How to become a knowledge entrepreneur: development and validation of training

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Abstract

Purpose – Knowledge entrepreneurship encourages students to apply their knowledge and skills to societal, digital and ecological challenges – not only just in business but also in careers and social contribution. This study aimed to validate training that promotes using education-derived knowledge to address real-world issues and build career awareness.

Design/methodology/approach – Drawing on career training, effectuation, and design thinking, the program was implemented at five universities ($N = 40$). Its impact was assessed through pre/post data and comparison with a control group ($N = 41$) that did not receive the training.

Findings – Training participants showed significant improvement in marshaling (entrepreneurial self-efficacy) and career competencies. While both groups were similar before training, training participants reported significantly higher scores across all variables afterward.

Originality/value – The training proved effective in fostering career self-reflection and applying effectuation principles, helping bridge the graduate skills gap by encouraging students to leverage their existing knowledge and abilities.

Keywords Knowledge entrepreneurship, Career competencies, Training, Effectuation, Design thinking

Paper type Research paper

Introduction

Universities play a key role in achieving the United Nations (UN) Sustainable Development Goals (SDGs) through education, research and innovation (European University Association, 2018). This critical role and their responsibility in contributing to sustainable societies are widely acknowledged (Filho *et al.*, 2024). As part of civil society, universities foster curiosity, scientific thinking and entrepreneurship, generating knowledge to address societal, digital and ecological challenges. This makes them vital in equipping students with the skills needed to

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Data availability statement: Data of the studies will be available in the Open Science Framework repository at https://osf.io/r2hme/?view_only=a58cf3dede404a02b6d328bdbe6fd61b. This project will be made public upon publication.

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Ethics approval statement: Ethical approval from Saarland University's ethical board was not required, as we complied with the ethical guidelines and standards of Saarland University's ethics advisory board, the German Science Foundation's national regulations and the Declaration of Helsinki of 1964 and its later amendments.

Consent: Informed consent was obtained from all individual participants included in the studies.

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tackle these issues (European University Association, 2018). Meanwhile, employers report a graduate skill gap, with students lacking essential competencies (Hossain *et al.*, 2022). To bridge this gap, these skills must be integrated into teaching, ensuring students can recognize and apply them effectively.

The aim of this study is to introduce training aimed at students transitioning from graduation to their careers, focusing on developing career competencies and the intention to apply their knowledge to current challenges, thereby reducing the graduate skills gap. It responds to calls for research on opportunity identification (Saks and Gaglio, 2002) and incorporates effectuation and design thinking approaches. Additionally, the study contributes to curriculum development that supports campus-wide implementation and addresses aspects of the SDGs (Filho *et al.*, 2024) and aims to help students in the transition phase by reducing the graduate skills gap.

Knowledge entrepreneurship and opportunity identification

Knowledge entrepreneurship involves using one's competencies to drive societal progress by addressing digital, ecological or social challenges (Sparfeldt *et al.*, n.d.). Examples of knowledge entrepreneurship include helping seniors use smartphones, initiating local environmental efforts or organizing community projects like playgrounds. It reflects an individual's ability to create change, with or without starting a business (Schnellbächer, n.d.), and is also relevant to career development – especially during the transition from university to work. However, little research has explored who engages in knowledge entrepreneurship or whether it can be taught (Markman *et al.*, 2019) or whether people can be actively trained to tackle such challenges. This study therefore developed and tested training aimed at fostering knowledge entrepreneurship in students nearing graduation.

The first step in knowledge entrepreneurship is identifying opportunities. Alvarez and Barney (2007) describe two approaches: discovery and creation. Most opportunities, however, involve both – reassembling existing elements in new ways (Arend *et al.*, 2015; Zhu *et al.*, 2021). Hence, opportunity identification, a creative process (Amabile, 1997), can be conceptualized as the creation or discovery of ideas that are then translated into (business) opportunities through taken actions (Ardichvili *et al.*, 2003; Zhu *et al.*, 2021). According to the model of opportunity identification and development (Ardichvili *et al.*, 2003), individuals must reorganize and connect existing knowledge, identify relationships between different pieces of information and creatively combine this information to generate new ideas. Hence, opportunities can be discovered in the environment through searching and combining new ideas (Gielnik *et al.*, 2012) as well as be created by individuals through creative processes (Sarasvathy, 2001). As a core element of knowledge entrepreneurship, opportunity identification depends on individuals being aware of their competencies and believing they can apply them effectively. In the university-to-work transition, career competencies are particularly crucial for recognizing such opportunities.

Career competencies, entrepreneurial self-efficacy and behavioral intentions

Career competencies refer to the knowledge, abilities, and skills essential for career development and shaped by the individual (Akkermans *et al.*, 2013). These include career reflection, goal-setting, career planning and self-presentation and are categorized into knowing how (skills), knowing why (motivation) and knowing whom (networks). Career competencies have been linked to outcomes like perceived employability (Blokker *et al.*, 2019) and subjective career success (Presti *et al.*, 2022). Addressing the graduate skills gap (Hossain *et al.*, 2022) requires helping students reflect on their abilities beyond the traditional curriculum. Perceiving such a gap can motivate engagement in training, as shown by increased adoption of MOOCs due to heightened psychological needs. According to career construction theory (Savickas, 2005), career competencies are key psychosocial resources that are necessary to handle (un)predictable, current and future career-related tasks. As such, encouraging people

to reflect on the three questions of knowing how, why and who could help them to be more aware of their competencies as well as of their network. This is why we assume that training on knowledge entrepreneurship will positively influence participants' career competencies.

Next to career competencies, the belief in one's ability to tackle challenges – entrepreneurial self-efficacy (McGee *et al.*, 2009) – is key to knowledge entrepreneurship. This belief is a vital personal resource for entrepreneurial success (Drnovšek *et al.*, 2010) and is positively linked to entrepreneurial intentions across all education levels (Newman *et al.*, 2019; Salmony and Kanbach, 2022). It also predicts entrepreneurial success more strongly than general self-efficacy (Glosenberg *et al.*, 2022) and can be enhanced through education and training (Boukamcha, 2015; Newman *et al.*, 2019). For knowledge entrepreneurship training, the marshaling facet is especially important, as it reflects confidence in networking, communicating ideas and gaining support (McGee *et al.*, 2009). While originally business-focused, entrepreneurial self-efficacy was adapted in this study to fit broader digital, ecological and social challenges, aligning with the goals of knowledge entrepreneurship.

Beyond these two constructs, actual behavior, such as signing a petition or becoming politically active, can also be a relevant concept of knowledge entrepreneurship, next to developing solutions to existing issues (Sparfeldt *et al.*, n.d.). Knowledge entrepreneurship is thus understood as both developing solutions using innovative ideas as well as showing engagement in social or ecological issues by behaving in a politically important way. Due to the focus of our training on existing challenges, we assume that participants might also report higher intentions to engage in these behaviors after attending the training as awareness of the challenges increases.

One approach that addresses creative processes among (knowledge) entrepreneurs is the effectuation approach by Sarasvathy (2001). Effectuation is a multidimensional, formative construct that consists of three subdimensions experimentation, flexibility and affordable loss as well as pre-commitments (Chandler *et al.*, 2011). As such, effectuation approaches use a set of given means and focus on the selection of possible effects that can be created by that respective set of means (Sarasvathy, 2001).

A key principle of effectuation relevant to knowledge entrepreneurship is means-orientation, which emphasizes starting with available resources – what one can do, whom one knows and what one has (Sarasvathy, 2001, 2009). This aligns closely with the core elements of career competencies (Akkermans *et al.*, 2013). Rather than pursuing abstract creative ideas (DeTienne and Chandler, 2004), this approach focuses on realistic, resource-based opportunities. These can be pursued with partners (leveraging relationships), tested within acceptable risk limits (affordable loss) and adapted as conditions change (leveraging contingencies; Zhu *et al.*, 2021).

Effectuation has the advantage that ideas are based on available resources and hence closer to the individual's interests and knowledge (Sarasvathy, 2001; Zhu *et al.*, 2021). These ideas created are thus more feasible as they do not, or to a lesser extent, require the acquisition of new resources. Furthermore, the inherent aspect of flexibility and an experimental orientation is already built into the effectuation approach (Zhu *et al.*, 2021). Effectuation can thus be considered an action- and implementation-orientated approach which leads to more ideas that are pursued compared to classical creativity training, which is rather association-based and thus leads to more creative ideas. As both training approaches in the study from Zhu *et al.* (2021) led to an increase in identified and pursued business opportunities, we decided to combine both approaches in our training to get the best out of both. To incorporate creativity training, we decided to rely on the design thinking approach. Through the application of effectuation principles and design thinking steps and simultaneously highlighting knowledge entrepreneurship as the focus of the developed training, participants should thus develop their career competencies, marshaling as well as specific behavioral intentions regarding existing challenges. Put more formally:

Hypothesis. Participating in knowledge entrepreneurship training will increase participants' career competencies (reflection on motivation, reflection on qualities and networking), marshaling and behavioral intentions regarding knowledge entrepreneurial behavior.

Methods

Sample

We conducted the training at five universities in four European countries (Germany, Spain, Poland and Portugal). At each university, we promoted the training through the university's social media channels and career center newsletters. The advertisement included the workshop title "Become a Knowledge Entrepreneur" and highlighted key themes such as teamwork, solving social, environmental and digital problems, expanding your network and discovering and leveraging your knowledge and networks. Interested students could register through their respective advisors. In total, 60 people participated in the training – 17 in Spain, 12 in Germany, 10 in Poland and 21 in Portugal. Of these, 40 attended both days, filled in the questionnaire after the training and consented to the use of their data. Ethical approval from Saarland University's ethical board was not required, as we complied with the ethical guidelines and standards of Saarland University's ethics advisory board, the German Science Foundation's national regulations and the Declaration of Helsinki of 1964 and its later amendments. The demographic characteristics of this final sample are described in Table S1. The mean age of the whole sample was 26.18 (SD = 7.71, ranging from 19 to 60), and 77.5% of the participants were female. Almost all (85.0%) reported being students. We are aware that this sample is relatively small; however, this is not unusual in field experiments (see also Zhu *et al.*, 2021).

To test whether the participants in the training did not differ in the relevant measures before participation, we also collected data from a control group. We aimed to collect data from at least 36 people, as this would allow us to discover an effect size of Cohen's $d = 0.60$ when comparing the control group to the training group, assuming an $\alpha = 0.05$ and test power of $1-\beta = 0.80$. These participants were contacted during a career fair at a German university. We deemed this appropriate, as attending a career fair implies considering the next steps regarding one's career and would also be a potential target for our training. For the control group, participants answered the same items as the training participants regarding behavioral intentions and career competencies. In total, 57 participants filled out the questionnaire. Of these, 41 agreed that their data could be used for scientific purposes. In the control group, 23 participants reported being female, 15 indicated being male and three reported identifying as non-binary. The mean age among participants was 24.78 (SD = 4.07). The two samples were thus comparable regarding age and gender.

Measures

As the workshop was conducted in English for all participants, we also used English questionnaires for all measures and workshops.

Career competencies were measured using ten items from Akkermans *et al.* (2013), which were answered on a scale from 1 = disagree to 5 = agree. We used the sub-scales reflection of motivation (three items), reflection on qualities (four items) and networking (three items). The items were introduced by the following text: "The following statements are about what you like about your job. If you are not yet employed/still studying, please think about a future job." A sample item reads, "I know what is important to me in my career." The scale exhibited satisfactory reliability at timepoint 1, Cronbach's $\alpha = 0.87$, timepoint 2, Cronbach's $\alpha = 0.73$ and for the control group, Cronbach's $\alpha = 0.76$.

Behavioral intentions were measured twofold. First, we used three marshaling items from McGee *et al.* (2009). These items were answered on a scale from 1 = *very little* to 5 = *very much*. A sample item reads "How much confidence do you have in your ability to network, i.e. make contact with and exchange information with others." This scale was found to exhibit roughly satisfactory reliability at both measurement points, McDonald's $\omega_{TP1} = 0.57$, McDonald's $\omega_{TP2} = 0.61$ and for the control group, McDonald's $\omega_{CG} = 0.61$. Second, we developed 11 more specific behavioral intention items related to digital, ecological and social challenges. The items were introduced with "The next points relate to possible actions to drive

digital, environmental, and social transformation. Please think of a digital, environmental, or social transformation that is particularly relevant to you. To what extent can you imagine the following possible actions?" A sample item is "I would sign a petition." Participants could answer the scale using response options from 1 = *not at all possible* to 5 = *very possible*. The items were reliable at both, timepoint 1, McDonald's ω = 0.85, timepoint 2, McDonald's ω = 0.85 as well as for the control group, McDonald's ω = 0.75.

We additionally decided to measure two constructs as covariates. Career curiosity comprises having an inquisitive mindset regarding one's career to allow further learning and growth as a person (van der Horst *et al.*, 2021). As such, career curiosity might be a relevant construct to assess when conducting training on knowledge entrepreneurship. To assess career curiosity, we used three items from Savickas and Porfeli (2012) and Maggiori *et al.* (2017), which were answered on a scale from 1 = *not very strong* to 5 = *very strong*. The items were introduced saying "Different people use different strengths to build their careers. No one is good at everything; each of us puts more emphasis on some strengths than others. Using the scale below, please rate how strongly you have developed each of the following skills." A sample item is "How much have you developed the ability to investigate options before making a choice." The reliability of the scale was only roughly satisfactory, McDonald's ω = 0.47.

Next to career curiosity, general self-efficacy could also influence knowledge entrepreneurship intentions. Self-efficacy originated from social cognitive theory (Bandura, 1986) and describes an individual's perception of being capable to control ones environment. Generalized self-efficacy can also lead to fostering career behaviors (Rudolph *et al.*, 2017). As such, participants with low general self-efficacy might also profit more from participation in knowledge entrepreneurship training, as they are less aware of their knowledge and skills. To measure general self-efficacy, we relied on items from Schwarzer and Jerusalem (1995). Participants were asked to indicate their agreement with each of the ten items on a scale from 1 = *not at all true* to 4 = *exactly true*. A sample item of the scale reads, "I can always manage to solve difficult problems if I try hard enough." The scale was reliable, McDonald's ω = 0.93.

Development of the training and procedure

To develop the training, we relied on previous studies that developed career (Koen *et al.*, 2012), effectuation (Zhu *et al.*, 2021) and creativity training (Zhu *et al.*, 2021) as well as existing design thinking approaches (Rauth *et al.*, 2010). We aimed to have a split focus with effectuation on the first day to ensure that participants know themselves and their skills, abilities and networks, and with design thinking on the second day, allowing participants to use their obtained knowledge from Day 1 and apply it in a creative way to existing challenges. Before the start of Day 1, participants had to fill in the first questionnaire online to qualify for participation (measurement time 1, T1). This questionnaire included items on knowledge entrepreneurship (which are not part of this study), career curiosity, general self-efficacy, career competencies, marshaling items and behavioral intentions regarding current challenges. For a full description of the training development, please refer to the supplemental material.

Day 1 started by asking about participants' expectations, as communicating the relevance of the training as early as possible is important to increase the perceived usefulness and training effectiveness (see also Koen *et al.*, 2012). Then, the definition of knowledge entrepreneurship was introduced. After this, participants were introduced to the effectuation principles from Sarasvathy (2001). This was followed by a more detailed introduction of the "start with your means" effectuation principle, in which participants learned about the essential questions of who they are, what they know and who they know (Sarasvathy, 2001). This effectuation principle was then linked to discovering participants' knowledge, skills, abilities and other characteristics (KSAOs). The KSAOs were followed by focusing on the third question of the "start with your means" principle: Who do I know? For this, participants learned about what networking is and how it can be done and had to reflect on their network using another handout. In a final step, the participants were asked to think about a social, ecological or digital challenge for the next day that they would like to address.

We outlined Day 2 according to the design thinking approach so that participants went through all steps of this process within one day. We started by introducing the design thinking process of empathizing, defining, ideating, prototyping and testing (Rauth *et al.*, 2010). During the introduction of the empathize phase, the trainers gave examples for each of the three challenge categories. After these examples, participants were asked to brainstorm in groups as many problems as they could think of that were caused by the transformations. The following step is the define step. Participants had to define one of the identified challenging problems more precisely, specifying who is involved in the problem, what are the needs of those involved, causes of the problem. Having an actionable problem statement is crucial for the third step, which is called ideation. This step focuses on idea generation using tools such as brainstorming (Rauth *et al.*, 2010). Participants conducted three different exercises: 4-3-2, Very Important Person (VIP) and Post-it comparison to gather ideas on how to solve the identified problem and rank-order obtained solutions. In the fourth step, prototypes for the chosen idea were built in a quick and low-resolution way. Again, participants were reminded of their KSAOs and network, which should be considered while developing the prototype. In the workshop, the participants presented the prototype to the other groups and received feedback. To wrap up the workshop, the trainers asked participants to reflect again on their own most important visions for their career and life, specifically focusing on their obtained knowledge regarding their KSAOs, network and design thinking. After participating, the second questionnaire, which consisted of items on career competencies, marshaling and behavioral intentions regarding current challenges, had to be filled out (measurement time 2, T2).

Results

Means, standard deviations and bivariate correlations of all variables for the training participants are presented in Table 1. All data and code for the analyses can be found following this link: https://osf.io/r2hme/?view_only=a58cf3dede404a02b6d328bdbe6fd61b.

In the first step, we tested whether the control group and the training group differed prior to their participation in the training. To test this, we conducted a MANOVA, comparing the means of marshaling, behavioral intentions and career competencies of the control group to the training group before participation. Hence, this analysis allows us to examine the effects of multiple dependent variables within a single analysis and is not affected by α-error accumulation. We assumed that the training group should not differ from the control group before participation. We observed no significant effect of group, Pillai's trace $V = 0.07$, $F(1, 79) = 1.98$, $p = 0.125$, $\eta_p^2 = 0.07$. To ensure that both groups did not differ in any of the relevant outcomes, we decided to follow up this result with ANOVAs for each dependent variable. For marshaling, we observed a significant difference between the groups, $F(1, 79) = 5.31$, $p = 0.024$. The training group prior to participation reported significantly more marshaling ($M = 3.80$, $SD = 0.57$) than the control group ($M = 3.46$, $SD = 0.73$). However, we did not observe significant differences for either behavioral intentions, $F(1,79) = 3.07$, $p = 0.08$ or career competencies, $F(1, 79) = 1.76$, $p = 0.19$. Hence, both groups did not differ from each other, aside from marshaling, prior to the training.

In the second step, we compared the control group to the training group after participation using a second MANOVA. There was a significant effect of group on the three dependent variables, $V = 0.23$, $F(1, 79) = 7.70$ $p < 0.001$, $\eta_p^2 = 0.23$. The results indicate that the control group differed significantly from the training group after participation regarding all three outcome variables. Compared to the control group, the training group after participation thus reported significantly more marshaling, $F(1, 79) = 19.61$, $p < 0.001$, significantly higher behavioral intentions, $F(1, 79) = 5.37$, $p = 0.023$ and significantly more career competencies, $F(1, 79) = 15.29$, $p < 0.001$. All means and standard deviations can be found in Table 2. Hence, we can confirm our assumption that training participants did only differ in marshaling from other students before they participated in our training but reported more career competencies, marshaling and behavioral intentions after participation than the control group. This indicates

Table 1. Means, standard deviations and correlations with confidence intervals of the training group

Variable	*M*	*SD*	1	2	3	4	5	6	7
1. Marshaling – T1	3.80	0.57							
2. Marshaling – T2	4.09	0.53	0.43** [0.13, 0.65]						
3. Behavioral intentions – T1	3.67	0.61	0.31 [−0.00, 0.57]	0.48** [0.20, 0.69]					
4. Behavioral intentions – T2	3.75	0.60	0.36* [0.05, 0.60]	0.63** [0.39, 0.78]	0.73** [0.55, 0.85]				
5. Career competencies – T1	4.08	0.49	0.59** [0.34, 0.76]	0.32* [0.01, 0.57]	0.29 [−0.03, 0.55]	0.19 [−0.13, 0.47]			
6. Career competencies – T2	3.73	0.68	0.44** [0.15, 0.66]	0.14 [−0.18, 0.43]	0.16 [−0.16, 0.45]	0.06 [−0.26, 0.36]	0.55** [0.29, 0.73]		
7. Career curiosity	3.99	0.42	0.43** [0.13, 0.65]	0.42** [0.12, 0.65]	0.40** [0.10, 0.63]	0.35* [0.05, 0.60]	0.43** [0.14, 0.66]	0.57** [0.32, 0.75]	
8. General self-efficacy	3.79	0.58	0.61** [0.37, 0.77]	0.31 [0.00, 0.57]	0.19 [−0.13, 0.48]	0.26 [−0.06, 0.53]	0.62** [0.38, 0.78]	0.49** [0.21, 0.70]	0.47** [0.19, 0.68]

Note(s): $N = 40$. T1 = training group pre-training and T2 = training group post-training values in square brackets indicate the 95% confidence interval for each correlation
*$p < 0.05$ and **$p < 0.01$
Source(s): The authors

Table 2. Means and standard deviations of the control group and training group

	CG (*SD*) (n = 41)	T1 (*SD*) (n = 40)	T2 (*SD*) (n = 40)
Marshaling	3.46 (0.73)	3.80 (0.57)	4.09 (0.53)
Behavioral intentions	3.40 (0.76)	3.67 (0.61)	3.75 (0.60)
Career competencies	3.55 (0.58)	3.73 (0.68)	3.99 (0.42)

Note(s): T1 = training group pre-training and T2 = training group post-training, CG = control group. All items were rated on a scale from 1 to 5
Source(s): The authors

that participation in the training significantly affected the career competencies, marshaling and behavioral intentions.

In the final step, we conducted a multivariate analysis of covariance (MANCOVA) with time as the independent variable (T1 = before training and T2 = after training), career curiosity and general self-efficacy (both assessed at T1) as covariates and career competencies, marshaling and behavioral intentions as dependent variables. This analysis tested our hypothesis that participation in our knowledge entrepreneurship training increases participants' career competencies (reflection on motivation, reflection on qualities and networking) and behavioral intentions regarding knowledge entrepreneurial behavior. We found that time was an overall significant predictor, Pillai-Trace = 0.30, $F(3, 35) = 5.03$, $p = 0.005$, $\eta_p^2 = 0.30$. Time was a significant predictor of marshaling, $F(1, 37) = 10.43$, $p = 0.003$, $\eta_p^2 = 0.22$, and career competencies, $F(1, 37) = 9.00$, $p = 0.005$, $\eta_p^2 = 0.20$. There was a significant increase in both outcomes from T1 to T2. However, time did not significantly predict behavioral intentions, $F(1, 37) = 1.48$, $p = 0.231$, $\eta_p^2 = 0.04$. Hence, we can conclude that our hypothesis was partially supported in that career competencies and marshaling increased due to training participation, but behavioral intentions did not. Additionally, neither general self-efficacy, Pillai-Trace = 0.17, $F(3, 35) = 2.35$, $p = 0.090$, $\eta_p^2 = 0.17$, nor career curiosity, Pillai-Trace = 0.18, $F(3, 35) = 2.47$, $p = 0.078$, $\eta_p^2 = 0.18$, were significant predictors for the outcome variables–with two exceptions: General self-efficacy was predictive of differences in marshaling, $F(1, 37) = 4.47$, $p = 0.041$, $\eta_p^2 = 0.11$, but not of differences in behavioral intentions, $F(1, 37) = 0.45$, $p = 0.507$, $\eta_p^2 = 0.01$, nor of differences in career competencies, $F(1, 37) = 3.59$, $p = 0.066$, $\eta_p^2 = 0.09$. Career curiosity in turn did predict differences in career competencies, $F(1, 37) = 5.04$, $p = 0.031$, $\eta_p^2 = 0.12$, but not in behavioral intentions, $F(1, 37) = 0.73$, $p = 0.400$, $\eta_p^2 = 0.02$ or in marshaling, $F(1, 37) = 3.74$, $p = 0.061$, $\eta_p^2 = 0.09$. Furthermore, neither general self-efficacy nor career curiosity significantly interacted with time to predict trends in the three dependent variables. Using Pillai's trace, the interaction of time and general self-efficacy was $V = 0.08$, $F(3, 35) = 1.07$, $p = 0.374$, $\eta_p^2 = 0.08$ and the interaction of time and career curiosity was $V = 0.11$, $F(3, 35) = 1.41$, $p = 0.255$, $\eta_p^2 = 0.11$. We can thus conclude that training participants demonstrated greater career competencies and marshaling after participation. Additionally, those with higher general self-efficacy experienced more significant increases in marshaling, while those with higher career curiosity showed greater improvements in career competencies.

Discussion

This study aimed to introduce and validate training on how to become a knowledge entrepreneur. For this, we developed a two-day training specifically addressing students in the transition phase from universities to starting their careers. The workshop was conducted at five European universities to test its applicability across different countries. Using a within-subject design, participants had to fill in questionnaires before and after attending the training. Our results show that the training successfully increased values in career competencies and

marshaling, but not behavioral intentions to apply their knowledge to existing challenges. Furthermore, our results indicate that participants did not differ from other students before participating in the training, except for marshaling, but reported higher values in all three outcome variables after their participation. We can thus conclude that the training helped students to become aware of their competencies, and it can thus be deemed a successful training for the transition phase from university to work and for universities to foster their efforts in contributing to the SDGs (Filho *et al.*, 2024).

In line with previous research (e.g. Zhu *et al.*, 2021), we used the effectuation approach as well as creativity exercises to help students raise their awareness of their existing knowledge and how to apply it to current challenges. Following the opportunity identification model (Ardichvili *et al.*, 2003), entrepreneurial alertness and opportunity identification depend on existing knowledge, social networks and personality traits. By incorporating these aspects into our training, we further highlight their significance, along with creativity and the effectuation approach. This provides additional support for research by DeTienne and Chandler (2004) and Zhu *et al.* (2021). Furthermore, with this training, we followed the call from Arend *et al.* (2015) to test effectuation empirically in that we developed our training based on the means-orientation principle of effectuation, which led to an increase in reported career competencies and marshaling among participants.

We did, however, not obtain significant increases in behavioral intentions regarding current challenges. The participants did not report an increase in these intentions after participation. However, after participation, they reported higher values in these intentions than a control group. One reason for this result could be that the items assessed behaviors that were less associated with career-related aspects, and the training, with its focus on means and design thinking, might not have directly addressed such behaviors. Additionally, with its career focus, behaviors such as signing a petition or becoming politically active were probably less encouraged in this training than building up one's network. If an increase in these behavioral intentions should be the main goal, the training might need adaptations to address such more political behaviors rather than career-related behaviors. However, this result might also hint that the ability to identify opportunities was not trained enough, as called for by Saks and Gaglio (2002). Future research should thus focus more on how to specifically train students in identifying opportunities to apply their knowledge and skills and thus contribute to the fulfillment of the SDGs.

The covariates general self-efficacy and career curiosity only played a minor role in differences across time. We only observed a significant effect of general self-efficacy on marshaling. This aligns with results from Rudolph *et al.* (2017), who reported a meta-analytic correlation of 0.54 between occupational self-efficacy and career-adapting responses. Hence, having a higher belief in their capability to control the environment also led to a higher confidence in their abilities to make others believe in their vision and network. Additionally, career curiosity did predict changes in career competencies. But neither general self-efficacy nor career curiosity nor the interactions of these two with the factor of time had significant effects on any other variable. They were, however, significantly related to most variables when only the bivariate correlations were considered (see Table 1). We would thus encourage future research to address the role of these two variables further. As far as this study is concerned, we would assume that the two covariates only played a minor role in the observed effects. This could, however, also be due to rather high values in both, with means around four on a scale ranging from 1 to 5. Furthermore, previous studies mostly assessed career curiosity as an outcome of interventions (e.g. Koen *et al.*, 2012; van der Horst *et al.*, 2021) rather than as a predictor for a change. Hence, another possibility would be to assess career curiosity at both time points to test whether the intervention itself also influenced this variable.

Practical implications

With the global labor market facing a significant shortage of approximately 75% (Manpower Group, 2023) and employers reporting discrepancies between workforce demands and

graduates' qualifications (Hossain *et al.*, 2022), this training could serve as a valuable tool for educators. By helping students recognize the knowledge, skills and abilities they have acquired alongside their degree, universities can better bridge the graduate skills gap. We developed this training to make it an easily applicable training at universities across Europe and other parts of the world to allow them the implementation of a campus-wide course that helps to facilitate the achievement of the United Nations' SDGs (European University Association, 2018; Filho *et al.*, 2024). With this study, we showed that our training helps students to become aware of their career competencies and marshaling. We thus deem it appropriate training, especially for students who are approaching the end of their university time and are considering entering the job market. Hence, offering the training to these students can help them navigate the job market with better knowledge about their competencies and acquired knowledge.

Furthermore, this study shows that the effectuation and design thinking approaches can be helpful tools not only for entrepreneurs but also for people in transition phases from university to the job market. Especially focusing on means orientation can be beneficial for these people as it helps them to reflect on their already existing knowledge, skills and abilities. We would therefore encourage others to adopt effectuation principles and design thinking approaches in training beyond entrepreneurship, including in career-related or higher education settings.

Limitations and future directions

This study is – like others – not without limitations. First, the sample size is relatively small, and especially cross-university comparisons are thus not possible. This is, however, not uncommon for experimental field studies (see also Zhu *et al.*, 2021), as recruitment for such training can be very difficult. Future research should thus aim at obtaining larger sample sizes to allow for comparisons across groups and universities and to replicate our findings. The comparison between universities and countries might be especially interesting, as universities might differ in their career programs and offers and participants might thus differ in their prior knowledge depending on which university they come from. However, regarding the obtained effect sizes and the fact that data supported most of our hypothesized effects, we are optimistic that the training is nonetheless effective in increasing students' career competencies and marshaling.

Second, the reliability of the marshaling scale and career curiosity scale were not satisfactory in any of the samples, ranging between McDonald's $\omega = 0.47$ and 0.61. Hence, future research should either use different items to cover these constructs or examine possible reasons for this low reliability. The results for marshaling thus need to be interpreted with more caution than other results. These results are also in contrast to the study from McGee *et al.* (2009), who reported a Cronbach's $\alpha = 0.80$ for the marshaling items.

Third, we only examined the effectiveness of the training directly after participation and in European countries. Future research should also assess the long-term success of the training, for example, by collecting additional data after six months. This would provide a clearer understanding of the training's long-term effectiveness. Furthermore, the training should be conducted outside of Europe, as regional differences – such as varying unemployment rates for graduates and other countries- or region-specific factors – might influence the outcomes. Nonetheless, we assume that the training topic remains relevant across countries, as most nations face similar challenges.

Fourth, we observed that considerably more women than men participated in our workshop. We can only make assumptions regarding possible reasons for this imbalance. One reason might be that we advertised the workshop with keywords such as teamwork, extend your network or solve digital, ecological and social problems, which might have appealed more to women than men. Future research is thus not only encouraged to collect more data with male participants but also examined potential reasons for the higher participation rate of women in this kind of workshop.

Conclusion

This study introduced training to enhance knowledge entrepreneurship among students in the transition phase from graduating to starting a career. The training helps students to reflect on their career competencies and marshaling. Participants of the training did, however, not report heightened behavioral intentions to use their knowledge to tackle existing challenges. Compared to a control group, participants did not differ before training, ruling out self-selection effects, but exhibited significant differences to the control group after participation regarding all three outcome variables. We conclude that the developed training is a valid tool to support students during their critical transition phase. It also enables universities to actively contribute to the fulfillment of the Sustainable Development Goals while addressing the graduate skills gap currently faced by employers.

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Supplementary material
The supplementary material for this article can be found online.

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