CHEMPRENEURS: EFFECTS ON THE FOUNDATION REALISATION OF STUDENTS IN GERMANY

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ABSTRACT

Universities with chemistry faculties are expected to produce chempreneurs. Chempreneurs, in turn, are expected to change the chemical industry and transform it towards sustainability. Chemistry students are 54 % less likely to start a business than the average German student. Which is why we conducted a comparative study among chemistry students of all grades in Germany to determine the effect of factors on start-up behaviour. Previous evaluations through comparative analyses of the student samples show significant differences in all areas such as subjective norm, foundation knowledge, perceptions, intentions and motives, and barriers related to the students' culture. By including student samples with significant differences in age gender, origin, migration background, nationality and hypotheses about the influence of these factors on the intentions, perceptions, motives and barriers of both groups were developed and tested. A random sample of chemistry students from Germany was included. We found a number of significant effects in relation to their start-up behaviour and the influencing factors. We discuss the results and suggest new approaches for the education of chemistry students and for future research approaches.

Keywords: Chempreneurs, Entrepreneurs, Chemistry Students, Germany, Barriers

INTRODUCTION

The potential applications for products and concepts from chemistry are present and necessary in the context of global challenges such as human health, crop production, energy conversion and storage, safe and abundant water, climate change and others. The chemical industry accounts for 6.7 % of the gross domestic product in Germany and ranks third in the world behind the USA and China (Bundesministerium für Wirtschaft und Klimaschutz , 2023; Statista, 2023; Rudnicka, 2023). The challenges in the context of the desired climate neutrality and circular economy represent a challenge for the chemical industry. For the chemical industry to continue, the gap between science and entrepreneurship must be bridged, for example through technology transfer (Sachse & Martinez, 2016). Technology transfer can take the form of patenting, licensing or start-ups. As an opportunity for technology transfer, entrepreneurship has attracted the attention of many different disciplines (Kirzner, 1985). With globalisation and its impact on cultural diversity, entrepreneurship has become an important research area in its own right. Due to the belief of many authors that entrepreneurship is learnable, many studies have been conducted on entrepreneurial intentions among university students, with diverse majors

such as business administration, at the beginning of their careers, e.g. (Abigail, Jeslin, Vijayarangan, & Rakhi, 2022; Ajzen I. , 1991; Franke & Lüthje, 2004). Due to the specificity of STEM students in terms of their learning patterns, behaviours and self-efficacy, it is not advisable to generalise from other courses of study or cultures (Rittmayer & Beier, 2009). This study focuses on identifying the action gap between the idea and a business start-up among chemistry students in Germany.

LITERATURE REVIEW

The best-known models for investigating entrepreneurial readiness and its influencing factors include the entrepreneurial event model (EEM) (Shapero, 1985) and the theory of planned behaviour (TPB) (Ajzen I. , 1985). The explanatory power of the models and applied elements may differ across countries and disciplines (Engle, et al., 2008). Moreover, understanding cultural diversity has become increasingly important due to globalisation, which has led to cross-cultural comparative studies on entrepreneurial intentions, such as (Giacomin, et al., 2011), (Pruett, Shinnar, Toney, Llopis, & Fox, 2009) or (Sesen & Pruett, 2014). The TPB is the more frequently cited model that is favoured (Walther, Dobrucka, & Haubold, 2023). The TPB model includes intention to start up as a dependent variable and the mediators attitude, subjective norm and perceived behavioural control as factors (Ajzen 1991, p. 182). For this study, the model was extended to include the factors start-up knowledge, perceived educational support, perceived support from the university/research institution and perceived career opportunity. The adapted model can be found in Figure 1.
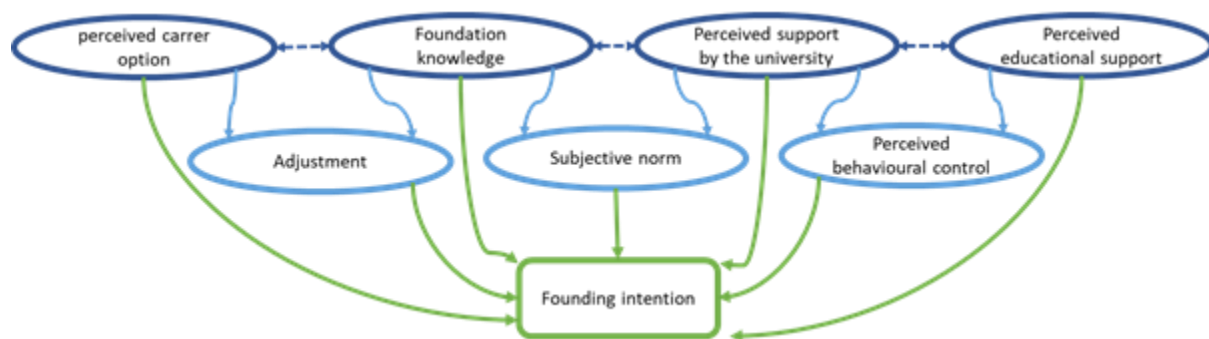

Figure 1
ADAPTED RESEARCH MODEL ACCORDING TO THE THEORY OF PLANNED BEHAVIOUR

Economic situation and Entrepreneurial Intentions

The differences in entrepreneurial intentions between countries can also be explained by the level of economic development or the economic climate. These differences, analogous to country differences, have implications for the amount and type of entrepreneurial activity (Iakovleva et. al. 2011). An annual survey such as that of the Global Entrepreneurship Monitor (GEM) has conducted an annual survey of entrepreneurial activity in more than 59 countries since 1997. These reports thereby show the development of entrepreneurial activity in a representative cross-section of a population group for the respective year (Bosma et. al., 2011). This allows us to understand the impact of different effects.

The evaluation of entrepreneurship studies can vary depending on the research question and objective. As a result, studies exist with different focuses. Some studies include the topic of cultural differences in terms of entrepreneurial motivation, which can be defined by comparing countries of origin, nationalities and places of residence. The readiness to start a business can be assessed by surveying individual population groups, as in the case of comparative studies, or by combining cross-sectional studies from different country reports into an overall survey, as in the case of the Global Entrepreneurship Monitor. In its 2023 report, the latter compared 49 countries on the basis of various key figures such as total early-stage entrepreneurial activity (TEA), which is defined as the percentage of a population aged between 18-64 years who run or want to start a new business. United Arab Emirates was identified as the country with the highest TEA rate (25.5 %) and simultaneous income of > \$40,000 GDP/cap in 2023. Germany's TEA rate is 9.1 %, which puts it in 30th place among the participating countries (GEM (Global Entrepreneurship Monitor), 2023).

Another focus of comparative studies is on the different start-up behaviour and its reasons between the genders or among female entrepreneurs. Depending on the methodology used, both the willingness to start a business and the reasons for the differences were examined. This made it possible, for example, to analyse significantly higher start-up intentions among Greek IT students than among male participants in the study. As influencing factors for the general intention to start a business, a negative influence by entrepreneurial barriers, such as knowledge and skills to entrepreneurship, and internal barriers such as time and risk were indicated (Sitaridis, 2019). As a further research focus, the direct environment of study participants is described as a social norm or perceived social norm. Positive influences are described by a positive attitude of the environment or a positive perception of the attitude of the environment on the willingness of study participants from South Korea, Malaysia or Vietnam, for example, to start a business (Kim & Huruta, 2022; Koe & Majid, 2021; Nguyen, 2020). Other demographic variables examined in the literature are income, the respective occupation of a parent, graduation background and age (Singh, 2014, Pinazo Dallenbach & Castelló Sirvent, 2023).

Foundation knowledge

Entrepreneurship knowledge is understood as basic knowledge about business administration and entrepreneurship in relation to foundations. The transfer of entrepreneurial knowledge within the framework of educational measures can be seen as a suitable method of increasing the number of potential foundations (cf. Raposo et al. 2008, p. 498). The foundation knowledge of potential founders has an influence on their foundation behaviour in two areas. On the one hand, the corresponding attitude is needed in individuals and on the other hand, knowledge about business start-ups can be imparted to participants with entrepreneurship courses (cf. Potter 2008, p. 50). Lack of preparation can prevent interested students from potentially founding a company (Wang/Wong 2004, p. 170). Within a chemistry degree programme, the necessary knowledge for founding a company is not imparted. These are the results of a study by Teixeira (2008), which found that the interviewees who would like to start their own business were aware that their technical and business management skills were not sufficient (cf. Teixeira 2008, p. 61). Thus, a dependence of entrepreneurship on learnable factors can be described (cf. Kolvereid/Moen 1997, pp. 158-159). From the studies with the TPB model it can be deduced that knowledge about starting a business can influence a person's intention to start a business (cf. Roxas/Cayoca-Panizales/de Jesus 2008, p. 73). This effect can be explained

by the connection between cognitive barriers to starting a business and entrepreneurial knowledge (cf. Roxas/Cayoca-Panizales/de Jesus 2008, p. 68). The article by Abigail (2022) et al. examined the impact of incorporating Entrepreneurship-Education (EE) into the undergraduate chemistry curriculum in India. It compared surveys of students with EE in the curriculum with those without. The results indicate a positive effect of EE. At the same time, this survey represents the only one specifically referring to chemistry students (Abigail et al., 2022). Packham et al.(2010) compared the impact of EE on the entrepreneurial attitudes of French, German and Polish students. Based on these described correlations, we hypothesise that general knowledge about business start-ups has a positive influence on the willingness of chemistry students in Germany to start a business (H1).

Perceived educational support (PES) & Perceived Support of the university (PSU)

In addition to the university as a place of teaching, educational institutions can play a role as business promoters, for example through cognitive support (Trivedi 2016, p. 795). Measures can be taken to increase or raise awareness of entrepreneurship as a career option. These measures can be used to strengthen self-confidence in starting one's own business (cf. Hills 1988, pp. 113-114; Gorman/Hanlon/King 1997, p. 71; Trivedi 2016, p. 795). In some cases, studies show a significant influence of a university environment that is perceived as supportive and a stronger intention to found a business (cf. Schwarz, Almer-Jarz, Wdowiak 2006, p. 39). While the study by Trivedi (2016) could not prove any direct significant influence on the start-up behaviour of study participants. Support mechanisms that are available in the university environment can, if they are perceived by the students, influence the perception of entrepreneurship and thus positively influence the attitude of the students (Autio et al. 1997). This is why we assume that university entrepreneurship education support has a positive influence on the willingness of chemistry students in Germany to start a business (H2).

Subjective norm

The subjective norm is described as the second predictor within the TPB and is described as the social pressure perceived by the individual about the implementation of a desired behaviour (Ajzen 1991, p. 188). The perceived pressure on the individual with direction and effect depends on the opinion of most of the reference persons from the person's close environment (cf. Ajzen 1985, p. 14). The social environment is often defined as family and friends (cf. Hisrich 1990, p. 215). Peers can also be a factor in the subjective norm. The perceived normative environment can be influenced by the socialisation of individuals in a peer environment (cf. Nanda, Sørensen 2008, p. 20; Kautonen, Luoto, Tornikoski 2010, p. 588). Through the common exchange in such an environment, higher intentions for business start-ups can take place (cf. Hisrich 1990, p. 210). The literature points to different perceptions of the entrepreneurial environment, which can lead to women experiencing gendered inequalities (Karatas¸-Özkan & Chell, 2015). Women are socialised differently and thus perceive opportunities differently (DeTienne, 2007). They point to the possibility of gender specificity in the processes, structures and discourses of academic entrepreneurship (Fältholm, Abrahamsson, & Källhammer, 2010). Further research showed a higher proportion of male students in entrepreneurship courses and a degree with a focus on entrepreneurship when pursuing a business degree compared to their female peers (Menzies & Tatroff, 2006), which led the authors

to conclude that there may have been an influence of commonly held myths on the female respondents. This refers to negative gender stereotypes in the social environment of women entrepreneurs that persist in their lives as business owners (Baron, Markman, & Hirza, 2001). These stereotypes can have a distorting effect on the concept of entrepreneurship in terms of gender (Nilsson, 1997; Delmar & Holmquist, 2004). In this context, research reports that students see a successful manager as having typical masculine attributes (Yim & Bond, 2002). This means that society has less normative support for women entrepreneurs and implicitly interprets this as less desirable (Baughn, Chua, & Neupert, 2006; Langowitz & Minniti, 2007). As a result, women themselves perceive starting a business as a career option as less desirable (Veciana, Aponte, & Urbano, 2005). From this we conclude for our research that the acquaintance with a company founder among the students' acquaintances has a positive influence on the willingness of chemistry students in Germany to start a company (H3).

Perceived career options

Perceived career option is the personal attitude towards a particular career based on individual beliefs and experiences (Roy/Akhtar/Das 2017, p. 1020). Based on individual analysis and consideration in relation to one's own interests, values and experiences (Zikic/Klehe 2006, p. 393), a deeper understanding of personal career ambitions and desired work activity can be developed (Zikic/Saks 2009, p. 119). Business start-ups can be an option compared to other career options (Douglas/Shepherd 1999, p. 231; Roy/Akhtar/Das 2017, p. 1020). Individuals compare perceived career options available on the basis of attributes such as willingness to take risks, workload, financial success or recognition and select the option with the greatest personal benefit (Roy/Akhtar/Das 2017). Individuals' perceptions of their own abilities and skills play a crucial role (Douglas/Shepherd 1999, p. 235). Thus, individuals with confidence in a career option may have the impression that their skills are not sufficient in some respects to be successful (Boyd/Vozikis 1994, p. 70; Wilson/Kickul/Marlino 2007, p. 398), which is tantamount to excluding this career option. Economic factors can also influence career options. Starting a business as a career option becomes more likely when there are few vacancies in existing companies (Dyer Jr 1995, Kirchhoff 1992). Due to the rapid access to jobs with perceived career opportunities in Germany, it can be assumed that starting a business as a career option is less likely (Gehrke/Weilage 2018, pp. 99-100). We conclude that the perceived career opportunities of chemistry students in Germany have a negative influence on their willingness to start a business (H4).

Motives and barriers to entrepreneurship

Previous studies have investigated numerous motivating factors and barriers to entrepreneurship among study participants. The research by (Walther, Dobrucka, & Haubold, 2023), comparing different studies, found "Implement my own idea", "Independent" and "Creating something of my own" as the strongest motivating factors, while "Lack of initial capital", "Excessively risky" and "Lack of knowledge" as the biggest barriers to entrepreneurial activity. The extrinsic factors mainly point to economic activities, while the intrinsic factors highlight some personality-related characteristics. Personality is considered to be the combination of genetic and cultural influences (George & Jones, 2005), which means that cultural diversity between and within a nation can be an influential factor in business creation.

Previous studies (e.g. Busenitz, Gomez & Spencer, 2000; George & Zahra, 2002; Mueller, Thomas & Jaeger, 2002) consider the nationally dominant culture as one of the most important moderating factors between economic activities and entrepreneurship. Within their studies, Pruett et al. (2009) and Giacomin et al. (2011) point to the significant differences in intentions and perceptions of motives and obstacles, respectively, due to cultural differences between nations. Wach & Bilan (2021) indicate that the entrepreneurial intention of Polish students is significantly positively influenced by the Polish culture of negative barriers and experiences with a family business in their own household. We conclude that there is a correlation between high perception of motives and barriers and the willingness of chemistry students to start a business. This effect is positive for motives (H5) and negative for barriers (H6).

METHODOLOGY

This study is part of a comparative study of German and Polish chemistry students that examines innovation-oriented technology transfer from the students' perspective. Due to time and cost constraints, a longitudinal design was chosen for our study. The chosen method was a survey with one measurement point (August 2022 - January 2023) to collect prospective and current data using an online questionnaire.

Additional questions were added to the questionnaire used in this article. The questionnaire was translated into English, French, Spanish and Polish by specialised staff and then checked for loss of meaning. The target group for the survey was students from the departments of chemistry as well as related fields (biochemistry, analytics, industrial chemistry, process engineering, industrial biology and food chemistry) who were contacted by mail, personally in lectures or via online social media networks like Instagram.

Questions

The questionnaire used in this study is composed of questions from different studies. The questions are divided into demographic factors, the probability of founding or career intentions and the assumed influencing factors from the TBP with supplemented questions. The questions were asked in the fixed order of demographic questions, external influencing factors, start-up probability and personal influencing factors. After the demographic questions on gender, migration, nationality and age, participants were excluded due to their student status in order to obtain the desired data. Subsequently, study-relevant characteristics such as place of study, field of study, intended degree, total duration of study, type of employment or the presence of founders in the environment were recorded and questions were asked to determine the latent constructs. For this, questions from different studies were used, which were adapted to a 6-point Likert scale to force selection. Absolute ignorance (1) to comprehensive knowledge (5) for questions on basic knowledge, or I don't know (0), don't agree at all (1) to completely agree (5) for the others. The probability of founding a company was asked through two different types of questions, on the one hand the probability of founding a company after graduation from very unlikely (1) to very likely (6) and on the other hand the career intentions with the options public service, employment and founding a company.

Based on the career intentions, the entrepreneurial intentions (TEA rate) for the students are determined by percentage calculation. An overview with the question categories used, the

number of questions, the presence of the answer option "I don't know" as well as the question source can be found in Table 1.

Question Categories	number of questions	Answer option "I don't know"	Question source	Addition of own questions
Foundation knowledge	3	no	(Cook, Heath, & Thompson, 2000)	no
Perceived educational support (PES) & Perceived Support of the university (PSU)	10	yes	(Roy, Akhtar, & Das, 2017)	yes
subjective norm (SN)	2	no	(Saeed, Yousafzai, Yani-De-Soriano, & Muffatto, 2015)	no
Founding intention	2	no	(Saeed, Yousafzai, Yani-De-Soriano, & Muffatto, 2015)	no
Perceived Career options (WCO)	6	yes	(Cook, Heath, & Thompson, 2000)	no
Perceived Behavioural control (PBC)	9	yes	(Zapkau, Schwens, Steinmetz, & Kabst, 2015)	no
Self-assessment for the foundation (SF)	3	yes	(Krueger, Reilly, & Carsrud, 2000)	no
Motives for Starting a Business	17	yes	(Pruett, Shinnar, Toney, Llopis, & Fox, 2009), (Solesvik, 2013)	yes
Barriers to Starting a Business	19	yes	(Pruett, Shinnar, Toney, Llopis, & Fox, 2009), (Solesvik, 2013)	yes

Table 1
OVERVIEW OF APPLIED STUDY QUESTIONS WITH SURCES; NUMBER AND ADDITIONS

Participants

A total of 4,367 people and 120 professors or student representatives were contacted. In February 2023, we received completed questionnaires from 1,287 participants, a response rate of 29.4 %, which is acceptable compared to other web-based studies [58]. Before conducting our statistical analyses, we excluded 320 participants due to incomplete data. We also excluded participants who reported that they were not currently a student (n = 135), or belonged to another field (such as teaching or electrical engineering), or were studying in another country (n = 21). The final sample thus consisted of 811 students, 498 from Germany. The average time spent in the questionnaire was 9.25 minutes. A summary of the distribution of study participants can be found in Table 2.

Table 2 SUMMARY OF THE STUDY PARTICIPANTS		
Types: number of…		**Number (n)**
total		1,287
exluded		476
included		811
German		498
SUB groups		
Gender	Male	239
	Female	252
Migration Background	yes	116
	no	382
Nationality	Other	77
	German	421
University type	Public	397
	private	92
desired degree	Bachelor	262
	Master	126
	PhD/Dr.	110
income	no income	183
	Part time job	281
	Full time job	34
Founder-approved	yes	204
	no	294
department	Other chemistry	103
	Chemistry	321
	Business chemistry	74

The students from Germany were on average 24.2 years old (SD = 3.42, range 17-35) and almost homogeneously divided between men (48.0 %) and women (50.6 %). Almost a quarter (23.3 %) have a migration background, while 84.5 % have German citizenship. Most of the participants (64.5 %) are studying chemistry at a public university (79.9 %) and 52.6 % are in a Bachelor's programme (25.3 % Master's programme, 22.1 % doctoral programme). Only 36.7 % of the students (n = 183) do not have an income from employment, whereas 6.8 % (n = 34) reported full-time employment. Most students have no founders among their acquaintances (n = 294, 59.0 %). The majority of the students with n = 321 (64.5%) are studying classical chemistry, while n = 103 students are taking chemistry-related courses such as food chemistry, process engineering, biochemistry, and n = 74 students are also studying business chemistry.

Statistical analysis

The statistical analysis was carried out with IBM SPSS Statistics version 28.0.1. The data were tested for normal distribution using Shapiro-Wilk tests. Not all variables in the data set have a normal distribution and some variables have an ordinal scaling. The (Fisher & Yates, 1938) logistic ordinal model is used to study the effect of continuous and categorical variables on a dependent variable (Reed & Wu, 2013). First, an exploratory factor analysis (EFA) is carried out with the maximum likelihood extrusion method. Variables with a factor loading of less than 0.5 are excluded for further calculations. As a further parameter, the reliability measure Cronbach's Alpha (CA) is used, which is considered reliable if it exceeds the threshold value of 0.7 (Nunnally, 1978). This allows 12 variable factors to be generated from 69 variables.

To prepare an ordinal logistic regression (OLR), the results are coded as $Y = 1$ or $Y = 0$, where the result either occurs (1) or does not occur (0). Further, OLR is performed as an analysis on the factor variables. Thus, OLR is used to determine the effect size (Exp(B)) as 95 % Wald confidence interval, predict effects, detect trends and helps predict the relationship between an endogenous variable at the ordinal level and two or more categorical or continuous exogenous variables. Chi-square test and goodness-of-fit according to Person and Deviance as well as pseudo R-squared according to Nagelkerke and Cox I Snell are given as further parameters for the OLR.

The significance level was defined as 5 %. The calculation of the probability of founding a company is based on the percentage of participants who selected founding a company as a career option.

RESULTS

Entrepreneurial Intentions

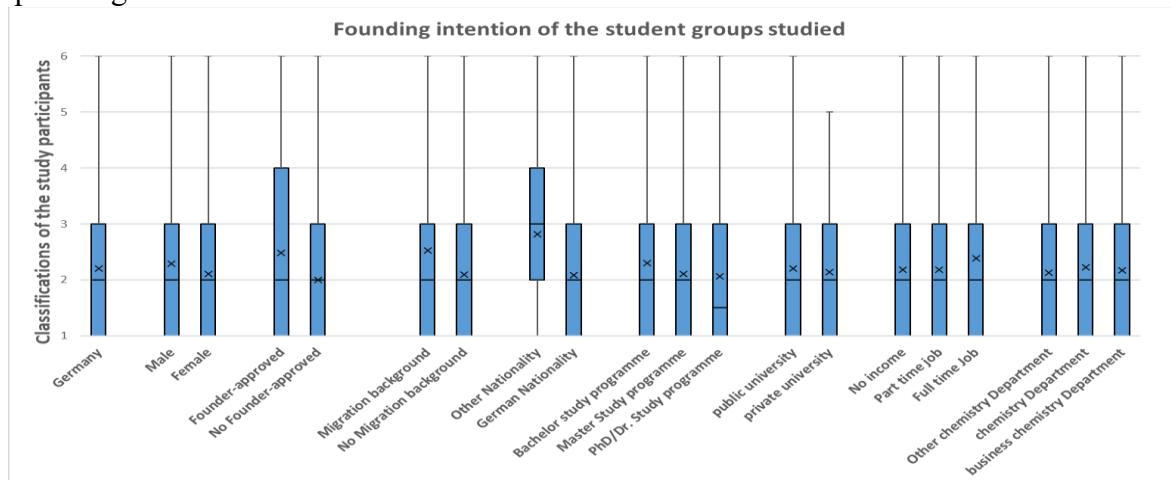The readiness of chemistry students in Germany to start a business is shown for all subgroups in Figure 2.

Figure 2
BOXPLOT FOR THE FOUNDING INTENTIONS OF THE (SUB) GROUPS OF STUDENTS

As Figure 2 shows, the intentions of chemistry students in Germany to start a business are rather low across all groups, with medians and mean values around 2. This speaks for low start-up probabilities. Only the SUB groups of students with founders in their circle of acquaintances (founders-approved) and students with a different nationality, i.e. no German nationality, have either a higher median or a higher 3rd quartile. Another special feature is the classification of private universities, where the quartile distribution and the students' classifications mean that potential founders with a maximum rating of 6 (on the Likert scale) count as outliers.

The factor analysis, after selecting variables with at least 0.5 factor loading and a Cronbach's alpha (CA) of at least 0.7, yielded 12 factor variables. The further course of the ordinal regression was thus limited to the variable factors see table 3.

Table 3 QUESTIONS IN THE VARIABLE FACTORS	
variable factors	**Questions from survey**
foundation knowledge	To what extent do you know about the tasks involved in setting up a business?
	To what extent can you distinguish between a "good" and a "bad" start-up idea?
	Do you know of any funding organisations that can help you with your start-up?
education support	My college/university offers lectures on the topic of start-up/entrepreneurship
	My college/university offers projects on the topic of start-up/entrepreneurship
	My college/ university hosts conferences /workshops on startup/entrepreneurship
	My college/university puts students interested in starting a business in touch with each other
	My college/university has a start-up center
	My college/university motivates students to start a new business
	My college/university provides students with ideas for starting a new business
	My college/university provides students with the knowledge needed to start a new business
	I am aware of foundation events outside my university for people interested in foundation their own business.
	My university has clear rules for the transfer of ideas from research to a start-up company.
subjective norm	People I care about expect me to start a business after I graduate.
	People who are important to me think that I should start a business after I graduate.
perceived career options	The choice between the different career options is so complicated that I can't decide.
	The more I try to find out about different career options, the more confused I get.
motives 1	my personal independence
	the opportunity to be financially independent
	the improvement of quality of life
	earn more money than through wage labour
	to work in a varied profession
	the building of personal wealth
	to have more free time
	the difficulty of finding the right job
motives 2	the creation of jobs
	to contribute to the economy
	to contribute to regional economic development
motives 3	to be at the head of an organisation
	to lead people
	attainment of high social status
motives 4	the opportunity to realize my own ideas
	to create something on my own

variable factors	Questions from survey
barriers 1	a lack of entrepreneurial competence
	a of knowledge in the business world
	a lack of knowledge of the market
	a lack of experience of accounting
	a lack of guidance
	a lack of support in setting up a business
barriers 2	excessive risk
	my own fear of failure
barriers 3	the fiscal charges (taxes, court fees, etc.)
	paperwork and bureaucracy when starting up
	too much work when setting up a company
	a lack of support from people around me
barriers 4	the search for a business idea for a company that has not yet been realized
	a lack of ideas about which company to found

The results for the ordinal regression with the 12 factor variables and the 8 subgroups can be found in Table 4.

Table 4 THE ORDINAL REGRESSION RESULTS – CONTRAST RATIOS									
Parameters			Exp(B)	95 % Wald confidence Interval		Hypothesis test		Contrast ratios	
				Lower	Upper	Wald chi-square	p	C 1	C 2
SUB-groups	Gender	Male	1.38	0.96	1.98	2.96	0.086	0	0
		Female	1.00					0	0
	Founder	Founder-approved	1.47	1.02	2.12	4.28	0.039	0	0
		No Founder-approved	1.00					0	0
	Migration Background	Migration background	1.30	0.82	2.07	1.23	0.268	0	0
		No Migration background	1.00					0	0
	Nationality	Other	1.09	0.62	1.93	0.10	0.755	0	0
		German	1.00					0	0
	Study Programme	Bachelor	1.46	0.89	2.40	2.22	0.136	1	0
		Master	1.12	0.65	1.94	0.18	0.673	0	1
		PhD/Dr.	1.00					-1	-1
	University type	Public	0.95	0.57	1.56	0.05	0.828	0	0
		Private	1.00					0	0
	Income	No income	1.06	0.50	2.27	0.02	0.878	0	0
		Part time job	1.10	0.54	2.27	0.07	0.788	0	0
		Full time job	1.00					0	0
	Department	Other chemistry	1.69	0.88	3.25	2.45	0.117	0	0
		Chemistry	1.23	0.69	2.17	0.50	0.479	0	0
		Business chemistry	1.00					0	0

Parameters		Exp(B)	95 % Wald confidence Interval		Hypothesis test		Contrast ratios	
			Lower	Upper	Wald chi-square	p	C 1	C 2
Factor variables	Foundation knowledge	1.18	1.07	1.30	10.84	0.001	0	0
	Education support	1.00	0.98	1.02	0.03	0.873	0	0
	Subjective norm	1.68	1.48	1.90	67.58	< 0.001	0	0
	Perceived career options	1.05	0.97	1.13	1.21	0.271	0	0
	Motives 1	1.06	1.02	1.10	10.75	0.001	0	0
	Motives 2	1.01	0.95	1.08	0.15	0.695	0	0
	Motives 3	1.02	0.94	1.10	0.15	0.699	0	0
	Motives 4	1.16	1.05	1.28	8.37	0.004	0	0
	Barriers 1	1.01	0.97	1.05	0.18	0.671	0	0
	Barriers 2	0.97	0.92	1.02	1.58	0.209	0	0
	Barriers 3	0.87	0.78	0.96	7.27	0.007	0	0
	Barriers 4	0.99	0.91	1.08	0.06	0.807	0	0

The sub-groups show a significant influence among the founders in the students' circle of acquaintances (Founder-approved), which has already been shown in the boxplots from Figure 2. It can thus be assumed that students who already know about the founders/entrepreneurs from their circle of acquaintances are more inclined to start a business. This indirectly confirms the positive experience from the students' direct environment (Miralles/Giones/Riverola 2016).

At the same time, the factor variables show significant influence in the subjective norm, motives 1 and 4 and barriers 3. The subjective norm thus confirms the influence of the students' direct environment on their willingness to start a business. In the results, the subjective norm is the factor with the strongest effect (1.68), which confirms the literature that there is a direct correlation between the founding behaviour of students and the attitude of their environment towards it (Nanda/Sørensen 2008; Kautonen/Luoto/Tornikoski 2010 Miralles/Giones/Riverola 2016).

Motives 1 & 4 from the factor variables stand for "my personal independence", "the opportunity to be financially independent", "the improvement of quality of life", "earn more money than through wage labour", "to work in a varied profession", "the building of personal wealth", "to have more free time" and "the difficulty of finding the right job" or "the opportunity to realise my own ideas" and "to create something on my own". The direct influence of these variables indicates a desire for independence, freedom and fulfilment through something of one's own. These driving factors for starting a business have already been proven by Walther, S., Renata, D., & Haubold, S. (2024), Pruett (2009). The factor variable Barriers 3 with the variables "the fiscal charges (taxes, court fees, etc.)", "paperwork and bureaucracy when starting up", "too much work when setting up a company" and "a lack of support from people around me" as a significant negative influence points to the hurdles caused by a lack of knowledge of business administration in addition to the desire for free time. These hurdles can be overcome, for example, by introducing courses as additional modules to the curriculum. These barriers have already been proven in other studies such as Sesen (2014). Thus, these barriers represent a significant influence on the willingness of German chemistry students to start a business.

The genders show no significant difference in their start-up behaviour. This can be attributed to a high degree of equality (DeTienne, 2007). At the same time, this requires further investigation in order to further clarify the non-significant effect, for example by comparing the genders individually using an ANOVA analysis.

The contrast ratio only shows different values for the study program, which are not significant according to the test statistics used. The contrast ratio shows a factor of exp(1) = 2.718 higher odds ratio for the Bachelor students in comparison with PhD/Doctoral students. At the same time, however, the odds ratio for Master's students is lower than that of PhD/Dr. students by exp(-1) = 0.368. In other words, Master's students have a 63.2% lower odds ratio for the dependent variable, foundation probability, compared to Bachelor's students.

Table 5 summarizes the key figures for the model used.

Table 5 STATISTICAL KEY FIGURES FOR THE ORDINAL REGRESSION PERFORMED IN THE APPLIED MODEL						
Test	Model	-2 Log Likelhood	Chi-Square	df	sig	Pseudo R-square
Test of Parallel Lines	Null Hypotheses	1,195.13				
	General	1,090,756[b]	1,04,369	92	0.178	
Model fitting information	Intercept only	1,409.26				
	Final	1,195.13	214.131	23	0	
Goodness-of-Fit	Pearson		3,782.90	2,382	0	
	Deviance		1,195.13	2,382	1	
Pseudo R-squared	Cox / Snell					0.359
	Nagelkerke					0.379
	McFadden					0.152

As Table 5 shows, the applied model has a good fit to the data, as confirmed by various metrics. The -2 log likelihood, chi-square tests, and pseudo R-squared measures indicate that the model explains the variation in the data well and has a good model fit. The pseudo R-squared values indicate that the independent variables can explain about 35.9 % to 37.9 % of the variance in the entrepreneurial intentions. The Test of Parallel Lines shows that the assumption of parallel regression effects is fulfilled.

It follows that hypotheses 1, 3, 5 and 6 are confirmed while hypotheses 2 and 4 are rejected. A significant influence of knowledge about starting a business, university training support, as well as the perception of motives and barriers could be demonstrated.

DISCUSSION

In the distribution across the subgroups, the willingness to start a business shows a lower level for the participants of a PhD/Dr. study programme. Possible effects such as good job prospects for chemists with a doctorate can have an influence. At the same time, the subgroups of people who are known to start up a business and chemistry students who are not German nationals show a higher willingness to start a business. On the one hand, this suggests cultural influences in terms of nationalities (Giacomin, et al., 2011), and on the other hand on the positive experiences from the immediate environment of the students.

The results show very clearly a connection between the willingness of chemistry students and founders in their circle of acquaintances and the attitude of the environment of the students (subjective norm), the knowledge of how foundations work as well as motivating factors and barriers. We therefore recommend the establishment of at least one compulsory course on entrepreneurship and the support available from the respective institutions. In this way, knowledge about how reasons work can be increased and barriers can be broken down. One possible approach for this are guest courses by founders within the curriculum of a university. Through this, the students could build a network with founders and at the same time benefit from positive experiences. This would be in line with the findings of (Abigail, Jeslin, Vijayarangan, & Rakhi, 2022). At the same time, however, the findings of (Pruett, Shinnar, Toney, Llopis, & Fox, 2009) suggest a negative impact of EE on German students. Critical authors state that the greatest learning outcomes come from practical application (Gendron 2004,). The impact of EE on German chemistry students should be directly investigated and examined in detail.

The present study gives a first overview of gender-specific differences in chemistry students in Germany and their willingness to start their own business. However, since this is not a representative study but a random sample, only tendencies can be identified. We therefore recommend a representative study for future research. Future evaluations should clarify how different the various SUB groups of chemistry students see the influence of the various factors on the intentions of chemistry students to start a business or classify them in order to derive more targeted measures.

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