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# Utilizing Design Factory Principles towards Education 4.0 - Developing Innovation Spaces in Vietnam

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**ABSTRACT**

In developing Education 4.0, educational institutions need to redesign their learning environments and operations. Connecting real-life challenges from the world of work to the learning processes of the future workforce is crucial in achieving relevant competencies. This article, in the context of the EMVITET Erasmus+ capacity building project, discusses how the Design Factory principles can support the development of innovation spaces for Education 4.0 in Vietnam. In this qualitative practice-based study, three universities and three vocational institutions in Vietnam describe how they have applied the main ideas of the Design Factory concept to their own context. The results show that Design Factory principles can be successfully applied in the Vietnamese higher education and they can help in creating added values for all of the stakeholders including students, teachers and work-life partners. Some challenges in development and respective solutions for them are also discussed.

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## 1. Introduction

Education 4.0 requires new mindsets and competencies, but also novel application of physical and digital resources (Kunnari et. al. 2019; Miranda et.al, 2021). The rapid changes in the world of work and in Industry 4.0 drive educational institutions to further design the pedagogical practices and environments (Shwab, 2016). For higher and vocational education, this means that a traditional school environment is not enough, but it is crucial to connect the real-world challenges and work-life partners into the learning process of the future workforce. By creating this learning ecosystem model, educational institutions can better assure that their students learn relevant competencies. Acting as a part of the model, work-life partners are benefited from the fresh perspectives of students and the diverse professional expertise of the educational institutions in solving their ambiguous business challenges. Education 4.0 means coming out of the boxes towards a more connected learning ecosystem with new roles for teachers, students and work-life partners.

The EMVITET *"Empowering Vietnamese Teachers for Transformation towards Education 4.0*" Erasmus + Capacity Building in Higher Education (CBHE) project, has focused on developing a

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learning ecosystem for Education 4.0 in Vietnam, initiated by six Vietnamese educational institutions with the facilitation of three European partner universities. In this three-and-a-half-year project (2019-2022), the concept of Education 4.0 was described:

*"Education 4.0 shifts mindsets and approaches in learning and teaching. Digitalisation enables learning to occur anywhere which makes learners key actors in their own learning. Teachers change their role to facilitators of learning. Instead of focusing so much on degrees, learning concentrates on relevant competencies. Education 4.0 refers also to ecosystems of educational institutions and the world of work, which produce innovations and evolve in the change. It means that in education we do not just adapt to changes, but we actively build our own meaningful future. In Education 4.0, the traditional ways of implementing education are not enough, but we need to rethink learning and education to match the needs of the changing world." (Kunnari et al. 2019)*

The EMVITET- project is responding to the need in Vietnam to improve the quality of Education 4.0 by strengthening the student-centered and competence-based education and by building collaboration with industry. These connections between university and industry are crucial in establishing national innovation systems, but they are still in the early stages and there are areas of development (Hoc & Trong, 2019; Nguyen et al., 2017). It has been noted that the higher education sector is not yet operating to its full potential to provide mutual benefits for all stakeholders. On the other hand, the added value of the university-industry has been identified (Hoc & Trong, 2019, Polt et al., 2002; Guimon, 2013; OECD, 2002, 2012) including, for example: improving the quality of teaching, providing students opportunities to build their own career by working closely with companies, providing the university with appropriate information to develop curricula that satisfy the practical needs of companies, reputation enhancement of both education and industry. In Vietnam, there is already awareness of the benefits (Hoc & Trong, 2019) and also positive mindset toward strong linkages between education and industry (Jamaludin et al., 2020). However, not all of the solutions are fully developed such as establishing innovation spaces for collaborating with industry.

During the process of the EMVITET project (2019- 2022), teachers and managers from the six Vietnamese educational institutions were engaged in opening their minds to what Education 4.0 can mean in practice. Three competence areas were determined for teachers (see Kunnari et al., 2021), namely, Pedagogy and Learning Design in Education 4.0, Digital Technology in Education 4.0 and Learning Ecosystem in Education 4.0. These competence areas are overlapping as pedagogy, digital technologies and learning ecosystems are all essential for Education 4.0. The last one is the most important one for building learning ecosystems with industry and business. It highlights the importance of emotional intelligence in creating added values for all of stakeholders who are students, teachers and companies. The activities of the EMVITET project have included study visits to Finland, and collaborative face-to-face and online learning workshops together with teachers and managers to create an empowering learning process to develop pedagogical practices and effective use of digital technologies as well as learning ecosystems towards Education 4.0 in Vietnam.

Häme University of Applied Sciences (HAMK), Finland, has been responsible for facilitating the development of innovative models on how to enhance the successful collaboration between educational institutions and the world of work. Universities of Applied Sciences (UAS) in Finland have the mission to train professionals with an emphasis on labour market needs and to conduct research and development, which supports instruction and promotes regional development in particular. On the mission level, the education in UAS emphasises cooperation with the business, industry and service sectors at the regional level in particular. HAMK has implemented several concepts to address this need. These include Entrepreneurial University and Design Factory.

Design Factory (DF) was established in HAMK especially to enrich collaboration with industry, where industry and businesses can benefit from finding solutions for new challenges in rapidly changing and disruptive business environments. On the other hand, the DF concept was implemented particularly to address the need for interdisciplinary student projects for an industry that extends beyond traditional disciplinary boundaries and Degree Programmes. By doing so, the DF concept provides larger

opportunities to find solutions to industry problems and challenges that are typically not limited to a single discipline or Degree Programme inside the university. Besides that, they offer students better opportunities to learn skills for the changing world, such as problem-solving, creativity, collaboration and innovation.

During the study visits to Finland in 2019, both Vietnamese managers and teachers were introduced to the work-life related higher education and especially to the HAMK Design Factory model. The development activities continued during 2020 and 2021 with online workshops and assignments on how to apply these ideas to the Vietnamese context.

## 2. The aim and approach of the article

The aim of this article is to explore what achievements the Vietnamese teachers gained and what challenges they confronted in developing innovation spaces for Education 4.0 in Vietnam. In this qualitative practice-based study, we start by describing the Design Factory approach and principles, which the Vietnamese teachers utilized in their innovation space development. After that, six case-studies of different higher and vocational institutions utilizing the Vietnamese practitioners' own experiences and descriptions are introduced. Finally, at the end of the article are discussion and conclusion for some ideas that can help in developing innovative spaces for Education 4.0 in Vietnam.

## 3. Design Factory approach and principles in university-industry collaboration

In 2019, HAMK Design Factory (HAMK DF) was established to strengthen the learning ecosystem with work-life by providing an interdisciplinary product and service design and learning platform uniting students, teachers, researchers, and industry. It offers authentic physical, digital, and social learning environments for all the stakeholders aimed at solving real-life business challenges with a design thinking approach (Meinel & Leifer, 2011; Jussila et al., 2020; Kunnari et al., 2021; Lahdenperä et al., 2022). The core values guiding HAMK DF include equality, inclusiveness and passion for learning. Most often the used approach in HAMK DF for university collaboration builds on design thinking, at times also modified to particular needs of university-industry relationships, for example, design thinking for data-analytics (Järvenpää et al., 2022).

From the previous study related to the development of HAMK DF, the pedagogical approach was elaborated as co-creation pedagogy (Kunnari et al., 2019), whose main elements are student-centered learning, competence-based education, teachers as co-creative facilitators and passion-based co-creation resulting in a new creation - whether tangible like a prototype of a product or intangible like a prototype of a service or process. Another study (Kunnari, 2021) identified the new role of teacher-facilitator in the pedagogical approach highlighting the need to change the mindset towards trust in learning and development, collaborative work with work-life partners, experimental attitude with the joy of uncertainty and an acceptance of incompleteness. In the following, the actual steps in DF operations with students and companies are described.

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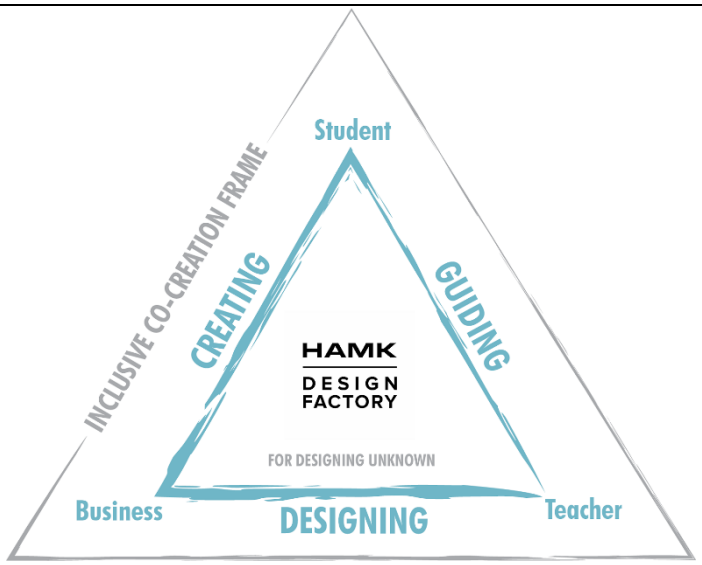


**Figure 1. Co-creation pedagogy framework (Jussila et al., 2020; Kunnari et al., 2019).**

Co-creation pedagogy considers three important roles: students, teachers and companies. Companies have a demand for solutions for real-life business challenges that provide authentic learning environments for students. Students are at the centre for creating solutions for companies in authentic learning environments and teachers work as facilitators guiding the process and co-designing the challenge with the companies. From a teacher-facilitator perspective, the process starts with discussions with partners interested in collaborating with the university. When a mutually beneficial collaboration is identified, the brief of the challenge is co-designed by the partner and teacher-facilitator(s).

The DF concept is best suited for complex or wicked problems, where there is uncertainty in problem and solution space, put simply the path from problem to solution is unknown and there is no "one correct" or optimal solution to the problem. Depending on the case, formal agreements may be signed by the parties, which can involve the exchange of resources necessary for completing the process. The teacher-facilitator(s) then organizes the course or learning event that begins the student learning process. Each project implementation is unique, however, the design thinking process followed by the students includes typically six common steps (Jussila et al. 2020):

- Step 1, students are introduced to the challenge and students start to explore the problem space by empathizing with the users and doing desk research on existing knowledge and possible solutions related to the problem space. Desk research aims to develop analytical skills related to the topic area of the design challenge by collecting existing information (e.g., solutions, products, ideas, learnings) in the context of the design challenge and relevant related areas (Wiesche et al., 2018). Commonly, following or parallel to desk research interviews are conducted with the aim to understand and synthesize user needs and develop empathy for the identified user group(s) (Beckman & Barry, 2007).

- Step 2, students define the problem worth solving based on the understanding gained from the user research. The problems are typically formulated as "How might we…?" statements (Charosky et al., 2018). For example, "How might we design a wearable smart vest that measures the vitality of the worker and informs in case there is a need to take a break from work? The problem worth solving should be desirable, feasible, viable and sustainable from the perspective of users (Lahdenperä et al., 2022).

- Step 3, students ideate solutions to the problem worth solving. Several idea generation methods can be used by the students with or without guidance from the teacher-facilitators depending on the students' competence and previous experience in ideating. For an overview of idea generation methods and creativity methods suitable for design thinking, see, for example, the study of Kirjavainen & Katja Hölttö (2021) or the design thinking toolbox (Lewrick et al. 2020) for more practical instructions.
- Step 4, students create one or more prototypes to make their ideas more tangible and easier to communicate. Creating prototypes has several aims including exploring different ideas while focusing on specific and important needs in an innovation project and learning to take ownership of innovation projects (Wiesche et al., 2018). Prototypes are ideal for thinking with your hands and testing your assumptions.
- Step 5, students test the prototype with users. Testing is a crucial part of the design thinking process. The aim of testing is to evaluate the generated ideas based on feedback and refine those ideas by building on empirical learnings (Wiesche et al., 2018).
- Step 6, students pitch the solution to the client. Pitching of the solution is an important part of the communication of the innovation project (Kunicina et al., 2018). Teacher-facilitators have a role in pitching training and can also support the pitching process by organising practice rounds for the students. Pitching templates and pitch decks can be used as aids to support student pitching. Models such as NABC-model: Need, Approach, Benefits and Competition or similar can be helpful for students to prepare their pitching.

## 4. EMVITET partners' case-studies in developing their innovation spaces

The following case-studies reveal the applications of the HAMK Design Factory concept and principles that have been done during EVMITET- project. Here, all of the six Vietnamese partner institutions provide their own narrative related to individual starting points in strengthening collaboration with enterprises and developing their pedagogical practices accordingly. They also elaborate on how they have developed their own innovation spaces with the lessons learnt with HAMK Design Factory. Besides this, they identify success factors and challenges in development and analyse some solutions for them.

### 4.1. Design Factory establishment and implementation in Lac Hong University

Lac Hong University (LHU), founded in 1997, is one of Vietnam's first private universities, located in Dong Nai, an industrial province in the country's southern critical economic zone (including Dong Nai, Binh Duong, Ho Chi Minh City, Ba Ria - Vung Tau). There are currently around 600 staff individuals including over 500 teachers from 10 different faculties, and approximately 7,300 students. LHU's diploma system is rather diverse, providing students with a variety of options, including undergraduate (3.5 to 5 year Bachelor Degree), second diploma (2 year Bachelor Degree), and graduate (1.5 year Master Degree, 3 year PhD Degree). LHU focuses on an active pedagogical approach to provide high-quality human resources who have specialized knowledge, professional competence, qualified skills, management ability and soft skills such as computer science, foreign languages, communication, and teamwork. Aside from enrollment and training, one of the university's most essential goals is to create a learning ecosystem that will help students find jobs after graduation.

In 2006, LHU founded Lac Hong Electronics Club model with the goal of providing a venue for students to exchange their knowledge and professional abilities after class. After that, considering the Techshop model in the United States, which has a variety of machines and tools that anybody can sign up for and

use to build whatever they want. Lac Hong Open Workshop replaced Lac Hong Electronics Club in 2014. This is a maker area where students may come to test prototype their designs using tools and equipment under free guidance from educators and Workshop members. However, because the output of activities mostly focused on discrete trials rather than the running curriculum, this approach had a lot of troubles during operation.

Managers and teachers at LHU discovered that the HAMK DF model was more advantageous to them during the EMVITET project. *"We realized that it is necessary to bring the creative activities of the students at this maker space to solve the real problems of society and business",* stated by an LHU member.

Simultaneously, LHU actors recognized the increase of the teaching efficiency by involving students directly in the process of creating products with businesses. To encourage students' creative entrepreneurial spirit, they transformed the maker space model into the Lac Hong Design Factory (LHDF). Different from its previous forms, LHDF is now an environment where students, teachers, and entrepreneurs collaborate to address real-world business problems. Instead of building a costly R&D team, corporations can use the school's equipment and specialized human resources. Simultaneously, it provides a path for lecturers and students to approach difficulties based on the real-world requirements, which serves as the foundation for their startup ideas.

Following the steps in the design thinking process developed by HAMK DF in Finland, the solar energy cleaning robot is considered LHDF's most successful project (*http://solarbot.vn/)*. Previously, prototypes were built for testing right away, ignoring or skipping empathy and defining processes (Steps 1 and 2). However, these initial stages are critical since they help to clarify project execution and avoid spending time for redoing when the to-be-solved problem is identified incorrectly.

Students, teachers, and businesses are the three major target groups for LHDF's activities. For students, the maker space is equipped with hand tools, electric tools, CNC machines, laser cutters, and 3D printers to support basic manufacturing activities. There are classes on equipment safety, machine tool operating instructions, software design instructions and design processes. These courses are shared with other active members or teachers. Teachers are encouraged to serve as mentors for the groups' themes and to give classes on issues relating to product design and manufacturing. Internship activities, human resource exchange seminars, and alumni events foster relationships and collaboration ideas with businesses. Students have to register to join and perform steps in the manufacturing process when they receive requests from companies to manufacture new products or improve production lines. Teachers serve as a link between students and companies.

Actors in the LHDF have discovered that meeting the requirements of the stakeholders is crucial to the model's success. Businesses have the financial means to fund R&D initiatives at a low cost. Students have a fantastic experience on real projects relating to their major, a chance to approach businesses directly, and follow up the businesses' ideas after graduation. The teaching method used by teachers is really effective in motivating students. Furthermore, instructors receive financial support to help the DF continue to operate.

Nevertheless, the LHDF actors have faced certain difficulties. Finding suitable real projects from businesses for students to participate is quite hard at the lecturer level. It is challenging to fulfil more projects with other businesses while ensuring that their deadlines are met. Students cannot dedicate their complete attention to this activity since they must attend other classes. Therefore, it is difficult to meet the deadlines. When lab equipment fails to meet the technological standards needed to enable product development, the school faces numerous challenges on an organizational level.

LHDF has been looking for genuine projects and increasing connections with businesses, particularly local micro and small firms, through student internships, to address the aforementioned concerns. Second-year students will intern at the company to learn about the issues that the company is facing. Students can introduce LHDF's activities to businesses so that they can share assistance solutions, and students can use this project as a graduation project instead. Students will also be able to obtain work after completing the programme.

The greatest advantage of this model, according to LHDF's experience, is that it meets the needs of stakeholders. Real-world projects, job prospects, and entrepreneurial chances are available to students. Resources for R&D and recruitment possibilities are made available to businesses. Teachers and schools increase teaching effectiveness by using real-world initiatives to solve problems with student output jobs and raise income.

### 4.2. Maker Space in University of Technology and Education, University of Danang

University of Technology and Education - The University of Danang (UTE-UD) was established in 2017 for human resources training in engineering and technology to serve the socio-economic development in the Central and Western highland areas of Vietnam. Currently, the total number of staff is about 240 people with 160 teachers working at 6 different faculties and the number of students is about 5000. UTE-UD now mainly focus on undergraduate programs with 16 majors related to engineering and technology. With highly emphasis on engineering and technology training, UTE-UD always tries to apply new pedagogies in teaching and learning. In addition, UTE-UD integrates into the training programs design thinking, design-implement experiences to develop design capacity, thinking and creative abilities for students. UTE-UD also establishes some Study Research Teams (SRTs) in which students can study and work together on innovation projects. By implementing these solutions, students are supported to develop their design and implementation capabilities. However, this also poses the challenge of having a working space with fabricated machines to create more favorable conditions for students and lecturers.

When participating in the EMVITET project and visiting the DF model of HAMK University, UTE-UD actors realized that *"This is the model that we want to implement to meet the requirements of learning and research for teachers and students at UTE-UD. The DF can provide an innovation space where teachers and students can design, create, innovate and develop the competencies needed to instantly meet work-life requirements. Teachers can build and run practice-based courses and workshops for students where they have a practical environment, practice professional skills, develop creative and entrepreneurial spirit; as well as solving real challenges from work-life partners".*

Therefore, right after returning to Vietnam, UTE-UD deployed to build and purchase equipment to set up UTE's Maker Space with some equipment such as a 3D printer, laser cutting machine, CNC machine, mechanic machine, and electronic measuring devices. UTE-UD also built and trained a team of lecturers and especially senior students to participate in operating and guiding, supporting students and lecturers when teaching, learning and doing research at Maker Space.

To succeed in developing Maker Space, UTE-UD actors have recognized the following aspects. The most important thing is the management mindset of the need to strategically invest in innovative spaces to promote not just only student learning and research but also the University development in Education 4.0. Also, the change in teaching and learning pedagogies which enhances design thinking and design-implement activities and encourages students to work as a team to do projects. Design-implement activities and projects should focus on technology for Industry 4.0 and real work-life problems. To support the activities it is crucial to build an operational team including teachers and senior students for guidance and support. Furthermore, investments in equipment and working space for Maker Space are essential.

UTE-UD actors have also pointed out some challenges for teacher, student and organizational levels. For teachers, it is time-consuming due to hard work. Teachers also need instruction and learning how to use the new types of equipment and how to find real work from the industry. For the students, there is limited time due to other studying. It also requires a passion for learning and a lot of skills, as it is not so easy to work with industry partners. At the organizational level, it requires a new mindset, strategy, budget, and management to enhance collaboration with work-life partners outside the university.

To solve these above-mentioned difficulties, UTE-UD actors believe that they must strengthen cooperation activities with businesses in seeking cooperation opportunities as well as investing resources for Maker Space development. Further, they must invest more in building human resources to organize activities for Maker Space as well as buy more equipment to meet the needs of teachers and students. Teachers need to improve their professional skills and recruit more capable students to build a service team for Maker Space; try to cooperate with the company to solve real-world problems. And finally, new teaching and assessment methods need to be applied throughout the university to encourage students to creatively solve real work-life problems.

The added value of Maker Space, according to UTE-UD is that students will be able to use the Maker Space to translate the Science, Technology, Engineering, and Mathematics theories they learn in the classroom into prototypes for technological solutions for real-world problems. It is not only an educational facility but also a solution and invention laboratory. Maker Space also supports and enhances collaborative teaching and learning; the application of PBL and TBL for teaching and learning. Further, it enhances industry cooperation and helps to build an ecosystem of University-Industry-Student for Education 4.0.

### 4.3. The Maker space model in Ho Chi Minh City University of Technology and Education

Established in 1962, Ho Chi Minh City University of Technology and Education (HCMUTE) is one of the leading universities in the field of technology and technical teacher education in Vietnam. It is located in a strategic location in Ho Chi Minh City with many industrial parks around and with nearly 800 staff and 25,000 students. HCMUTE currently provides 55 Bachelor programs in engineering, economic, industrial management, languages, accounting, graphic arts, and technical teacher training for vocational schools and colleges, 11 Master programs, and 6 PhD programs in engineering and education.

HCMUTE is an application-oriented university. It has the longest history in technical teacher training since its establishment compared with other newly established universities in this field. Its alumni are working in the industry all over Vietnam with many holding senior management positions. It has a good reputation for work-readiness. It has invested in many practical workshops, and modern laboratories as well as established many creative spaces for students such as Open lab and Maker Space. The idea of HCMUTE's Maker space establishment arose from a visit to Arizona State University through the HEEAP project (https://heeap.org). The function of HCMUTE's Maker space is to supply a creative space, high-tech equipment as well as guides to help students do their research projects. This improves students' practical skills and increases students' research motivation.

After participating EMVITET project and visiting HAMK’s Factory Design model, HCMUTE actors learned that to run the maker space more successfully they need to engage industry partners in activities at Innovate Maker Space by funding the projects and bringing their project results to the real life. HCMUTE has been constructing a New Innovative Maker Space which was launched in August, 2022.

Innovative Maker Space will be a bridge between enterprises and HCMUTE in scientific research and technology transfer. The university invests in creative spaces, a team of researchers (lecturers and students), and enterprises having R&D capital and using products transferred from research projects.

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Conducting the EMVITET project, HCMUTE actors also found some similarities with the design thinking approach and their way to implement team-based competition. Currently, there are a number of cooperative relationships with businesses to coordinate and support HCMUTE in training, equipment supports, scholarships, internships and employment after graduation for students. One of the enterprises that have greatly supported HCMUTE in sponsoring is Mitsubishi Electric Vietnam Company. In order to enhance the competitiveness of the project-based learning activities and attract the participation of many students, HCMUTE and the Mitsubishi Viet Nam Company have organized a competition named MITSUBISHI ELECTRIC CUP. Through this competition, HCMUTE actors have assessed the students' abilities including design thinking, knowledge system, creativity, aesthetic thinking, teamwork skill, presentation skills and critical thinking. Also, thanks to this cooperation, important conclusions have been drawn to form the development strategy of the university. HCMUTE is increasing the connection between business and school, replicating the project-based teaching activities, using real projects as case studies for students and transferring of research results to enterprises.

According to HCMUTE actors, the biggest difficulty in implementing projects with enterprises is that they require projects in a short time while lecturers and students are overloaded with teaching load thus very few projects are done duly. Therefore, the university only focuses on small research projects which are able to be integrated into specific courses as formative assignment series and deliver the courses in the format of project-based learning courses. On the other hand, HCMUTE believes that facilitation from the government in terms of tax deduction policies to companies who supportively conduct project-based learning curricula together with educational institutions will help improve the companies' willingness on this training model.

### 4.4. Implementation of DF concepts in HUE Industrial College

Hue Industrial College (HUE IC) is a vocational training institution established in 1899, a place to train and provide human resources from the vocational level or below in majors such as Mechanics, Automotive Mechanics, Electrical Engineering, and Electronics telecommunication, Heat and cold technology, Information technology, Materials technology, Environmental technology, Food Technology, Chemical engineering, Construction engineering, Economics, Tourism, Foreign languages, and other disciplines. Currently, the total number of staff is about 175 with 160 teachers and the number of students is about 3,700.

Before the EMVITET project, the group of lecturers participating in the project, as well as some other lecturers, have already applied advanced student-centered teaching methods such as Project base Learning, Flipped Learning, and Adaptive Learning in the classroom. Specifically, the lecturer gives topics that are closed to the subject content and then deploys them for students to work in groups. Each group discusses and solves a separated problem. The lecturer is a facilitator. After completing the exercise, students write the report and present their results to the classroom, and the lecturer will assess. However, the topics or problems are just illustrative examples, not close to reality, no multidisciplinary mechanism and no cooperation with businesses or companies required. The student products are made at the school's practical workshops during their studies.

The DF is a new concept for Hue Industrial College, as well as vocational education institutions in Vietnam. The main idea of the DF is to build on the same principles and values of open co-creation, passion-based and multidisciplinary (Björklund et al., 2017), which HUE IC actors found meaningful.

*"The DF is a real-world environment for students to develop their competencies. The multi-disciplinarity or interdisciplinarity, new pedagogical approach for passion-based co-creation requires*

*the creation of an interdisciplinary platform for learning and product and service design that unite students, teachers, researchers, and businesses."*

HueIC has realized that it is necessary to cooperate with businesses, send students to practice at enterprises as well as bring real projects to the school so that students have the opportunity to improve their practical skills and other competencies.

Although HueIC has not established the DF yet, the group of lecturers participating in the EMVITET project has tried to implement a few projects according to the DF's ideas, with the participation of students, lecturers and businesses at the center of research and technology transfer follow the steps of the design thinking process.

One of the piloting examples is the yearly organized half marathon and cycling race held in Hue city. DIA DU Company, a company providing technology solutions, was interested in a solution to digitize the contest participants' data. Therefore, the company cooperated with HueIC to find solutions for problems. Specifically, the company's problem was how to detect object motion parameters such as trajectory, speed and the total time from departure to destination. How to display these above parameters of more objects on a PC or smartphone simultaneously?

A HueIC student group (3 students, including IT and electronic students) was responsible for finding a solution for this project. They followed six steps of design thinking:

1. Students explored and analyzed the needs of the company – Teachers worked as facilitators.
2. Students defined problems worth solving: Designing an App to display an object's parameters such as Trajectory, speed, and time. Finding motion tracking devices to get those above parameters (to purchase) and Finding communication protocol between the software and hardware.
3. Students ideated solutions: The Motion Tracking System (MTS) monitors the object's movement with parameters such as distance, trajectory, motion speed and time of the object's movement, including the software and hardware. Each subject was fitted with a tracking device. The data from many of these devices at the same time was sent to Cloud Server via 3G/4G connection with HTTP protocol. And then the administrator accessed the data and displayed all information on the Web or mobile app.
4. Students made prototype solutions: In the 4th step, students began to build the software and hardware of MTS based on the final idea in the third step.
5. Students tested prototypes with users: After making the prototype system, the MTS was tested with users in the real world, some mistakes/feedback were recorded to improve the product.
6. Students pitched the solution at the company: In this final step, students presented their final product to the company, got evaluation and feedback, and planned to develop the product.

Based on this experience, HUE IC actors feel that a real project with business is a great opportunity for vocational students so that they have learnt more technical knowledge from businesses, for example, multidisciplinary knowledge, work readiness skills such as problem-solving, team working, presentation skills. Lecturers have a chance to upgrade their knowledge as well as a new pedagogical approach to teaching.

HueIC actors have also faced some difficulties and challenges. The competencies of vocational students are quite low, so they still have limitations to get practical knowledge and skills from companies. Furthermore, most of the teachers have not been trained in advanced teaching skills and methods, especially related to the Design Factory issues. Because HueIC is located in the central region, there are few businesses and companies to cooperate with the institution in technical fields, except information

technology businesses. The perception of cooperation with educational institutions of enterprises is limited, and there is no common vision.

In the near future, HueIC will build a DF environment at the school to provide good conditions for lecturers, students and businesses to participate in solving practical problems. HueIC also seeks to promote business relationships so that teachers and students have more opportunities to get many practical projects as well as funding from businesses. At the organizational level, they also feel that there is a need to change policies to encourage teachers and students to participate in real school projects.

According to HueIC actors, the DF model will have essential benefits. Students and teachers get a creative and learning environment based on real projects from businesses. Thereby, students have good opportunities to improve their technical and soft skills. Teachers have the opportunity to get new and practical knowledge from businesses as well as have funding to implement projects. Enterprises have the opportunity to work at the institution and participate in training with the school in order to find a suitable labour source for their business.

### 4.5. Case College of Technology II and Creative Startup Center

College of Technology II (HVCT) specializes in high-quality technical training and multi-disciplinary education. Besides, this college also has professional orientation along with a number of other fields such as scientific research, and technology transfer to meet socio-economic development. Currently, HVCT consists of 5 departments, 8 faculties, 7 centers with a total of 121 staff, lecturers and staff; in which more than 60% of lecturers have master's degree or higher. More than 2700 students are studying at the school in 25 different majors. HVCT focuses on training highly skilled human resources, besides constantly fostering teachers in terms of expertise, pedagogy, especially in the field of technology.

As one of the high-quality vocational colleges in Vietnam, HVCT researches new methods and comprehensively develops students' competencies. Start-up activities are expected to create economic growth, make positive contributions to socio-economic development, and contribute to meeting the increasing and diverse needs of society. In the vocational college system, the issue of entrepreneurship has not been really paid attention to, promoting development, while students in this system have very good practical skills.

After joining the EMVITET project, HVCT teachers realized that the principles of Design Factory can be piloted in their school. They found that HVCT should create a creative space for students to research and manufacture products according to orders from enterprises. In addition, faculties will be able to collaborate and work together in analyzing the market as well as advise students on technical-related solutions, and at the same time seek funding from industry partners and negotiate with businesses to commercialize products.

The HVCT Creative Startup Center was born in early 2021 to promote the spirit of entrepreneurship among students and equip the knowledge and skills of entrepreneurship for lecturers and students who have been studying on and off-campus. The aim was to create a favorable environment to form and realize ideas, build startup projects, create jobs for students after graduation, create opportunities to access scientific achievements and learn through knowledge exchange. The center has already been implementing many activities such as strengthening Skills training by developing the program called "Experience 24 hours as a student at HVCT ". They have also organized training courses on creativity and entrepreneurship skills, trading in industry products (restaurants, tourism, fashion design, beauty care, etc.) and commercialization of scientific research applications. The Center also had tasks such as: connecting to find funding packages from industry partners, building practical application models, and

establishing Student - Alumni Association. The center connects departments with short-term training programs, associates, and online training with skill improvement programs.

Furthermore, in the near future, the center has plans for developing a scientific journal of HVCT, organizing cultural exchange, seminars and scientific conferences for Vietnamese and international students, linking international open learning materials to exchange learning experiences, and enhancing the promotion of creative products from students to domestic and foreign enterprises.

The center was born in a timely manner and was able to respond to problems in the context of Vocational Education, which could not develop startups while skilled human resources were abundant. The Center has solved the big problems faced by HVCT: equipping students with necessary soft skills that have not been paid attention to in the vocational college system before; promoting the spirit of entrepreneurship among HVCT students and equipping knowledge and skills about entrepreneurship for lecturers and students, who have been studying inside and outside the college; creating a contest for lecturers and students to exchange, research and learn professional skills; creating a favorable environment for lecturers - students to form and realize ideas, start-up projects, creating jobs for students after graduation; creating opportunities for lecturers - students to access new scientific achievements at home and abroad through direct methods or online, visits, advanced learning.

In the early stage of establishing the center, there are also some difficulties related to teachers who do not pay much attention to soft skills training. For them focusing on vocational skills is the main goal, so the first difficulty is to have a mindset to harmoniously combine training soft skills for students in addition to the vocational skills training process. For the knowledge about startups, only business majors are relatively complete, engineering and service industries majors are completely empty, so it is difficult to start startup projects for them. The center has collaborated with STARTUP EDUCATION organization to combine training on soft skills as well as training on entrepreneurial knowledge, especially in the technical field for both lecturers and students in an online training course. Besides, it also encourages faculties to cooperate with enterprises in training as well as solving problems from enterprises with graduation projects and start-up projects.

Although the center has been in operation for 1 year, it has trained more than 2,700 new students in soft skills and has more than 12 registered start-up topics, including 1 excellent project to participate in the competition STARTUP KITE of the Ministry of Labour, Invalids and Social Affairs. In each course, the center will still maintain soft skills training as a compulsory subject in the curriculum and so in the near future, all students in the school will receive soft skills training to meet Education 4.0. According to the annual plan, HVCT will also organize competitions on entrepreneurship to find and develop groups of students with suitable ideas under the guidance of the center to achieve the best results.

### 4.6. HITC'S Startup Center following the Design Factory approach

Ho Chi Minh City Industry and Trade College (HITC), established in 1976, is one of the prestigious colleges not only in the South of Vietnam but in the entire country. HITC has maintained its status and reputation since the day it was established. The uniqueness of their teaching method with the hardworking and enthusiastic teachers can live a remarkable impact on the lives of students. Currently, the college is allowed to train 22 majors, with a total of 12,322 students and around 250 staff members. HITC has been included in the national project "Development of high-quality colleges by 2025" to suit the requirements of high-quality human resources in the 4th industrial revolution.

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Before working with the EMVITET project, only a few teachers had applied advanced student-centered teaching methods such as Project-based Learning, Flipped Learning in the classroom. Teachers mostly worked in small groups to share teaching activities and practical teaching experiences.

During the EMVITET project, many teachers at HITC obtained new things related to changing mindsets, applying digital tools, teams of teachers, and focusing on competence-based education to adapt to the new requirements from industrial partners and students' expectations. In the recent years, HITC and Business relationships have closely collaborated through memorandums of cooperation in training and employment. With the support of PUM (Programma Uitzending Managers) in Vietnam, many training courses have been organized for officials and lecturers who are expected to work in HITC. In this way, HITC teachers can achieve the desired results of becoming well-trained teachers so that they can inspire students to learn.

By utilizing design thinking steps, most teachers encourage students to raise their own ideas and possible solutions. The teachers will run some meetings with students and give feedback on ideas and possible solutions. In the case of needing help, the teachers will invite other teachers, or experts to participate in the meeting to get advice and feedback. Then, the prototype will be produced and tested, if the prototype does not meet the requirements or expectations, it will be adjusted or changed into a new one.

In September 2021, a new startup center was established to realize ideas. It was considered a very good environment for students, teachers and industrial partners to share and realise ideas. Initially, the center supports students and teachers in seeking help from industrial partners. In the future, the startup center will establish or suggest projects working with industrial partners.

HITC and Trung Nguyen Legend Coffee got long-term agreements to finance a new startup center for organizing activities to arouse the spirit of entrepreneurship and support students to start a business. First, this idea can create a big change in the lives of the students, so that at a young age they can generate new ideas and knowledge in businesses. Second, it can give them a *chance* to become young entrepreneurs, and people will recognize and acknowledge their works. Lastly, it can create a *chain* that their work will be connected to another business to create a very strong foundation. Besides, after learning the design factory model from HAMK, for creating a place for students to be creative with real-life projects, HITC's Start-up Center was established.

However, there are some challenges for students. HITC actors have noticed that they are not ready and familiar with realizing the ideas and working in groups with high pressure in making products fulfil real requirements. Teachers lack experience in engaging students to realize their ideas. The school does not have enough infrastructure and appropriate policies to promote students and teachers.

Since the beginning of 2022, a new office has been built and some guides and policies have been published to promote students and teachers to pursue their ideas or work on projects. Furthermore, a board of advisory has been established to closely help students and teachers.

The core value of the development of the Start-up Center at HITC is to provide an inspring space for students, teachers and industrial partners to ideate and share ideas, to work together on practical projects through the initiative process and steps given by the Design Factory model at HAMK. The Start-up Center will play an important role in strengthening the relationship between HITC and industrial partners in terms of improving the quality of training and ideating ideas.

## 5. Discussion and conclusions

In the EMVITET project, all of the Vietnamese partners have made their own development steps towards innovation spaces utilizing the design thinking approach and the model of HAMK Design Factory. Vietnamese partners have various names for innovation spaces, such as Design Factory, Maker

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Space, Creative Space or Start-up Center. All of them highlight the importance of integrating real-life cases into the learning processes of students. These innovation spaces can connect students, teachers and work-life partners to work together so that there is an added value for all. Students' learning is more effective and they have better motivation. Teachers can update their knowledge regarding current trends in work and business, and they can learn new methods for facilitation. Work-life partners can benefit from the expertise of educational institutions and have fresh perspectives of students to solve business challenges. With this kind of ecosystem, educational institutions can improve the quality of Education 4.0.

However, it is essential to note that the innovation space as a physical space like a room or building is not enough. There must be a certain pedagogical approach to apply, like co-creation pedagogy at HAMK (Kunnari et al., 2019), which puts students at the centre of actions and directs teachers to work as facilitators. Furthermore, design thinking steps can work well in concretizing how students can take the lead in company projects. These pedagogical approaches are quite new to the teachers and many Vietnamese partners mentioned that there is still a gap in teachers' competencies to work successfully in innovation spaces. Students are not always ready to innovate and ideate, thereby teachers really need to learn new ways of empowering and encouraging them. The EMVITET- teachers, who were trained in this Erasmus+ CBHE project, have an important role in disseminating new pedagogical practices.

The Vietnamese partners also expressed that working with projects is time consuming. It seems that if the work and learning in innovation spaces is an extracurricular activity, this problem remains. That is why the next step is to integrate design thinking and the learning activities of innovation spaces in the curricula. Some partners have already made this promising advancement. Another challenge mentioned was that companies usually need very rapid input while institutions feel difficult to respond. For this challenge, it is important to make innovation spaces' operation very solid by building an operational team and training staff to work efficiently.

The last crucial point, based on the experiences of Vietnamese partners, is the mindset change of all of the stakeholders, especially the leaders and managers. Education 4.0 is based on a learning ecosystem, which emphasizes win-win cooperation. The EMVITET partners have already made promising steps and now it is time to share the experiences and engage new partners from industry and business to join. Education 4.0 development requires that all of the stakeholders can go out of their comfort zones and discover new possibilities for sustainable learning.

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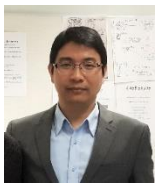

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