CERN IdeaSquare Journal of Experimental Innovation, 2023; 7(3): 32-37
DOI: https://doi.org/10.23726/cij.2023.1474

ORIGINAL ARTICLE

Developing students' transversal skills: A case study of an international product development project

Jari Jussila[1*], Milla Räty[2], Sanna-Maaria Siintoharju[1]

[1] HAMK Design Factory, Häme University of Applied Sciences, Hämeenlinna, Finland
2 HAMK International, Häme University of Applied Sciences, Hämeenlinna, Finland
*Corresponding author: jari.jussila@hamk.fi

ABSTRACT

One of the biggest challenges faced by higher education is the development of students' transversal skills. With the aim of uncovering practices that support the development of students' transversal skills, this case study investigates the students' perceptions of transversal skills development in an international product development project organised by inno.space Design Factory Mannheim and HAMK Design Factory. The interviews to survey the students' expectations early in the course and during the end of the course, point out the importance of physical learning environments, student mobility and interdisciplinary teams for transversal skills development.

Keywords: Transversal skills; design factory; product development project.

Received: September 2023. Accepted: November 2023.

INTRODUCTION

Higher education has the challenge and responsibility to educate good professionals (Collado et al., 2022). One of the biggest challenges faced by higher education is the development of students' transversal skills (Pinto, 2018), including physical and manual skills, thinking skills, social and communication skills, self-management skills, and core skills (Hart et al., 2021). However, academics and teachers do not feel prepared to integrate transversal skills into their teaching practices and course units (Pinto, 2018). Transversal skills are rarely taught explicitly, and it is assumed that students will acquire transversal skills through mobility (Standley, 2015), virtual mobility experience (Class et al., 2012; Rajagopal et al., 2020), or working as teaching assistants (Dimitrov, et al., 2014), for example. There are, however, some examples where development of transversal skills has been integrated into teaching practices and course units. Studies of students' interdisciplinary product development projects (Mikkonen et al., 2018; Collado et al., 2022; Figueiredo et al., 2022; Lahdenperä et al., 2023) have investigated how students transversal skills develop during the courses. Yet, it is unclear which practices in these course units support the development of students' transversal skills.

Design-based education and challenge-based courses (Thong et al., 2021; Vignoli et al., 2021; Lahdenperä et al., 2022; Lahdenperä & Jussila, 2023) aim to cultivate transversal skills. Hence, with the aim of understanding practices that support transversal skills development, this study investigates students' expectations and perceptions of skills development in working to solve authentic product development challenges of companies. The research is guided by the following research questions: 1) What are students' expectations with respect with an international product development project course? 2) How do the students perceive transversal skills development during the international product development project course?

A case study of an international product development project course was chosen as an extreme case (Flyvbjerg, 2006), where potentially all the elements of transversal skills could be developed in a single higher education course.

The international product development project (iPdP) course was organised by inno.space Design Factory Mannheim and HAMK Design Factory. The Mannheim University of Applied Sciences (HSMA) is composed of nine faculties. Inno.space, the Design Factory Mannheim is part of the Faculty of Computer Science. Inno.space Design Factory Mannheim offers interdisciplinary and international challenge-based courses in collaboration with global networks as well as local cooperation partners from industry, business, and society. The Häme University of Applied Sciences (HAMK) is organised into three types of units: Schools, Research Units, and a Design Factory. The role of the HAMK Design Factory is to organise international and interdisciplinary courses involving students from the different schools and international partners.

THEORETICAL BACKGROUND

After the digital revolution, new technologies are emerging at a faster pace and countries with unskilled labour are being left behind (O'Rourke et al. 2013). Courses like the international product development project are crucial for students to gain transversal skills. According to Von der Leyen (2022) "*we need better cooperation with companies because they know best what they need. And we need to match these needs with people's aspirations. But we also have to attract the right skills to our continent, skills that help companies and strengthen Europe's growth*". To make sure that nobody is left behind and that we in Europe have workforce with the needed skills, the European Commission has decided to call 2023 the European Year of Skills. More than three quarters of companies within the EU state that they are lacking workforce with the necessary skills. In 2023, all through Europe there have been investments in training and upskilling people also making sure that the skills that are taught are relevant for the needs of the labour market (Nuyts et al. 2022).

A popular framework for identifying needed skills is the 21st Century Skills, which are understood as skills that young people or students need in balancing and succeeding during their student life and the world of work. The core of these skills is divided into three categories: learning and innovation skills, life and career skills, and literacy skills (Rotterham & Willingham 2010; Gonzáles-Peréz & Ramírez-Montoya 2022; Fandino 2013). Learning and innovation skills include critical thinking, creativity, communication, and collaboration skills, which are also referred to as 4C's. A similar framework is the transversal skills and competences model prepared by the ESCO expert group. The model visualises the move from the internal to the external, from the core skills and competences defining the individual to the skills embedded in a broader social context illustrated in Figure 1 (Hart et al., 2021). Compared to the 4C's model, communication and collaboration is represented in the transversal skills and competences model by social and communication skills, creativity and critical thinking by thinking skills. In addition, the model includes self-management and physical and manual skills.

The development of critical thinking, collaboration, communication, and other soft skills has been found difficult to achieve in traditional teacher-centred learning environments (Fisher & Newton, 2014; Tynjälä, 1999). Such skills cannot be learned by reading textbooks or listening to lectures, as this type of procedural knowledge requires practical experience (Tynjälä, 2008). According to Tynjälä (1999) one of the most important challenges to university pedagogy is developing teaching methods that integrate formal, theoretical knowledge and more informal, practical knowledge, as well as development of meta-cognitive and self-regulative knowledge, which can be achieved by approaches such as problem-based learning.

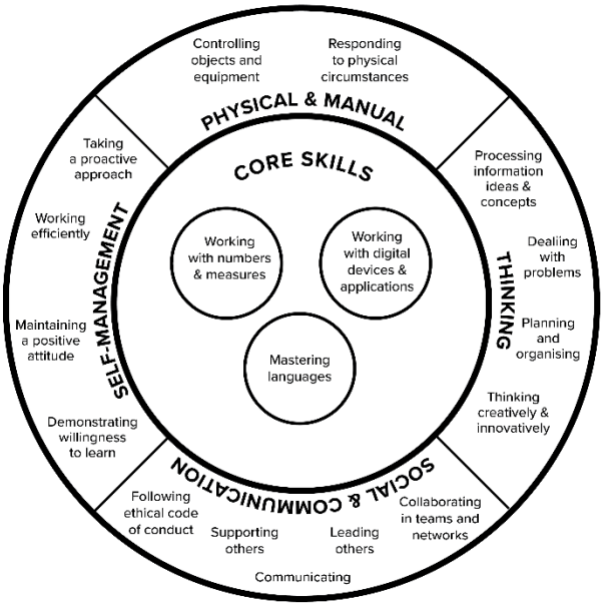

Fig. 1. Transversal skills and competences (modified from Hart et al., 2021).

Intensive engagement in the collaborative solution of authentic problems, such as product development problems, has been found to foster student learning outcomes of the highest order, including improved problem-solving abilities, enhanced communication and thinking skills, and continuing intellectual curiosity and creativity (Herrington, et al. 2010; Rule, 2006). Student-centred approaches have been found beneficial for soft skills development (Vogler, et al. 2018). These student-centred approaches include, for instance, problem-based learning, project-based learning, challenge-based innovation, and design-based education (Figueiredo et al., 2022; Lahdenperä et al., 2022; Joore et al., 2022; Vignoli et al., 2021; Tynjälä, 1999).

Following the afore mentioned student-centred approaches, some studies have been conducted on students' skills development in product development project courses organised at Aalto Design Factory, UPV Design Factory and HAMK Design Factory (Mikkonen et al., 2018; Collado et al., 2022; Figueiredo et al., 2022; Lahdenperä et al., 2023).

In a previous study on product development projects at Aalto Design Factory, perceived significance of socio-behavioural interpersonal skills was highlighted, in which teamwork, multidisciplinarity and communication skills formed the largest categories of student reported learning outcomes (Mikkonen, et al. 2018). In a recent survey carried out on product development project students, communication with multidisciplinary teams was the most prominent skill that student considered they had developed during the course (Figueiredo et al., 2022).

In UPV Design Factory the students perceived that teamwork and leadership, time planning, analysis and problem solving, application and practical thinking, effective communication, and innovation, creativity and entrepreneurship were the soft skills that they developed the most by participating in Design Factory projects (Collado et al., 2022). A study on HAMK Design Factory product development projects suggested that students can develop their innovation capabilities already during an eight-week course (Lahdenperä et al., 2023). The results of the study also showed that working in interdisciplinary teams and solving authentic product development challenges supported students in constructing and applying knowledge, as well as collaboration and communication (Lahdenperä et al., 2023).

METHODS AND DATA

A case study method was selected to explore students' transversal skills development in higher education. The iPdP course was chosen as an extreme case (Flyvbjerg, 2006) of transversal skills development practices. Extreme in the sense that iPdP included both student mobility and virtual mobility: each student team included students from two different higher education institutions representing various disciplines and study levels, and the physical learning environments in Germany and Finland were equipped with machines (e.g., 3D printers and laser cutters) and materials supporting the building of physical mockups and prototypes of products.

The data was collected by interviews from students participating in the iPdP that was organised from February 2023 to June 2023. The students worked in international and interdisciplinary mixed teams to solve four product development challenges provided by companies in Finland and Germany. Each team included three students from HAMK and three students from HSMA. The project started with 24 students in total, with 6 students working for each challenge.

Most of the interviews were conducted face-to-face, and a few on Zoom. All interviews were recorded. The first interview round was conducted early in the project and all the 24 students participated in the interviews. The second interview round was conducted at the end of the project in June and 23 students participated in the interviews. In the first round, interviews lasted around 3-5 minutes per student and in the second round a little under 10 minutes per student. The first set of interview questions were related to the students' expectations towards the course and their knowledge about the topic. It included questions such as: How do you choose the extra courses to be included in your degree? Why did you choose the iPdP course? What are your expectations towards the iPdP course? In the second round the interview questions were focused on how students' expectations were met and what they learned. The second round questions included: Can you name three things that you feel have improved by participating in the iPdP course? How were your expectations towards the course met? Did you learn something you didn't expect during the course?

The recorded interviews were transcribed to a spreadsheet software by the researcher that conducted the interviews. The transcriptions were anonymised before the analysis. The transcripts were categorized by two researchers independently and then discussed together for deriving the final categories and findings from the case study.

Table 1 presents the background information of the participating students.

Table 1. Background information of the respondents.

Background Information	Interviewed Students	Total (n)	Total (%)
Respondents	iPdP students	23/24	**95,8**
Study levels	Bachelor	15	**63**
	Master	9	**37**
Disciplines	Biomedical Engineering	1	**4,2**
	Business Administration	1	**4,2**
	Chemical Engineering	2	**8,3**
	Chemistry and Process Engineering	2	**8,3**
	Computer Science	4	**16,7**
	Electrical and Automation Engineering	2	**8,3**
	Information&Communication Technology, Bioeconomy	1	**4,2**
	International Business	5	**20,8**
	Medical Data Science	2	**8,3**
	Process Engineering	1	**4,2**
	Smart and Sustainable Design	3	**12,5**

In total the study included 24 students, representing 11 different disciplines, composed of mixed nationality and study level teams.

RESULTS

The results first describe the main reasons why the students chose the iPdP course, and what were their expectations of the course before participating. Secondly, the results describe the students' perceptions of learned skills and competences, and the unexpected learnings from the course. The reasons for selecting an international product development course are illustrated in Table 2.

Table 2. Reasons for choosing and applying for an international product development project.

Reason	Answers
Internationality	15
Attractiveness	11
Supports studies	9
Multidisciplinarity	5
Future skills	*5*
Hands-on, not theory based	*5*
Creativity	*4*

We categorised the responses based on the frequency of certain expressions recurring in the interviews. The most frequent category included *internationality*, where students were talking about trips to Finland or Germany or, for example, "*do ERASMUS in Germany*". The second most frequent category was *attractiveness* that included saying such as: "*I've never experienced anything like this before*", "*sounds cool*", "*DF, and the previous work = wow factor*". The third most frequent category was *supporting studies*, which included "*thesis opportunity*", "*wanted to improve my technical thinking skills more*", and "*opportunity to learn about prototyping*'.

Concerning the expectations towards the iPdP and how students perceived the improvements after the iPdP, we categorised students' responses in Figure 2 based on transversal skills and competences model (Hart et al., 2021).

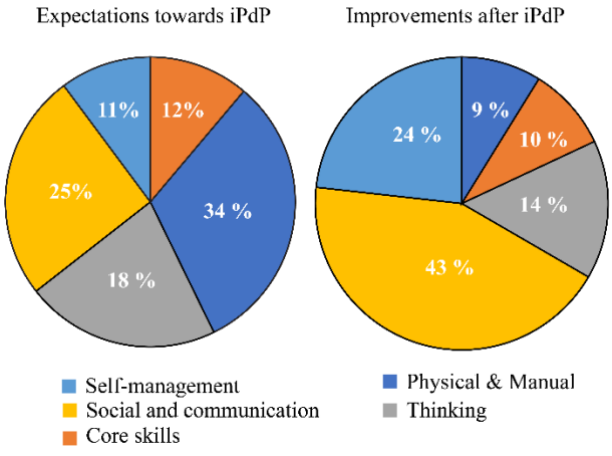

Fig. 2. Expectations of the iPdP and improvements after the iPdP from the transversal skills and competences perspective.

Physical & manual skills were the most often recurring category of expectations towards the iPdP. This was mostly related to physical circumstances of the course, such as "*work with a real company*", "*collaborate with companies, and to get to know them*", "*help with my future career*", but also "*to be able to create things*", "*get more into prototyping*", and "*more prototyping*".

Also many students expected their social and communication skills to develop: "*work with international people (never done that before)*", "*teamwork*", "*working together and evolving team working skills*", "*experience in working in bigger international team*" and so on. Some students also mentioned core skills, thinking and self-management related skills as expected learning outcomes, e.g., "*language skills*", "English language", "*get to know design thinking as a process*", "*develop problem solving skills*", "thinking ahead", "*innovating with others*", and "*openminded to learn everything*".

At the end of the course, the students clearly emphasised that their social and communication skills and self-management skills had developed. Related to social and communication skills, this was reflected in responses, such as "*teamworking skills*", "*understanding of different people from different backgrounds*", "*communication skills*", "*receiving and giving feedback*", and "*how to ask feedback*". In terms of self-management skills, students mentioned, for example, "*time management and flexibility*", "*commitment*", "*scheduling*", and "*consistency*". Of the core skills, "Figma" and "*new technological skills*" in general were mentioned.

We also wanted to know if there were any unexpected learnings from participating in the iPdP and in Table 3, we describe what students learned even without expecting it. Unexpected core skills students learned included "*How to use Figma and other tools*", "*Well, I had to learn 3D printing*", "*work with people online*", and for example "*I didn't expect to learn about laser cutting*". Social and communication skills also surprised some students, and they mentioned, for instance, "*I didn't expect teamwork to be so great*", "*teamwork in a multicultural team was harder than expected*" and "*Working with people from different degree fields, backgrounds and age groups was eye opening*".

Table 3. Unexpected learnings from the course.

Unexpected learnings	Answers
Social and communication skills	4
Core skills	4
Physical & manual skills	2
Self-management skills	1
Thinking skills	1

Overall, student perceptions after the iPdP emphasised social and communication skills and self-management skills more than before participating in the course.

DISCUSSION AND CONCLUSIONS

The research aimed at uncovering practices that support development of students' transversal skills in

higher education. A case study of an international product development project course was chosen as an extreme case (Flyvbjerg, 2006), where in a single higher education course all the elements of transversal skills (Hart et al., 2021) could be potentially developed.

Comparing the responses received to the two research questions, about student expectations and perceptions of transversal skills development in an international product development project, the study uncovered interesting findings. What students most expected was physical and manual transversal skills development. In Design Factories physical and manual skills development is often promoted by requiring students to create physical prototypes of solutions to the challenges and trying them out in the real environment. This gives students the opportunity to respond to the physical circumstances of the solution environment and to work with different prototyping equipments, such as 3D printers and laser cutters. However, at the end of the course students perceived having learned mostly about social and communication skills. This can be related to the practice of forming interdisciplinary student teams consisting of students from mixed nationalities and study levels, where communication challenges can arise from communicating in a foreign language, from the different cultural backgrounds of the students, from the various disciplinary languages used inside the student team, and from the need to interact with the stakeholders of the challenge. Although this finding suggests that further research is needed, it does imply both theoretical and practical contributions of this study.

From the theoretical perspective the case study findings point out to important skills development perceived by the students, which are missing from transversal skills frameworks. Interdisciplinary teamwork and knowledge of other cultures and habits are missing as skills from the map of transversal skills and competences (Hart et al., 2021) and framework of transversal skills (Valūnaitė et al., 2019), but feature on transversal skills defined by the National Agency for Quality Assessment (Larraz et al., 2017). However, all the above frameworks on transversal skills are missing the disciplinary literacy skill (Airey, 2011; Hunter et al., 2023), which students in interdisciplinary teams need to learn.

From a practical perspective the findings of the study indicate that implementing mobility inside a course, and organising learning in interdisciplinary, international, and mixed study level teams, creates opportunities for students to develop a variety of transversal skills within a single course. On the other hand, students may require different type of guidance and support than what would be needed when teams are composed of students from a single discipline, nationality, and study background.

What are the teaching practices that support teamwork and transversal skills development in interdisciplinary, international and multiple study level students' teams was not in the scope of this study, but opens up an interesting avenue for further research. Since the case study was limited to one international product development project course implementation, the transferability of the findings could be improved by investigating other similar course implementations.

REFERENCES

Airey, J., 2011, The disciplinary literacy discussion matrix: A heuristic tool for initiating collaboration in higher education. Across the disciplines, 8(3): 1-9. https://doi.org/10.37514/ATD-J.2011.8.3.18

Class, B., De Franchi, A., & Soeiro, A, 2012, Virtual mobility and lifelong learning: the new challenge for higher and continuing education institutions. In: EDEN 2012 Annual Conference (pp. 4-5).

Collado López, M. F., Villalonga Grañana, I., Giménez Carbó, E., & Gómez Martín, M. E., 2022, The UPV Design Factory. What is it good for? In: Towards a new future in engineering education, new scenarios that european alliances of tech universities open up (pp. 1892-1897). Universitat Politècnica de Catalunya.

Dimitrov, N., Dawson, D. L., Olsen, K., & Meadows, K. N., 2014, Developing the intercultural competence of graduate students. Canadian Journal of Higher Education, 44(3): 8. http://doi.org/10.47678/cjhe.v44i3.186040

European Commission (EC), 2020, European Skills Agenda.

Fandino, Y.J., 2013, 21st Century Skills and the English Foreign Language Classroom: A Call for More Awareness in Colombia. Gist Education and Learning Research Journal, 7: 190-208.

Figueiredo, S., Ganoo, A., Eriksson, V., & Ekman, K.,2022, Future-ready skills development through Experiential Learning: perceptions from students working in multidisciplinary teams. CERN IdeaSquare Journal of Experimental Innovation, 6(2): 12-19. https://doi.org/10.23726/cij.2022.1397

Fisher, K., & Newton, C., 2014, Transforming the twenty-first-century campus to enhance the net-generation student learning experience: Using evidence-based design to determine what works and why in virtual/physical teaching spaces. Higher Education Research & Development, 33(5): 903-920. https://doi.org/10.1080/07294360.2014.890566

Gonzaléz-Peréz, L.I., Ramiréz-Montoya, M.S., 2022, Components of Education 4.0 in 21st Century Skills Frameworks: Systematic Review. Sustainability. Vol., 14, Issue 3. https://doi.org/10.3390/su14031493

Hart, J., Noack, M., Plaimauer, C., & Bjørnåvold, J., 2021, Towards a structured and consistent terminology on transversal skills and competences. Brüssel: Europäische Kommission und Cedefop. Towards a structured and consistent terminology on transversal skills and competences, Esco (europa. eu).

Herrington, J., Reeves, T. C., & Oliver, R., 2009, A practical guide to authentic e-learning. New York: Routledge

Joore, P., Björklund, T., Thong, C., & Zancul, E. D. S., 2022, Co-creating the future through design-based education in innovation hubs. CERN IdeaSquare Journal of Experimental Innovation, 6(2): 1-3. https://doi.org/10.23726/cij.2022.1413

Lahdenperä, J., Jussila, J., Järvenpää, A-M., Jumisko-Pyykkö, S., 2023, Developing students' innovation capability through interdisciplinary product development projects for industry. 1st Design Factory Global Network Research Conference 'Designing the Future'5-6 October 2022.

Lahdenperä, J., & Jussila, J., 2023, HAMK Design Factoryn design-based education-malli. LUMAT-B: International Journal on Math, Science and Technology Education, 8(1), 55-59. https://urn.fi/urn:nbn:fi:hulib:editori:lumatb.v8i1.2009

Lahdenperä, J., Jussila, J., Järvenpää, A. M., & Postareff, L.,2022, Design Factory--Supporting Technology Students' Learning of General Competences through University-Industry Collaboration. LUMAT: International Journal on Math, Science and Technology Education, 10(1): 127-150. https://doi.org/10.31129/LUMAT.10.1.1672

Larraz, N., Vázquez, S., & Liesa, M., 2017, Transversal skills development through cooperative learning. Training teachers for the future. On the horizon, 25(2): 85-95. http://doi.org/10.1108/OTH-02-2016-0004

Mikkonen, M., Tuulos, T., & Björklund, T., 2018, Perceived long-term value of industry project-based design courses: Alumni reflections from two decades of the Product Development Project. DS 91: Proceedings of NordDesign 2018, Linköping, Sweden, 14th-17th August 2018.

Nuyts, V., Matthaes, F., 2022, European Commission Press Release. Retrieved from: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_6086

O'Rourke, K. H., Rahman, A. S., & Taylor, A. M., 2013, Luddites, the industrial revolution, and the demographic transition. Journal of Economic Growth, 18: 373-409. https://doi.org/10.1007/s10887-013-9096-y

Pinto, S., 2018, Intercultural competence in higher education: academics' perspectives. On the Horizon, 26(2): 137-147. https://doi.org/10.1108/OTH-02-2018-0011

Rajagopal, K., Firssova, O., Op de Beeck, I., Van der Stappen, E., Stoyanov, S., Henderikx, P., & Buchem, I., 2020, Learner Skills in Open Virtual Mobility. Research in Learning Technology, 28. http://doi.org/10.25304/rlt.v28.2254

Rotherham, A.J., Willingham, D.T., 2010, "21st Century" Skills: Not New, but a Worthy Challenge. American Educator, Vol. 34, p.17.20.

Rule, A. C., 2006, The components of authentic learning. Journal of Authentic Learning, Vol. 3, No. 1: 1-10.

Standley, H. J., 2015, International mobility placements enable students and staff in Higher Education to enhance transversal and employability-related skills. FEMS Microbiology Letters, 362(19): fnv157. https://doi.org/10.1093/femsle/fnv157

Thong, C., Cotoranu, A., Down, A., Kohler, K., & Batista, C., 2021, Design innovation integrating deep technology, societal needs, radical innovation, and future thinking: a case study of the CBI A3 program. CERN IdeaSquare Journal of Experimental Innovation, 5(1): 32-39. https://doi.org/10.23726/cij.2021.1291

Tynjälä, P., 1999, Towards expert knowledge? A comparison between a constructivist and a traditional learning environment in the university. International Journal of Educational Research, 31(5): 357-442. https://doi.org/10.1016/S0883-0355(99)00012-9

Tynjälä, P., 2008, Työelämän asiantuntijuus ja korkeakoulupedagogiikka. Aikuiskasvatus, 28(2).

Valūnaitė Oleškevičienė, G., Puksas, A., Gulbinskienė, D., & Mockienė, L., 2019, Student experience on the development of transversal skills in university studies. Journal of Pedagogika, 133(1): 63-77. http://doi.org/10.15823/p.2019.133.4

Vignoli, M., Balboni, B., Andreea, C., Dosi, C., Noemi, G., Kirstin, K., & Christine, T., 2021, Inspiring the future change-makers: Reflections and ways forward from the Challenge-Based Innovation experiment. CERN IdeaSquare Journal of Experimental Innovation, 5(1): 1-4. https://doi.org/10.23726/cij.2021.1323

von der Leyen, U., 2022, 2022 State of the Union Address by President von der Leyen. Retrieved from: https://ec.europa.eu/commission/presscorner/detail/en/speech_22_5493