Multidisciplinarity and teamwork in virtual real-life projects — reflection as a tool for development

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Abstract

Project teams will increasingly work virtually in multidisciplinary teams. The degree of virtuality varies from fully virtual to hybrid. The purpose of this study is to identify how the virtual team (VT) members experience multidisciplinary project work and team development in the context of international real-life projects in Higher Education Institutions (HEI). The data were gathered from student project teams´ final reports (n=7) and students´ individual reflection diaries (n= 37). Thematic content and sentiment analysis were used.

The results showed that team members can experience professional diversity and team development in different ways. This can lead, among other things, to social isolation. However, multidisciplinarity was largely perceived as a positive factor in teamwork. The importance of team-level and individual-level reflections are also emphasized. The results of this study will be taken into further discussion at HEIs to ensure that the students acquire the competences needed in virtual project teams.

Keywords: *virtual project; hybrid team; multidisciplinary; project team development*

Tiivistelmä

Projektitiimit työskentelevät yhä useammin virtuaalisesti monialaisissa tiimeissä. Virtuaalisuuden aste vaihtelee täysin virtuaalisesta hybridiin. Tarve tutkia tarkemmin monialaista virtuaalista tiimityötä on korostunut pandemian aiheuttamien toimintaympäristöjen muutoksien vuoksi. Tämän tutkimuksen tarkoituksena on selvittää, miten virtuaalitiimin jäsenet kokevat monialaisen projektityön ja tiimin kehittymisen aitojen projektitoimeksiantojen yhteydessä korkeakouluissa. Kyseessä on laadullinen tapaustutkimus, minkä aineisto kerättiin virtuaalisesti työskenteleviltä opiskelijaprojektitiimeiltä. Projektitiimien loppuraportit (n=7) ja opiskelijoiden henkilökohtaiset reflektiopäiväkirjat (n=37) analysoitiin käyttämällä temaattista sisällönanalyysiä sekä tunneanalyysia.

Tuloksissa ilmeni, että tiimin jäsenet voivat kokea monimuotoisuuden ja tiimin kehittymisen eri tavoin. Tämä voi johtaa muun muassa sosiaaliseen eristäytymiseen. Kuitenkin monialaisuus koettiin pääosin positiivisena tekijänä tiimityössä. Tutkimus korostaa myös tiimitason ja yksilötason reflektioiden merkitystä virtuaalisten ja monimuotoisten opiskelijaprojektitiimien ohjaamisessa. Tutkimuksen tulokset otetaan huomioon korkeakoulujen opetussuunnitelmatasolla käytävässä jatkokeskustelussa, jotta varmistetaan, että opiskelijat voivat kehittää virtuaalisissa projektitiimeissä tarvitsemiaan osaamisia.

Avainsanat: *virtuaalitiimi; hybridi tiimi; monialaisuus; projektitiimin kehittyminen*

Introduction
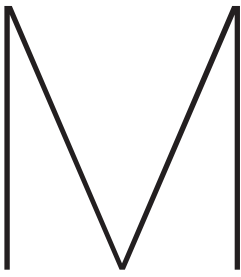
Members of various project teams will increasingly innovate in multidisciplinary and multicultural virtual teams (VTs) (Zuofa & Ochieng, 2017) where the degree of virtuality is varying from fully virtual to hybrid (Chamakiotis et al., 2021). The need to further examine teamwork has emerged due to the increased work in virtual and hybrid project teams caused by the Covid-19. Even those professionals who could work face to face are used to the flexibility of working and want to continue working from home all or part of the time (de Souza Santos & Ralph, 2022), the same applies to students. The increase in virtual project work has highlighted new demands for better understanding of how to organize multidisciplinary collaboration in various learning environments at HEIs.

The purpose of this study is to identify how the team members experience multidisciplinary project work and team development in VTs in the context of international real-life projects at HEIs. This study will use Wheelan´s (2005) group development stages for analysing teams' development considering both team and individual level experiences (Liao, 2017). The study results will be taken into further discussion on the curriculum level at HEIs to ensure that the students acquire the competences needed in virtual project teams.

Multidisciplinarity and team development in virtual project teams

Virtual project teams can be described "As a group of people who work interdependently with a shared purpose, across space, time, and organizational boundaries, using ICT tools to communicate and collaborate" (Maduka et al., 2018, p. 699). Chamakiotis, Panteli and Davison (2021) suggest that VTs vary in terms of their degree of virtuality from purely virtual to hybrid.

We understand team success as team performance leading to project task results and team development. The success of VTs depends among other things on team members´ professional diversity. It is argued that diverse professional knowledge of the members add value to innovation outcomes (Batarseh et al., 2018) and has a positive influence on team performance (Liang et al., 2007). However, different disciplinary backgrounds may lead to situations where applying knowledge in work and communication can be problematic (Hannah & Simeone, 2018).

Wheelan (2005) has presented an Integrated Model of Group Development (IMGD). It is a mix of Tuckman´s traditional model and diverse leadership styles (Vaida & Serban, 2021). According to IMGD, groups achieve maturity through the process of working together through four stages of development:

• Stage 1: Dependency and Inclusion. Members are focusing on the leader and spending a significant amount of energy to achieve a feeling of safety and inclusion in their group. They are polite and follow rules.

• Stage 2: Counterdependency and Fight. The team members feel secure enough to state their opinions and disagree with each other and the leader. Conflicts will arise and provide an opportunity for setting psychological boundaries to facilitate shared understanding of direction and goals.

• Stage 3: Trust and Structure. Communication becomes more open. The group can carry out more mature negotiations about their goals and procedures due to the positive relationships between members.

• Stage 4: Work and Productivity. Communication is even more direct and open. The leader´s role has changed, and he or she can step back, and support the group to self-organize and work autonomously. (Wheelan, 2005.)

IMGD is proposed as a group development model if the team wants to change the emphasis from individuality to group thinking (Vaida & Serban, 2021).

Real-life projects and reflection

Learning in real-life projects at HEIs leads to improvements in professional and teamwork skills. However, some challenges exist, for example in virtual environments activities aiming to improve teamwork skills are not always fully integrated into the real projects (Varhelahti, 2017) and projects lack the authenticity necessary to demonstrate to students the benefits of virtual teamwork skills (Brewer et al., 2015). In addition, teachers are concerned with learning outcomes and learning, while companies are more interested in final outputs of the project work (Jaime et al., 2019).

The quality of the final outputs may inform about the team development but also reflections on teamwork are needed (Raymundo, 2020). Both team level and individual level reflections should be included because virtual collaboration is considered as a team construct formed out of the opinions and experiences of the individual team members (Liao, 2017).

Research approach

This study reports learnings of MuPIC (Multidisciplinary Projects in an International Context) online course focused on developing engineering and project management skills in virtual and multidisciplinary teams.

In this 5 ects course postgraduate students from four European universities formed virtual project teams and worked eight months on a product development assignment from industrial companies. The teams were hybrid; the project teams worked mainly virtually, but the team members met their local study mates and sometimes their coach face to face.

Methods and data collection

This is a qualitative case study and the data were gathered during two MuPIC pilot courses from every team´s final project report (n=7) and from the students´ individual reflection diaries (n=37). This study addresses the following research questions.

• How team members in multidisciplinary project teams have experienced team development?

• How is multidisciplinarity experienced by the members of the project teams?
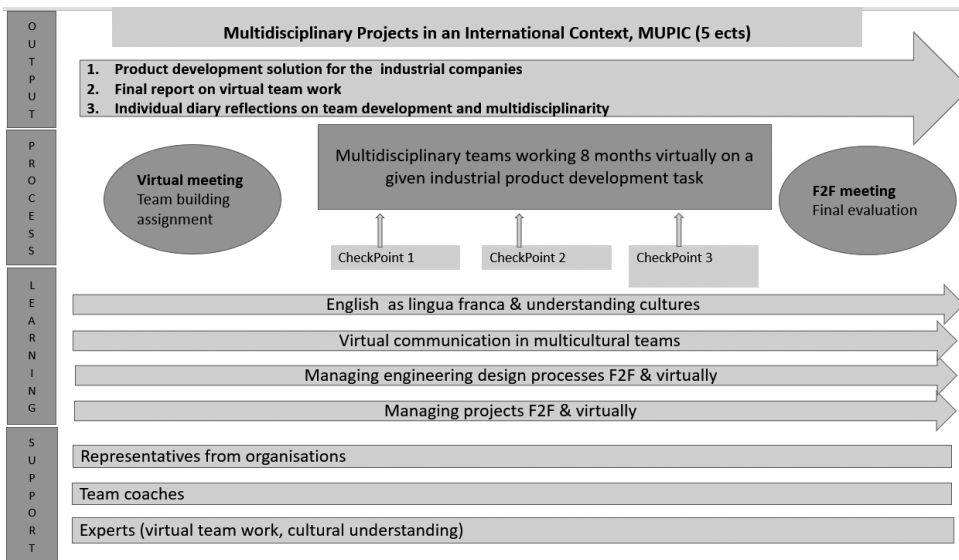
Figure 1. MuPIC-course structure

There were four student teams consisting of 4-5 students in both pilot courses. The study fields (professional roles) of the students - Engineering, Marketing, Management and Art & Design - were included in all teams. There were representatives from Czech, Belgian, Finnish, Spanish universities in every team. The English language level varied between and inside the teams, ranging from A1 to C2 (Common European Framework for Languages).

The students had become familiar with the Wheelan´s (2005) IMGD model during the MuPIC course and they were asked to reflect their team development according to it. In both pilots, the teams had to provide final reflection at the end of the project. In addition, the team members made diary reflections for each three check points (CPs) during the project. The data were analysed using thematic content analysis of the reflections to identify common themes and underlying meanings embedded within the re-flections (Wankhade et al., 2022). Also, sentence-level sentiment analysis was conducted.

Results

Project teams´ final reports

Reflections on the virtual team development were included in every project team's final report. The teams were asked to discuss what went well and what could be improved. The results of the analysis are shown in the Table 1.

The most discussed theme was time management that caused challenges in the project teamwork. Companies were sometimes hard to reach, the timeframe for the project work was tight and teachers did not share the timetables for the meetings early enough.

The second theme was communication that was at a good level within the teams,

Table 1. Themes in project final reports

Pilot	Theme	Positive tone	Negative tone
Pilot 1			
Team a	Learning	This type of project provides learners basic understanding and skills to better cooperate in such environments.	
Team b	Time management		Some group members failed to deliver their work in time
Team d	Time management	Team followed up the communication plan and it worked well	Teams do not have any information about schedule or content of the final week; because xx did not submit his part of work
	Communication		One of the main reasons for this was language problems
	Diversity		There were two engineering designers from different countries and different approach to solving this problematic
Pilot 2			
Team a	Time management		The team members have different reaction time to WhatsApp messages
	Diversity	Communication is running smoothly; The project team thinks that the communicative style is very similar	It is natural that the engineering and business points of view are different.
	Communication	Within the team and that has reduced the possibilities for conflicts during the project	When the project report needs a table or figure and outputs from everyone, there have been cases when the two sides see things differently
			Problems with information flow from the customer company
Team b	Time management	Our culture's doesn't have so much differences	Keeping the schedule was very difficult
	Diversity		Each project is different and each field of study has their own way to present and produce text
	Learning Communication	We learned to listen each other and to speak more clearer so that other could understand us.	
Team c	Time management		A team do not have the needed the additional information from the company in time
		Open and stress-free communication was seen as important element of this learning project	The team has suffered of the email issues and the reliability of this communication method is questioned.
	Communication		
Team d	Time management	Every team member respected deadlines	The client had postponed or cancelled many scheduled meetings with short warning
	Diversity & Isolation		Two working streams which acted very independently during the project
			The project team has felt the lack of instructions
	Communication	Communication within the team was in high level	

but some challenges due to the diverse professional backgrounds exist e.g., terminology, and reporting style. Moreover, communication with the companies has been sometimes difficult.

Thirdly, reflections on the multidisciplinarity of the team members are mainly positive and negative reflections are related to the professional diversity causing misunderstandings in ways of working. Some members worked quite independently, and some level of social isolation has been identified.

In the project final reports, it was also explained how challenges caused by diversity were faded through adjustment (e.g., language adjustment to improve communication mentioned by 3 teams), open communication and creating professional sub teams to avoid social isolation. Professional sub teams situated in the same HEI and had the possibility to meet face to face.

Individual reflection diaries

For deeper analysis of the individual reflections the study fields (see Table 1) were recoded into two professional roles. Business role (marketing and management, N=19) and Engineering role (art and engineering, N=20).

First, in individual reflections all team members and leaders evaluated the team stage they reached by the end of their project work. Applying IMGD by Wheelan (2005) the stages are numbered 1-4, where the stage 4 is the highest and most mature stage of team development (Table 2).

Table 2. Evaluation of team development stages by professional roles

Pilot	Stages within the teams	
Pilot 1	business role	engineer role
Team a	1	2
Team b	2	3
Team c	-	4
Team d	-	3
Pilot 2		
Team a	4	-
Team b	2	3, 3, 2
Team c	4	3, 3, 4
Team d	4	4, 3

Secondly, discussions on multidisciplinarity in reflection diaries were identified and third, the sentiment of the tone in discussions was analyzed and quantified by the team member's professional role (Table 3).

Both professional roles have experienced learning and possibility to develop their own competences in real-life projects positive. Negative statements refer to social isolation and challenges in communication. Most of the negative statements were found in the reflections for the second check point (CP). Overall, both roles have had more positive than negative experiences. The team members with an engineer role had more negative experiences than those with a business role.

Discussion

Wheelan (2005) has stated that groups achieve maturity through the process of working together. VTs in these two MuPIC-courses worked eight months together and at the end of the project, within some teams the members had diverse opinions on

Table 3. Team members´ individual experiences on multidisciplinary teamwork

Business role	Engineer role
Positive (n=17)	**Positive (n=19)**
Learning from other disciplines	**Learning from other disciplines**
While following the work of engineers it was great to see how fast they reacted to the feedback from the client and changed the solution. At the same time we learned more about understanding dependencies of different materials and robots within the solution.	I also learnt a few marketing and economic concepts related to this project that I never heard about before.
Team members individual autonomy in field specific decisions	**Learning how to communicate**
Opportunity to lead their own work in their special field of business and make lots of decisions by themselves	Some specific tasks were easy to understand for the concerned students and had to be clarified for the others. This shows again why communications skills are very important, specifically in english.
Authentic project to practice team leading skills	**Managers skill to lead the team**
Creating my own leadership philosophy and really thinking how and which kind of leadership I want to practise in the future was a perfect set up for this course. In this course, I was able take those learnings into practise and test them in a real situation.	Takes care of the homogeneization of the different parts and shares impressions and questionings with all of us.
Negative (n=15)	**Negative (n=19)**
Professional segments and social isolation	**Professional segments and social isolation**
Designer thinks that this is not in his field	We are making every task quite independently and there is not so much collaboration or brainstorming together" / "I had real difficulties to get member team interested in what I have done.
Poor communication	**Poor communication**
We now know that the final product should be an excel file including information and calculations, but I am not sure what kind of calculations.	I wanted to discuss about that in team only few members interacted with me.

the stage they had reached. This may indicate that building relationships at IM-GD stage 1 had not succeeded in all teams and relates to the feeling of isolation of some team members. Especially in virtual multidisciplinary teams, the most important factor affecting success is building relationships and trust at the first stage of the project (Varhelahti & Turnquist, 2021).

Secondly, this study showed that most of the challenges were discussed in the individual reflections for the second check point. This indicates that most of the teams had reached the IMGD stage 2. At this stage conflicts arise when it is time to share an understanding of direction and goals (Wheelan, 2005). However, there might have been some lack of handling challenging situations because some of the teams did not develop further. Thirdly, creating a learning environment including a real-life project resulting to strong task-orientation may turn the focus of the learning process to the final output (see Jaime et al., 2019) and lower the importance of developing team working skills. As Kauffmann and Golan (2014) suggest teams may be successful in providing the task results without building relationships at the IMGD stages 1 and 2. For example, in Pilot 1, a team was at the lowest levels of team development but was graded best for the final grading of the course. It can be assumed that with such a low level of team development, the role of the leader has been strong throughout the project.

It was in the interest of this study also to analyse how multidisciplinarity within the VTs is experienced. Experiences were mainly positive and related to learning from other disciplines both substance and terminology as well as improved communication skills. However, also challenges existed and they related to the IMGD stage 2 where applying knowledge into teamwork requires reaching the shared understanding of the goals. The results showed that some teams were able to adapt in the challenging situation by creating professional subgroups. However, as an individual experience some team members, especially with an engineering role, expressed social isolation due to the lack of shared understanding. In addition,

the autonomy of the team members sometimes led to social isolation and feelings that the team members were interested only in their own respective fields. This may be linked to the teams that did not focus on the relationships at IMGD stage 1 and 2 but jumped to the higher stages to work autonomously.

Without a doubt, teamwork in virtual multidisciplinary teams is a multifaceted process and the success of these teams is also influenced by team development. The results showed that especially IMGD stage 2, with all its challenges, is a cornerstone for team development. The skills for communication and handling challenging situations are highlighted.

Enhancing multidisciplinary virtual project work at HEIs

Multidisciplinarity in students´ virtual project teams was not a straightforward factor. First, this had a particular impact on communicating task-related knowledge. Second, professional diversity led sometimes to social isolation, especially experienced by the team members having an engineering role.

These challenges were not clearly observed during the project at the team level or by the teachers. Team development is undoubtedly an individual experience. These findings underline the value of both team level and individual level reflections on teamwork (e.g. Liao, 2017). To be able to support students and student teams, both team level and individual reflections are an important tool for the teachers to be able to follow the student teams´ development and intervene and give support in a timely manner.

References

Batarseh, F., Daspit, J. J., & Usher, J. M. (2018). *International Journal of Management Science and Engineering Management, 13*(1), 1–10. https://doi.org/10.1080/17509653.2016.1275865

Brewer, P. E., Mitchell, A., Sanders, R., Wallace, P., & Wood D. D. (2015). Teaching and learning in cross-disciplinary virtual teams. *IEEE Transactions on Professional Communication, 58*(2), 208–229. https://doi.org/10.1109/TPC.2015.2429973

Chamakiotis, P., Panteli, N., & Davison, R. M. (2021). Reimagining e-leadership for reconfigured virtual teams due to Covid-19. *International Journal of Information Management, 60*, 102381. https://doi.org/10.1016/j.ijinfomgt.2021.102381

Hannah, M. A., & Simeone, M. (2018). Exploring an ethnography-based knowledge network model for professional communication analysis of knowledge integration. *IEEE Transactions on Professional Communication, 61*(4), 372–388. https://doi.org/10.1109/TPC.2018.2870682

Jaime, A., Olarte, J. J., García-Izquierdo, F. J., & Domínguez, C. (2019). The effect of internships on computer science engineering capstone projects. *IEEE Transactions on Education, 63*(1), 24–31. https://doi.org/10.1109/TE.2019.2930024

Kauffmann, D., & Golan, C. (2014). How team leaders can use ICT to improve trust among virtual teams to increase collaboration? *International Journal of Engineering and Innovative Technology, 3*(9), 204–217.

Liang, T., Liu, C., Lin, T., & Lin, B. (2007). Effect of team diversity on software project performance. *Industrial Management & Data Systems, 107*(5), 636–653. https://doi.org/10.1108/02635570710750408

Liao, C. (2017). Leadership in virtual teams: A multilevel perspective. *Human Resource Management Review*, *27*(4), 648–659. https://doi.org/10.1016/j.hrmr.2016.12.010

Maduka, N. S., Edwards, H., Greenwood, D., Osborne, A., & Babatunde, S.O. (2018). Analysis of competencies for effective virtual team leadership in building successful organisations. *Benchmarking: An International Journal 25*(2), 696–712. https://doi.org/10.1108/BIJ-08-2016-0124

Raymundo, M.R.D.R. (2020). Fostering creativity through online creative collaborative group projects. *Asian Association of Open Universities Journal, 15*(1), 97–113. https://doi.org/10.1108/AAOUJ-10-2019-0048

de Souza Santos, R. E., & Ralph, P. (2022). A grounded theory of coordination in remote-first and hybrid software teams. *Proceedings of the 44th International Conference on Software Engineering (ICSE '22), USA*, 25–35. https://doi.org/10.1145/3510003.3510105

Vaida, S., & Serban, D. (2021). Group development stages. A brief comparative analysis of various models. *Psychologia-Paedagogia, 66*(1), 91–110. https://doi.org/10.24193/subbpsyped.2021.1.05

Varhelahti, M. (2017). *Teknologiavälitteisen viestintäosaamisen kehittäminen liiketalouden ylemmissä ammattikorkeakoulututkinnoissa-Työelämän tarpeista opetussuunnitelmiin* [Doctoral thesis, University of Turku].

Varhelahti, M., & Turnquist, T. (2021). Diversity and communication in virtual project teams. *IEEE Transactions on Professional Communication, 64*(2), 201–214. https://doi.org/10.1109/TPC.2021.3064404

Wankhade, M., Rao, A.C.S., & Kulkarni, C. (2022). A Survey on sentiment analysis methods, applications, and challenges. *Artificial Intelligence Review, 55*, 5731–5780. https://doi.org/10.1007/s10462-022-10144-1

Wheelan, S. A. (2005). *Group Processes: A Developmental Perspective*. Boston, MA, USA: Allyn and Bacon.

Zuofa, T., & Ochieng, E. G. (2017). Working separately but together: Appraising virtual project team challenges. *Team Performance Management, 23*(5/6), 227–242. https://doi.org/10.1108/TPM-06-2016-0030