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How to facilitate technology push innovation strategy in a university context – towards an action-based startup experience

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Abstract

The one-semester master's seminar "Startup Experience" enables student entrepreneurs to explore potential applications based on existing and patented university technologies. On this premise, they develop their own technology-based venture while following a specific course structure that includes action-oriented learning sessions, regular mentoring sessions with representatives from the startup scene, reflective diaries after each session, and ongoing interactions with various stakeholders in the field of the respective application. This paper will present the conceptual development, practical execution and evaluation of the seminar.

Keywords: Technology Application Selection; Spin-off; Action-based learning; Entrepreneurial Education

1. Introduction

In recent years, great emphasis has been placed on transferring technological innovations from science to the industry through commercialization [1]. One of the main sources of such technological innovations are universities and other public research organizations [2], which are seen by policymakers as increasingly conducive to technology transfer [3]. Universities benefit from the translation of knowledge gained through research into practice by means of financial gains or other non-monetary benefits. One way for a university to commercialize technology and transfer it to industry is through spin-offs [4]. Therefore, a narrow definition of a university spin-off is a company that exploits intellectual property or patented inventions from university research [5]. However, this exploitation is only successful if the technology is transformed into a product or service that creates value and can be introduced to the market [2]. Although the relevance of knowledge creation and distribution at universities is emphasized as an important driver of technological innovation and economic growth, and commercialization is pursued [6], many newly developed technologies remain untouched. One of the main reasons for this problem is the lack of detecting suitable applications for technologies [7]. Several approaches can be found in the literature that aim to convert technologies or technological knowledge into value by identifying applications for technologies and selecting the most promising ones [8]. One method is Technology Application Selection (TAS), which can be understood as a crucial part of technology transfer, as it focuses on the identification and selection of suitable applications for new technologies [9], making it a highly relevant topic that should be pursued fostering university spin-offs [8]. In addition, research has shown that previous studies have focused on testing parts of TAS, but consistent, systematically reviewed, and scientifically evaluated studies are lacking [10, 11].

Research shows that incorporating entrepreneurship into education has led to outcomes such as commercialization of

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innovations [12, 13]. To support the process of commercialization in the form of spin-offs in the university context by incorporating the identification of applications for technologies developed and patented at the university, a practically oriented teaching format was developed. As a result, university researchers bring in their patented technologies, which students work on during the seminar to identify applications and convert them into viable business models. The researchers act as experts to the students throughout the process and can use the results to launch a spin-off.

To this end, the TAS process will be integrated at the beginning of the seminar to understand the technology in detail, identify multiple and diverse applications and select the most promising ones. Manthey et al. [2] state, through this process, "the strategy-idea fit can be verified and a strategy for the following process can be set". Consequently, the seminar follows various steps of the entrepreneurial journey, such as prototyping, defining the value proposition and business model, and drafting a compelling pitch to provide students with the fundamentals of transforming the original patented technology into a promising business model. As action-based learning activities in university contexts are getting increasingly important in entrepreneurship education the seminar has been structured according to this approach [14]. Rather than teaching about entrepreneurship and aligning it with the entrepreneurial process, the seminar is about educating for and through entrepreneurship [15].

The goal of the seminar is threefold: students get the opportunity to develop entrepreneurial intention and skills, researchers get the opportunity to explore the potential of their technologies, and the TAS process can be systematically tested and evaluated. The paper aims to demonstrate this design of a practical approach to transform a university's patented technologies into promising business models, paving the way for technology commercialization. Due to the previously described problematic nature of this process, the seminar incorporates the identification of applications for patented technologies through the integration of TAS. To this end, an introduction to the subject is first given in Section 2. The course itself, its description, structure, and evaluation are described in Section 3. Finally, the conclusion of the paper is presented in Section 4.

2. Theoretical Part

TAS is an innovation approach aiming to transform technological knowledge into value [16]. Thereby, it is a technology-push approach that is not often used, as the market-pull innovation approaches gain more attention [17, 9, 18]. It was developed by Larsen et al. who modified a general market-pull model, resulting in the first TAS model [19]. The TAS process is designed to understand a technology at a very deep level so that several alternative applications for it can be identified, which must then be evaluated to select the most promising application, see Fig. 1. Within the process the technology must be first characterized to ensure a deep and comprehensive understanding of the technology. Based on this technology characterization, multiple and alternative applications for the technology must be identified. After identifying several alternative applications, they are evaluated to finally decide on one application to pursue.

Fig. 1: Technology Application Selection (TAS) process [19]

The current state of research shows that there are several TAS approaches, with most studies mainly examining parts of the TAS process using theoretical and practical approaches. Of these studies, few are concerned with developing and testing practical approaches to promote the discovery of new technological applications. Moreover, there is a great need for a systematic and scientifically tested TAS process, but most studies are inconsistent and lack scientific evaluation [10, 11]. Accordingly, the paper conceptualizes, implements, and evaluates the TAS process in a seminar to develop a practical approach to foster technology application discovery.

The KIT is an elite university and is considered one of the most prestigious universities in Germany [20]. In 2021 it contributed to innovations with 120 notices of inventions, 51 patent applications and 37 spin-offs [21]. KIT in Karlsruhe is a key player in making the city an attractive location for startups. Karlsruhe offers a great network with the largest regional active high-tech entrepreneur network in Europe, the largest university group for founders and the largest university incubator in Germany. KIT sees itself as an active part of this stronghold of knowledge and offers various curricular formats to this end. In this regard, the Startup Experience seminar was first initiated three semesters ago. While it was initially a pilot project with freely chosen technologies of the university to test the framework conditions of the seminar, researchers of the KIT can now bring in their patented technologies who are interested in a spin-off.

A frequently tested framework for seminars in entrepreneurship education at KIT, in particular at the Institute for Entrepreneurship, Technology Management and Innovation, is shown in Fig. 2.

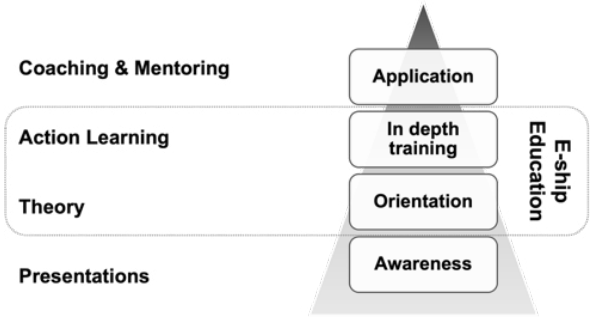

Fig. 2: Seminar framework [22].

The framework comprises mainly four elements. Starting with the *awareness* for entrepreneurship, presentations are held that tune into the respective topic. With the element *theory*, in which theories of entrepreneurship are taught, students should receive an orientation to the topic. Build upon those elements

an in-depth training is realised by *action learning*. The goal is to apply theory to a simulated context. Research has proven that such active learning improves student learning outcomes [23]. This evidence can also be cited in the case of entrepreneurship education [24], especially when students apply what they learn in a real-world context. Real-world learning not only helps them develop new skills, but also ways of thinking [25]. According to Bell and Bell [15], this structured learning activities should be consistent with the entrepreneurial process. Within the approach of these last two elements in figure 2, entrepreneurship education is carried out. Finally, the approach is to promote entrepreneurship by supporting the application process with *coaches and mentors*.

To address the need to transform patented technologies from universities into spin-offs by emphasizing the identification of the application as a crucial point of technology transfer, we have developed a hands-on seminar based on the described framework. We present our course material of "Startup Experience" with the following principles:

- Real-life-simulation
- TAS process integration
- Action-based learning
- Mentoring
- Learning diaries

3. The course

3.1. Course description

Startup Experience is a one-semester master's seminar that allows up to 24 students to experience firsthand the life of a founder by simulating a real-world context. Participants go through an entrepreneurial journey with a team of three to five students over a six-month period. It is simulated that the teams work together on their own startup ideas, which they have developed based on a patented KIT technology to achieve the foundation of a potentially successful spin-off. Fig. 3 shows

For this purpose, the participants are given a technology developed from researchers at the KIT to work on, find applications, and develop a promising business model for it, see Fig. 3. This technology-driven innovation strategy aims at using new or emerging technologies and thus commercializing university research. Meanwhile the researchers act as external consultants to ensure technological feasibility and to obtain feedback for the development of the application and business model. To take a systematic and consistent approach to identify an application for KIT technologies, the TAS method is used and integrated at the beginning into the seminar process.

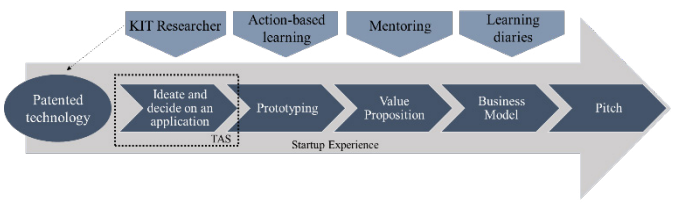

Fig. 3: Course description Startup Experience.

In terms of content, students start by finding and deciding on an application for the presented patented technology and move on to prototyping, defining the value proposition and business model. In the end, they design a convincing pitch for their developed idea and present it in front of the researcher and several stakeholders of the Karlsruhe entrepreneurial ecosystem. This entrepreneurial journey is supported by learning-by-doing activities in a group and networking context. Within six one-day sessions, students become familiar with relevant theory and apply it at once. The action-based learning approach is realized by providing a stimulus with a theoretical presentation and then asking the entrepreneurial teams to apply the theory to their own idea. In the various sessions, students are given not just one stimulus, but several, to give students, the opportunity to put the content instantly into practice.

In addition, the student teams are paired with two mentors who already have their own entrepreneurial experience, such as having founded their own startup or working in a startup. This allows the mentors, to help and navigate the students through their entrepreneurial journey and develop the foundations for a potentially successful spinoff. Teams are obliged to meet with the two mentors at least after each of the six sessions but can also contact them at any time if they need feedback or assistance.

Not only is mentoring an opportunity for student teams to further elaborate and validate their ideas but writing a learning diary also supports this process. After each session, each participant must reflect on the session itself and the development of the previous entrepreneurial journey. Hägg [26] shows that this reflective thinking plays an important role in the educational process and, moreover, provides the link between theory and practice in an experiential pedagogical approach.

At the end of the seminar the students and their teams will be evaluated on the following components:

- Business report
- Pitch Presentation
- Mentoring Sessions
- Learning Diary
- Active participation

The first three components are group-based assessments. The student teams have to present their developed application for the technology and respective business model in a business report of maximum 20 pages. In addition to this report, the teams have to give a 5 minutes pitch presentation on their business model in front of a jury: the researcher of the patented KIT technology, several stakeholders of the Karlsruhe start-up ecosystem such as professors, industry representatives, and entrepreneurs. As mentioned earlier, teams will also be evaluated on their participation in the mentoring sessions after each day of the seminar.

The other two components focus on the individual performances of the students. The learning diary is to be submitted two to three pages after each session of the seminar with guiding questions on the respective topics of the sessions. Students' active participation in the six sessions of the seminar is also part of their evaluation. Research shows that active

participation as part of the entrepreneurial experience is important in developing students' entrepreneurial interest and potential for business creation [27]. Accordingly, not only active participation in the seminars is required, but also participation in entrepreneurial events within the Karlsruhe ecosystem.

The seminar is led by two EnTechnon lecturers in charge, who follow a co-teaching approach and provide the main content, but also act as the primary contact person. Co-teaching in this context means that two lecturers work together to teach a heterogeneous group of students [28]. In addition, the seminar content is also taught by other stakeholders who are experts in the field they teach.

3.2. Course structure

The course is mainly divided into six sessions over the period of one semester, see Table 1. It begins with an introduction to the seminar and getting to know each other. This also sets the spirit for the topic of entrepreneurship with a presentation. After that, there is a special focus on team building, as participants will work in teams throughout the whole seminar. This is to ensure that teams are working together effectively and not bogged down by conflict or other problematic issues [29]. After the teams have been formed and the students have gotten to know each other, an introduction to the TAS process is given, which in turn is divided into five phases.

The first phase is for "*understanding*" the patented technology and to familiarize students with the technology for which an application needs to be identified during the seminar. Accordingly, the patented technology is to be characterized and its features assessed. Since the seminar is designed to spin-off university research, at this point the researcher of the technology will be involved, invited to the session to present the technology in detail and answer questions from the students. Based on this, students subsequently explore first application ideas through different creativity techniques and enter the second phase of the TAS process *"ideate"*. To encourage creativity, students are presented with three ideation anchors, based on which they develop different application ideas for the technology. The numerous ideas collected must then be clustered according to their originality and feasibility, i.e., from a subjective perception. Therefore, in the following, the ideas are additionally grouped thematically, and duplicates are eliminated.

Phase three *"decide"* is given as homework, which allows the students for more creative freedom and gives them enough time to elaborate their ideas in detail based on extensive research and renewed consultation with the researcher and to check it against four to seven criteria such as technical feasibility, market attractiveness and profitability. Further it is important for the students to exchange their ideas with experts and other stakeholders already at this stage, which is part of their homework [30, 31]. Therefore, the teams also meet with their mentors. These discussions feed into a decision matrix, which the teams use to finally settle on the three best-ranked and most promising ideas.

The second day of Startup Experience is about "*defining"* the three ideas that the students have chosen, phase four of TAS. It aims to understand the underlying problems and also the customer. In addition, the jobs that the product or service will perform must be defined, and the desired outcomes need also to be monitored. The final step of this phase is to determine the critical hypotheses for the ideas to be tested in the next step. The hypotheses created must be validated by the teams by the next meeting with their stakeholders through interviews, surveys and expert discussions in order to adapt their ideas according to the lean startup approach [32].

"Sharpening" the idea is the goal of the third day and thus also the last phase of the TAS process. Here, students need to identify trends and competitors in relation to their idea and their industry. With this preliminary work, the participants can then clearly differentiate their idea from other products and services and work out its added value. The result is a well-formulated value proposition statement. This statement is a common and acknowledged practice in entrepreneurship to support the development of an idea, as you are able to present the idea to others in a simple and quick way [33]. After these two and a half days, the TAS process is complete and with it the development of a promising application for the patented technology in terms of various types of feasibility, superficial financial considerations, and a comprehensive analysis of the customer. The decision is also supported by several feedback sessions with experts and potential customers. This is not the end as the idea still needs to be thought through further to be solid.

Table 1. Startup Experience content.

Seminar day	Curriculum	Homework
1	Introduction	TAS Phase 3
	Team Building	Expert and stakeholder discussions
	TAS Phase 1	
	TAS Phase 2	
2	TAS Phase 4	Validation of hypotheses
3	TAS Phase 5	Customer interviews
	Impact	
	Prototyping	
	Decision-Making	
4	Market + Marketing	
	Vision + Mission	
5	Financial Planning	Pitch Presentation
	Business Model Canvas	
	Pitching	
6	Pitch Presentations	

The teams are sensitized to think about the *impact* of their idea in the short and long term, not only on an economic level, but also on an environmental and social level. To further elaborate the idea, the first *prototype* is built using different techniques and presented to the group to get feedback and improve the Minimum Viable Product (MVP). An MVP should attract first customers as it has enough features and thus validates the product [34]. The day ends with an introduction

to *decision making*. Entrepreneurs need to make decisions all the time, and often with limited information [35]. For this reason, students will be introduced to the Effectuation Decision Canvas, which was developed specifically to support early-stage startup decision-making [36].

On the fourth day, the participants deal again with the market and its competitors, because it is very important as an entrepreneur to be well informed about current market events. Therefore, the market must be segmented according to customers, sales channels identified, and a marketing strategy developed based on this. With all the information students now have about their idea, teams need to explore how to make it happen. What are the possible revenue streams, what are the core activities and processes of the startup, and how can they implement them as a team. Together, the teams finish by defining a vision and mission.

The fifth day will provide an introduction to financial planning as a very important element of success. Afterwards, the information gathered so far are summarized in the Business Model Canvas. This supports the students in getting an overall picture of their idea and develop a pitch [37]. An introduction to pitching is also part of the fifth day. The seminar ends with the students' pitches in front of a jury composed of the researcher of the patented technology and various stakeholders of the Karlsruhe entrepreneurial ecosystem such as professors, industry representatives and entrepreneurs.

3.3. Evaluation

The university has developed an own standardized evaluation form which is scientifically proven and used as a measurement instrument for each lecture and seminar. The students are asked to provide feedback on the course itself, the premises, the lecturers, and general information about their studies. There is also a free text passage at the end for students to comment on the seminar. Students who complete this assessment give favorable ratings, but the instrument is not designed to assess a newly developed course.

For this reason, after completing the entire seminar, participants were asked to answer a survey, but also to give an interview. An overall positive picture of the seminar and the TAS process was painted. It was helpful for the students to start with a patented technology presented by a researcher rather than follow a market-pull approach. Meanwhile, it was also a challenge for the students to start with a technology they did not know yet and with which they first had to familiarize themselves, for which they would have liked to have had more time.

The TAS process was rated as simple and understandable due to the step-by-step instructions provided to the participants. Nevertheless, not all students strictly adhered to them, as in some cases a different order of items was felt to be more appropriate. On the one hand, TAS supported the consideration of all alternatives, gave some helpful tools for the whole process and encouraged learning new approaches. On the other hand, there was some criticism that students had unclear tasks and did not understand the difference between tasks within the process. Also, some information for the TAS process was missing and students were dissatisfied with the limitations of the process.

The students also mentioned the triple feedback they kept getting during the seminar: from the researcher, from the mentors and from the stakeholders. This was helpful for them to constantly develop and adapt their idea and to be able to react quickly to changing stakeholder needs.

With regard to the seminar organization, they particularly stressed the support and helpful information provided to them. At the same time, they criticized that they received too little information and wished for more opportunities to consult the supervisors. Nevertheless, seminar participants were positive about the impact of the lecturers. In addition, the students would like to emphasize the good interpersonal atmosphere they perceived in Startup Experience, as it ensures good cooperation and mutual motivation. The majority of the students seemed to be very satisfied with the seminar and confirmed that they would choose this seminar again.

Examination of the students' Business Report and personal reflection journals, provided some evidence of the impact of the course on the students. The quality of reflection was generally quite high and showed good personal insight and learning. Furthermore, the final pitches showed interesting and partly promising business models. The stakeholders of the Karlsruhe entrepreneurship ecosystem were fascinated by the quality of the ideas developed.

The evaluation is still ongoing, but the first impressions of the researchers are very positive as they are involved in the process and can observe the progress. They also appreciated the opportunity to contribute their knowledge and technology to a course, as they were concerned that the technology would not be utilized because they lacked the necessary startup-related knowledge needed to develop a business plan.

Based on the feedback received, the seminar will be adapted accordingly. First of all, more time should be allocated to give students the opportunity to familiarize themselves with the patented technology. Even though the three-way feedback is of great value in developing students' ideas, the session is extended with research to help students understand the technology better and more easily. Also, differentiation between the tasks given to the students should be made clearer for the students and provide them with more relevant information. Therefore, a booklet could be helpful to support the teams in their entrepreneurial journey. However, flexibility in the application of the TAS process should be maintained. Besides other forms of communication will be taken in to consideration to consult the lecturer at any time.

4. Conclusion

This paper presented a concept for a teaching format at a university that supports the transformation of patented technologies from a university into a spin-off, thus enabling the commercialization of patented technologies. To this end, university researchers can bring in their patented technologies to be exploited by students into mature business models during the seminar and use the results to establish a spin-off.

The problem with leaving most of these technologies untouched is that suitable applications for them are not found,

which is why TAS was part of the conceptualization of the seminar. TAS is a process for converting technologies or technological knowledge into value, which makes it an appropriate method for the expressed need. TAS was placed at the beginning of the seminar to ensure a deep understanding of the patented technology, but also to support the process of finding an application for an existing patented technology to realize its potential. The seminar developed was used to systematically test and evaluate the TAS process.

After this starting point, and with the most promising applications that the participants could think of, the seminar followed an entrepreneurial journey to further simulate the real-life context of an entrepreneur. The entire seminar was designed for action-based learning, so that students could immediately apply the presented content to the patented technology and its applications. Based on this design of the seminar, we were able to provide a format for researchers to develop applications and business models for their patented technologies. So far, the feedback has been that this type of opportunity is appreciated, and the applications and business models developed seem promising. Nevertheless, a limitation of this research is that no predictions can be made about how many spin-offs will result from this seminar.

The students got the opportunity to experience the life of a founder firsthand by getting to work on a patented technology from the university, which was very motivating for them. They indicated that it was helpful to start with such technology, and according to their feedback, the university should offer the seminar every semester, as participation was only recommended by the students. In addition, students highlighted the three-way feedback they received. The researcher's close involvement with the patented technology itself made it easy for students to get feedback, especially if the application is feasible. Interaction with stakeholders and the entrepreneurial ecosystem in Karlsruhe allowed to assess the status quo of the business model and adapt it according to requirements. Finally, the feedback from the participants was valued by the mentors to get an independent perspective on the developed application and business model. The feedback was also a valuable source to develop the seminar accordingly and make it more suitable and effective in the next semester. This shows that this format needs even more validation. Even if a real-life-simulation is aimed at, it is limited by the time the seminar takes place, as only 6 sessions are held within 6 months.

The integration of the TAS process into the seminar provided initial insights into the effectiveness of promoting university spin-offs through this method. TAS proved to be a convenient approach for developing applications for a technology because it was easy for participants to understand and implement, but becoming familiar with the technology seems to be the crucial part within the process for which the seminar participants need enough time. So far, research on the suitability of this format is limited as it has only been conducted three times.

Nevertheless, the distinction between the phases of the process should be made clearer in further concepts, as the participants had the impression of working on the same task again. Although a systematic and scientifically evaluated TAS process has been tested, further studies need to focus on such a practical approach to further assess the suitability of TAS. As part of this the transfer of the concept to other smaller universities with limited resources or even to another context, such as an accelerator program, also needs to be explored. This shows that future researches should incorporate TAS combined with an entrepreneurial journey to support technology commercialization.

References

[1] Ravi R., Janodia M. D., 2022. Factors Affecting Technology Transfer and Commercialization of University Research in India: a Cross-sectional Study. *Journal of Knowledge Economy* 13, pp. 787–803.

[2] Manthey S., Terzidis O., Tittel A., 2022. Technology Application Selection - the TAS Framework.

[3] Siegel D.S., Phan P.H., 2005. Analyzing the Effectiveness of University Technology Transfer: Implications for Entrepreneurship Education. In: Libecap, G.D. (Ed.) *University Entrepreneurship and Technology Transfer*. Emerald Group Publishing Limited, Bingley, p. 1-38.

[4] Miranda F. J., Chamorro A., Rubio S., 2018. Re-thinking university spin-off: a critical literature review and a research agenda. *Journal of Technology Transfer* 43, pp. 1007–1038.

[5] Di Gregorio D., Shane S., 2003. Why do some universities generate more start-ups than others?. *Research policy* 32, pp. 209-227.

[6] Müller C., Fujiwara T., Herstatt C., 2004. Sources of bioentrepreneurship: the cases of Germany and Japan. *Journal of Small Business Management* 42, pp. 93-101.

[7] Lynn F., Heintz S., 1992. From experience: where does your new technology fit into the marketplace?. *Journal of Product Innovation Management* 9, pp. 19-25.

[8] Manthey S. I., Eckerle C., Terzidis O., 2022. Tackling the critical hurdles – revising technology-based ideation processes. *17th European Conference on Innovation and Entrepreneurship*.

[9] Terzidis O., Vogel L., A Unified Model of the Technology Push Process and Its Application in a Workshop Setting. 2018. pp. 111–135.

[10] Henkel J., Jung S., 2009. The technology-push lead user concept: a new tool for application identification.

[11] Kuo, D. C. L., Lin, C. C., Yang, J.L., 2011. Reconsidering the role of brainstorming in the marketing of technology-driven innovation. *International Journal of Technology Marketing* 6(1), pp. 4-16.

[12] Lackeus M., 2015. Entrepreneurship in education, what, why, when, how, Entrepreneurship 360 background paper. OECD, Paris.

[13] Rasmussen E.A., Sørheim R., 2006. Action-based entrepreneurship education. Technovation 26(2), pp. 185-194.

[14] Grant K., 2022. Enabling Undergraduate Student Entrepreneurs to Structure Their own Experiential Learning Course. *European Conference on Innovation and Entrepreneurship* 17, pp. 249-257.

[15] Bell R., Bell H., 2020. Applying educational theory to develop a framework to support the delivery of experiential entrepreneurship education. *Journal of Small Business and Enterprise Development* 27(6), pp. 987-1004.

[16] Maier M.A., Hofmann M., Brem A., 2016. Technology and trend management at the interface of technology push and market pull. *International Journal of Technology Management* 72, pp. 310–332.

[17] Bishop, G.L., Magleby, S.P., 2004. A Review of Technology Push Product Development Models and Processes. *Proceedings of the ASME 2004 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference* 3a, pp. 383–392.

[18] Leavy, B., 2012. Collaborative innovation as the new imperative – design thinking, value co - creation and the power of "pull". *Strategy and Leadership* 40(2), pp.25-34

[19] Larsen J., Magleby S., Howell L., 2001. An Engineering Approach for Matching Technology to Product Applications. *13th International Conderence on Engineering Design (ICED01).*

[20] Weisenburger E., 19.07.2019. KIT ist wieder Elite-Uni. https://bnn.de/karlsruhe/kit-ist-wieder-elite-uni.

[21] Karlsruher Institut für Technologie, 01.03.2022. Zahlen, Daten, Fakten. https://www.kit.edu/kit/daten.php.

[22] Terzidis O., Presse A., Metzeler F., 2013. Creativity in Teaching and Learning - Existing Concepts and new Formats. *Entrepreneurship Research - Discussing Today the Awareness of Tomorrow : YERC 2012*, pp. 96–113.

[23] Freeman S., Eddy S., Mcdonough M., Smith M., Okoroafor N., Jordt H., Wenderoth M., 2014. Active Learning Increases Student Performance In Science, Engineering, And Mathematics. *Proceedings Of The National Academy Of Sciences* 111, pp. 3410-3415.

[24] Lassas-Clerc N., Delmar F., Fayolle A., 2008. Entrepreneurship Education Initiatives: Does Active Learning Really Make Difference? (Summary). *Frontiers Of Entrepreneurship Research* 28.

[25] Lewis L.H., Williams C.J., 1994. Experiential Learning: A New Approach. In: Jackson, L., Caffarella, R. S. (Eds.). Jossey-Bass, San Francisco.

[26] Hägg G., 2021. The entrepreneurial diary – a reflective learning activity to enhance the judgmental abilities of student entrepreneurs. *International Journal of Entrepreneurial Behavior & Research* 27(5), pp. 1142-1165.

[27] Olokundun M., Moses C. L., Iyiola O., Ibidunni S., Ogbari M., Peter F., Borishade T., 2018. The effect of non traditional teaching methods in entrepreneurship education on students entrepreneurial interest and business startups: A data article. *Data in Brief* 19, pp. 16-20.

[28] Aicha D., 2021. Co-Creation Strategy, New Challenges in Entrepreneurship Education. *GATR Journal of Buiness and. Econnomics Review* 6(2), pp. 112–121.

[29] Klein C., DiazGranados D., Salas E., Le H., Burke C. S., Lyons R., Goodwin G. F., 2009. Does Team Building Work? *Small Group Research* 40, pp. 181–222.

[30] Campanella F., Del Giudice M., Thrassou A., Vrontis D., 2020. Ambidextrous organizations in the banking sector: an empirical verification of banks' performance and conceptual development. *The International Journal of Human Resource Management* 31, pp. 272-302.

[31] Harrison J. S., Bosse D. A., Phillips, R. A., 2010. Managing for Stakeholders, Stakeholder Utility Functions, and Competitive Advantage. *Strategic Management Journal* 31, pp. 58-74.

[32] Eisenmann T. R., Ries E., Dillard S., 2012. Hypothesis-Driven Entrepreneurship: The Lean Startup. *Harvard Business School Entrepreneurial Management Case No. 812-095*.

[33] Kirchberger M., Wouters M., Anderson J. C., 2020. How Technology-Based Startups Can Use Customer Value Propositions to Gain Pilot Customers. *Journal of Business-to-Business Marketing* 27, pp. 353-374.

[34] Ries E., 2011. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business, New York City.

[35] Busenitz L.W., Barney J.B., 1997. Differences between entrepreneurs and managers in large organizations: biases and heuristics in strategic decision-making. *Journal of Business Venturing* 12(1), pp. 9– 30.

[36] González M.M., Terzidis O., Heblich B., 2022. Enabling Entrepreneurs to Build on their Means: The Effectual Decision-Making Canvas. *Conference proceeding 28th 31st IEEE ICE/ITMC and IAMOT Conference IEEE*.

[37] Trimi S., Berbegal-Mirabent J., 2012. Business Model Innovation in Entrepreneurship. *International Entrepreneurship and Management Journal* 8, pp. 449-465.