universities.

Importantly, the used data in that panel study only addressed international students who studied in the first semester of a bachelor's or master's degree program and intended to obtain their degree in Germany (Falk et al., 2021). That is, international credit-seeking students who only study in Germany for a semester or two, e.g., Erasmus students, were not part of the sample.

In the winter term 2017/2018 N = 4,751 international students pre-registered for the International Student Survey. In the bachelor's program 1,892 (39.8%) of the participants attended (who were my dissertations' study sample) and in a master's program 2,859 (60.2%) took part. The international students were enrolled at 135 higher education institutions[1] (75.1% universities and 24.2% universities of applied sciences), which were distributed across all federal states of Germany, and studied in 36 different subject groups. Thus, they reflected the broad diversity of subject groups in Germany. The international students obtained their higher education entrance qualification (HEEQ) in 134 different countries or at a preparatory college (Studienkolleg) in Germany. Most students with 12.9% in the overall sample obtained their HEEQ in India, followed by China (9.7%), Syria (4.9%), Russia (4.3%) and in the United States (4.2%). According to the DAAD regional classification (DAAD & DZHW, 2019), all countries were categorized to the following regional groups: Western Europe (10.1%), Central and South-Eastern Europe (10.5%), Eastern Europe and Central Asia (10.5%), North Africa and Middle East (18.5%), North America (4.6%), Latin America (8.5%), Sub-Saharan Africa (4.5%) and Asia-Pacific (32.9%).

[1] except for universities of music and art (Falk et al., 2021)

The international students' mean age was 25.29 years (*SD* = 4.21) at the initial measurement date by the registration. The proportion while of female students was 44.2% while the proportion of male students was 55.6%. Six students (0.1%) identified as "other" with respect to their gender, while one student did not specify this.

Table 2

Bachelor and master sample of the International Student Survey

Bachelor and Master Sample	**Registration**		**1st academic year**		**2nd academic year**		**3rd academic year**		**Follow-up survey of panel-dropouts**
	2017/2018 Winter semester		**2017/2018 Winter semester**	**2018 Summer semester**	**2018/2019 Winter semester**	**2019 Summer semester**	**2019/2020 Winter semester**	**2020 Summer semester**	
STEM subjects [a] (e.g., engineering, natural sciences and mathematics)	*n* = 2,740	57.7%	*n* = 2,170	*n* = 1,856	*n* = 1,347	*n* = 1,383	*n* = 1,001	*n* = 967	
Non-STEM subjects [a] (e.g., law, economics, social sciences or other humanities)	*n* = 2,011	42.3%	*n* = 1,658	*n* = 1,414	*n* = 1,080	*n* = 1,109	*n* = 830	*n* = 766	
Total	*N* = 4,751	100.0%	*N* = 3,828	*N* = 3,270	*N* = 2,427	*N* = 2,492	*N* = 1,831	*N* = 1,733	

Note. Adaptation of "Methodenbericht zum 'International Student Survey' aus dem Projekt 'Studienerfolg und Studienabbruch bei Bildungsausländern in Deutschland im Bachelor- und Masterstudium' (SeSaBa). Release 2" by S. Falk, T. Thies, H. H. Yildirim, J. Zimmermann, J. Kercher, and J. Pineda, 2021, *Bavarian State Institute for Higher Education Research and Planning (IHF)*, p. 2 (https://nbn-resolving.org/urn:nbn:de:0168-ssoar-75723-1).

[a] Categorization into STEM and non-STEM subjects based on the specification of the Federal Statistical Office (destatis, 2018) of the winter semester 2017/2018 and the statistics of the Federal Employment Agency (2019).

4.2 Analyses

All analyses were calculated with IBM SPSS Statistics version 28 (2021) and 29 (2023) and Mplus Version 7 (Muthén & Muthén, 1998–2015). Missing data in all four studies were handled with the full information maximum likelihood (FIML) method as implemented in Mplus although missing rates of all constructs were very low (< 1%).

In *Study 1* and *2*, multi-group regression analyses were performed in order to assess differences between subjects in STEM and non-STEM disciplines in a cross-sectional way at the beginning of the studies. The sociodemographic predictor variables, as well as study-related language skills and acculturation orientations and their interaction terms were entered into the model stepwise in *Study 1* and were tested via Wald-tests to assess the appropriateness of equality constraints between the subject groups. In *Study 2*, all predictor variables were inserted, and a Wald-test was run to test the appropriateness of equality constraints between the subject groups. By non-significant Wald-tests (at $p > .05$) the respective model paths were restricted to be equal. In the next step, the interaction terms (interactions between gender and parental academic background and between gender and the country groups) were inserted and it was tested if these paths could be equated across subject groups. For reasons of model parsimony, interaction terms that did not yield statistical significance in both subject groups were removed from the model before the next predictor was inserted. The final models in both studies incorporated all predictors, in addition to the significant interactions between gender and the other predictors. In the last step, the intercepts were tested and set equal if the Wald-test was not significant.

To ascertain information regarding the development, as well as the prevalence of inter-individual differences in change, about the motivational components, study-related language skills, and indicators of study success over the study course, in *Study 3* latent growth curve models (LGCM) were conducted (Bollen & Curran, 2006; McArdle &

Nesselroade, 2003). Linear models were specified, and the alternative forms of the slope were tested, including the quadratic and free loadings, in instances where the fit statistic for the linear model was unsatisfactory. Consequently, conditional LGCM with predictors were employed to examine the development of international students' expectations and value beliefs over the course of the study, while considering inter-individual differences by gender, subject group (STEM/non-STEM), parental academic background, cultural background, and in further LGCM also their intersections with gender.

In *Study 4*, the inter- and intra-individual dynamics between expectations, value beliefs, language skills and study satisfaction or dropout-intentions of international STEM students in Germany were investigated. A Random-Intercept Cross-Lagged Panel Model (RI-CLPM; Hamaker et al., 2015; Mulder & Hamaker, 2021) was specified for each of the two subjective indicators of study success (dropout-intention and study satisfaction). The RI-CLPM is particularly apt for distinguishing between inter-individual and intra-individual variability, as it encompasses both variance components reflecting the variability in predictors and outcomes that are stable across waves (between-level), as well as changes over time in intra-individual measures (within-level; Hamaker et al., 2015). This approach enabled me to explore inter-individual relationships on a between-person level, facilitating the identification of disparities among diverse student groups on the time-invariant components of the assessment instruments. The analysis was also improved with an examination of intra-individual relationships on a within-person level, to encompass temporal changes within individuals while maintaining a comprehensive perspective. Inter-individual relations are essential in describing relations between time-stable characteristics for the dependent variables, which are applicable with both cross-sectional and longitudinal data. Observing intra-individual relations is advantageous in analyzing the effects of changes in the study variables over time, which can only be done with longitudinal data. The RI-CLPM components like random intercepts, cross-lagged paths etc., were described and explained in detail in *Study 4*.

To recap, one of the primary objectives of the RI-CLPM is the identification of within-person autoregressive and cross-lagged effects (Mulder & Hamaker, 2021) and the consideration of time-stable variances in a simultaneous way. To examine inter-individual differences in the random intercepts of these variables with respect to gender, parental academic background, students' cultural background, and the interaction between these factors, their effects on the random intercepts were conducted. Subsequently, interaction terms were integrated, representing interactions between gender and parental academic background, and between gender and country groups. To adjust for biases by multiple testing, in *Study 4* the Benjamini-Hochberg (Benjamini & Hochberg, 1995) correction was used.

In the analyses of this thesis, the effects of age and previous residence in Germany were controlled to ensure internal validity and generalizability of the findings.

5 Discussion

With this dissertation I wanted to shed light on the research of international students' study success, the important psychological predictors of study success like sense of university belonging and expectancies and value beliefs and its sociodemographic predictors from an intersectional perspective (Eccles et al., 2004; Eccles & Wigfield, 2024; Flam, 1991; Good et al., 2012; Harackiewicz et al., 2016; Walton et al., 2015; Wigfield & Eccles, 2000, 2020). Despite the increasing number of international students, particularly in Germany as the fourth-largest host nation (12% of the student body), unfortunately the bachelor students encounter several challenges studying abroad, reflected in the high estimated dropout rates (41% of international bachelor's students vs. 28% among domestic students, Heublein et al., 2022). Given the general importance of international students in the student body and their remarkably high dropout rates, the dissertation hereby presented, aimed to examine study success of international STEM students and its study success factors (sense of university belonging, expectations and values, SEVT) the current status quo at the beginning of their studies and explored potential differences between subject groups (*Study 1 and 2*). Further, the dissertation delineates the longitudinal developmental effects of expectancies and value beliefs (SEVT) as predictors of study success over the study course with a period of five semesters and across diverse courses, with consideration of sociodemographic characteristics (*Study 3*). Lastly, my thesis addressed the intra- and inter-individual dynamics of these predictors of study success, as expectancies and value beliefs (SEVT), and study success, as dropout-intention and study satisfaction whilst also examining their reciprocal relationships over time (*Study 4*). Overall, the effects of sociodemographics beyond gender effects and their intersectional interplay as well as cultural resources were investigated, which might influence the study success of international STEM students and its predictors. All studies were investigated from an intersectional perspective. In particular, the three key research aims were the following:

1. Regarding research aim 1, I examined the relation between gender, parental academic background, cultural background and cultural resources (i.e., study-related language skills and acculturation orientations) with sense of university belonging, academic self-efficacy and value beliefs of a large sample of international STEM students at the beginning of their studies at the end of their first semester in Germany. Additionally, while focusing on STEM students, the design allows us to compare the pattern of results between STEM and non-STEM subjects and thus to infer whether any findings are indeed specific to the situation of international STEM students or reflect a more general pattern (*Study 1* and *2*).

2. Among research aim 2, it was investigated the longitudinal development of motivational factors such as expectancies and value beliefs across the study course, with a sample of international students in Germany. Furthermore, the investigation focused on the differences in their development by gender and its interplay with subject group (STEM vs. non-STEM), parental academic background and cultural background (*Study 3*).
3. Research aim 3 of this dissertation focused on the consideration of the inter- and intra-individual dynamics between expectations, value beliefs and dropout-intentions, as well as study satisfaction on a sample of international STEM students in Germany. Additionally, the inter-individual differences in these variables were analyzed regarding gender, parental academic background and students' cultural background, as well as the intersectional interplay of gender with parental academic and cultural background in relation to the motivational constructs, study satisfaction and dropout-intentions over the course of study (*Study 4*).

These aims addressed the outstanding research among international bachelor students and offered a more comprehensive understanding of the diverse motivations of international students and provided a foundation for the development of targeted interventions. These interventions aim to enhance specific components of study motivation and to implement tailored solutions that address the various groups within the international student population. In the discussion, the summary of results was presented (5.1), then in 5.2 the results were interpreted. The aspects to be considered were described in 5.3, followed by the practical implications (5.4). In 5.5 implications for future research were provided. The discussion closes with the conclusion (5.6).

5.1 Summary of results

The results of this research were presented in the order of the research aims 1 to 3 with regard to the *Study 1–4*.

To sum up the results of the multi-group regression models for **research aim 1**: The international students indicated high levels of academic self-efficacy, attainment, intrinsic, and utility value. But similarly indicated high perceived psychological costs (*Study 2*). Further, no direct gender effects in all study motivation variables and sense of university belonging showed significance (*Study 1* and *2*). Thus, contrary to previous findings and hypotheses, the results did not indicate disadvantages for female STEM-students in that sample. Yet, female students from Central and South-Eastern Europe, North Africa and Middle East or Asia-Pacific showed lower levels of sense of university belonging than their male fellows in both subject groups (in the sense of intersectionality, *Study 1*). Additionally, first-generation students showed a lower sense of university belonging (*Study 1*) and lower academic self-efficacy (*Study 2*) than continuous-generation students. Regarding the cultural background, all international students from outside of Western Europe indicated significantly higher costs, that implies that coping with cultural distance might be a relevant study success factor (*Study 2*). Among acculturation orientations, *Study 1* and *2* revealed consistent results; higher levels of host-culture orientation were positively associated with higher levels of sense of university belonging, attainment, intrinsic and utility values, whereas home-culture orientation was negatively related with intrinsic values. Thus, supporting contact with host-culture students might provide a beneficial resource. Study related language skills yielded significant positive associations with sense of university belonging, academic self-efficacy, attainment, intrinsic and utility value, but negative associations with psychological costs. The only significant difference between STEM and non-STEM students in *Study 1* and *2* was that international STEM students demonstrated lower levels of academic self-efficacy compared to non-STEM students. All other findings applied for both subject groups.

The unconditional LGC models regarding **research aim 2** (*Study 3*) showed that the pattern of latent intercepts corroborated the conclusions drawn from previous descriptive and cross-sectional analyses first measurement occasion of the same sample (*Study 2*). These models indicated high initial means of expectancies, attainment, intrinsic and utility values, as well as psychological costs. The latent slopes showed slight increases in study-related language skills and psychological costs, while academic self-efficacy remained stable. Furthermore, the latent slopes of attainment, intrinsic and utility value exhibited a slight decrease. Given the high levels of perceived psychological costs at the start of the international students' studies in Germany (*Study 2*), even small increases over the study course are considered as an important and disturbing finding. The conditional main effect models showed limited evidence for significant gender effects on the level or development of the motivational components. Nevertheless, gender positively influenced the attainment value slope. This finding suggests that, over the study course, female students report a reduced decline in the personal importance they rank on their academic efforts. The analyses revealed some incidents of discrepancies between the subject groups with respect to experienced costs, study-related language skills, and academic self-efficacy. In particular, STEM students experienced higher psychological costs during the initial stages of their studies, in comparison to non-STEM students. These costs increased more as the study course progressed. International STEM students also showed less improvement in study-related language skills, due to a negative significant slope effect. A negative intercept effect for academic self-efficacy by subject group showed significance: STEM students showed lower levels of expectancy than non-STEM students. This effect was further compounded by a significant interaction effect gender and subject group on the slope for academic self-efficacy. While females demonstrated a less pronounced increase in the non-STEM subjects, the opposite was observed in the STEM field, where females exhibited a more positive development in comparison to males.

Further, the findings of *Study 3* indicated that parental academic background showed a significant effect on the level and development of academic self-efficacy, as well as on the development of intrinsic motivation throughout the study course. Initial findings indicated that continuous-generation students exhibited higher levels of academic self-efficacy compared with first-generation students. However, these differences diminished as the study course progressed. In addition, the results revealed that continuous-generation students exhibited a more pronounced decline in intrinsic motivation compared to first-generation students. Though, these differences were not evident at the start of the study. The interaction of gender and parental academic background did not yield significance. Likewise, in *Study 3* several effects for students from different cultural backgrounds on the intercepts as well as on the slopes, in some instances in interaction with gender, showed significance.

In particular, students coming from outside of Western Europe indicated higher psychological costs and lower study related language skills in the LGCM, where the absence of significant slope effects implied that these levels might remain stable over time. These effects among cost values were qualified by interactions with gender except for students from North America and Sub-Saharan Africa. Further, students from North America showed high levels of academic self-efficacy, which diminished over the study course due to the negative slope effect. They further showed lower levels of attainment, intrinsic and utility value and students from North Africa and Middle East showed high attainment, lower intrinsic by an increase over time and high utility value. Moreover, students from Sub-Saharan Africa showed high attainment and high utility value. Additionally, students from Asia-Pacific showed lower levels of academic self-efficacy and intrinsic value as well as students from

Central and South-Eastern Europe showed lower levels of intrinsic value by an increase over time and high utility value. With regard to research aim 2 this dissertation further posits that the relevance for international students of study-related language skills and psychological costs were underpinned by the results of the LGCM in *Study 3*, where students from countries outside of Western Europe indicated negative effects on study-related language skills as well as negative effects on the intercept of cost values at the beginning of their studies, partly in intersection with gender, which remained both stable over the time.

Regarding **research aim 3** (*Study 4*), the correlations of the random intercepts on between-level (time-invariant) showed negative relations of dropout-intentions with study related language skills, academic self-efficacy, attainment, intrinsic and utility value, i.e., students with higher levels of adaptive value beliefs (personal, intrinsic and utility value) showed lower levels of dropout-intention. But on the other hand, there was a significant positive association with cost values, i.e., students who experienced higher psychological costs showed higher dropout-intentions. The results further indicated positive relations of study satisfaction with study-related language skills, academic self-efficacy, attainment, intrinsic and utility value, i.e., students with higher levels of adaptive value beliefs (personal, intrinsic and utility value) showed higher levels of study satisfaction. But also, the relation between study satisfaction and psychological costs was negative, i.e., students who perceived higher psychological costs indicated lower study satisfaction. The RI-CLPMs showed some demographic differences in study motivation on between level, thus no main effects of gender nor parental academic background on study success factors, dropout-intention and study satisfaction yielded significance. Nevertheless, the results yielded some significant interactions of gender with parental academic background in the sense of intersectionality. Female continuous-generation STEM-students showed lower levels of dropout-intention, female first-generation STEM students the highest. In the RI-CLPM for study satisfaction, no significant interaction of parental academic background with gender could be identified. Among the cultural background, only a few isolated differences in the study success factors, dropout-intention and study satisfaction between different country groups showed evidence. Thus, significant interactions of cultural background with gender (in the sense of intersectionality) could be found. Female students from Central and South-Eastern Europe and Asia-Pacific demonstrated lower intrinsic motivation in comparison to their male counterparts, whereas female students from Latin America and Asia-Pacific exhibited significantly higher dropout-intentions in comparison to their male counterparts. Moreover, female students from Central and South-Eastern Europe and North Africa and Middle East indicated significantly lower study satisfaction than their male counterparts. In summary, female students from these country groups were particularly disadvantaged. The analyses yielded only a few effects over time at the within-level and particularly on the cross-lagged paths, so there was little evidence of reciprocal relationships between changes in motivational characteristics, dropout-intention and study satisfaction at the intra-individual level over time.

To sum up the results about research aim 3, the expected inter-individual correlations (between-level) between study-related expectancies and values and the dropout-intentions of international bachelor’s students in STEM-subjects were established. Further, disadvantages regarding the motivational study success conditions of international female first-generation students were identified. Students from different regions of origin, particularly female students from Central and South-Eastern Europe, Sub-Saharan Africa and Asia-Pacific, were disadvantaged. There was little evidence of reciprocal relationships between changes in motivational characteristics, study satisfaction and dropout-intentions at an intra-individual level over time (*Study 4*).

5.2 Do SEVT and sense of belonging assumptions fit to international students?

In this section, I consider, if the assumptions of the SEVT and sense of belonging were transferable on the international bachelor students' sample in Germany. In addition, the main effects of sociodemographic predictors were interpreted (5.2.1–5.2.3). Then, the intersectional findings and further interaction effects with gender were discussed (5.2.4). In 5.2.5, the impact of cultural resources is considered. Potential disadvantages regarding subject groups were provided (5.2.6). This chapter closes with an overview of disadvantaged groups within the sample of international students (5.2.7).

The "chilly climate" for females in STEM regarding sense of university belonging was not confirmed, as well as no differences by subject group. But female international STEM and non-STEM students from some country-groups showed lower sense of university belonging. Most EVT assumptions could be replicated with the sample of international (STEM) bachelor students, also in the longitudinal studies. The results indicated that international students in Germany perceived higher cost values, which remained stable over time. The SEVT factors were also in the assumed pattern associated with dropout-intention and study satisfaction in that sample. But *Study 4* showed little evidence of reciprocal relationships between changes in expectancies and values and dropout-intentions and study satisfaction for international STEM students. The present findings, for the reasons outlined below, do not imply a complete lack of within-person effects within the SEVT components, nor do they imply a general inconsistency with the SEVT. The database of this dissertation offers large measurement intervals of six months, located at the end of the semester. Yet, motivation might change during the semester, for example in response to the challenges of exam preparations, bad grades, complex seminar preparatory tasks in STEM – unfortunately, such fluctuation were not captured in the present design. Furthermore, the implemented measures did not specifically address (momentary) changes in expectancies and value beliefs and study success, and currently no SEVT research on ideal timeframes to expect within-person changes in motivational components exist. To provide final conclusions concerning the question of whether the EVT assumptions hold with respect to the dynamics of intra-individual development, further research is required to explore the implications of different measurement intervals and scale formats regarding the assessment of intra-individual change over relatively short periods.

5.2.1 Disadvantages of female (STEM) students

Regarding the cross-sectional results of sense of university belonging (*Study 1*) and study motivation as expectancies and value beliefs (*Study 2*), this dissertation showed, that the hypothesized disadvantages for female STEM students were not relevant in general for international students. However, the disadvantage experienced by female students from some specific country groups could only be identified through the lens of intersectionality.

Hence, no main effects of gender were substantiated except the negative one for academic self-efficacy for females in the LGCM (*Study 3*).

One potential explanation for the absence of main gender effects is that international students pursuing STEM-related courses represent a highly selected group, characterized by a strong commitment to their academic pursuits (e.g., Jiang et al., 2020; Wille et al., 2020). In particular, female students who successfully navigated the bureaucratic and academic challenges to pursue (STEM) studies abroad (Morris-Lange, 2017) may have a strong sense of identification with their choice, which could mitigate the impact of gender minority stereotypes and potential backlash effects (Froehlich et al., 2022). Consequently, gender disparities in feelings of belonging, expectancies and value beliefs, as evidenced in large-scale international studies of high school students (e.g., PISA and TIMSS; Else-Quest et al., 2010), may not be applicable to this particular group. In the future, it would thus be beneficial to include information regarding subject choices and attitudes towards STEM among the close social environment of female students (i.e., family and friends) to investigate whether female international students in STEM fields benefit from the STEM support they receive from this environment. As Entrich et al. (2024) observe, students from higher socioeconomic status backgrounds currently constitute the majority of those pursuing studies abroad, because they are more likely to be admitted to universities that offer favorable study abroad opportunities. Furthermore, students who elect to pursue a STEM degree program abroad despite encountering challenges such as financial constraints, obtaining visa permissions, and navigating reservations among parents and peers or cultural (gender-) norms might constitute a distinct sample with particularly favorable motivational patterns and high intentions to persist, thus reducing the overall variance in these constructs.

5.2.2 Are international first-generation students disadvantaged?

First-generation students of this sample were disadvantaged with regard to sense of university belonging (*Study 1*) and level and development of academic self-efficacy (*Study 2* and *3*). The disadvantaged effects for first-generation students could be reasoned by missing role models in the family, limited information about academic requirements and missing academic biographies (Walton & Cohen, 2011). Furthermore, a lower conception of the possible study career could be another boundary in the family for first-generation international students. Further, continuous-generation international students benefit from mostly higher socioeconomic status and thus have the choice to choose universities with particularly favorable study options (Entrich et al., 2024). To perceive a positive mentoring experience with the lecturers or supportive faculty person was important for undergraduate STEM students to foster scientific self-efficacy, value beliefs and career intentions (Limeri et al., 2024). Additionally, being the first in the family to study, even abroad as an international student and identify in the gender minority in many STEM fields, could prime feelings of isolation or uncertainty of belonging (Höhne & Zander, 2019; Totonchi et al., 2023), especially for students coming abroad against all boundaries, e.g. parental restrictions, insufficient support. Therefore, first-generation students may benefit from university belonging interventions, e.g. promoting their host-culture orientation by offering contacts to other students (Thies & Falk, 2024), which could also foster their language skills.

5.2.3 Are international students from specific regions of origin disadvantaged?

International students from some regions of origin were disadvantaged, as the results of this thesis revealed. In particular, students coming from outside of Western Europe showed high levels of psychological costs at the study start (*Study 2*), and these levels might remain stable over the study course (*Study 3*). Students from North America showed lower levels of attainment, intrinsic and utility value, students from North Africa and Middle East as well as from Central and South-Eastern Europe showed lower intrinsic value by increasing over time. Students from Asia-Pacific showed lower levels of academic self-efficacy and intrinsic value. Students from other country groups showed a more advantageous pattern.

The heterogeneous results in the psychological predictors of study success regarding the students' region of origin could possibly be reflected in educational and economic differences in many countries within these regions, what might constitute so-called push factors (political instability, lack of economic opportunities, limited access to education and personal safety concerns; Gbollie & Gong, 2020). This could influence the individual value of studying abroad compared to students from Western Europe who might have fewer worries. Further explanations for these patterns could be offered by cultural differences in factors that form the study subject selection (e.g., selection of the study program by cultural norms and the family who provides the money for the stay abroad), and in the importance to perform in the study program, even if they feel not to belong or indicating their skills as not sufficient. Moreover, coping with cultural distance seems crucial. Students from countries with a higher cultural distance to Germany might experience more demands and perceived boundaries (Bethel et al., 2020; Suanet & van de Vijver, 2009).

5.2.4 What about intersectionality?

It is necessary to consider that intersectionality is originally a political approach, based on the critical race theory and posits those characteristics, serving for discrimination or perceived disadvantages (Crenshaw, 2017; Ferree, 2010). All characteristics need to be considered as interacting characteristics, because in reality they are inseparable as the holistic approach of individuals posits (Cole, 2009; Knapp, 2012). Else-Quest (2024) mentioned that the task of science in this case is not only to identify groups and their individual beat, but to use this approach methodologically to inform about how to reach equality. Thus, not to change the groups perceiving disadvantaged, but to make the higher education system more equal to all students (Else-Quest, 2024). Of course, in this dissertation I could not offer the complete intersectional description of all individuals of the international students in Germany, but I provide as one of the first an intersectional perspective as a statistical-mathematical approximation of the theory. Against this background, the research in this dissertation did not only focus on the differences by gender and the possible intersections but offers advice to implement suitable interventions to mitigate inequalities in the higher education system. Moreover, it is imperative to acknowledge that the present dissertation focused encompassed the conventional dimensions of disadvantage that have previously been delineated in extant research, particularly within the context of STEM in higher education. The significant interaction of parental academic background with gender on dropout-intention of the international STEM students, i.e., female continuous-generation students showed a lower dropout-intention than their male fellows, gender differences were minor between first-generation students. One explanation might also result in a lack of role-models, in combination with limited information on academic requirements and academic biographies

(Walton & Cohen, 2011) or in persisting stereotypes on women in STEM that particularly challenge the first-generation students. This is in line with Parker et al.'s (2020) results, which showed that gender does not influence the expectancy-value components alone, but also in interaction with multiple characteristics.

The intersectional perspective enabled me to identify disadvantages for international female first-generation students and international female students from Central and South-Eastern Europe, North Africa and Middle East or Asia-Pacific. One reason for that results might be the perceived discrimination due to perceived gender-stereotypes (Bick et al., 2022 (preprint); Froehlich et al., 2022). Another explanation for these findings could be cultural differences in gender specific role models, that influence values regarding different cultural backgrounds from different gender perspectives. For example, the relevance of studying as a male or a female in Germany and in a specific subject could be shaped by cultural norms and can vary according to culture due to the expectations and appreciation of parents.

Particularly, in STEM subjects, female students showed a more positive development than male students (*Study 3*). This might be explained by positive experiences of female international STEM students, which could disprove negative stereotypes about females in STEM (e.g., Limeri et al., 2024) or an increase in perceived academic similarities (Chen & Rosenzweig, 2024).

Furthermore, the integration of additional predictors of academic motivation, as proposed by the SEVT, could offer valuable insights, like the role of parents' general gender role beliefs (Froehlich et al., 2022). As posited by Flam (1991) feelings of discrimination have been shown to be a contributing factor. Besides, the similarity of attitudes of peers on STEM studies indicated to be a significant factor (e.g., Chen & Rosenzweig, 2024). Including those factors could offer a valuable opportunity to gain a more profound understanding of (intersectional) disparities in academic motivation and university belonging.

5.2.5 (How) do international students benefit from cultural resources?

Acculturation orientations. *Study 1* and *2* yielded consistent results in terms of acculturation orientations. Significant positive relations of host-culture orientation with sense of university belonging, attainment, intrinsic and utility values were observed. This dissertation confirms the assumptions regarding sense of belonging and corroborates previous research on adolescent immigrant learners (i.e., school-context: Schachner et al., 2017). Further, the dissertations' results partly support findings on host-culture orientation with adjustment and productive adaptation (Berry, 1997; Bierwiaczonek & Kunst, 2021). One reason could be offered by results from Taušová et al. (2019), who identified indirect effects on adaptation, i.e., a lower perceived cultural distance was associated with higher adaptation to the host-culture, while host-culture orientation showed a positive correlation with adaptation process. Thus, the interplay of region of origin, perceived cultural distance and acculturation orientation should be explored. Nevertheless, a higher host-culture orientation was identified as a valuable resource for international students to promote more contacts (e.g., by study-buddy-programs) which in turn was shown to be reflected in a higher sense of university belonging and eases daily hassles at the university and beyond. Furthermore, it can encourage the discussion of study-related questions and familiarize them with student life in the host country. In turn, this has been shown to be reflected in a higher sense of university belonging (Pekerti et al., 2020; Szabó et al., 2020; Thies & Falk, 2023). In addition, encouraging contacts with fellows of the host country can promote self-perceived language competence in the host language and thus also increase self-efficacy and reduce costs, as mentioned below.

Study-related language skills. The dissertations' results implied that international bachelor (STEM) students' language skills are highly relevant for their feeling to belong to the university, their expectations and value beliefs and their study success. They are obligated to acquaint themselves with and adapt to the novel higher education culture to feel competent in managing academic demands and thus feel more able to master their studies and experience decreasing demands. Hence, this dissertation underpins the relevance of findings in former research, which has demonstrated a robust relationship between language proficiency and study success and integration among international students (e.g., LaCosse et al., 2020; Le Roux & Groenewald, 2021; Wisniewski et al., 2022). Enhanced language proficiency has been demonstrated to facilitate connections with faculty members and scholarship holders, so providing access to role-models and enhancing model learning, verbal comprehension of social support resources, and mastery experiences (Bandura, 1997). Furthermore, improved language skills were helpful to recognize the academic requirements and ensured that international students were able to obtain all support programs and information of significance, notably concerning academic formalities. Failure to comply with formalities can result in increasing costs and reducing self-efficacy, which in turn can lead to higher dropout risk and lower study satisfaction. Consequently, the enhancement of language proficiency in academic contexts has the potential to decrease study satisfaction, as it can facilitate enhanced academic self-efficacy, sense of belonging within the campus community and reduced psychological costs among international STEM students (Limeri et al., 2024; Thies & Falk, 2023). Thus, the low levels of language skills could be caused by lack of specific compulsory language courses in the curriculum, or missing contact between international students from outside of Western Europe and local students. Cultural differences (also in the higher education culture) might be a further reason that might hinder that contact (Rienties & Ramanau, 2024). Since the item reflects the student’s expectation of whether his or her language skills are sufficient to cope with their academic studies, a higher perceived skill level may also facilitate interaction with professors and scholars as part of their social integration (Thies & Falk, 2023; Wisniewski et al., 2022). Because of that overlap of the constructs and regarding the item text “My language skills are sufficient to cope with my academic studies”, the interpretation is given as both a language component and as a domain-specific self-efficacy or expectancy component, but it is still open to discussion. These persistent language barriers, which were apparent in all four studies of this dissertation, may be one reason why international students from all non-Western European country groups perceived high psychological costs in Germany over the course of their studies.

In that vein, a moderation of cost values with academic self-efficacy could be possible, too. Therefore, in the RI-CLPM (*Study 4*) for dropout-intention within-within interaction of academic self-efficacy and cost values on dropout-intention (analogue to findings of Schnettler et al., 2020) from one measurement occasion on the next were tested stepwise with the script by Speyer et al. (2023) but non yield significance. In future research, an additional analysis with study-related language skills, as an expectancy component, and cost value might be fruitful to shed light on inter-and intra-individual associations about this.

5.2.6 Are STEM students disadvantaged?

Beyond the challenges in cultural differences, the higher education system in Germany might be perceived stressful for international students, as *Study 3* indicated. At the beginning of their studies, STEM students showed higher levels of psychological costs than students in other subjects, which tend to rise over the study course. This may be due to differences in curricula and lecture styles (Clark & Lovric, 2009). It places significant emphasis on fostering independence and self-directed learning in STEM subjects. This STEM specific didactic could stand in contrast to the country’s prior educational model, which relied on structured, guided learning environments. The transition to this new system encounters some challenges, particularly for students who face language or cultural barriers that hinder their ability to seek assistance from peers or instructors (e.g., Bethel et al, 2020; Jindal-Snape & Ingram, 2013). This might be one reason for the LGCM results, that international students in STEM subjects also showed less increase in study related language skills than their counterparts in other subjects, probably due to reduced verbal language usage in STEM fields, which mostly focused on technical jargon. Lower levels of academic self-efficacy in STEM subjects were observed in *Study 2* and *3*. In *Study 3*, this was qualified by an interaction effect. I.e., female students in STEM subjects demonstrated a more positive development than male students, which was already mentioned in the intersectionality section (5.2.4). The high failure rate in exams with more than 60% (Federal Statistical Office, 2025) indicates a highly competitive environment in STEM subjects, which is partly the result of a high number of exams. Consequently, adapting to different higher education cultures necessitates time and effort, and even perseverance to successfully complete all required seminars and tests per semester (Apolinarski & Poskowsky, 2013; Pineda, 2018). Students who choose a STEM degree program in a foreign country despite several barriers, e.g., financial constraints, obtaining visa permissions (Morris-Lange, 2017) and negotiating parental and peer reservations, and cultural (gender-)norms (e.g., Froehlich et al., 2022), could be a selective sample regarding favorable motivational patterns and high intentions to persist.

5.2.7 Overview: Who is disadvantaged?

To sum up, the pattern of results identified some groups who were disadvantaged in the sample of this dissertation and who need tailored support throughout their studies in relation to the research aims of this dissertation (*Studies 1–4*):

- International STEM students with negative levels of academic self-efficacy (*Study 2* and *3*), and lower development of study-related language skills (*Study 3*), and higher psychological cost (*Study 3*). The effect of academic self-efficacy was qualified by gender, i.e., female students in STEM subjects showed a more positive development than male students.

- First-generation students because of positive relations for continuous-generation students with sense of university belonging, academic self-efficacy (*Study 1– 3*) and with intersectional perspective, higher dropout-intention for female first-generation students in the STEM sample (*Study 4*).
- International students coming from outside of Western Europe indicated higher psychological costs and lower study related language skills (*Study 2, 3*), where the absence of significant slope effects implied that these levels might remain stable over time. In *Study 3*, the effects among cost values were qualified by interactions with gender except for students from North America and Sub-Saharan Africa. However, the RI-CLPMs (*Study 4*), solely confirmed the lower study related language skills for international STEM students.
- Moreover, international students from Central and South-Eastern Europe, North America, Latin America, North Africa and Middle East, Sub-Saharan Africa and Asia-Pacific showed some tendency regarding their disadvantages among belonging, expectancies and values (see *Study 1–4*).

Further, the intersectional results revealed disadvantages for *female students from some country groups:*

- Central and South-Eastern Europe with a lower sense of university belonging (*Study 1*), lower levels of intrinsic motivation and study satisfaction (*Study 4*)
- Latin America, who showed significantly higher dropout intentions (*Study 4*)
- Asia-Pacific with a lower sense of university belonging (*Study 1*), lower intrinsic values, lower levels of study satisfaction and higher dropout-intention (*Study 4*)
- North Africa and Middle East showed a lower sense of university belonging (*Study* 1) and significantly lower levels of study satisfaction (*Study 4*).

Thus, it was not a general concern for all women in STEM. However, international (female) STEM students over the study course, first-generation international students, in particular, female first-generation students, and all international students from countries outside Western Europe, in some instances especially female students from some country groups, need tailored support.

5.3 General limitations

The present thesis provides numerous notable findings regarding theoretical and empirical matters of research on international bachelor students' study success in Germany and its psychological predictors. My dissertation is one of the first examining intersectional perspectives on international students' study success and its predictors, the longitudinal perspective on the international students' expectancies and values and the intra- and inter-individual dynamics regarding subjective study success factors. Further, the large and heterogeneous sample enabled me to compare those contingencies for STEM and non-STEM international students. However, certain limitations must be acknowledged.

First, some limitations associated with the examined sample of international bachelor students in Germany need to be considered. A comparison of this study's sample with the broader international student population in other nations could reveal disparities in demographic and cultural characteristics. This limitation also includes existing differences in higher education systems, including the varying costs of education and cultural dissimilarities. Consequently, the external validity of the dissertations' findings may be limited to other student populations, such as domestic students or international students in other countries than Germany. Furthermore, as the present dissertation focused exclusively on degree-seeking students in Germany, its findings may not be directly applicable to credit-seeking international students (e.g., Erasmus students) who reside in the country for a shorter duration. Against that background, their sense of university belonging, their study-related expectations and value beliefs as well as their study success factors might be influenced and differ by environmental factors, including study conditions, may varying potentially offering students different opportunities and challenges. Consequently, it is recommended that the generalizability of the findings to other samples be considered with caution.

The current study sample of this dissertation was constrained to bachelor students, as master students may potentially experience distinct and more heterogeneous (study) experiences, e.g., in terms of expectancies and value beliefs, depending on previous experiences in STEM or other study fields in Germany or abroad. This may lead to different patterns and dynamics between study motivation and study success over the study course. Consequently, to examine these differences and to ascertain the generalizability of the current findings, it necessitates further research.

It is imperative to acknowledge that the current dissertation has been constrained in its exploration of students' demographic characteristics, particularly with respect to the intersectional interplay that is characteristic of the STEM higher education context. Previous research in this area has identified a range of possible dimensions of disadvantage. For instance, we may have omitted dimensions of inequality that have not yet been investigated from an intersectional perspective, such as physical or mental disability or learning difficulties (e.g., Rußmann et al., 2024). Moreover, in the sense of intersectionality, it would be fruitful to explore further potential disadvantages besides the already investigated ones, for example, first-generation students and similarities from different cultural backgrounds, or being in a perceived minority due to religion, some officially mentioned grants, sexual orientation, due to disabilities (visually remarkably or not), or additional individual or cultural characteristics.

Furthermore, the distribution of the country groups exhibited a small number of cases across a select number of investigated country groups. Consequently, it is possible that certain effects may remain unidentified within these groups. Hence, the operationalization of the concept of cultural background is, to a certain degree, lacking in precision. Due to the categorization into country groups defined by the DAAD (DAAD & DZHW, 2019), differences between countries within country groups were not examined here, as some countries had small numbers of cases resulting in small intraclass correlations (ICCs). It is crucial to acknowledge the presence of cultural heterogeneity within these country groups (and potentially even among the individual countries themselves). To illustrate this point, consider the category of Sub-Saharan Africa, where students from a magnitude of various cultural strains were matched, or in a similar vein, in the region of Asia-Pacific. These countries might exhibit substantial cultural differences, not only in their lived culture but also in their higher education systems and culture practices in higher education institutions. Future research could concentrate on investigating the relevance of these effects and the specific groups for whom they are important.

It was also noted that the use of some measurement instruments needs to be accompanied by certain limitations. First, using self-report measures might imply some bias due to socially desirable responding as evidenced by research conducted by Holtrop et al. (2021) and Mummendey (1981). Second, some constructs were assessed with a single item or some subscales, particularly those pertaining to value beliefs, were measured using solely two items, which may have restricted their content validity. While this is a prevalent methodology in large-scale panel studies, future research may benefit from utilizing more comprehensive measurement instruments for the investigated constructs. Moreover, the usage of a new, more comprehensive study satisfaction scale (Kegel, Bohndick, et al., 2025), as well as the introduction of an instrument to measure active verbal language skills would be advantageous (Wisniewski et al., 2022). These should carefully address the specific needs of international students in a culturally sensitive way, to promote equal opportunities and a possible stay in

Germany, especially to cover the demand for skilled workers in STEM (e.g. Hoffmeyer-Zlotnik & Grote, 2019).

Further, the operationalization by the HEEQ (Federal Statistical Office, 2020) as an indicator of students' cultural background is somewhat imprecise. It is possible that students obtaining their HEEQ in one country may be born in a different national context and yet feel a sense of belonging to a different cultural group.

Overall, it is relevant to reflect for whom those subscales were conceived and who examined the items. Currently, 86% of the psychological studies were from WEIRD perspectives (WEIRD signifies "Western, well educated, industrialized, rich and democratic countries"; Henrich et al., 2016; Landmann et al., 2023, 2024). Therefore, it is questionable to what extent the perspective of non-WEIRD individuals is adequately represented and if the constructs themselves have the same connotations for non-WEIRD people. Their perceptions and interpretations of significance from the perspective of someone from a non-WEIRD culture should be recognized. Thus, scales, which include non-WEIRD perspectives would be beneficial (Henrich et al., 2016), in particular, with regard to the diverse cultural backgrounds of international students in future research.

Furthermore, the studies of this dissertation differ from previous longitudinal studies on the (S)EVT constructs, which focused on shorter measurement intervals and were not designed to examine within-change and interrelationships (Benden & Lauermann, 2023; Schnettler et al., 2020). The study design of the International Student Survey investigated the students over longer periods (one semester each), using longer measurement times of six months. So, this design does not provide insight into motivation over the semester or in response to specific life events during the study. Thus, frequent assessments would be valuable for future research. Integrating tech devices like smartphone applications could get flexible answers to questions in students' day-to-day lives and could capture short-term motivation changes and their connection to specific personal and situational characteristics during the semester, like critical life events. Therefore, e.g., experience sampling methods (ESM) might be beneficial, offering insights into the semester challenges (Dormann & Griffin, 2015; Kegel, Wloch, et al., 2025). With regard to the few within-effects of *Study 4*, and discussions among the perfect time-intervals for investigating motivational changes of international students, it could be beneficial to additionally include measurements of the temporal motivation theory in future investigations to enhance the self-reported data with log-file data of e.g., e-learning systems, to gain objective data (Janson et al., 2024). Currently this method is widely used to identify why students do not engage, to depict the delay between deadline distance to procrastination but could also offer information if the EVT components might be predicted by the student's actual behavior. To sum up, a mixed-method design with self-reported data in different instances of measurement duration intervals, daily data assessment and the use of objective data, like log-file data or data of the students' grades would enhance the current research. Also, a further measurement occasion before the international students move abroad to investigate the predictors of their decision to study (in STEM) in Germany despite various obstacles including potential prejudices, (gender) stereotypes, financial challenges, visa constraints, university requirements and restrictions, and cultural differences might shed light on the selection processes of studying abroad and the status quo of belongingness and motivation before the stay abroad (Froehlich et al., 2022; Jiang et al., 2020; Poort et al., 2022; Wigfield & Eccles, 2000; Wille et al., 2020).

This thesis focused on the developmental effects on subjective indicators of study success, i.e., students' dropout-intention and study satisfaction, evidence for objective measures was not provided. Future research considering contingencies between within-person changes in motivational components and objective indicators of success such as indicators of achievement, like grades (e.g., Eccles & Wigfield, 2024), course credit points or factual dropout information by the university counselling service as an objective instrument might provide additional insights.

In *Study 1* or *2* multi-level analyses were not performed, because the ICCs (clustering by subject areas) showed little variance between countries, yet all ICCs were lower than < .01 which suggests that the independence of observations can be assumed.

Already, many researchers perform RI-CLPM analyses, yet a guideline for alpha error correction is pending. Therefore, in *Study 4*, we controlled the false discovery rate (q < .05), using the Benjamini-Hochberg correction (Benjamini & Hochberg, 1995) to take into account that the RI-CLPM with the predictors and their intersections offer largest number of statistical comparisons. The decision to apply the correction in *Study 4*, but not in *Study 1–3*, reflects differences in analytical complexity and the number of tested paths. Particularly, this was necessary due to the model's higher complexity, including a relatively large number of estimated paths and comparisons. In such cases, the likelihood of false positives increases substantially, warranting statistical correction to ensure the robustness of inferences. Contrary, *Study 1–3* tested fewer paths and comparisons and were nested within the measurement occasions, so the risk of false positives was less pronounced. Therefore, uncorrected p-values were described in *Study 1–3* whereas the corrected ones were presented in *Study 4*, but the uncorrected were interpreted, while still interpreting results in light of potential false-positive risks and others might use another way to handle these contingencies. It would be appreciated if the scientific community could comment on this. Currently, there was no established procedure for reliably estimating the power of *Study 3*'s latent growth curve models, but due to the sample size and the nested structure, there was no advice for overpowered models, as well as the fit indices implied good to excellent fits even after the addition of the interaction terms in the sense of intersectionality.

5.4 Practical Implications

The results of this thesis provide valuable insights into the implementation of tailored interventions, which were mentioned in this section, for diverse groups of international (STEM) students in Germany. As previously stated (section 5.2.7), women in STEM fields were not disadvantaged generally. The results point to specific needs of international (female) STEM students, first-generation international students, particularly female first-generation students, and international students from countries outside Western Europe. In certain instances, the need for support is particularly pronounced for female students from specific country groups. Most results that have been reported in this dissertation indicate small effect sizes. Though, these effects might have major impact on students' academic and future careers and were essential for the individual. Consequently, it is relevant to consider practical implications.

The mentioned impact on study-related language skills among international STEM students could be mitigated by increasing the use of active verbal language. This approach could enhance the sense of belonging among international students, thereby encouraging them to remain in the country. Furthermore, this strategy might address the demand for skilled workers in STEM (Hoffmeyer-Zlotnik & Grote, 2019). To this end, the implementation of targeted support interventions is required, such as some curricular anchored language courses, additionally to the B2 to C1 level certificates of the study language, which need to be achieved at the beginning of the study course. Topics might be subject related language courses, language related peer programs, etc. These interventions should carefully and culturally sensitively respond to the specific requirements of students from different cultural backgrounds to promote equal opportunities, particularly about the transition to the German labor market. Improved language skills have been demonstrated to facilitate the establishment of contact with (host country) faculty members, thereby fostering a sense of belonging (Thies & Falk, 2023) and providing access to role models (Bandura, 1997). This, in turn, has been shown to enhance role-model learning, leading to an increased ability to comprehend social support offers and to facilitate mastery experiences (Bandura, 1997). Consequently, enhanced study-related language skills could also lead to elevated academic self-efficacy among international students, diminished perceived psychological costs, and a stronger sense of belonging within the campus community (Limeri et al., 2024; Thies & Falk, 2023).

The findings on acculturation orientations in the cross-sectional studies in this thesis suggest that it would be advantageous for the adaptation process to support international students' host-culture orientation. Promoting contact to peers or fellows of the host-country may help in this regard (Serrano-Sánchez et al., 2021). Moreover, perceiving international contacts, not only to people of the host country, support the personality development of international students (Zimmermann et al., 2021b). Interventions to promote host-culture orientation may support international students' sense of university belonging and may lead to higher levels attainment, intrinsic and utility value. Examples of such initiatives include study buddy programs, which offer support of experienced (domestic) students from higher semesters who provide assistance for international first-year students in navigating potential day-to-day challenges at the university. These programs also encompass academic support, where discussions are facilitated to help international students become familiar with student life in the host country. Whilst many universities have already established such programs, their specific effectiveness on international students' host-culture orientation and for further educational outcomes requires further evaluation.

Particularly, there is a need to support interventions that aim to reduce the dropout-intention among (female) first-generation international STEM students. These interventions should be promoted in a manner that is sensitive to the potential feelings of discrimination or stigmatization that these students may experience (e.g., by avoiding questions such as "Are you the first in your family to attend academia?"). In this regard, it would be advantageous to extend the scope of existing support programs for domestic students, tailoring them to the needs of international students. This approach could simultaneously facilitate engagement with the host culture and provide opportunities for the practice of the host language. A notable example of such an initiative is the *Peer-First program* at the FernUniversität in Hagen (2025). As part of this peer mentoring, students will work together in small groups and support each other on a variety of topics, ranging from organizational and content-related questions about study courses to personal challenges. That groups should provide a safe space for open dialogs, sharing of experiences, broadening perspectives and developing solutions (FernUniversität in Hagen, 2025). The significant relations between parental academic background and the psychological predictors of/and study success in this dissertation suggest that first-generation international (STEM) students may particularly benefit from interventions to increase their sense of university belonging, academic self-efficacy and reduce the dropout-intentions for female first-generation students. In the US, several studies have corroborated the effectiveness of such interventions for first-year college students (Murphy et al., 2020; PERTS, 2025; Walton & Cohen, 2011; Walton et al., 2023). For example, the key studies by the *College Transition Collaborative* focused on racial-ethnic minority and first-generation students revealed an overall treatment effect of their 30 minutes belonging online-interventions (Walton et al., 2023). Here, participants received personalized reports from older students who described experiencing a sense of alienation during the initial weeks at college but indicated a decrease in these feelings over time. An analogous intervention by Marksteiner et al. (2019) based on a sample of first-semester bachelor's students in Germany within a one-to-one laboratory context, where first-generation students in the intervention groups exhibited a considerably elevated sense of belonging at the commencement of the second semester when compared to students in the control group. Accordingly, analogous interventions for (international) first-generation students were required, particularly incorporating adapted role models that align with their cultural backgrounds and affirm their migratory and academic experiences, to thereby foster their academic self-efficacy. The dissertations' results implied that interventions promoting academic self-efficacy should particularly encourage international first-generation students, the adaptation of teaching methods and study environments to enhance academic self-efficacy, mostly during the initial stages of STEM degree programs and among first-generation students, has the potential to yield favorable outcomes (Bandura, 1997; Linnenbrink & Pintrich, 2002). Thus, the relationship of mentee and mentor is crucial, because positively perceived mentoring was relevant for scientific self-efficacy, value beliefs and career intentions for undergraduate STEM students (Limeri et al., 2024). As the PERTS (Project for Education Research That Scales 2025) online intervention is freely available for universities in the US, a similar validated German version would be beneficial, to promote the international STEM students' study success.

The findings of my dissertation implied that demands consideration is the pervasive psychological costs experienced by students, particularly those coming from countries outside Western Europe, and, particularly by female students in some country-groups. Consequently, interventions designed to mitigate the study-related psychological costs of international students should be integrated into university counselling services. To assist them in overcoming the challenges they might encounter due to increased cultural distance. The integration of cost interventions that apply student statements to show students that their struggles during university entry are a common experience shared by many others has provided some initial examples of cost interventions (Rosenzweig et al., 2022), but the results were heterogeneous and the transferability to international students in the Germany merits further exploration.

A promising and at the same time parsimonious version of such above-mentioned interventions, like mentoring programs, workshops, peer-tandems, seminar and group intervention, would be programs that simultaneously promote host-culture orientation, host language skills and contact with fellow students of the host-country, thus combining all the factors that promote study success, sense of belonging and expectancies and favorable pattern of value beliefs.

The student counselling service needs to address the potential support requirements, particularly in relation to perceived discrimination, in a culture sensitive manner. These issues should also be mentioned in (STEM) lectures. In this respect, higher education institutions have the potential to deliver workshops aimed at familiarizing STEM professors or lecturers with culturally sensitive ways of dealing with such issues. Thus, Benuto et al. (2018) state that the many and complex aspects of culture, along with the number of variables considered cultural (e.g., immigration status, language, acculturation) combined to further complexify the process of creating evidence-based training guidelines and require a review of cultural competency training methods that integrate psychological science (for further examples, see e.g., Degens et al., 2016; Saiki et al., 2017).

Nevertheless, the few cross-lagged effects that point to further challenges at the study’s conclusion should not be neglected either, despite lacking a consistent pattern. Thus, the within-time effects in *Study 4* suggest that intra-individual changes in motivation seem important for study success towards the end of a study program. This stage may merit scrutiny. Problems with finalizing written exams, finding a job and residence permit worries could increase stress and susceptibility to motivation influences (Apolinarski & Poskowsky, 2013; Pineda, 2018; Stemmer, 2014) and need further research, perhaps with a lens on the various stages of concluding the degree program. These difficulties may encompass a range of concerns, including apprehensions regarding future career prospects and the inherent uncertainty surrounding the thesis process. In such circumstances, the student counselling service could offer special preparatory courses for writing the thesis and, if necessary, provide special language support for international students.

5.5 Future research

In this section, some detailed information on potential aims on future research beyond the findings of this dissertation were described. Firstly, the steps that are near to the results of the dissertation. Subsequently, the concepts presented are of a hypothetical nature.

Against the theoretical framework of this dissertation, the next step into future research with the International Student Survey would be among the changes and the inter- and intra-individual differences of sense of university belonging, with dropout-intention, study satisfaction and subjective well-being, sociodemographic characteristics, cultural attitudes and an individual characteristic like the big five by using a RI-CLPM from an intersectional perspective. Thus, three of the big five personality dimensions, in particular, agreeableness, extraversion and neuroticism, predicted academic and social integration of international students in Germany (Yildirim et al., 2022). The big five, i.e., emotional stability, were positive related to psychological adaptation for pupils abroad, agreeableness and extraversion were positive related to host-cultural behavior, what underline the relevance of the big five for sojourners (Serrano-Sánchez et al., 2022). Moreover, Bohndick et al. (2025) demonstrated that all facets of the big five, which could be allocated as individual characteristics in the SeSaBa model, exhibited by the students showed a significant relation to sense of belonging. Furthermore, their results demonstrated a positive relation between classmates' openness and agreeableness with sense of belonging (Bohndick et al., 2025). Regarding the relation of sense of university belonging on well-being, results on international students in Germany in the dissertations sample revealed, that high levels of sense of belonging was beneficial for the adaptation process of international students in Germany, because sense of university belonging was positively associated with higher levels of well-being, higher student satisfaction and negatively with dropout-intentions (Yildirim et al., 2021). About multiplicative disadvantages by sociodemographic characteristics in the SeSaBa model, for example, Ruedas-Gracia et al. (2023) showed that in education, changes in school belonging varied by gender identity, but this available evidence does not report differences based on racial identity or socioeconomic status. To understand how diverse groups function regarding low school belonging among students who identify as minoritized racially and socioeconomically, they analyzed via growth curve modelling the changes in university belonging among individuals. Their results indicated that the belonging levels remained stable across time for the whole sample, but analyses revealed racial, gender, and income-based differences, with students of color (vs. white students), female students (vs. male students), and low-income students (vs. non-low-income students) reporting lower belonging levels over time. Longitudinal and intersectional analyses revealed previously overlooked nuances in group differences in university belonging (Ruedas-Gracia et al., 2023). The intersectional analyses illustrate the relevance of avoiding overlooking important differences in heterogeneous groups (e.g., gender, race) at intersections of identities and should include students' intersectional identities and experiences, rather than focusing solely on a single identity by Ruedas-Gracia et al. (2023). Additionally, results by Zimmermann and Serrano-Sánchez (2023) revealed no significant changes in the mean level of subjective well-being over the course of the study using discontinuous latent growth curve models. Nevertheless, differences in the development of subjective well-being by, e.g., gender and regions of origin among others, yield significance. Thus, analysis on well-being including the sociodemographic predictors with a lens of intersectionality might be fruitful.

As part of cultural, academic and social integration as well as individual characteristics in the SeSaBa model of study success, the impact of future skills on the study success of international students in different subject groups could be assessed. These could offer a further resource to buffer the international students' demands. Future skills were commonly understood as future-relevant skills, which are intended to ensure individual and collective ability to act in the context of social and technological innovations and the related changes in society and its subsystems and thus may be also advantageous for the development of subjective study success (García-Pérez et al., 2021; Huffman & Huffman, 2012; OECD, 2025). Davies et al. (2011) for example, defined ten skills, which were pronounced as beneficial for future workforces: 1. sense-making, 2. social intelligence, 3. novel and adaptable thinking, 4. cross-cultural competency, 5. computational thinking, 6. new-media literacy, 7. transdisciplinary, 8. design mindset, 9. cognitive load management, and 10. virtual collaboration.

It might be beneficial to include items about personality, as individual characteristics in the SeSaBa model, such as the Big Five, as well as preferences and acculturation orientation items as personal attitudes, in order to implement not only sociodemographic characteristics, but also information on personal characteristics and culture-related attitudes. In that way, the influence of the big five, preferences and acculturation orientations on academic and social integration, psychological adaptation by staying/studying abroad, host-cultural behavior and sense of belonging could be ascertained to prove the transferability of the evidence to international STEM students and how they influence the motivational development (e.g., Bohndick et al., 2025; Serrano-Sánchez et al., 2022; Yildirim et al., 2022; Zimmermann et al., 2021b). Further, an inclusion of constructs like perceived instructors' mindsets (fixed vs. growth mindset) and belonging uncertainty by using the intersectional perspective might be interesting to prove the replicability of the results with non- and immigrant STEM students with effect by perceived mindsets and gender but only slight tendencies to intersectional effects to the sample of international students (e.g., Höhne et al., 2024).

Regarding the sense of belonging results of *Study 1*, future research needs to shed light on the differences between sense of university belonging vs. belonging to a special (STEM) class or course. The research is quite heterogenous and uses belonging to university, to subject group or faculty, or a specific course synonymous but the effects are indeed different. For example, the results of Kreutzmann et al. (2018) showed, that an intervention of dancing fosters a sense of belonging in the dancing class, as evidenced by the findings of one class that underwent a dancing intervention, and as a result felt a stronger sense of belonging to the dance section and their class, rather than to the school as a whole, which may explain why only a few small differences were found between STEM and non-STEM students, in contrast to typical STEM findings, possibly the other studies focused more on the belonging to the concrete STEM course. Consequently, the investigation of class or course affiliation, along with university affiliation, which is particularly salient for international students, holds considerable promise for future research endeavors.

In the context of intersectionality, Morgenroth and Ryan (2018) postulated the need to explore what further factors might influence this phenomenon and how gender (a time-constant individual characteristic in the SeSaBa model) as a dependent variable might be assessed more fluidly, in order to define gender through the lens of social identity theory by Tajfel and Turner (1979), and to investigate how gender is constructed through speech and behavior. The act of merely marking or designating an individual as male or female would not constitute gender performance but should include time-varying component of gender self-determination; rather, gender should be characterized as a form of expression by using novel pronouns such as “ze” in the place of “they” or in German “xier” or “sier”, and that research does not use the term “others” to categorize it, because it marginalizes respectively excludes them (Klieber, 2025; Morgenroth & Ryan, 2018).

A literature review on queer students in international higher education (Campbell et al., 2024) reported that some of them perceive studying abroad as an opportunity for personal growth and a more accepting and safer environment. But they must neglect not only boundaries in English-speaking classrooms, on campus, and with their families as they navigate expectations and shift between different identities. Moreover, queer international students often find themselves solely identified as international students at universities, with their sexual orientations and other identities unrecognized. Sometimes LGBTQIA+ students from international backgrounds are marginalized in academic studies and programs, leading to a sense of not belonging to any specific group and facing potential double marginalization in higher education. Against this background, investigating sexual orientation and further potential disadvantages like a perceived minority due to religion, or due to disabilities (visually remarkably or not, e.g., Rußmann et al., 2024).

Research on the acculturation orientations as a time-varying cultural characteristic in the SeSaBa model should focus on cultural differences in the expectations of the international students regarding cultural differences between the home and the host-country and in differences in the educational systems between the country groups (e.g., Rienties & Ramanau, 2024) on the one hand. On the other hand, majority–minority acculturation preferences concordance analog to the Interactive Acculturation Model (IAM, Bourhis et al., 1997) among the international students and if discrepancies in that vein might influence the effects could also influence these relationships as a contextual factor and expand future research. Against this background, Matera et al. (2015) investigated how majority–minority acculturation, concordance, and immigrants’ generational status affect Italians’ attitudes toward Albanian immigrants using an experimental design, by observing the role of perceived threat and meta-stereotypes on those relations. The categorization was based on different culture maintenance levels and intercultural contact concordance. Matera et al. (2015) showed that majority members' attitudes were influenced by differences in contact, mediated by perceived threat and meta-stereotypes. Further an interaction of culture maintenance concordance with immigrants' generational status on attitudes yielded significance. Therefore, in future research it is relevant to investigate dynamic and reciprocal relationships between majority and immigrant acculturation preferences, validating that the most positive attitudes emerged when immigrants were perceived to adopt the same strategy as the majority, particularly concerning intergroup contact. Thus, including perceived cultural differences and the majority–minority acculturation dimension (Bourhis et al., 1997) beyond acculturation orientations will offer theoretical insights into potential influences of the psychological predictors of international (STEM) students study success. Hence, regarding acculturation orientations, it would also be interesting to include some time-varying factors in the analyses and if these attitude changes during the study course due to acculturation processes or due to changes in perceived stereotypes or discrimination.

Longitudinal relations between mental health and higher education should be investigated, because mainly cross-sectional research indicated that mental health affects educational achievement and is affected by educational experiences in dynamic contexts. To adjust for longitudinal, multidimensional and multicausal perspectives, theories like Study Demands-Resources Model (e.g., Bakker & Mostert, 2024), need-to-belong-theory (Baumeister & Leary, 1995) or SDT (Ryan & Deci, 2000) offer beneficial frameworks. The predictive role of mental health on academic experiences could be considered in relation to outcomes of study or career decisions and study success.

Mainly, the SEVT research focused on the beliefs that predict decisions rather than on how students think about these beliefs intentionally during the decision-making process of choosing STEM (Rosenzweig & Zhang, 2024), whereas the educational psychology research rarely concentrated on career beliefs but focused on more general beliefs about one's field of study. Further research should address this gap by investigating if the theoretical framework that synthesizes insights from multiple disciplines, thereby offering novel insights into an important, yet under-researched component of career decision-making, like the model for the study of other types of academic decisions with motivational precision by Rosenzweig et al. (2025), as well as subject choices and attitudes towards STEM of the family, seem transferable, especially to international students' motivational components and beliefs. Those findings would contribute to the theory on the relations between motivational beliefs and career outcomes by shedding light on how students consciously convert motivational perceptions into career choices. Implementing supportive structures to foster the stay-intentions of international students due to their career choices and expectations would be valuable.

5.6 Conclusion

My dissertation underlines the relevance of sense of university belonging and expectancies and values for the study success of international (STEM) students in Germany and the need of detailed investigations of influences by sociodemographic characteristics. The benefits of the large and heterogeneous sample of international students enhanced me to ascertain if these relations differ between STEM and non-STEM subjects. The findings of my dissertation contribute to a better theoretical understanding of the population of international students and their study success in Germany. Due to the perspective of intersectionality, some disadvantaged groups within the international student body could be identified.

The results of this thesis showed that the EVT components and sense of university belonging do not differ generally between STEM and non-STEM students. Only a few differences between STEM and non-STEM students for academic self-efficacy and in the longitudinal results as well for study-related language skills, and cost value indicate the relevance of additional analyses of the development over the study course to gain complete insight. The study success of international STEM students was significantly influenced by the EVT components over the study course. It was encouraging to note that among sense of university belonging, and EVT components female international STEM students were not disadvantaged in general. The findings depict the central impact of parental academic background (lower sense of university belonging and lower academic self-efficacy among first-generation students) in the international bachelor students first semester in Germany and over the study course until the fifth measurement occasion (LGCM). Those results were partly qualified by interactions with gender (highest dropout-intentions in the time-stable parts of the RI-CLPM among female first-generation STEM students). Against this background, tailored support and counselling for international first-generation students are necessary, potentially by an expansion of existing interventions.

At the start of the stay abroad, cultural differences were remarkably evident in the overall high psychological costs for all international students except the ones from Western Europe. These effects were inappropriately not decreasing over the time, particularly, for female international bachelor students from that country groups. Further disadvantages for (female) students from some country groups for study-related language skills, sense of university belonging, the SEVT components, dropout-intentions, and study satisfaction were identified. Without the intersectional approach, my research would have missed those intersectional results. Even if these effects seem small, for the individual, the demands, uncertainty, feelings of discrimination and do not fit in, are real and need our focus. Thus, there is a considerable need for intervention, but to date only a few (scientifically) substantiated measures have been implemented. As the cross-sectional results about acculturation orientations indicated, host-culture orientation was positively related to the sense of university belonging, attainment, intrinsic and utility values. Fostering contact with the host countries' peers would be beneficial to promote host-culture orientation and would offer a resource to increase the international students' language skills and thus hopefully decrease psychological costs.

The present dissertation indicates that the 'typical international student' is not real; rather, it suggests that international students can be considered a multidimensionally demographically diverse and heterogeneous group. It is imperative, therefore, that an intersectional approach be given greater consideration in order to take this heterogeneity into account.

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Appendix

Erklärung über den Umfang des eigenen Beitrags und des Beitrags der weiteren Autorinnen

Der Umfang des Beitrags der jeweiligen Autor*innen für die wissenschaftlichen Artikel (Studie 1 bis Studie 4) können der Tabelle A1 entnommen werden.

Tabelle A1

*Beitrag der Autor*innen an den wissenschaftlichen Artikeln nach Beitragsbereichen in Prozent*

Studie	Beitragsbereiche	M.Sc. Judith Sarah Preuß	Dr. Julia Zimmermann	Prof. Dr. Kathrin Jonkmann
1	Formulierung der Fragestellung	80	15	5
	Konzeption der Studie	80	15	5
	Aufbereitung und Auswertung der Daten	90	5	5
	Verfassen des Textes	80	15	5
2	Formulierung der Fragestellung	80	15	5
	Konzeption der Studie	80	15	5
	Aufbereitung und Auswertung der Daten	90	5	5
	Verfassen des Textes	80	15	5
3	Formulierung der Fragestellung	85	5	10
	Konzeption der Studie	85	5	10
	Aufbereitung und Auswertung der Daten	90	5	5
	Verfassen des Textes	85	10	5
4	Formulierung der Fragestellung	90	5	5
	Konzeption der Studie	95	5	0
	Aufbereitung und Auswertung der Daten	95	5	0
	Verfassen des Textes	90	5	5

Note. Angaben in Prozent (%).

Eidesstattliche Erklärung der Autorin

Hiermit versichere ich an Eides statt, dass ich die vorliegende Dissertation selbstständig und ohne unzulässige Inanspruchnahme Dritter verfasst habe. Ich habe dabei nur die angegebenen Quellen und Hilfsmittel verwendet und die aus diesen wörtlich, inhaltlich oder sinngemäß entnommenen Stellen als solche den wissenschaftlichen Anforderungen entsprechend kenntlich gemacht. Die Versicherung selbstständiger Arbeit gilt auch für Zeichnungen, Skizzen oder graphische Darstellungen. Die Arbeit wurde in gleicher oder ähnlicher Form weder derselben noch einer anderen Prüfungsbehörde vorgelegt und auch noch nicht veröffentlicht. Mit der Abgabe der elektronischen Fassung der endgültigen Version der Arbeit nehme ich zur Kenntnis, dass diese mit Hilfe eines Plagiatserkennungsdienstes auf enthaltene Plagiate überprüft und ausschließlich für Prüfungszwecke gespeichert wird. Es ist mir bekannt, dass wegen einer falschen Versicherung bereits erfolgte Promotionsleistungen für ungültig erklärt werden und eine bereits verliehene Doktorwürde entzogen wird.

Hagen, 02.06.2025

Judith Sarah Preuß, M. Sc.

Publication statement

The present doctoral thesis is based on the following articles; they have already been published or are in the publication process:

Study 1:

Preuß, J. S., Zimmermann, J., & Jonkmann, K. (2025). Intersectional perspectives on the university belonging of international STEM students. *Social Psychology of Education, 28*, 59. https://doi.org/10.1007/s11218-025-10017-9

Study 2:

Preuß, J. S., Zimmermann, J., & Jonkmann, K. (2023). Academic self-efficacy and value beliefs of international STEM and non-STEM university students in Germany from an intersectional perspective. *Education Sciences*, *13*(8), 786. https://doi.org/10.3390/educsci13080786

Study 3:

Preuß, J. S., Zimmermann, J., & Jonkmann, K. (2025). The development of expectations and value beliefs among international students in Germany over the study course: Effects of sociodemographic characteristics, subject groups and their intersectional interplay. *Manuscript submitted for publication*.

Study 4:

Preuß, J. S., Zimmermann, J., & Jonkmann, K. (2025). International STEM students in Germany: An intersectional perspective on the longitudinal dynamics between expectations, value beliefs and study success. *Manuscript submitted for publication*.

Study 1

Preuß, J. S., Zimmermann, J., & Jonkmann, K. (2025). Intersectional perspectives on the university belonging of international STEM students. *Social Psychology of Education, 28,* 59. https://doi.org/10.1007/s11218-025-10017-9

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Intersectional perspectives on the university belonging of international STEM students

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Abstract
Previous studies suggested that associations between sociodemographic characteristics and university belonging varied between subject groups. In particular, female (first-generation) students in STEM subjects were assumed to experience a "chilly climate" that was reflected in their lower levels of university belonging. But less is known about the demographic and psychological prerequisites of the university belonging of international students. In this cross-sectional study we investigated how gender, parental academic background, students' cultural background (i.e., region of origin) and their cultural resources (i.e., study-related language skills and acculturation orientations) as well as their intersectional interplay related to the university belonging of international STEM students in Germany and compared the results to a sample of international non-STEM students. Stepwise multi-group regression analyses with cross-sectional data of $N = 1{,}590$ degree-seeking international bachelor students ($n_{\text{STEM}} = 882$, $n_{\text{non-STEM}} = 708$) at the end of their first semester in Germany did not reveal substantial differences in the level and predictors of university belonging between STEM and non-STEM international students. In both subject groups, there was no main effect of gender but some significant interactions between gender and cultural background (i.e., region of origin). First-generation students showed lower levels of university belonging than continuous-generation students. Higher levels of study-related language skills and host-culture orientation were consistently related to higher levels of university belonging but none of these variables interacted with gender. The results corroborate the need for further (intersectional) research to adequately capture the heterogeneity amongst international STEM students. Theoretical and practical implications for the implementation of tailored belonging interventions are discussed.

Keywords International students · Sense of university belonging · Female STEM students · Intersectionality · Multi-group regression analyses

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1 Introductions

International students, i.e., foreign students who obtained their university entrance qualification abroad are an important group at universities in many countries. For example, in 2020, approximately 4.4 million international students were enrolled in the OECD which represents about 7% of the higher education students in these states (OECD, 2022). Nearly 22% of them studied in the United States, 13% in the UK, 10% in Australia and about 8% (i.e., 369,000) were enrolled at German universities (OECD, 2022). That is, Germany is the fourth largest receiving country of international students in the OECD. Nearly 53% of international students in Germany are enrolled in a STEM-program (DAAD & DZHW, 2023). Therefore, international students could help to mitigate the shortage of skilled employees in Germany (Hoffmeyer-Zlotnik & Grote, 2019), especially in the STEM domain. Yet, unfortunately, current estimations suggest very high dropout rates among international students in the bachelor's programs at German universities compared to domestic students (41% versus 28%, Heublein et al., 2022). Against this background, gaining a better understanding of psychological conditions that contribute to the academic success of international STEM students are of core scientific and societal interest.

The *sense of university belonging* reflects students' relatedness to the campus community and their higher education institution (Locks et al., 2008) and is one of the most cited predictors for processes of successful academical and psychological adaption to the university environment and a successful completion of a degree program (Hausmann et al., 2007; Osterman, 2000). Further, in a study on doctoral students, a lack of university belonging was a risk factor for the imposter syndrome which in turn affected depression, stress, and illness symptoms (Sverdlik et al., 2020). A study from the US revealed that university belonging was particularly relevant for the academic success and intercultural adaptation of international students as compared to domestic students (Glass & Westmont, 2014). Moreover, LaCosse et al. (2020) showed that US STEM students who spoke English as a second language (in comparison to native speakers) particularly benefitted from a belonging intervention with regard to several academic outcomes. Hence, in view of these findings, high levels of university belonging can be assumed to be a crucial condition of academic success amongst international students (Thies & Falk, 2023; Yildirim et al., 2021).

The relevance of university belonging for student adaptation is further supported by different theoretical approaches. Baumeister and Leary (1995) defined belongingness in their *Need to Belong-Theory* as a fundamental human need to have enduring, positive, and meaningful interpersonal relationships (p. 499). Similarly, the *Self-Determination-Theory* (SDT, Ryan & Deci, 2000) posits social relatedness as one of three basic needs—next to autonomy and competence—that have to be satisfied in order to experience well-being, personal growth, and intrinsic motivation as key conditions for academic success.

However, previous research suggested that students who belong to a minority in their study program may not feel that they belong to their subject group or university. Although being an international student may imply a minority status in itself, further demographic characteristics, such as gender, parental academic background as well as cultural background (i.e., region of origin) and cultural resources (i.e., study-related language skills and acculturation orientations) may account for differences in the experience of belonging within the international student body. In particular, many studies proclaimed that—as a consequence of gender-stereotypes that declare STEM subjects as being a male domain—there was a "chilly climate" for women in STEM subjects which implied that they experienced lower belonging to their STEM subject than their male fellows (Flam, 1991; Good et al., 2012; Walton et al., 2015). Conversely, potential consequences of STEM-related gender stereotypes on female students' sense of belonging to their university have not thoroughly been researched which—in view of its outlined importance for academic success and well-being, and regarding international students—represents a valuable addition to the literature.

Hence, although being a female international STEM student already implies a minority status, further demographic characteristics, such as parental academic background and cultural background or cultural resources may also affect the experience of belonging and interact with gender differences (Cortina et al., 2017; Harackiewicz et al., 2016a). Yet, the *intersectional perspective* posits that different dimensions can be the base for (self-)categorizations as a minority member and that the effects of these dimensions interact, not just add up (Cole, 2009; Crenshaw, 2017; Ferree, 2010; Knapp, 2012).

Resource-based approaches to migrant adaptation further suggest that students' cultural resources such as language skills and acculturation orientations provide crucial conditions for the satisfaction of their need to belong and for their adaptation (Pekerti et al., 2020; Ryan et al., 2008). Coherently, studies from the school context showed that individual acculturation strategies and skills with respect to the host country language are important for students' social integration and belonging to their educational institution after a cultural transition (Kunyu et al., 2021; Schachner et al., 2017). In particular, higher levels of host-culture orientation and better language skills of the study program might provide resources that help female international STEM students to compensate for potential disadvantages in their sense of university belonging by enhancing social integration through more contact with their fellow students.

Against this background, the present study addressed the university belonging of international STEM students and its contingencies with gender, parental academic background, cultural background (i.e., region of origin) and cultural resources (i.e., study-related language skills and acculturation orientations). We also compared the pattern of associations between international STEM and non-STEM students to assess if the hypothesized disadvantages in university belonging for female students in STEM is indeed specific to the STEM field or might represent a generalized gender pattern.

1.1 Gender and university belonging of international students in STEM and non-STEM subjects

Female students continue to be underrepresented in STEM subjects in many OECD countries (Federal Statistical Office, 2020; OECD, 2022, 2023). Accordingly, gender has been discussed as an important dimension with regard to study success in STEM fields (Else-Quest et al., 2010; Goldman & Penner, 2016; MacPhee et al., 2013; Walton et al., 2015). Previous studies proclaimed a "chilly climate" (Flam, 1991) for female STEM students that was, for example, reflected in low levels of belonging to their STEM subject (Walton et al., 2015). One mechanism to explain such gender differences are gender stereotypes and associated backlash effects (i.e., social repercussion for counter-stereotypical behaviour, Rudman & Glick, 2001) that are negatively related to the motivation and the emotions of female STEM students (Froehlich et al., 2022). Indeed, Walton et al. (2015) detected a lower sense of subject belonging amongst female (as compared to male) engineering students in Canada. Similarly, Good et al. (2012) showed in a sample of 997 college students in the United States, that female students reported a lower sense of belonging to math than male students.

However, these studies focused on associations between gender and subject belonging and only considered STEM students. They did not address belonging to the university as a larger and more encompassing entity and did not provide a non-STEM comparison group. Hence, it remains unclear if female students in STEM experienced particular impairments to their university belonging and if these generalized across subject groups. Moreover, gender effects may play out differently in the group of international students. International students have already accomplished several challenges before starting their studies abroad (e.g., getting visa and study permissions, dealing with expectations and potential stereotypes of family, teachers and peers (Froehlich et al., 2022), and obtaining all relevant (language) qualifications). They decided for a STEM degree abroad despite potential gender stereotypes and possible cultural barriers (Froehlich et al., 2022; Wigfield & Eccles, 2000; Wille et al., 2020). Hence, this sample can be assumed to be highly selective and gender might not play the same role as in general student samples. To address this research gap and to investigate the experiences of international female STEM students, the present study took advantage of a huge sample that provided data from both STEM and non-STEM international students in Germany and thus allowed to compare gender differences in relation to sense of university belonging between the subject groups.

1.2 Intersectional perspectives on the university belonging of female STEM students

Gender is not the only demographic dimension that may define minority membership in a particular student population. *Intersectionality* describes the multiplicative linkage respectively interaction of different dimensions that can be the base for (self-)categorization as a minority member, for discrimination or for the experience of disadvantages (Crenshaw, 2017; Ferree, 2010). Hence, the effects of these dimensions are supposed to interact, not just to add up (Cole, 2009; Knapp, 2012). For example, Rainey et al.'s (2018) results showed that students who belonged to multiple underrepresented groups (e.g., were black and female) feel lower levels of belonging in STEM than white students and male black students. Further, Le Roux and Groenewald (2021) showed in their qualitative study, that sense of belonging is linked to the complexity of the intersectionality of race, ethnicity, gender and language. In particular, language skills and acculturation orientations may help to improve university belonging of international students (Berry, 1997; LaCosse et al., 2020). Further, disadvantages by gender could be buffered by better language skills and a higher host-culture orientation (Berry, 2006; Kunyu et al., 2021). Until now, most studies that addressed the interplay of gender, educational background and ethnic/cultural background with regard to sense of belonging come from the United States. Studies from the European context mainly focused on the school sector (e.g., Marksteiner & Kruger, 2016). In higher education in Germany, intersectionality has primarily been considered descriptively (Lörz, 2019). The intersectional perspective, however, allows for a more specific consideration of student groups beyond female students who may suffer from low levels of university belonging and thus offers starting points for specifically tailored interventions (Else-Quest et al., 2010; Harackiewicz et al., 2016a, 2016b; Schachner et al., 2019). To that end, the present study is not limited to the assessment of gender disparities in belonging, but further considers students' academic background, cultural background (i.e., region of origin) and cultural resources (i.e., study-related language skills and acculturation orientation) as well as their intersectional interplay with gender.

1.3 First-generation students and university belonging

Students who were the first in their families who studied at university reported lower levels of sense of university belonging. For example, Harackiewicz et al., (2016a) found that first-generation students tended to feel more uncertainty about belonging to their university than continuous-generation students. Janke et al. (2023) detected a positive relationship between continuous-generation status and sense of university belonging using data from two longitudinal survey studies at a German university. Unfortunately, the authors did not differentiate between the subject groups, although the students were enrolled in 20 different STEM and non-STEM study programs. Similarly, the results of Kreniske et al. (2022) suggested that first-generation students, students who come from a household with low income and those who meet both conditions reported a lower sense of college belonging than students from a high-income household and/or with academic background.

Due to the missing evidence on associations between parental academical background and sense of university belonging amongst international STEM students, we investigated if the reported findings are transferrable to this student population. Moreover, the interplay between gender and parental academic background was assessed to explore if female STEM students who are also first-generation students might be at particular risk to experience impairments of their university belonging.

1.4 Cultural background, cultural resources and university belonging

Previous research suggested that students' cultural background, i.e., their region of origin, may also influence their sense of belonging to their educational institution. For example, a study that used data from the 2003 *Programme for International Student Assessment* (PISA) of 15-year-old students from 31 countries yielded between-country mean level differences in school belonging that could partly be assigned to between-country differences in cultural dimensions such as power distance (Cortina et al., 2017). In particular, students living in high degree power distance countries, like many countries in Eastern Asia, showed lower levels of school belonging than students in Western countries with a lower power distance. Against this background, we investigated if international students' different cultural backgrounds, i.e., their regions of origin, also affected their sense of university belonging. Furthermore, from an intersectional point of view, the interplay between cultural background and gender was explored in order to investigate if the relationship between gender and university belonging differed by students' region of origin, i.e., if female students from certain regions were at a greater risk to experience disadvantages in university belonging than others.

Whereas the transition to university implies different challenges for all (first semester) students such as new study requirements, a possible change of residence, the separation from family and friends as well as the need to make new friends and to integrate into the new social environment (O'Keeffe, 2013; Sussman, 2002), international students are confronted with additional challenges such as possible language barriers and the acculturation process (Bethel et al., 2020; Geeraert & Demoulin, 2013; Greischel et al., 2019; Jindal-Snape & Ingram, 2013; Ward & Kennedy, 1993) that require the allocation of cultural resources (Le Roux & Groenewald, 2021; Pekerti et al., 2020; Ryan et al., 2008).

In this sense, former studies corroborated the importance of language skills for the academic and social integration of international students (e.g., LaCosse et al., 2020; Le Roux & Groenewald, 2021; Wisniewski et al., 2022). Language skills facilitate international students' participation in campus life and contacts to their fellow international and host national students and thereby increase their university belonging (Thies & Falk, 2023). In this vein, better language skills might also provide a resource for female STEM students that buffers against negative effects on belonging by increasing their social integration via contact to their fellow students (Cena et al., 2021; Kunyu et al., 2021; Ryan et al., 2008). Therefore, associations between self-perceived study-related language skills and university belonging as well as their interplay with gender were additionally assessed.

The overall way how migrants deal with migration-related challenges is described by their acculturation orientations (e.g., Berry, 2006; Ward & Kennedy, 1993). Acculturation is described as a continuous process of direct contact between different cultures that happens, for example, when individuals live outside their home countries (Berry, 1997).

Acculturation orientations are reflected in two independent dimensions (Arends-Tóth & Van de Vijver, 2007; Berry, 2006). On the one hand, the host-culture orientation describes how much a person is interested in getting in touch with people and culture of the host country. On the other hand, the home-culture orientation describes how much a person is interested in getting in touch with people and culture of the home country. Whereas a meta-analysis by Bierwiaczonek and Kunst (2021) indicated that the relationship between home-culture orientation and adaptation was less consistent than assumed, a positive association between host-culture orientation and sociocultural adaptation was consistently maintained. Accordingly, a recent study among immigrant high school students from six different countries with the PISA data that addressed the associations between host- and home-orientations and school belonging showed that overall, a higher host-culture orientation predicted a higher sense of school belonging whereas in some countries benefits of a higher home-orientation were additionally observed (Schachner et al., 2017). Similarly to language skills, higher levels of host-culture orientation might provide a particularly important resource for female STEM students at risk for low sense of university belonging as it may promote their sociocultural integration by the facilitation of intercultural contacts (Pekerti et al., 2020; Szabò et al., 2020). The potential role of the home-culture orientation, on the other hand, is less clear. Therefore, we investigated the associations between acculturation orientations and their interactions with gender in the prediction of university belonging.

1.5 Purposes of the present study

Despite the importance of international students at universities as well as for societies worldwide (DAAD & DZHW, 2022; OECD, 2022), little is known about international students' sense of university belonging and its predictors. Therefore, we investigated how gender, first-generation student status, cultural background (i.e., regions of origin), cultural resources (i.e., study-related language skills and acculturation orientations) as well as their intersectional interplay related to the sense of university belonging of international students in STEM subjects.

Against the background of the outlined theoretical assumptions and previous findings, we formulated the following hypotheses (*H*) and explorative research questions:

H1: We expected that the sense of university belonging of international STEM students was lower for (a) female than male students, (b) first-generation than continuous-generation students, students with (c) lower host-culture orientation and (d) lower study-related language skills (as compared to students with higher levels in these cultural resources). The effects of the cultural background, operationalized by regions of origin, and home-culture orientation on university belonging were investigated exploratively.

H2: We also expected that the negative effects of gender on sense of university belonging of international STEM students were more pronounced (a) for first- than continuous-generation students. By contrast, the negative gender effect is expected to be less pronounced for students (b) with higher host-culture orientation and (c) better language skills. Again, the moderation of the gender effect by cultural background, operationalized by regions of origin, and home-culture orientation was investigated exploratively.

H3: We expected that the effect of gender on sense of university belonging was stronger in STEM than in non-STEM subjects. We also exploratively tested whether any of the effects of the predictors or their interactions with gender differed between STEM- and non-STEM subjects.

As previous experiences in the host country may also help to establish or maintain social contacts and influence the experience of the cultural transition (Glorius, 2016; Zimmermann et al., 2021), we additionally considered previous residence in Germany as a covariate. Furthermore, potential influences of students' age were controlled.

To test these hypotheses, we used cross-sectional data from a large and heterogeneous sample of international students in Germany that endorsed students with different cultural backgrounds, studying in a broad range of different subjects and at different higher education institutions all over Germany and used the benefit of an international non-STEM student comparison group. We restricted the sample to bachelor students to make sure that the participants are more comparable with regard to previous experiences at the higher education institution and in their field of studies.

2 Method

2.1 Sample

This secondary data analysis based on data from the *International Student Survey* (Falk et al., 2021), which was carried out as a part of the interdisciplinary research project *Academic Success and Withdrawal Among International Students in Germany in Bachelor's and Master's Programs (SeSaBa)*. The online panel study included six measurements over a period of three years and maps the study trajectories of a cohort of international students in Germany between 2017 and 2020. All participants were international students who held a foreign citizenship and obtained their university entrance qualification (HEEQ) abroad or an equivalence of their HEEQ with the German abitur at a preparatory college (Studienkolleg) in Germany (Federal Statistical Office, 2020). Beyond this, additional participation criteria were defined: only students who started their studies in Germany in the winter term 2017/18 and indicated the intent to obtain a bachelor's or master's degree in Germany were admitted to the panel study. To ensure that the participants fulfilled these inclusion criteria they registered for the panel study by answering a short registration questionnaire (t0). The participation in the study was voluntary and participants were informed on data protection standards at the beginning of the study. They provided their informed consent at the beginning of each questionnaire. The present study refers to (demographic) data from this registration questionnaire and survey data from the first measurement (t1) that took place by the end of the first semester, i.e., between January and April 2018. For more information on the methods of recruiting, registration, participants statistics, used scales, etc. please consult the methodological report of the project (Falk et al., 2021; Pineda et al., 2022). We investigated the students' first semester in Germany as we were interested in the questions which (groups of) students start off with particularly high or low levels of university belonging as this is considered to provide an important resource for their academic success throughout the further study course. Furthermore, estimated drop-out rates were shown to be highest during the early stages of a degree program and were higher among international students in bachelor than in master programs (41% versus 28%, Heublein et al., 2022). That is, university belonging may provide a particularly important resource for bachelor students at their study onset. Focusing on the bachelor students further helped to avoid potential bias in the results as master students' belonging to their current educational institution may be affected by their experiences at other educational institutions (where they obtained their Bachelor degree) and may differ between those international master students who obtained their Bachelor degree in Germany and those who did not.

The final sample includes data from 1,590 ($n_{\text{STEM}} = 882$, $n_{\text{non-STEM}} = 708$) bachelor students who were studying at 123 universities in all 16 federal states of Germany and in 34 subject groups.[1] The sample represents 120 countries. Syrian students make up the largest group in the sample (8.6%, $n = 136$), followed by Chinese (6.5%, $n = 104$), Russian (5.6%, n = 89), Luxembourgian (4.0%, $n = 63$), Bulgarian (3.8%, $n = 60$), and US-American and Ukrainian students (each 3.7%, $n = 59$). These numbers are fairly comparable to the distribution of countries of origin amongst all international degree-seeking students in Germany. In particular, the top three countries of origin in the present sample range amongst the top five countries of origin amongst all international degree-seeking students in Germany (DAAD, & DZHW, 2019). The mean age of the STEM sample of bachelor students at t1 was $M = 22.95$ ($SD = 3.58$); 32.1% ($n = 283$) were female students and 542 of the participants have at least one parent with an academic degree (67.2%). The characteristics of the non-STEM sample were quite comparable, i.e., 445 of the participants have at least one parent with an academic degree (67.4%), the mean age was slightly higher ($M = 24.18$, $SD = 4.87$) and the proportion of female students was, as expected, higher (68.5%) as can be seen in Table 1. The descriptive results revealed some differences between STEM and non-STEM students with regard to the distribution of country groups (see Fig. 1). That is, students from North Africa and Middle East as well as Asia and Pacific were more likely to study a STEM subject whereas students from Europe, Central Asia and North America were more likely to be enrolled in a non-STEM subject.

Further information on demographic characteristics by subject groups is shown in Table 1.

[1] with the exception of music and art universities (Falk et al., 2021).

Table 1 Descriptive statistics of the study variables

Variables	STEM		non-STEM	
Female students (%)	283	(32.1%)	485	(68.5%)
Parental academic background (continuous-generation students) (%)	542	(67.2%)	445	(67.4%)
Country groups[a] (%)				
Western Europe (Reference category)	95	(10.8%)	148	(20.9%)
Central and South Eastern Europe	117	(13.3%)	116	(16.4%)
Eastern Europe and Central Asia	74	(8.4%)	133	(18.8%)
North America	21	(2.4%)	43	(6.1%)
Latin America	67	(7.6%)	53	(7.5%)
North Africa and Middle East	269	(30.5%)	62	(8.8%)
Sub-Saharan Africa	45	(5.1%)	33	(4.7%)
Asia and Pacific	194	(22.0%)	120	(16.9%)
Previous residence in Germany (yes)	253	(29.1%)	300	(43.0%)
	M	*SD*	*M*	*SD*
Age in years	22.95	3.58	24.18	4.87
Study-related language skills	3.98	0.92	4.03	0.96
Sense of university belonging	3.76	0.87	3.85	0.85
Home-culture orientation	2.92	0.90	3.00	0.90
Host-culture orientation	3.51	0.84	3.54	0.78

Note. $n_{\text{STEM}} = 882$, $n_{\text{non-STEM}} = 708$. Listwise deletion was used

[a]Country groups: Western Europe as reference category

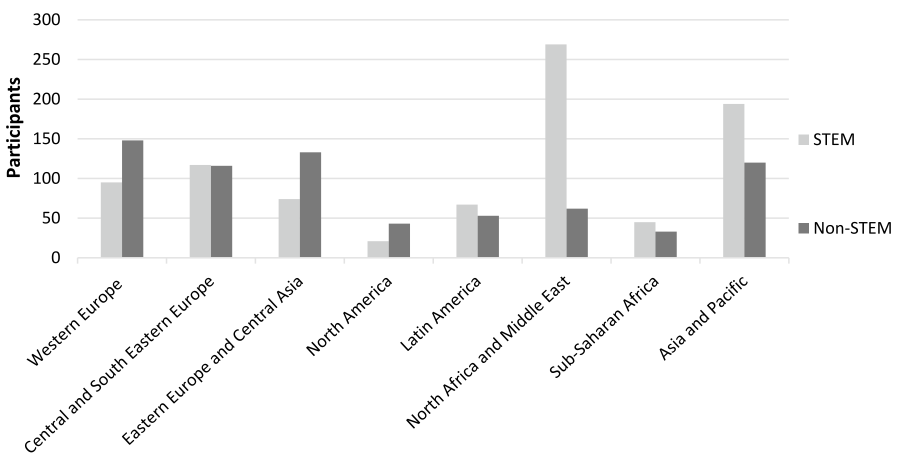

Fig. 1 Distribution of country groups by subject groups (STEM versus non-STEM). *Note.* $n_{\text{STEM}} = 882$, $n_{\text{non-STEM}} = 703$

2.2 Instruments/measures

2.2.1 Sense of university belonging

The sense of university belonging was measured at the end of the first semester in Germany with a scale by Bollen and Hoyle (1990). Participants indicated their level of approval with regard to three items (e.g., “I see myself as part of the community of my higher education institution”) using a 5-point Likert scale (1 = *strongly disagree* to 5 = *strongly agree*; Cronbachs’ $\alpha = .87$). The scale value was calculated as an arithmetic mean.

2.2.2 STEM versus non-STEM-subjects

The study subject groups were categorized into STEM and non-STEM subjects, based on the specification of the Federal Statistical Office of Germany of the winter semester 2017/2018 (Federal Statistical Office, 2018) and the statistics of the Federal Employment Agency (2019). Notably, the categorisation of STEM subjects is almost identical between the US and Germany (OECD indicator of 2021, 2024). For some additional analyses, STEM subjects were further categorized according to the proportion of female students, i.e., a study subject was considered as gender-segregated if the proportion of female students across all student groups, degree types, and university semesters was below 30% according to the higher education statistics for the academic year 2018 in Germany (Dressel & Wanger, 2008; Federal Statistical Office, 2018).

2.2.3 Gender

Participants indicated their gender (0 = *male*, 1 = *female,* 2 = *diverse*). Due to the small number of people indicating their gender as diverse (< 0.1%) and the resulting lack of comparability, participants who had selected the "diverse" category ($n = 6$) were excluded from the present analyses.

2.2.4 Parental academic background

Parental academic background was operationalized via the professional qualification of both parents. Students were categorized as first-generation students if they indicated that *none* of their parents held a bachelor’s, master’s or doctorate degree, otherwise, they were categorized as continuous-generation students (0 = *first-generation students*, 1 = *continuous-generation students*).

2.2.5 Cultural background

The cultural background was operationalised by the country of students’ university entrance qualification. These countries were categorised into eight country groups according to the regional coding system of the German Academic Exchange Service/DAAD (DAAD & DZHW, 2019). This variable was dummy-coded with

Western Europe as reference category and seven country group variables: Central and South Eastern Europe, Eastern Europe and Central Asia, North America, Latin America, North Africa and Middle East, Sub-Saharan Africa, and Asia and Pacific.

2.2.6 Study-related language skills

Study-related language skills were assessed with a self-formulated item "My language skills are sufficient to cope with my academic studies", participants indicated their approval on a 5-point Likert scale (1 = *strongly disagree* to 5 = *strongly agree*).

2.2.7 Acculturation orientations

Acculturation orientations were surveyed with four items each on host-culture orientation (Cronbachs' $\alpha = .81$) and on home-culture orientation (Cronbachs' $\alpha = .81$) adapted from Demes and Geeraert (2014). Participants indicated their level of agreement on a Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). A sample item was "It is important to me to have friends from my country of origin" (home-culture orientation) and "It is important to me to get to know and maintain German customs and traditions." (host-culture orientation). Both scale scores were calculated as means of the four respective items.

2.2.8 Previous residence in Germany

To inform about previous stays in Germany at t1, students replied to the question "Before your current stay in Germany, had you ever lived in Germany for at least 1 month?" with 0 = *no* or 1 = *yes*.

2.2.9 Age

Age was calculated from the year of birth indicated at t1 and described in years.

2.3 Analytical strategy

All analyses were carried out using IBM SPSS Statistics version 28 (2021) and Mplus Version 7 (Muthén & Muthén, 1998–2015). Missing data were treated by using the full information maximum likelihood estimator (FIML) as implemented in Mplus. Yet, missing rates of all constructs in the final model were lower than 1%. We performed multi-group regression analyses[2] in order to assess differences between STEM and non-STEM subjects. To that end, the predictor variables and their interaction terms were inserted stepwise. To sum up, we exerted the following steps (for detailed results on these steps see Table A1 in the appendix/supplementals): 1. We inspected the main effects of all predictors (inserted stepwise), 2.

[2] Due to the low intraclass correlations (ICC´s), multilevel analyses using country clusters were not feasible.

we added the interaction of gender and parental academic background, 3. we added the interaction terms of gender and country groups, 4. we added the interaction of gender and study-related language skills, 5. we added the interactions of gender and acculturation orientations. After each step, a Wald-test was used to test the appropriateness of equality constraints between the subject groups. If the test was not significant at $p < .05$, the respective paths of the model were restricted to be equal between groups. For reasons of model parsimony, single interaction terms that did not yield statistical significance in both subject groups were removed from the model before the next predictor was inserted. Hence, the final model included all predictors as well as the significant interactions between gender and the other predictors.[3] All continuous predictors have been grand mean centred as part of the analysis.

Since female students are not underrepresented in all STEM-subjects in Germany, as there are higher proportions of female students in some STEM subjects such as pharmacy (68.6%), biology (62.0%), and architecture (57.8%) (Federal Statistical Office, 2018), we also scrutinized the robustness of the results by repeating the analyses with a reduced data set that only contained the data of participants in STEM subjects with proportions of women under 30% which can thus be considered as gender-segregated (Dressel & Wanger, 2008; Federal Statistical Office, 2018) and in non-STEM subjects with proportions of women over 30%.[4] The results are shown in Table A2 in the appendix / supplementals.

2.3.1 Power analysis

A post-hoc power analysis with G*Power (Faul et al., 2007, 2009) showed that at $\alpha = .05$ and with $N = 1{,}590$ small (interaction) effects of ($f^2 = .02$) were detected with a probability of $1 - \beta = .97$. Thus, the target power of at least .80 (Cohen, 1988) was achieved.

3 Results

Preliminary analyses suggested that all conditions for the implementation of linear regression analyses were fulfilled. This implies normal distribution of the residuals, homoscedasticity of the residuals, linearity, no strong multicollinearity of the predictors, uncorrelated errors/residuals and no strong outliers. First, the descriptive results are presented, subsequently followed by the results of the multi-group regression analyses.

[3] To double-check our results, we further run our analyses by block wise addition (1. step all predictors, 2. all interactions, 3. final model with intercepts set equal) as well, which confirmed the pattern of results.

[4] Data refer to the proportion of female students across all student groups, degree types, and university semesters according to the higher education statistics for the academic year 2018 in Germany (Federal Statistical Office, 2018).

3.1 Descriptive analyses

In the descriptive analyses, listwise deletion was used. The descriptive statistics showed slightly different means of the main study variables in the two different subject groups (see Table 1). The means of sense of university belonging and host-culture orientation exceeded the theoretical scale means of three ($M_{\text{Sense of university belonging}}=3.80$, $SD=0.86$; $M_{\text{Host-culture orientation}}=3.52$, $SD=0.81$). The means of home-culture orientation ranged around this theoretical scale mean ($M_{\text{Home-culture orientation}}=2.95$, $SD=0.90$). The correlations between the study variables showed very similar patterns in the STEM and in the non-STEM group (see Table 2). Notably, there were no substantial differences with regard to the cultural resources study-related language skills, host- and home-culture orientation as well as with regard to sense of university belonging between female and male students (see Table A3).

Additionally, for female international students, the bivariate correlations of the percentage of female students in the study programme with sense of university belonging were not significant in STEM ($r=.09$, $p=.126$) as well as non-STEM subjects ($r=.08$, $p=.104$).

3.2 Multi-group regression analyses

Overall, the multi-group regression analyses revealed no significant differences in the predictors and intercepts of sense of university belonging between subject groups, with all Wald $\chi^2=0.01$ to 4.88, all p-values$>.056$, the detailed results of each step can be found in Table A1. As a consequence, all paths and the intercepts were restricted to be equal between the subject groups. Both models explained 12% of variance in university belonging ($R^2=.12$, $SE=.02$, $p<.001$). Hence, the subsequently reported findings equally apply to both students in STEM and non-STEM subjects, therefore we exemplarily describe the results for the STEM students.

In the model with all main predictors (see model *main predictors*, Table A1), female international STEM students showed a lower level of sense of university belonging than their male fellows ($b=-.12$, $SE=.05$, $p=.014$), but this relation (H3) did not differ between the subject groups (Wald $\chi^2=0.65$, $p=.422$). Against our expectations, gender did not show a significant relation with sense of university belonging (H1a) in the *final model* with all significant interactions (see Table 3).

By contrast, first-generation students showed significantly lower levels of sense of university belonging than their continuous-generation peers (H1b) in the *main predictors* model with $b=.12$, $SE=.05$, $p=.010$ (see Table A1) and in the *final model* with the significant interactions ($b=.13$, $SE=.05$, $\beta=.15$, $p=.006$), regardless of subjects group (Table 3). Against our hypothesis, no significant interaction between gender and parental academic background was identified (H2a, see Table A1, model *Test of interaction parental academic background * Gender*).

Furthermore, in the model with all main predictors (see model *main predictor*, Table A1), international STEM students from North Africa and Middle East showed

Table 2 Correlations between the study variables

Correlations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Sense of university belonging	–	.21**	– .04	– .01	.07	– .01	– .01	.05	.01	– .03	.05	– .06	– .07	.08*	.21**
2. Study-related language skills	.21**	–	– .05	– .11**	.01	.08*	.02	– .00	– .03	– .11**	.06	– .41**	.04	.01	– .02
3. Previous residence in Germany	.00	– .04	–	.11**	– .01	.02	.21**	– .07	.16**	– .14**	– .03	– .06	.12**	– .14**	.01
4. Age	– .06	– .07	.04	–	– .16**	– .15**	.08*	.15**	.06	.14**	.09*	.02	– .03	– .07	.03
5. Parental academic background	.05	.02	.08*	– .24**	–	– .05	.12**	.14**	.11**	– .05	.01	– .06	– .08	.04	.02
Country groups [a]															
6. Central and South Eastern Europe	.05	.09**	.08*	– .22**	.01	–	– .21**	– .11**	– .13**	– .14**	– .01**	– .20**	.05	– .06	– .01
7. Eastern Europe and Central Asia	.05	.07*	.22**	.03	.11**	– .12**	–	– .12**	– .14**	– .15**	– .11**	– .21**	.16**	– .08*	.02
8. North America	.01	.02	.02	.13**	.06	– .06	– .05	–	– .07	– .08*	– .06	– .12**	– .02	.13**	.08*
9. Latin America	.02	.04	.13**	.01	.11**	– .11**	– .09**	– .05	–	– .09*	– .06	– .13**	– .03	– .02	.12*
10. North Africa and Middle East	– .13**	– .10**	– .15**	.21**	– .07*	– .26**	– .20**	– .10**	– .19**	–	– .07	– .14**	– .25**	– .07	– .03
11. Sub-Saharan Africa	– .00	.04	– .12**	.07	– .08*	– .09**	– .07*	– .04	– .07*	– .15**	–	– .10**	– .02	– .03	– .00
12. Asia and Pacific	.00	– .26**	– .02	– .01	– .00	– .21**	– .16**	– .08*	– .15**	– .35**	– .12**	–	– .00	.06	.03
13. Female students	– .00	.02	.07*	– .03	.07*	.08*	.17**	.00	.05	– .21**	– .02	– .04	–	– .01	– .01
14. Home-culture orientation	.07*	– .03	– .11**	– .20**	.07	– .04	– .11**	.04	– .03	– .06	– .00	.12**	– .02	–	.16**
15. Host-culture orientation	.24**	– .02	– .01	.05	– .03	– .10**	.03	.06	.05	.03	– .04	.04	.03	.08*	–

Note. Correlations for the non-STEM group are above the diagonal. Correlations for the STEM group are below the diagonal. For categorial variables Spearman's rho is presented. $N = 1{,}590$, $n_{\text{STEM}} = 882$, $n_{\text{non-STEM}} = 708$. Listwise deletion was used

[a]Country groups: Western Europe as reference category

**Correlation is significant at the level of $p < .01$. *Correlation is significant at the level of $p < .05$

Table 3 Final multi-group model to predict university belonging of STEM students

Predictors	b	SE_b	p	95% CI
Final model				
Age	.00	.01	.704	[− .01; .01]
Previous residence in Germany	.00	.05	.941	[− .09; .10]
Study-related language skills	.20	.03	< .001	[.15; .25]
Country groups[a]				
Central and South Eastern Europe	.19	.12	.119	[− .05; .42]
Eastern Europe and Central Asia	.11	.14	.458	[− .18; .39]
North America	− .05	.18	.797	[− .39; .30]
Latin America	.02	.14	.889	[− .25; .29]
North Africa and Middle East	− .04	.10	.678	[− .24; .15]
Sub-Saharan Africa	.24	.16	.116	[− .06; .55]
Asia and Pacific	.18	.11	.096	[− .03; .40]
Home-culture orientation	.05	.03	.061	[− .00; .10]
Host-culture orientation	.24	.03	< .001	[.19; .29]
Female students	.16	.11	.137	[− .05; .38]
Parental academic background	.13	.05	.006	[.04; .22]
Inter Central and South Eastern Europe * Gender	− .38	.16	.015	[− .69; − .07]
Inter Eastern Europe and Central Asia * Gender	− .28	.17	.101	[− .62; .06]
Inter North America * Gender	.02	.23	.942	[− .44; .47]
Inter Latin America * Gender	− .25	.19	.186	[− .61; .12]
Inter North Africa and Middle East * Gender	− .35	.16	.030	[− .67; − .03]
Inter Sub-Saharan Africa * Gender	− .33	.23	.150	[− .77; .12]
Inter Asia–Pacific * Gender	− .31	.15	.031	[− .60; − .03]

Note. Inter = interaction term. $n_{\text{STEM}} = 801$. All non-significant interactions (gender*academic background and gender*acculturation orientations) were removed to ensure parsimony. $R^2_{\text{STEM}} = .12$, $SE = .02$, $p < .001$. Intercept: $M = 3.63$, $SE = 0.15$, $p < .001$. Wald-test $\chi^2 = 3.69(1)$, $p = .055$

[a]Country groups: Western Europe as the reference category

lower levels of sense of university belonging, than the reference group ($b = -.17$, $SE = .08$, $p = .036$), but in the *final model* with all significant interactions, country groups showed no significant relations with sense of university belonging (see Table 3). However, our analyses identified significant interactions between gender and certain country groups: Female students from Central and Southern Europe ($b = -.38$, $SE = .16$, $\beta = -.44$, $p = .015$), North Africa and Middle East ($b = -.35$, $SE = .16$, $\beta = -.40$, $p = .030$), and Asia and Pacific ($b = -.31$, $SE = .15$, $\beta = -.36$, $p = .031$) tended to show lower levels of sense of university belonging in both subject groups than their male fellows (see Fig. 2). The patterns of the country groups North America, Latin America, Sub-Saharan Africa, Eastern Europe and Central Asia did not significantly differ from the pattern of the reference category Western Europe which is shown in the left part of the figure. Hence, in these country groups, female students tended to show higher levels of university belonging than their male fellow students.

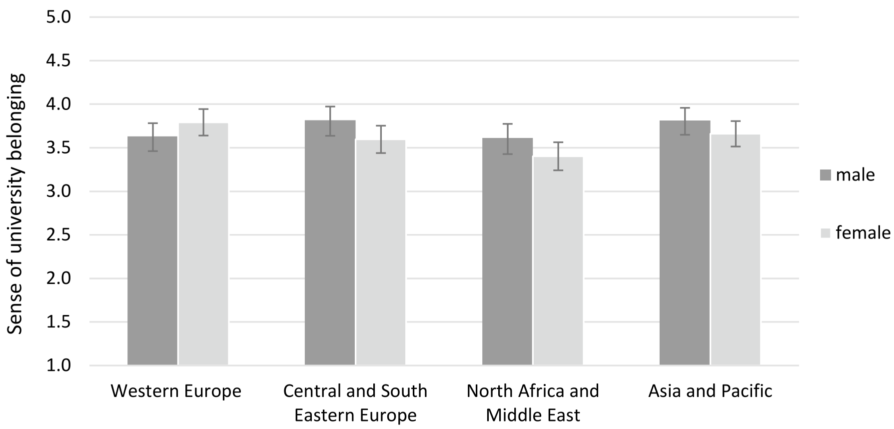

Fig. 2 Gender and university belonging: Significant interactions between gender and country groups. *Note.* $n_{\text{STEM}} = 801$. Error bars represent the standard errors. Country groups: Western Europe as reference category. All country groups that are not presented did not reveal substantial interaction effects, i.e., the pattern was the same as for Western Europe

Study-related language skills revealed a positive significant relation with sense of university belonging, in the *main predictors* model as well as in the *final model* ($b = .20$, $SE = .03$, $\beta = .21$, $p < .001$), so hypothesis 1d was confirmed. The interaction of study-related language skills and gender showed no significant relation with sense of university belonging, regardless of subject group (H2d, see model *Test of interaction study-related language skills * Gender* in Table A1).

In accordance with our hypothesis (H1c), higher levels of host-culture orientation ($b = .24$, $SE = .03$, $\beta = .23$, $p < .001$) were consistently related to higher levels of university belonging in both subject groups (in the *main predictors* model as well as in the *final model*), hence hypothesis 1c was confirmed. Home-culture orientation was not significantly related with sense of university belonging, both in the *main predictor model* and in the *final model*. Further, there were no significant interactions between gender and the acculturation orientations (H2b) (see model *Test of the interactions acculturation orientations * Gender* in Table A1).

Further, previous residence in Germany and the students' age were unrelated to the outcome. Further details, all unstandardized coefficients, standard errors, *p*-values and 95% confidence intervals are shown in Table 3 and the detailed steps in Table A1.

Additional analyses which excluded all participants in STEM subjects with proportions of women over 30% and in non-STEM subjects with proportions of women under 30% (Dressel & Wanger, 2008) with a sample size of $n = 1{,}217$, $n_{\text{STEM u30}} = 632$, $n_{\text{non-STEM o30}} = 585$, produced similar results ($R^2_{\text{STEM}} = .10$; $R^2_{\text{non-STEM}} = .11$) and confirmed the robustness of the current findings with the exception that the intercepts in these analyses slightly differed between the (reduced) subject groups (see in the appendix / supplementals, Table A2).

4 Discussion

As an important group at universities in many countries, international students' academic success is of core interest. Previous research positioned students' university belonging as an important condition of psychosocial development, well-being, academic success and students' persistence (Hausmann et al., 2007; Osterman, 2000; Sverdlik et al., 2020). Yet, former research postulated a "chilly climate" (Flam, 1991) for female STEM students that was reflected in a lower sense of belonging to their STEM subject than their male fellows (Walton et al., 2015). Furthermore, despite increasing numbers of international students in OECD countries and in Germany (DAAD & DZHW, 2022; Heublein et al., 2020; OECD, 2022), little is known about the sense of university belonging and its determinants amongst female international STEM students. Therefore, we investigated the relations between gender, parental academic background, cultural background (i.e., region of origin) and cultural resources (i.e., study-related language skills and acculturation orientations) as well as their intersectional interplay and the sense of university belonging of international students to identify subgroups of international students who might benefit most from belonging interventions. To that end, we used a large heterogeneous sample of international bachelor students in Germany with a non-STEM comparison group. Overall, our results did not reveal substantial differences with regard to the intercepts and correlates of university belonging between the subject groups. That is, the level of university belonging and all of the observed associations were the same for students in STEM and non-STEM subjects.

4.1 No overall disadvantages in university belonging for female STEM students but differences in interaction with country groups

Contrary to our hypotheses, the present study did not support overall disadvantages in university belonging for female international STEM students as the main effect of gender in the main predictor model was no longer substantiated once the intersection of gender and cultural background, operationalized by country groups, was considered. One reason could be that international STEM students represent a selective sample. In particular, female students who indeed made it happen, accomplished all bureaucratic and academic challenges and moved abroad to study a STEM subject may strongly identify with their choice and thus be less affected by gender and other minority stereotypes and potential backlash effects (Froehlich et al., 2022). This might be the reason why gender differences in school belonging that were confirmed in international data sets (PISA and TIMSS) on high school students (Else-Quest et al., 2010) did not manifest in this sample. Future research may benefit from including information on subject choices and STEM attitudes of students' families and friends in order to investigate if female international STEM students benefit from the STEM support of their close social environment. Notably, these findings were supported by our additional analyses that only included participants in STEM majors with proportions of women under 30% and in non-STEM subjects with proportions of women over 30% (Dressel & Wanger, 2008). The analyses of the reduced sample ($n = 1{,}217$) produced the same results and thus confirmed their robustness (see Table A2). Though, albeit the finding that there are no general differences in the sense of university belonging between female and male international students in both subject groups can be interpreted as good news, the intersectional analyses revealed gender-specific disadvantages for female students in some country groups, i.e., female international students from Central and Southern Europe, North Africa and Middle East or Asia and Pacific tended to show lower levels of university belonging than their male fellows in both subject groups, whereas female students were in advantage in the other country groups in both STEM and non-STEM subjects. This could serve as a possible explanation for the missing direct relation of gender and sense of university belonging in the model with all predictors and all significant interaction blocks, since the opposing directions of the associations between gender and sense of university belonging in the different country groups seem to have canceled each other out. These results illustrate a strength of the intersectional approach as it reveals the specific heterogeneity within the international student body. In future research it should be investigated why female students from some country groups are on advantage in terms of their university belonging whereas in other cases male students benefit. A possible explanation could be that men and women might react differently to differences in cultural dimensions such as power distance (Hofstede, 2011) between their home and host countries. For example, it was shown that students from high degree power distance countries (like many countries in Eastern Asia) showed lower levels of school belonging than their peers from Western countries with a lower power distance (Cortina et al., 2017), but research on gender differences regarding such cultural disparities is still missing. However, it is important to keep in mind that in some country groups the numbers of cases were really small. Additionally, the categorization into country groups could be biased and neglect possible cultural differences within the country groups, which might obscure the findings. Further research is needed to verify whether the observed effects can be replicated and which specific cultural characteristics in detail might be the most relevant to explain the differentiated transition experiences of male and female international students.

4.2 Lower belonging of first-generation students

In line with former research and our hypothesis, first-generation students showed lower levels of sense of university belonging than continuous-generation students. In the literature, missing role models, missing parental experience reports, and the feeling not to fit into the academic environment as a consequence thereof are discussed as potential explanations for this pattern (Walton & Cohen, 2011). With regard to the present sample of international students, first-generation students' feeling not to fit into the campus community might be additionally aggravated by differences between educational systems and practices in their home and host countries. Barth et al. (2022) further suggested that not only the parental academic background but also differences in academic expectations and (gender) stereotypes of peers may affect the belonging of STEM students. Yet, further research is needed to more thoroughly explore such mechanisms. Against our expectations and the findings reported by Harackiewicz et al., (2016a) or Marksteiner and Kruger (2016), no significant interaction between gender and parental academic background could be identified. That is, the challenges associated to being a first-generation student did not hit differently on male and female students but seemed to equally affect all international students in STEM and non-STEM subjects. Yet, further research is needed to validate these findings for international students in other (national) educational contexts.

4.3 The role of cultural resources

As assumed, a positive relation of study-related language skills and sense of university belonging was found. The more the students felt that they mastered communication in the language of their study program, the higher their sense of university belonging. Although the item reflected students' expectancy whether her or his language skills are sufficient to cope with their academic studies, higher skill levels may also facilitate the interaction with professors and fellows which were shown to be important for international students' university belonging (Thies & Falk, 2023). That implies, that study-related language skills may affect university belonging (partly) via their contribution to students' social integration (Kunyu et al., 2021; Le Roux & Groenewald, 2021; Ryan et al., 2008; Wisniewski et al., 2022). These results were in line with LaCosse et al. (2020) and underline the relevance of feeling familiar with the language to feel to belong. No significant interaction of gender and study-related language skills with regard to sense of university belonging could be identified, hence interventions to foster study-related language skills could be beneficial for all international students, regardless of gender and subject-groups.

With regard to the acculturation orientations, no significant relations of home-culture orientation and sense of university belonging were found. Likewise, home-culture orientation did not moderate the association between gender and university belonging. This is in line with earlier findings on home-culture orientation (Bierwiaczonek & Kunst, 2021; Schachner et al., 2016) that revealed an inconsistent pattern of results. As expected, higher levels of host-culture orientation were consistently related to higher levels of sense of university belonging in both subject groups. Our findings confirm our assumptions and the results of previous research from the school context on adolescent immigrant learners (i.e., Schachner et al., 2017). This finding also fits in with the results of previous studies which showed that a higher host-culture orientation may promote more contacts and a higher frequency of contacts with host-country fellows (Pekerti et al., 2020; Szabó et al., 2020) which in turn was shown to be reflected in a higher sense of university belonging (Thies & Falk, 2023). Yet, host-culture orientation did not moderate the association between gender and university belonging. Hence, both female and male international students might similarly benefit from measures to increase their host-culture orientation in terms of their university belonging.

4.4 Practical implications

First, our results on the association between parental academic background and sense of university belonging suggest that first-generation international students may particularly benefit from interventions to increase their sense of belonging. In the US, several studies corroborated the effectiveness of such interventions for first-year college students (Murphy et al., 2020; PERTS, 2023; Solanki et al., 2020 (meta-analysis); Walton & Cohen, 2011; Walton et al., 2023; Yeager et al., 2016). A similar laboratory intervention, implemented by Marksteiner et al. (2019) for first-semester bachelor's students in Germany showed that first-generation students in the intervention groups reported a significantly higher sense of belonging at the beginning of the second semester than control group students. Hence, similar interventions might be beneficial for international first-generation students, e.g., with adapted role-models that fit their individual cultural backgrounds and endorse their specific migration and study experiences.

In contrast to previous studies no direct relations between gender and university belonging or between regions of origin and university belonging were identified. Yet, gender effects on university belonging differed by country groups, i.e., females from Central and Southeastern Europe, North Africa and Middle East or Asia and Pacific tended to show lower levels of university belonging than their male fellows in both subject groups whereas female students were at an advantage in the other country groups. This suggests that—in view of limited resources—female students from these country groups might be the ones to consider first when belonging interventions are set in place.

Furthermore, the positive relation of study-related language skills and sense of university belonging suggests that a beneficial intervention to promote the sense of university belonging amongst international students is the implementation of language courses. Better language skills may also help to promote contacts with professors and fellows that were shown to be central to make international students feel that they belong to the campus community (Le Roux & Groenewald, 2021; Thies & Falk, 2023).

Finally, our findings suggest that interventions to promote host-culture orientation may also be helpful to support international students' sense of university belonging. This could, for example, be achieved by study-buddy-programs, in which experienced (domestic) students from higher semesters support international first-year students to help them with potential daily, not only university, challenges, to discuss questions about their studies and to familiarized them with student life in the host country. Such programs have already been implemented in many universities, yet their specific impact on international students' host-culture orientation and further educational outcomes still warrants further investigation.

4.5 General limitations and future directions

First, in contrast to many previous studies that were focussing on womens' sense of belonging in the STEM field, we opted for the investigation of institutional belonging for two reasons: First, in view of the increased probability of subject changes during the first semesters (Spangenberg & Quast, 2016) the institution might represent a more stable entity during the early study stages. Furthermore, university belonging was approved to be an important predictor of study success and in the prevention of student withdrawal (Hausmann et al., 2007; Osterman, 2000). Yet, in previous studies the differentiation between and psychological implications of belonging to distinct academic entities, such as subjects, faculties or the institution as a whole, have not thoroughly been considered. Moreover, their differentiation might be contingent upon institutions characteristics such as the university profile or portfolio. In particular, the correlation between subject belonging and university belonging might differ between institutions with a specific STEM focus (in such a case subject belonging and university belonging might be exchangeable) and others with a broader spectrum. Likewise, gender differences in belonging might be moderated by institutional characteristics. Further research is needed in order to explore these research gaps and to gain deeper insights into the commonalities and particularities of subject versus university belonging.

Second, it is important to consider that the present study investigated a specific sample of international students in Germany. As a consequence, our results might not be transferable to other student populations like domestic students or international students in other host countries than Germany, due to the differences in higher education systems, for example in terms of study fees, and cultural differences. In particular, as the present research referred to degree-seeking students in Germany, the transferability to credit-seeking international students (e.g., Erasmus students) who stay in the country for a shorter period of time might be limited, too.

Moreover, the distribution of country groups showed a small number of cases in some of the investigated country groups which may limit the validity of findings for these groups. Further, the aggregation to country groups itself bears the risk of overgeneralization, in particular as participant numbers also vary between the countries within the country groups. As a consequence, some countries might not be sufficiently reflected in the aggregated country group results.

Furthermore, some limiting facts with regard to the implemented measurement instruments need to be considered. On the one hand, the survey exclusively used self-report measures which might imply some bias due to socially desirable responding (Holtrop et al., 2021; Mummendey, 1981). On the other hand, some constructs were measured with only one item which may have constrained the content validity, e.g., for study-related language skills, a more differentiated approach to language would be useful. Although this is a common approach in large panel studies, further research may benefit from using some more detailed measurement instruments of the investigated constructs. In particular, implementing an instrument to measure active verbal language skills would be beneficial (Wisniewski et al., 2022).

To conclude, this study investigated the relation of gender, parental academic background, cultural background (i.e., region of origin) and cultural resources (i.e., study-related language skills and acculturation orientations) and their intersections in a cross-sectional design to map their associations at the begin of the study abroad time. As with all correlational research, no causal inferences can be drawn. Furthermore, longitudinal analyses that address the differential trajectories of sense of university belonging amongst STEM students in comparison to non-STEM students over the study course as well as its relationship with academic success in view of potential differences by students' gender, academic, and cultural background and cultural resources and their interplay are considered a worthy endeavor for further research.

4.6 Conclusion

As little is known about the sense of university belonging of international STEM students the present study aimed to help close this research gap. The cross-sectional data of the large and heterogeneous sample of international students provided us with the advantage of a non-STEM comparison group, which allowed us to investigate if effects of gender, parental academic background, cultural background and cultural resources were specific to the STEM context or apply to all international students. The present study revealed some good news as we could not confirm a "chilly climate" in the form of a generally lower university belonging for female international STEM students in Germany. Yet, the intersectional perspective revealed interactions between gender and country groups that suggest differentiated associations between gender and sense of university belonging for international students with different cultural backgrounds that require further exploration. By contrast, international first-generation students (regardless of their subject group) felt a lower sense of belonging to university than international continuous-generation students. Finally, better study-related language skills and a higher host-culture orientation were identified as potential cultural resources with regard to the promotion of university belonging amongst female and male international STEM and non-STEM students in Germany. Hence, we hope that the present research has advanced the theoretical understanding of international STEM students' university belonging by providing a more detailed view on disadvantaged groups in the international student body in Germany. Further, we aspired to increase awareness for the overall heterogeneity amongst international students. The typical international student does not exist—this notion may provide some starting points for more tailored (belonging) interventions and support services for international students that could be offered to specific groups of international students in order to help them feel more at home at their host universities.

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Data availability All data have been made publicly available at the OSF and can be accessed at https://osf.io/yknc8/?view_only=58ee8bac0f724da582e5c2aafdc14860

Declarations

Conflict of interest The authors have no conflict of interest to report.

Ethical approval Due to the non-controversial nature of the content and design of the study an ethics approval for this research was not required as per the ethical guidelines of the German Psychological Society (DGPs) and data protection standards at the time of data collection.

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Study 2

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Article

Academic Self-Efficacy and Value Beliefs of International STEM and Non-STEM University Students in Germany from an Intersectional Perspective

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Abstract: The expectancy–value theory (EVT) positions expectations and value beliefs as important predictors of academic success. We, thus, investigated the prevalence of academic self-efficacy and intrinsic, attainment, utility, and cost values amongst international STEM students in Germany, as well as their associations with gender, parental academic background, cultural characteristics, and their interplay. We also compared STEM to non-STEM students. Analyses with hierarchical multi-group regression models using data from 1590 international bachelor students (n_{STEM} = 882, $n_{\text{non-STEM}}$ = 708) revealed high levels of academic self-efficacy, attainment, intrinsic, and utility values but also high costs. International STEM students indicated lower levels of academic self-efficacy than non-STEM students; all other results were similar in both subject-groups. There were no direct associations between gender and the expectancy–value components but continuous-generation students showed higher academic self-efficacy than first-generation students. Significant associations between cultural background and all expectancy–value components were identified, most of them applied to costs. In some cases, the associations differed by gender. Study-related language skills were related to all expectancy–value components whereas host- and home-culture orientations were distinctly associated with attainment, intrinsic, and utility values. Implications of the results for interventions supporting the academic success of international STEM students and future research needs are discussed.

Keywords: international students; academic self-efficacy and value beliefs; (situated) expectancy–value theory (SEVT); STEM students; intersectionality; multi-group regression analyses

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1. Introduction

A comprehensive answer to the Special Issue's leading question of who is sticking with STEM requires the consideration of many aspects. For example, it is important to consider who comes to study STEM subjects at German universities and to explore these students' (psychological) prerequisites for study success that may influence who stays and who goes in due course.

An important group amongst the STEM students at German universities constitutes international students. These are foreign students who obtained their university entrance qualification outside of their study country [1,2]. In 2020, approximately 4.4 million international students were enrolled in the OECD which represents about 7% of the higher education students in these states [3]. About 369,000 international students studied at German universities, i.e., 11% of the student body [3]. Nearly 52% of the international students in Germany were enrolled in STEM subjects [4]. Hence, international students could help mitigate the shortage of skilled workers in STEM fields (e.g., in Germany; see Hoffmeyer-Zlotnik and Grote [5]). Yet, unfortunately, many international students struggle with their studies as the high dropout rates of 41% in the bachelor's and 28% in master's programs (compared to 28% and 21% among domestic students) show [6]. Against this background, understanding the (psychological) prerequisites of international STEM students' academic success is essential.

A prominent psychological approach to explain interindividual differences in academic choices and success is the (*situated*) *expectancy–value theory* (EVT [7]; SEVT [8]). It suggests that study-related expectations and value beliefs are building blocks in explaining why some individuals succeed whilst others struggle or drop out of their studies. Yet, previous meta-analytic research showed that learners differ in their expressions of these psychological constructs by their demographic characteristics such as gender, parental academic background, cultural background, and their interplay [9]. Accordingly, a thorough assessment of individual differences in international STEM students' study-related expectations and value beliefs at the beginning of their studies in Germany is an important endeavor in order to identify student groups who might be at risk for (academic) struggles throughout the further study course.

In the present study, we addressed the manifestation of expectations and value beliefs amongst international STEM students. In doing so, we assessed how demographic (gender and parental academic background) and cultural characteristics (cultural background, study-related language skills, previous residence in Germany, and acculturation orientations), as well as the intersectional interplay (e.g., [10,11]) between gender and parental academic and cultural background, relate to these motivational constructs at the beginning of the students' degree courses in Germany. In doing so, we aim to contribute to a better understanding of the heterogeneity within the (international) student body with regard to their (psychological) prerequisites for STEM success. This may help to identify target groups for tailored interventions to prevent study dropout and, thus, shed light on the question "Sticking with STEM: Who comes, who stays, who goes, and why?".

1.1. Expectancy and Value Beliefs

The EVT [7] explains behavior and behavioral intentions using expectancy and value components which are influenced by one's own experiences, cultural norms, and the environment, e.g., family and peers [12]. The expectancies (for success) and subjective task values of individuals are postulated as the most relevant psychological predictors of task choice, performance, and effort in the chosen tasks [7]. The EVT was extended to the situated expectancy–value theory (SEVT) [8]. Eccles and Wigfield [8] described this extension as a situated and cultural view on the EVT model, pointing to the relevance of the specific situation, i.e., environmental conditions and the cultural background, for the development of expectancy and value hierarchies.

The first central factor of the EVT, expectancy, incorporates different theoretical conceptions of self-belief such as (academic) self-concepts [13,14] and self-efficacy [15,16]. For both constructs. there is evidence that they adequately represent the expectancy factor (i.e., Eccles and Wigfield [17]). In the present study, we focused on self-efficacy. Bandura [15,18] defined general self-efficacy within the social cognitive learning theory as a person's assessment of the extent to which he or she expects to be able to master tasks and challenges or to achieve goals. Self-efficacy can be understood as a generalized construct, but can also refer to specific domains, e.g., academic self-efficacy.

Academic self-efficacy describes students' beliefs that they can control and reflect their study behaviors, understand and successfully process learning material, and meet academic requirements [19]. The *Social Cognitive Career Theory* (SCCT) [20] drew on this social cognitive framework to explain three closely related aspects of education and career development: (a) development of career-relevant interests, (b) selection of study and career choices, and (c) performance and persistence in education and occupation. According to the SCCT, the development of STEM interests before the study starts, the choice of a STEM subject, and the academic success in STEM are predicted by individuals' self-efficacy beliefs in their interplay with the environment [19,20].

Pertaining to the second factor of EVT, value beliefs, four value components are differentiated: attainment value (importance of success for self-image, identification with the subject and school in general), intrinsic value (interest and enjoyment of the task), utility value (utility for short- and long-term personal goals), and cost value (potential costs of investing time in this activity rather than another).

Both expectations and value beliefs guide individuals, their educational achievements, and related decisions both consciously and unconsciously [21–23]. Wigfield and Eccles [23] reported accumulated findings from more than 35 years of research which support these assumptions. Results from the secondary school context revealed that expectations and value beliefs, as well as their interaction, predicted (math) achievement [24,25]. Former studies corroborated that individuals are more likely to choose STEM studies if they show higher STEM-related self-efficacy and ability self-concepts [26] (for a general review, see [27]). Furthermore, positive value beliefs with regard to mathematics and science among adolescents at the beginning of high school were associated with STEM achievement, as well as STEM subject choices, not only in high school, but also 7 years later in college [28].

Yet, even if the decision to study a STEM subject has already been made, differences in STEM students' self-efficacy and value beliefs, e.g., due to their perceived minority status as a female or first-generation student, occur and should not be neglected, as they were shown to be relevant for study success [9,29,30]. For example, a study with a sample of first-year engineering undergraduates showed that higher levels of engineering self-efficacy and highly valuing engineering were related to higher engineering persistence [31].

To conclude, empirical findings corroborate the importance of expectations and value beliefs (as well as their interplay) in the prediction of academic choices and success in STEM fields and beyond. As a consequence, investigating both the level of and the interindividual differences in these constructs amongst international STEM students at the beginning of their studies is important to identify student groups who might be at risk of struggling in or dropping out of their degree programs.

1.2. Differences in Expectations and Value Beliefs by Gender and Parental Academic Background

Gender. One of the purposes of the EVT [7] is to explain gender differences in STEM-related academic attitudes and decisions such as subject choices.

Indeed, in the university context, female students remain to be underrepresented in many STEM subjects. In the US—despite differences between subjects (e.g., 19% female students in engineering-technology and computer science vs. 39% in physics)—the overall proportion of 35% female students in STEM corroborates the gender imbalance [2]. Similarly, in Germany, female students remain to be underrepresented in STEM subjects [32] with, for example, only 16% females in engineering and 21% in computer science [32,33]. We may, thus, assume that the female international STEM students in Germany represent a selective sample who chose to study STEM despite the unpopularity of these subjects amongst their same gender fellows. This may have implications with regard to gender differences in their study-related expectations and value beliefs. Yet, to the best of our knowledge, there is no systematic research on gender differences in expectations and value beliefs amongst international STEM students in Germany and beyond, although many studies addressed these issues in different stages of the educational career. For example, a meta-analysis of 187 studies by Huang [29] identified gender differences in academic self-efficacy that were moderated by subject area. Males showed higher levels of self-efficacy in mathematics, computer science, and science than females. Importantly, gender differences in academic self-efficacy also varied with age. The largest effect size occurred for respondents who were over 23 years old, which supports their importance in higher education.

A more recent meta-analysis (n = 176) revealed gender differences in all expectancy–value components but costs (mostly because there were not enough studies available) across different subject fields [9]. In particular, males showed higher levels of expectancy for success in math, science, computing, engineering, and physical sciences (small to medium effect sizes). In biological sciences, there were no gender differences in expectancy for success. With regard to the value components, the results showed higher levels of intrinsic value for males in math, science, computing, physical sciences, and engineering (medium effect sizes), whereas females reported higher intrinsic values with regard to biological sciences. Yet, for utility and attainment value, gender differences were less obvious; males only indicated higher levels of utility value in computing. Moreover, males showed higher overall task value in computing and math, whereas girls showed higher overall task value in physical sciences (all small effect sizes). All other gender differences were negligible. With regard to the cost component, the low number of studies and effect sizes limited the results. The only substantial effect sizes were observed for physical science, where females reported higher costs (medium effect size). Overall, gender differences were weaker for general science expectancy/value than they were in more precisely defined areas of STEM (e.g., physical or biological sciences). With regard to the interaction of gender and other demographic characteristics, only one significant interaction, for gender and age (categorized into elementary school, middle school, high school, and (young) adult samples) was observed, i.e., the gender gap in expectancy for success was larger for older samples in more advanced stages of the educational career [9].

To conclude, both meta-analyses [9,29] suggested that gender differences in STEM-related expectancies and values in the favor of males are prevalent in all educational stages. Surprisingly, the findings suggest that gender differences gain importance in more advanced stages of the educational career despite potential self-selection mechanisms with regard to university subject choices. These considerations led to our investigation of the relationship between gender and expectancy–value components at the beginning of international STEM students study time abroad.

Parental academic background. Previous research on the role of the parental academic background with regard to academic decisions and success suggested that students' generational status, i.e., being a first-generation or continuous-generation student, was decisive [34,35]. Being the first in the family who is studying at a higher education institution contains several barriers with regard to academic success, e.g., due to missing role models, knowledge about the campus life, or a lack of university belonging. Several studies substantiated advantages of being a continuous-generation student with regard to the academic success of students with and without an immigrant background in Germany [36–38].

Yet, few studies considered the association between parental academic background and study-related expectancies and values. Findings from the school context by Gaspard et al. [39] showed associations of parental academic background with ability self-concept and task value (attainment) in math; high school students with at least one parent who holds an academic degree reported a higher academic self-concept and higher task (attainment) values. Former research using a sample of secondary education students in Germany showed significant correlations between socioeconomic status (which included parental academic background) and all expectancy and value components. In particular, positive associations for expectancy, attainment, intrinsic, and utility value (r = .15 to .11) and a negative one for cost value ($r = -.09$) were identified [40]. Accordingly, Goldman et al. [41] revealed that first-generation college students indicated higher levels of cost value and that these more strongly increased during the semester as compared to continuous-generation students.

Overall, these few findings suggest that coming from a non-academic household may have negative consequences with regard to international students' (STEM) expectations and values. Yet, further empirical research to evaluate these tentative assumptions is needed.

1.3. Expectations and Value Beliefs and Cultural Characteristics

The (S)EVT and related research postulated that cultural norms, such as individualism and collectivism, influence expectations and value beliefs [8,12,21,42,43]. Accordingly, previous studies showed that gender differences in STEM attitudes and success varied between European countries [44,45]. The authors explained these differences with references to cultural norms. Furthermore, Donohue [46] showed that cultural norms predicted the intrinsic value of undergraduate university students in the United States. Mok et al. [47] reported associations between cultural norms and the utility value of study programs amongst a sample of international students in Germany. Hence, we deemed it was important to consider students' cultural background as an external predictor of the EVT factors and included students' countries of origin (summarized to country groups) into our analyses. Former studies also showed a strong relation between language skills and international students' study success and emphasized their importance for the academic (and social) integration (e.g., Wisniewski et al. [48]). Language skills may help students to feel more confident to succeed in the study program, thereby increasing their task enjoyment and motivation to persist. Likewise, as language skills may reduce (cultural) barriers and facilitate participation in campus life, psychological costs such as the experience of loneliness and stress may decrease. Therefore, a measure of self-perceived study-related language skills was included in the analyses to analyze potential effects of these skills on international students' expectancies and value beliefs. Previous experiences in the host country were shown to have an impact on cultural transition experiences [49,50]. In particular, previous experiences in Germany might influence expectations of students to be able to handle (academic) challenges and thereby increase their academic self-efficacy. Furthermore, knowing what to expect in Germany may reduce fear and stress during the acculturation process, thus increasing enjoyment and decreasing psychological costs. Hence, we additionally considered previous residence in Germany.

Beyond the general importance of cultural norms and differences, the EVT also emphasizes that individual differences in approaching a culture may influence the formation of expectancy and value beliefs [8,42]. In addition, acculturation theory suggests that, for international students, differences in their approaches to both their host- and their home-culture are essential. According to Berry [51], such differences are captured in individuals' acculturation attitudes, i.e., their attitudes toward and interest in the involvement with the home- and the host-culture. Importantly, home- and host-culture orientation are considered to reflect two independent constructs [51,52]. Home- and host-culture orientations correlated positively with sociocultural adaption in the school context and beyond (e.g., Berry [51]). This suggests its relevance with regard to the formation of education-related expectancies and values.

However, a recent meta-analysis by Bierwiaczonek and Kunst [53] indicated that the relationship between host- and home-culture acculturation and adaptation might be weaker and less consistent than assumed. The only relationship that was consistently maintained even in longitudinal designs was the positive association between host-culture orientation and sociocultural adaptation. Yet, the authors concluded that the heterogeneity and instability of effects might be due to the heterogeneity in samples, e.g., with regard to the duration of their stay abroad. For example, it could be that acculturation orientations are more relevant regarding the sociocultural adaptation in the early stages of migration (e.g., at the beginning of a study program abroad) and become less relevant at later stages. The authors, thus, called for further studies on the relationship between acculturation orientations and sociocultural outcomes which—in the present case—are captured by students' study-related expectancies and values [53]. In line with previous findings, we speculated that a higher host-culture orientation could probably serve as a kind of resource during the adaption process and reduce the perceived costs of studying abroad during the adaption of international students in Germany.

1.4. Intersectionality

Intersectionality is defined as the interaction of multiple characteristics on diverse dimensions, which could build the base for discrimination or the experience of disadvantages [54,55]. Hence, the effects of these dimensions are developed in interaction/intersection, not just added up [10,11]. Results of studies in the US revealed that the confluence of multiple minority status-generating characteristics (e.g., gender, ethnicity, and parental academic background) conditioned lower levels of academic achievement in the school and higher education sector [56,57]. Most current studies on the interaction of gender, educational background, and ethnic/cultural background characteristics were conducted in the US. Most studies based on European data primarily examine the school sector [44,45]. With regard to higher education in Germany, intersectionality has mainly been considered at a descriptive level [38].

This unequal distribution of intersectional research between the US and Europe was also noted by Parker et al. [9]. Their meta-analysis provides the most comprehensive research work to date that considered an intersectional perspective on students' expectancy and value beliefs in different academic domains. Parker et al. [9] pointed out that gender influences the expectancy–value components not only alone, but also in interaction with multiple characteristics. In particular, their analysis revealed interactions of gender and social class (operationalized by socioeconomic status) in the math domain for expectancy, intrinsic value, and (by trend) for utility value. In all cases, the gender effect sizes were highest in high-socioeconomic status samples. Similar patterns were found for science expectancy. Yet, in view of the limited data on these interactions, the results need to be interpreted with caution and require further research.

Beyond these meta-analytic findings, a study that considered samples from 65 universities in the US revealed that female first-generation students reported significantly lower levels of self-efficacy than female continuous-generation students and male students, regardless of their academic family background [58]. In contrast, Else-Quest et al. [59] reported that, although gender gaps in self-beliefs and value beliefs in science and math slightly varied among Latin, Asian American, and Caucasian 10th grade high school students in the US, these differences tended not to be statistically significant. Seo et al. [60] used a similar but nationally representative sample of US 10th graders and showed that male adolescents' math self-concept was more positive than females among Whites and Latinxs but not among Blacks and Asians.

Given the heterogeneity and small number of previous findings, the current research considered intersectional effects between gender and students' academic and cultural background from an intersectional perspective to allow for a more specific consideration of potential disadvantage and dropout risks of specific student groups.

2. Purposes of the Present Study

The (S)EVT and previous findings emphasize that expectancy and value beliefs are important determinants of academic success [21–23]. However, to the best of our knowledge, there are no studies that specifically addressed expectations and value beliefs of international STEM students. In order to close this research gap, we examined how gender, parental academic background, and cultural characteristics (i.e., cultural background, study-related language skills, previous residence in Germany, and acculturation orientations) are related to the academic self-efficacy and value beliefs of a large sample of international STEM students. Moreover, despite our focus on students in STEM subjects, the design allows us to compare the pattern of results between STEM and non-STEM subjects; we can, thus, infer if any findings are indeed specific to the situation of international students in STEM or reflect a more general pattern.

On the basis of previous findings, we formulated the hypotheses below.

2.1. Relations with Gender

H1a. *Female international STEM students show lower levels of academic self-efficacy than male international STEM students.*

H1b. *Female international STEM students show higher levels of cost value than male international STEM students, but lower levels of intrinsic, attainment and utility values.*

2.2. Relations with Parental Academic Background

H2a. *International STEM students who are first-generation students report lower levels of academic self-efficacy than international STEM students who are continuous-generation students.*

H2b. *International STEM students who are first-generation students report higher levels of costs than international STEM students who are continuous-generation students. We did not assume differences in intrinsic, attainment and utility values, but assessed these for explorative reasons.*

2.3. Interactions of Gender and Parental Academic Background

H3a. *Female international STEM students who are first-generation students report lower levels of academic self-efficacy than female international STEM students who are continuous-generation students and than male STEM students.*

H3b. *Female international STEM students who are first-generation students report higher levels of cost values than female international STEM students are continuous-generation students and than male international STEM students.*

No interaction effects between gender and parental academic background were expected for intrinsic, attainment, and utility values, yet we assessed these for explorative reasons. We further pursued some exploratory questions on the associations of cultural background and its interaction with gender, as well as acculturation orientations. In particular, we assessed if academic self-efficacy and value beliefs of international STEM students differed by country groups and if these associations were moderated by students' gender.

Additionally, we examined how study-related language skills, previous stays in Germany, host-culture orientation, and home-culture orientation were related to academic self-efficacy and value beliefs of international STEM students.

In order to address these questions, we used data on bachelor students from a large and diverse panel sample of international students in Germany that provided information from students of different cultural and parental academic backgrounds, studying all over Germany in an extensive range of subject groups and at different higher education institutions. Notably, this dataset provided us with the great advantage of a large control group of international non-STEM students.

3. Method

3.1. Sample

The data come from the first wave of the 3 year German panel study on international students (*International Student Survey* [61]), which was conducted in the interdisciplinary research project *Academic Success and Withdrawal Among International Students in Germany in Bachelor's and Master's Programs (SeSaBa)*. The online survey (presented in German and English language) addressed international students, i.e., students who held a foreign citizenship and obtained their university entrance qualification outside of Germany or at a preparatory college (German: *Studienkolleg*) [1]. Further inclusion criteria were that international students had to study in the first semester of a bachelor's or master's degree program in winter term 2017/2018 and intended to obtain their degree in Germany [61]. The participants registered for the study by answering a short questionnaire (t0) to confirm they content the inclusion criteria. They also received information on data protection standards provided their informed consent here and at the beginning of each questionnaire. The first wave took place at the end of the first semester between January and April 2018.

The analysis sample included data from 1590 international bachelor students (n_{STEM} = 882, $n_{\text{non-STEM}}$ = 708). They were studying at 123 universities (with the exception of music and art universities [61]) in all 16 federal states of Germany and in 34 subject groups. The participants came from 120 different countries. The largest group was from Syria (8.6%, n = 136), followed by China (6.5%, n = 104), Russia (5.6%, n = 89), Luxembourg (4.0%, n = 63), Bulgaria (3.8%, n = 60), and the United States and Ukraine (each 3.7%, n = 59). At t1, their mean age was 23.5 years (SD = 4.25); 48.3% (n = 768) were female and 457 (32.7%) were first-generation students. Further information on the demographic characteristics of the sample is shown in Table 1.

Table 1. Descriptive statistics of sample characteristics and control variables.

Variables	STEM		Non-STEM	
Mean age in years (*SD*)	22.95	(3.58)	24.18	(4.87)
Female (%)	283	(32.1%)	485	(68.5%)
Parental academic background (continuous-generation students) (%)	542	(67.2%)	445	(67.4%)
Country groups (%)				
Western Europe (Reference category)	95	(10.8%)	148	(20.9%)
Central and South Eastern Europe	117	(13.3%)	116	(16.4%)
Eastern Europe and Central Asia	74	(8.4%)	133	(18.8%)
North America	21	(2.4%)	43	(6.1%)
Latin America	67	(7.6%)	53	(7.5%)
North Africa and Middle East	269	(30.5%)	62	(8.8%)
Sub-Saharan Africa	45	(5.1%)	33	(4.7%)
Asia and Pacific	194	(22.0%)	120	(16.9%)
Previous residence in Germany (yes) (%)	253	(29.1%)	300	(43.0%)

Note. $N = 1590$, $n_{\text{STEM}} = 882$, $n_{\text{non-STEM}} = 708$ (in the descriptive statistics, listwise deletion was used).

3.2. Instruments and Scales

Academic self-efficacy. Academic self-efficacy was measured using a three-item short scale on general self-efficacy expectations (ASKU) [62] that participants were instructed to answer with regard to their studies. An example item is "In difficult situations, I can rely on my abilities.". The participants indicated their level of agreement on a five-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The scale revealed a high internal consistency [63] with $\alpha = .78$.

Study-related value beliefs. Intrinsic value was measured with two items from a scale by Westermann et al. [64] (German translation by Heise and Thies [65]). A sample item was "I find my studies really interesting." ($\rho = .73$). The study-related attainment value, utility value, and costs were measured with items based on Gaspard et al. [66]. There were two items each on attainment value (e.g., "My studies are very important to me personally."; the Spearman–Brown reliability coefficient was $\rho = .69$), utility value (e.g., "My studies will positively influence my future."; $\rho = .72$), and costs (e.g., "I have to make many personal sacrifices for my studies."; $\rho = .57$). Students indicated their level of agreement using a five-point Likert scale ranging from 1 = *strongly disagree* to 5 = *strongly agree*.

STEM versus non-STEM-subjects. The categorization of the study subject groups into STEM and non-STEM subjects was based on the specification of the Federal Statistical Office of Germany for the winter semester 2017/2018 [32] and the statistics of the Federal Employment Agency [33]. In this categorization, for example, human medicine and health science, agricultural science, forestry, nutritional science and veterinary medicine, business engineering specializing in economics, and social science were considered as non-STEM subjects, whereas, e.g., pharmacy, business engineering specializing in engineering sciences, architecture, interior design, and spatial planning were considered as STEM subjects, in addition to the more familiar STEM subjects [32,33].

Gender. Participants specified their gender using the categories 0 = *male*, 1 = *female*, and 2 = *diverse*. Because of the small number of students who chose the category "diverse" (< 0.1%) it was not possible to separately analyze this gender category. As a consequence, participants who indicated their gender as "diverse" ($n = 6$) were omitted from the sample.

Parental academic background. Students were categorized as first-generation students if they reported that *none* of their parents held a bachelor's, master's, or doctorate degree; otherwise, they were categorized as continuous-generation students (0 = *first-generation students*, 1 = *continuous-generation students*).

Cultural background. We operationalized the participants' cultural background by the country of students' university entrance qualification. These countries were categorized into eight regions according to the German Academic Exchange Service's (DAAD) regional coding system [4,67], i.e., Western Europe (which served as the reference category), Central and South Eastern Europe, Eastern Europe and Central Asia, North America, Latin America, North Africa and Middle East, Sub-Saharan Africa, and Asia-Pacific.

Study-related language skills. The participants indicated their study-related language skills by answering the self-formulated item "My language skills are sufficient to cope with my academic studies." on a five-point Likert scale (1 = *strongly disagree* to 5 = *strongly agree*).

Previous residence in Germany. Students responded to the question "Before your current stay in Germany, had you ever lived in Germany for at least 1 month?" with 0 = *no* or 1 = *yes* to provide information about a potential previous residence in Germany.

Acculturation orientations. Host-culture orientation (α = .81) and home-culture orientation (α = .81) were measured with four items each that were adapted from Demes and Geeraert [68]. The participants rated the statements on a five-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Sample items were "It is important to me to have friends from my country of origin." for the home-culture orientation and "It is important to me to get to know and maintain German customs and traditions." for the host-culture orientation.

Age. Participants age at the first measurement was calculated from their year of birth.

3.3. Analytical Strategy

All analyses were calculated with IBM SPSS Statistics version 28 [69] and Mplus Version 7 [70]. Missing data were handled with the full information maximum likelihood (FIML) method as implemented in Mplus although missing rates of all constructs were very low (< 1%). Preliminary analyses confirmed that all conditions for linear regression analyses were met. To assess potential dependencies in the data due to the clustering of participants in country groups, we first inspected intraclass correlations (ICC's). Yet, all ICCs were low (< .01) which suggests that the independence of observations can be assumed. Thus, multi-group regression analyses were performed to evaluate significant differences between STEM and non-STEM subjects. All continuous predictors were grand-mean-centered as part of the analyses. In a first step, the predictor variables were inserted, and a Wald-test was run to test the appropriateness of equality constraints between the subject groups. According to non-significant Wald-tests (at p > .05), the respective model paths were restricted to be equal. In the next step, the interaction terms (interactions between gender and parental academic background and between gender and the country groups) were inserted, and it was tested if these paths could be equated across subject groups. If the interaction terms did not yield statistical significance in both subject groups, they were removed from the model. In the last step, the intercepts were tested and set equal if the Wald-test was not significant. In all analyses, effects of age were controlled.

3.4. Power Analyses

A post-hoc power analyses using G*Power Version 3.1.9.7 [71,72] revealed that, with a significance level of α = .05 and N = 1590, even small (interaction) effects of (f^2 = .02) could be detected with a probability of $1 - \beta = .96$. Accordingly, a target power of at least .80 according to Cohen [73] was achieved.

4. Results

4.1. Descriptive Analyses

The international students showed high means of academic self-efficacy and all value components (see Table 2). Despite slightly different means, the overall pattern was the same in both subject groups. The highest values were observed for attainment value, intrinsic value, and utility value, which all clearly exceeded the scale mean of three. The means of academic self-efficacy and cost value were lower, but also exceeded the scale means. T-Tests revealed significant difference between STEM and non-STEM students in academic self-efficacy whilst all other differences were negligible (see Table 2). The bivariate correlations between the study variables in the STEM and non-STEM sample are presented in Table 3. Overall, the correlation pattern was similar in both subject groups and yielded small to moderate sizes associations.

Table 2. Descriptive statistics of main scale study variables.

Variables	STEM		Non-STEM		*t*-Tests		
	M	*SD*	*M*	*SD*	*t(df)*	*p*	*d*
Study-related language skills	3.98	0.92	4.03	0.96	0.96(1561)	.335	.05
Home-culture orientation	2.92	0.90	3.00	0.90	1.64(1518)	.102	.08
Host-culture orientation	3.51	0.84	3.54	0.78	0.68(1519)	.498	.04
Dependent variables							
Academic self-efficacy	3.71	0.71	3.81	0.69	2.72(1553)	.007	.14
Value beliefs							
Attainment value	4.49	0.68	4.48	0.60	−0.33(1559)	.745	−.02
Intrinsic value	3.99	0.82	4.06	0.80	1.78(1559)	.075	.09
Utility value	4.53	0.67	4.51	0.61	−0.53(1559)	.598	−.03
Cost value	3.45	0.89	3.39	0.91	−1.30(1559)	.193	−.07

Note. n_{STEM} = 882, $n_{\text{non-STEM}}$ = 708 (in the descriptive statistics, listwise deletion was used).

4.2. Multi-Group Analyses

All models explained substantial variance in academic self-efficacy (12% STEM; 15% non-STEM), attainment value (8% STEM; 11% non-STEM), intrinsic value (12% both subject groups), utility value (8% STEM; 12% non-STEM), and cost (7% STEM; 9% non-STEM). Overall, the multi-group analyses yielded very few differences between STEM- and non-STEM students (Table 4). That is, most of the reported results represent generalized patterns that apply to international students in STEM subjects and beyond. As a consequence, the below description of results is focused on the results for the STEM sample; findings from the comparison group of non-STEM students are only considered in cases of significant differences between the subject groups. In line with the results from the t-tests, differences in the adjusted intercepts were only identified for academic self-efficacy (adjusted M = 3.55, SE = 0.11, p < .001 for STEM students; M = 3.63, SE = 0.12, p < .001 for non-STEM; Wald χ^2 = 5.83, p = .016). All other Wald-tests on the adjusted intercepts—for attainment (M = 4.43, SE = 0.07), intrinsic (M = 4.13, SE = 0.06), utility (M = 4.48, SE = 0.07), and cost value (M = 3.12, SE = 0.07)—did not yield significance (all p-values > .136).

Contrary to our assumptions, we did not find associations between gender and any expectancy or value components (Table 4). That is, the hypotheses H1a and H1b had to be rejected.

Parental academic background showed a significant association with academic self-efficacy (b = .08, SE = .04, β = .12, p = .027) which implies that, in line with hypothesis 2a, continuous-generation STEM students showed higher levels of academic self-efficacy than first-generation STEM students.

Parental academic background showed no statistical significance in relation with cost value. Hence, hypothesis 2b was not supported.

Contrary to our assumptions, no significant interaction of parental academic background and gender in relation with academic self-efficacy (H3a) and cost values (H3b) could be identified which implies the rejection of both hypotheses.

Table 3. Correlations between the study variables.

Correlations	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1. Academic self-efficacy	-	.15 **	.30 **	.20 **	−.10 **	.39 **	.00	.01	.07	.03	.05	.15 **	−.02	−.06	−.04	−.17 **	.01	.02	.04
Value beliefs																			
2. Attainment value	.21 **	-	.36 **	.49 **	.10 **	.11 **	.07	−.01	−.09 *	.04	.00	−.17 **	.08 *	.05	.11 **	−.02	.04	−.02	.19 **
3. Intrinsic value	.34 **	.40 **	-	.30 **	−.22 **	.31 **	−.01	.06	−.05	−.01	.01	−.01	.03	.04	.04	−.17 **	.01	−.07	.10 *
4. Utility value	.21 **	.62 **	.38 **	-	.08 *	.16 **	.07	.01	−.00	.09 *	.10 **	−.13 **	.12 **	.07	.02	−.15 **	.10 *	−.04	.18 **
5. Cost value	−.07 *	.21 **	−.11 **	.17 **	-	−.22 **	−.01	.14 **	−.02	.03	−.00	.12 **	.03	.08 *	.02	.06	.03	.07	.13 **
6. Study-related language skills	.27 **	.11 **	.27 **	.13 **	−.15 **	-	−.05	−.11 **	.01	.08 *	.02	−.00	−.03	−.11 **	.06	−.41 **	.04	.01	−.02
7. Previous residence Germany	.00	−.06	−.05	−.03	.02	−.04	-	.12 **	−.01	.02	.21 **	−.07	.16 **	−.14 **	−.03	−.06	.12 **	−.13 **	.02
8. Age	−.04	.01	.01	−.05	.06	−.07	.08 *	-	−.12 **	−.15 **	.08 *	.15 **	.06	.14 **	.09 *	.02	−.03	−.07	.03
9. Parental academic background	.07 *	.02	.07	−.00	.03	.02	.08 *	−.24 **	-	−.05	.12 **	.14 **	.11 **	−.05	.01	−.06	−.08	.04	.02
Country groups																			
10. Central and South Eastern Europe	.05	−.06	.04	.04	.00	.09 **	.08 *	−.22 **	.01	-	−.21 **	−.11 **	−.13 **	−.14 **	−.01 **	−.20 **	.05	−.06	−.01
11. Eastern Europe and Central Asia	.04	.00	.04	.09 *	−.04	.07 *	.22 **	.03	.11 **	−.12 **	-	−.12 **	−.14 **	−.15 **	−.11 **	−.22 **	.16 **	−.08 *	.02
12. North America	.04	−.09 *	−.04	−.11 *	.04	.02	.02	.13 **	.06	−.06	−.05	-	−.07	−.08 *	−.06	−.12 **	−.02	.13 **	.08 *
13. Latin America	.07	.03	.05	.07 *	.10 **	.04	.13 **	.01	.11 **	−.11 **	−.09 **	−.05	-	−.09 *	−.06	−.13 **	−.03	−.02	.12 *
14. North Africa and Middle East	−.04	.12 **	−.10 **	.03	.07	−.10 **	−.15 **	.21 **	−.07 *	−.26 **	−.20 **	−.10 **	−.19 **	-	−.07	−.14 **	−.25 **	−.07	−.03
15. Sub-Sahara Africa	−.03	.13 **	.08 *	.12 **	.00	.04	−.12 **	.07	−.08 *	−.09 **	−.07 *	−.04	−.07 *	−.15 **	-	−.10 **	−.02	−.03	−.00
16. Asia and Pacific	−.07	−.09 *	−.09 **	−.18 **	−.05	−.26 **	−.02	−.01	−.01	−.21 **	−.16 **	−.08 *	−.15 **	−.35 **	−.12 **	-	−.00	.06	.03
17. Gender	−.04	−.03	−.00	.07 *	.00	.02	.07 *	−.03	.07 *	.08 *	.17 **	.00	.05	−.21 **	−.02	.04	-	−.01	−.01
18. Home-culture orientation	−.05	−.04	−.06	−.05	−.00	−.03	−.11 **	−.20 **	.07	−.04	−.11 **	.04	−.03	−.06	−.00	.12 **	−.02	-	.16 **
19. Host-culture orientation	.03	.12 **	.14 **	.09 *	.01	−.02	.01	.05	−.03	−.10 **	.03	.06	.05	.03	−.04	.04	.03	.08 *	-

Note. Correlations for the non-STEM group are above the diagonal. Correlations for the STEM group are below the diagonal. For categorial variables, Spearman's rho is presented. n_{STEM} = 882, $n_{\text{non-STEM}}$ = 708. Listwise deletion was used. Country groups: Reference category, Western Europe. ** Correlation is significant at the level of $p < .01$. * Correlation is significant at the level of $p < .05$.

Table 4. Results of the multi-group models for STEM students.

Predictors	**Academic Self-Efficacy**			**Attainment Value**			**Intrinsic Value**			**Utility Values**			**Cost Value**		
Final Model	***b***	***SE***	***p***	***b***	***SE***	***p***	***b***	***SE***	***p***	***b***	***SE***	***p***	***b***	***SE***	***p***
Age	.00	.00	.468	−.00	.00	.830	.01	.01	.013	−.00	.00	.566	.01	.01	.017
Previous residence in Germany	−.02	.04	.634	.02	.04	.501	−.05	.05	.271	−.03	.04	.480	−.00	.05	.971
Study-related language skills	.27	.02	< .001	.09	.02	< .001	.23	.02	< .001	.08	.02	< .001	−.17	.03	< .001
Country groups[a]															
Central and South Eastern Europe	.14	.06	.027	−.13	.09	.160	−.11	.07	.147	.08	.09	.348	.35	.08	< .001
Eastern Europe and Central Asia	.10	.07	.122	.06	.11	.557	−.10	.08	.222	.17	.11	.110	.24	.09	.007
North America	.30	.10	.002	−.63	.13	< .001	−.25	.11	.027	−.61	.13	< .001	.56	.13	< .001
Latin America	.12	.08	.137	.05	.10	.606	−.05	.09	.561	.15	.10	.143	.50	.10	< .001
North Africa and Middle East	.06	.06	.335	.17	.08	.024	−.21	.07	.004	.11	.07	.135	.39	.08	< .001
Sub-Saharan Africa	−.03	.09	.759	.41	.12	< .001	.05	.11	.666	.21	.12	.063	.33	.12	.006
Asia and Pacific	.12	.06	.073	.11	.08	.194	−.15	.07	.047	−.09	.08	.292	.17	.09	.045
Gender	−.05	.04	.160	−.04	.09	.625	−.01	.04	.829	−.06	.09	.529	.05	.05	.303
Parental academic background	.08	.04	.027	−.04	.05	.459	.06	.04	.180	−.04	.05	.434	.00	.05	.998
Home-culture orientation	−.02	.02	.439	−.02	.02	.393	−.07	.02	.002	−.02	.02	.333	.05	.03	.055
Host-culture orientation	.03	.02	.151	.12	.02	< .001	.14	.03	< .001	.10	.02	< .001	.04	.03	.169
Gender × parental academic background				−.01	.07	.873				.03	.07	.618			
Central and South Eastern Europe × gender				.34	.12	.003				.19	.12	.096			
Eastern Europe and Central Asia × gender				.09	.13	.475				.11	.13	.400			
North America × gender				.47	.17	.006				.60	.17	< .001			
Latin America × gender				.26	.14	.066				.25	.14	.072			
North Africa and Middle East × gender				−.00	.12	.987				.11	.12	.347			
Sub-Saharan Africa × gender				−.14	.17	.397				.05	.17	.746			
Asia-Pacific × gender				.00	.11	.999				.12	.11	.263			

Note. n_{STEM} = 803. [a] Country groups used Western Europe as the reference category. The final model of each dependent variable is presented here.

With regard to cultural background, some country groups yielded statistically significant associations with academic self-efficacy: students from Central and South Eastern Europe (b = .14, SE = .06, β = .37, p = .027) and North America (b = .30, SE = .10, β = .41, p = .002) showed higher levels of study-related self-efficacy as compared to the reference group Western Europe. Beyond this, students' cultural background played a role with regard to all investigated value outcomes, with most associations being substantiated between cultural background and cost value, as presented in Table 4. In particular, students from all other country groups indicated higher cost value than their fellows from Western Europe (β's ranged from .19 to .63). Furthermore, students from North America (b = −.25, SE = .11, β = −.31, p = .027), from North Africa and Middle East (b = −.21, SE = .07, β = −.26, p = .004), and from Asia-Pacific (b = −.15, SE = .07, β = −.18, p = .047) showed lower levels of intrinsic value in comparison to the students from Western Europe.

No significant interactions of country groups and gender in relation with academic self-efficacy could be observed. Yet, some instances of interactions between country groups and gender were detected for attainment and utility value (Figures 1 and 2, Table 4), pointing toward differences between male and female students that only occurred amongst students from these country groups. In particular, female students from Central and South Eastern Europe (b = .34, SE = .12, β = .58, p = .003) and North America (b = .47, SE = .17, β = .80, p = .006) reported higher attainment values than their male fellows. The same applied to female students from North America with regard to their perceptions of utility values (b = .60, SE = .17, β = .92, p < .001). Regarding cost and intrinsic value, no intersections of country groups and gender showed statistical significance (all p-values > .060).

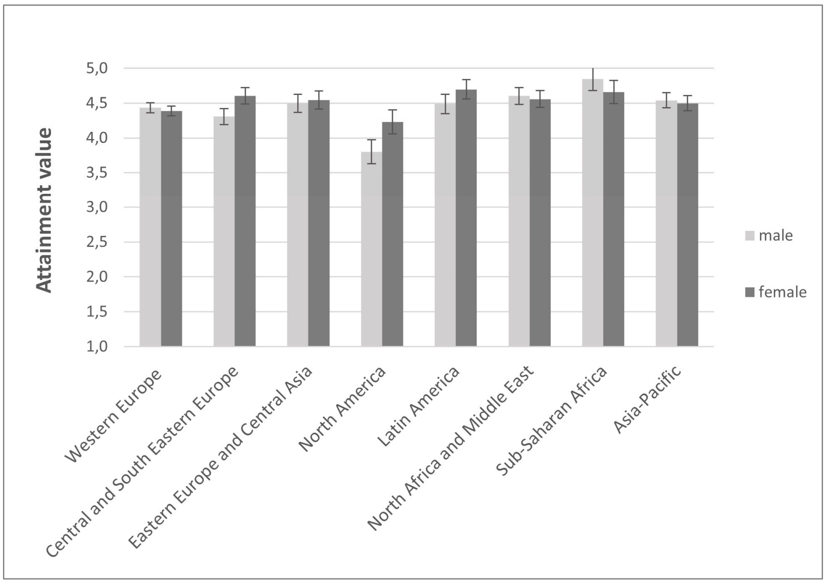

Figure 1. The interaction of country groups and gender in the prediction of attainment value. n_{STEM} = 803. Error bars represent the standard errors. Reference category: Western Europe.

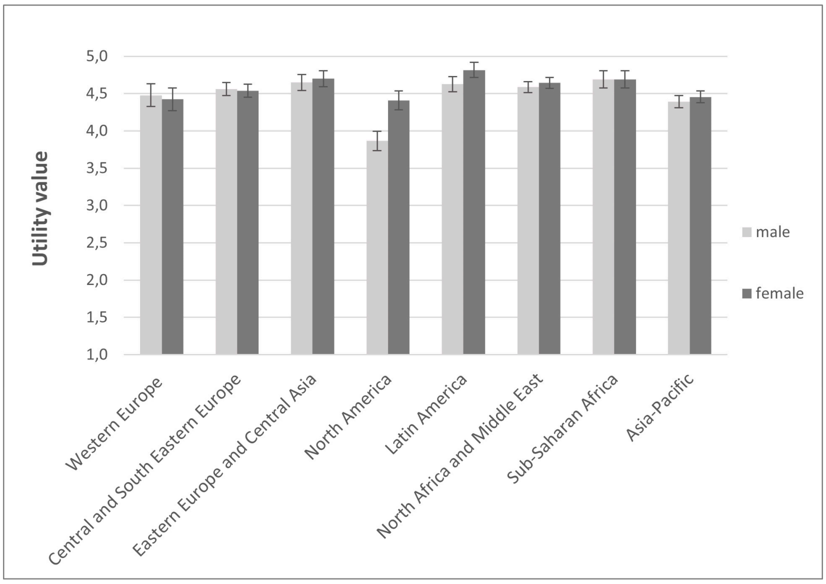

Figure 2. The interaction of country groups and gender in the prediction of utility value. n_{STEM} = 803. Error bars represent the standard errors. Reference category: Western Europe.

Study-related language skills showed a positive significant relation with academic self-efficacy (b = .27, SE = .02, β = .34, p < .001), attainment value (b = .09, SE = .02, β = .12, p < .001), intrinsic value (b = .23, SE = .02, β = .26, p < .001), and utility value (b = .08, SE = .02, β = .11, p < .001), whereas a negative association with cost value (b = −.17, SE = .03, β = −.17, p < .001) could be identified. By contrast, previous residence in Germany showed no significant association with the dependent variables (all p-values > .270).

Moreover, acculturation orientations showed no significant relation with academic self-efficacy. However, acculturation orientations were positively related with attainment value (b = .12, SE = .02, β = .15, p < .001), intrinsic value (b = .14, SE = .03, β = .15, p < .001), and utility value (b = .10, SE = .02, β = .13, p < .001), i.e., a higher host-culture orientation was associated with higher levels in the three value components, whereas a higher home-culture orientation was only related to lower levels of intrinsic value (b = −.07, SE = .02, β = −0.08, p = .002).

With regard to age, a small positive relation with intrinsic value (b = .01, SE = .01, β = .06, p = .013), as well as cost (b = .01, SE = .01, β = .05, p = .017), showed statistical significance.

5. Discussion

Despite increasing numbers of international students in OECD countries such as Germany [3,67,74], little is known about their (psychological) prerequisites for study success. Given the relevance of expectations and value beliefs for a successful completion of the academic track [21–23], we explored their manifestation amongst international STEM students in Germany and investigated if former findings on differences in these variables by gender, parental academic background, and cultural background that were identified amongst school students or in US student samples were transferable to our sample. Beyond this, we also investigated associations with study-related language skills, previous residence in Germany, and the international students' acculturation orientations. To support our findings, we compared the associations between STEM and a non-STEM comparison group as a kind of robustness check and to explore potential differences between subject groups.

In general, the international students showed high levels of expectations and value beliefs. Yet, only the means of academic self-efficacy differed significantly between the subject groups, i.e., international STEM students showed significantly lower levels of academic self-efficacy than international non-STEM students. All other results (regression paths in the multi-group model, unadjusted and adjusted means) did not significantly differ between the subject groups. Against our expectations, there were no direct associations between gender and the expectancy–value components. Yet, the parental academic background was related to academic self-efficacy as continuous-generation students showed higher academic self-efficacy than first-generation students. By contrast, the relation between parental academic background and cost value was not significant, and there were no interactions between gender and parental academic background.

Furthermore, significant associations between cultural background and all expectancy–value components were identified, most of them referring to cost. In some cases, the associations differed by gender. Study-related language skills were positively related to academic self-efficacy and attainment, intrinsic, and utility value but negatively to costs. By contrast, no significant associations between previous residence in Germany and the outcome variables were substantiated. With regard to the acculturation orientations, host-culture orientation was positively related with attainment value, intrinsic value, and utility value, whereas home-culture orientation was negatively associated with intrinsic value. Below, we discuss the outlined results in more detail.

5.1. High Levels of Expectations and Value Beliefs Amongst International STEM Students

With regard to the manifestation of expectancies and values amongst international students, the analyses revealed high levels of all expectancy and value components. That is, at the beginning of their studies, international students in Germany seemed to be quite optimistic about their potential to meet the requirements of their degree courses and value their studies for several reasons, such as intrinsic joy, personal importance, and utility for their future. Yet, despite the rather high levels of academic self-efficacy being rather high, comparisons between the subject groups revealed that international STEM students scored lower than their fellows in non-STEM subjects. This applied to both the unadjusted means (that were compared via t-tests) and the intercepts in the final multi-group regression model that included all main predictors and, thus, controlled for potential differences between the subject groups in these variables. These results were in line with the findings by Lee et al. [75] who reported similar differences between the subject groups. This might be reasoned in the high reputation of STEM subjects as being particularly demanding and prestigious, which might decrease students' expectations to be able to master the upcoming academic challenges [76,77]. Furthermore, the international students also reported high levels of costs, i.e., they feel that their studies in Germany require great personal sacrifices and cause many worries. Interestingly, in opposition to the common finding that higher intrinsic, attainment, and utility values are accompanied by reduced costs [78], attainment and utility values were positively correlated with costs in the present sample. That is, international students who indicated that their studies are very important and useful to them also experienced substantial strain. This pattern might be specific to international students who have to master additional challenges beyond the academic context such as the cultural transition. It might also reflect an incident of introjected regulation, i.e., motivation from partially internalized values such as seeking approval and protecting the ego [79]. In the present case, the students' high levels of attainment and utility values might be influenced by the values and expectations of significant others. As a consequence, the students do not benefit from these elevating motivations but still suffer from increased costs. In the future, person-centered analyses that investigate if there are distinct motivational profiles amongst international (STEM) students and how these are linked to values and expectations of significant others might help to better understand the observed pattern. Furthermore, future research may also investigate the development of the expectancy and value components over the study course and how they interact in the prediction of study outcomes. Maybe the high costs decrease the positive effects of the other value components. This may provide further insights into the question why so many international students are dropping out of their degree courses [6] despite their rather high levels of self-efficacy, as well as intrinsic, attainment, and utility values at the beginning of their studies.

5.2. Differences in Expectations and Value Beliefs by Gender and Parental Academic Background

Against our expectations, no direct associations between gender and any expectancy or value components could be found. This points to an important difference between previous findings from school and general student samples where females revealed less favorable STEM expectations and value beliefs than males [9,29]. This pattern might be reasoned in the sample selectivity of international degree-seeking STEM students in Germany. International students have already accomplished several challenges before starting their studies abroad (e.g., getting visa and study permissions, dealing with expectations and potential stereotypes of family, teachers and peers [80], and obtaining all relevant (language) qualifications). They decided for a STEM degree abroad despite potential (gender) stereotypes and possible cultural barriers [22,25,28,80,81]. Hence, this sample can be assumed to be highly selective (which is corroborated by the high levels of expectancies and value beliefs). In this highly selective sample, gender might not play the same role as in general student samples. Yet, further longitudinal studies are needed to investigate if gender differences may unfold during later stages of the study programs.

Consistent with our hypothesis, continuous-generation students indicated higher levels of academic self-efficacy; that is, they were more optimistic to fulfil all necessary study requirements than their first-generation fellows. This is in line with the results of Wille et al. [25], who identified a significant positive correlation between socioeconomic status and math expectancy in a school sample. One explanation could be that parents with an academic background may be able to provide more (financial) support and helpful role models to their children. On the one hand, this may let them feel that their parents trust in their persistence and that they fit into their study environment. On the other hand, the parents' potential to provide financial support may reduce their fear of having to drop out of their studies due to a lack of financial means. Contrary to our hypotheses, no significant relations between parental academic background costs could be identified. Hence, our results did not support the findings of Goldman et al. [41], Meyer et al. [40], and Wille et al. [25] who showed that first-generation college students indicated higher levels of costs as compared to continuous-generation students, and that this effect even increased across the semester [41].

Lastly, and also contrary to our hypotheses, no interactions of parental academic background and gender in the prediction of academic self-efficacy and cost values yielded significance. That is, earlier findings which showed that female first-generation students are particularly disadvantaged in terms of lower self-efficacy [58] and increased cost value [9,82] could not be substantiated for international STEM students. Although the present findings may be interpreted as good news as (female) first-generation international STEM students do not seem to be more challenged by their studies than their fellows from academic households, further research may investigate the persistence of this pattern over the study course.

5.3. Differences in Expectations and Value Beliefs by Cultural Characteristics

The results of this study also indicate that students' cultural background played a role with regard to all investigated outcomes, with most effects being identified for costs. Beyond the rather high mean levels, substantial differences between the country groups were substantiated as students from all country groups indicated higher cost values than their fellows from the reference category Western Europe. One explanation could be that coping with cultural distance is a relevant factor. Students from more culturally distant countries may experience greater challenges [83,84] which makes them experience higher study costs. Yet, the relations between costs and further factors of adaptation abroad poses an important question that could be addressed in future explorational research. In particular, with regard to the (psychosocial) counselling of international students, it might be helpful to further explore if international students who perceive higher costs are more likely to suffer from burnout or reduced psychological wellbeing.

Some further associations between single country groups and expectancy and value components were observed, as well as some interactions between country groups and gender. The latter corroborate the findings of previous studies which suggested heterogeneous associations between gender and expectancy–value components in different ethnic groups in the US [59,85–87]. Overall, our results on cultural differences and their interplay with gender in the prediction of expectancy–value components enhance the knowledge on these contingencies amongst international students in Germany. Yet, in order to validate these findings and to explore the mechanisms that account for the observed effects, further research that more closely considers (cultural) differences between and within these country groups is deemed essential.

A previous residence in Germany showed no significant association with expectations and value beliefs. This might be reasoned in the rather unspecific measure that did not distinguish between different types of previous residence (e.g., holidays, school exchange, and family stay abroad) and the duration of these stays. Further research may thus benefit from considering such information. Contrary, study-related language skills were positively related with academic self-efficacy, attainment values, intrinsic value, and utility value, but negatively with cost value. This corroborates the importance of language skills with regard to academic success and its (psychological) prerequisites [48,88]. Further research might differentiate between skills in study program language (as assessed in our study) and host country language (which are not necessarily the same as, for example, students may be enrolled degree courses that are taught in English at German universities) and consider more extensive and objective measures of language competencies such as test scores.

Lastly, the analyses showed that acculturation orientations were not significantly related with academic self-efficacy, but were associated with attainment, intrinsic, and utility values; that is, a higher host-culture orientation was associated with higher levels in all three value components whereas a higher home-culture orientation was related to lower levels of the intrinsic component. These results partly support evidence from Berry [51] who pointed to the positive associations of host-culture orientations with adjustment and productive adaption in the school context and beyond. They are also in line with findings from a meta-analysis by Bierwiaczonek and Kunst [53], which suggested that the host-culture orientation was particularly relevant in the early stages of migration. Yet, whilst a higher host-culture orientation was approved as a valuable resource for international students, the results on the home-culture orientation showed a contrary pattern as a higher home-culture orientation was related to lower intrinsic value. That is, students who are very engaged with their home-culture seem to be less prone to enjoy their studies abroad.

5.4. Implications for Practice

Of course, it is important to mention that all reported results reflect small effect sizes. Yet, even small effect sizes matter, because these small effects may influence the whole academic career and, thus, gain practical relevance. Against this background, some practical implications that may be inferred from the present results are considered.

In line with former research, international first-generation students showed lower levels of self-efficacy than continuous-generation students in both subject groups. That implies that interventions promoting academic self-efficacy should particularly consider the encouragement of international first-generation students, e.g., by directly addressing them with teaser-texts such as "You are the first in the family who studies (abroad)? Meet others and find information regarding. . .".

One further important finding with regard to practical implications was the overall high levels of perceived costs amongst the international students that were increased for students from countries outside of Western Europe. These findings suggest that it will be most helpful to integrate interventions that address the reduction in psychological costs into the counselling programs for international students. Even though some promising examples of interventions that directly address psychological costs were described in previous studies [89,90], future research is needed to further elaborate and evaluate these interventions and to adapt them to the specific needs of international (STEM) students. In the meantime, interventions that address related topics and conditions of psychological costs may be usefully employed. On the one hand, interventions may address general study management skills such as time management (e.g., Middendorff [91]). On the other hand, our findings suggest that it might be beneficial to complement cost interventions for international students with elements of intercultural trainings as information on cultural differences and hands-on practices on how to handle these effectively as this may also contribute to the reduction of perceived costs. This suggestion is corroborated by findings from Poort et al. [81] who showed that the engagement in intercultural group work reduced perceived costs. With regard to higher education policy, establishing part-time study programs and blended learning models may also help to decrease perceived study burdens and, thus, psychological costs (e.g., Middendorff [91]). To conclude, addressing psychological costs is deemed particularly important as recent studies suggested that cost value moderate the effect of the other (S)EVT components on academic outcomes [78]. This also suggests that interventions which increase academic self-efficacy or attainment, intrinsic, and utility values may pay off in terms of reduced psychological costs. For example, previous studies suggested that the use of cooperative learning strategies, setting specific, short-term goals and encouraging goal reflection would be helpful to support students' academic self-efficacy [15,92], which in turn may also reduce the psychological costs.

Lastly, our findings on acculturation orientations suggest that it will be advantageous for the adaptation process to support international students' host-culture orientation. For example, promoting contact to the campus community may help in this regard [93]. Likewise, a deliberate approach toward the own home-culture orientation may help students to maintain their study motivation and enjoyment.

All implications need to consider the relations of study-related language skills and the expectancy–value components regardless of subject group. The more the students feel they can master study-related communication, the higher their study-related expectancy and the more adaptive their value beliefs will be. Wisniewski et al. [48,88] described language skills (particularly reading skills) to be highly predictive of academic success in the study entry phase of international students. Our findings support Wisniewski's [48,88] results and suggest that one mechanism by which language skills affect the academic success might be via international students' more adaptive study-related expectations and value constellations.

Importantly, as there were almost no differences between the subject groups, all of the suggested interventions may be equally beneficial for all international students in STEM and non-STEM subjects. Furthermore, in contrast to previous studies, almost no direct relations for gender and parental academic background with the value components were detected; that is, in this highly selected sample of international university students, it is probably not necessary to make targeted offers for female or for first-generation students.

5.5. General Limitations

First, it is important to consider that we investigated a specific sample, i.e., international students in Germany. The (international) student body in other countries might differ from this sample, e.g., with regard to their demographic and cultural characteristics. Likewise, the study conditions and environment will be different and, thus, present students with other chances and challenges that might influence their study-related expectations and value beliefs. Hence, caution is warranted with regard to the transferability of the present results to other samples. Likewise, our sample was limited to bachelor students. As master's students may have different and more heterogeneous (study) experiences in their subjects and beyond, their expectancies and value beliefs may be different and require further research.

Moreover, the distribution of country groups showed a small number of cases in some of the investigated country groups. This might be a reason why some effects may not have been identified for these groups or may have been inflated by few extreme cases. Furthermore, differences between the countries within the country groups were not investigated. As a consequence, it is questionable to what extent the results can be applied to each and every single country, particularly due to the small number of cases in some countries.

We examined the associations of gender, parental academic background, and cultural characteristics with the expectancy–value components in a cross-sectional design to explore contingencies between these variables at the beginning of the study time abroad. This was deemed important to get an understanding of which student groups might have increased risks of facing challenges in their studies or dropping out of university due to their maladaptive expectancy–value constellations. Further longitudinal analyses are needed to explore the differential trajectories of the expectancy–value components amongst STEM students over the study course and the longitudinal relations between study-related expectancy and value beliefs and academic success of international STEM students. Additionally, the interplay of acculturation orientations and study-related expectancy and value beliefs needs to be focused on future research, to more precisely understand their longitudinal interdependencies and the role of the duration of the stay abroad [53]. Furthermore, due to the non-experimental cross-sectional design of the present study, no causal interpretation of the results is possible.

Additionally, there were some limitations with regard to the used measurement instruments. First, only self-report measures were used which might imply some bias due to socially desirable responding [94,95]. Second, some of the subscales (particularly in value beliefs) were measured with only two items which may have restricted their content validity. Although this is a common approach in large panel studies, further research may benefit from enclosing more detailed measures of the investigated constructs.

6. Conclusions

Despite these limitations, the present study provided important insights with regard to the manifestation of and differences in study-related expectations and value beliefs as (psychological) prerequisites for study success amongst international STEM students (and non-STEM students) in Germany.

Importantly, without an intersectional perspective, some of the contingencies between demographic characteristics and the expectancy–value components would not have been detected. Hence, the intersectional perspective can be helpful in differentiating effects of belonging to multiple potentially disadvantaged groups [54,96]. We hope that the present results may encourage further research on the heterogeneity amongst internationals students in Germany and its implications with regard to their specific strengths and potential support needs.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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Study 3

Preuß, J. S., Zimmermann, J., & Jonkmann, K. (2025). The development of expectations and value beliefs among international students in Germany over the study course: Effects of sociodemographic characteristics, subject groups and their intersectional interplay. *Manuscript submitted for publication*.

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Study 4

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