LAB University of Applied Sciences

Improving the outcomes of collaborative projects through automated team design

Case: LAB University of Applied Sciences

LAB University of Applied Sciences
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Abstract

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Title of the thesis

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Abstract

The study proposes a model solution for team design in higher education. The case study is LAB University of Applied Sciences. The solution aims at improving the outcome of teamwork in the context of collaborative projects where students and external businesses are involved.

The research is exploratory, and it is divided into a theoretical and empirical part. The theoretical part collects secondary data form electronic sources. The empirical part gathers primary data from survey and open questions to LUT staff members and LAB teachers. The used data are both qualitative and quantitative.

The findings of the study show that the surveyed teachers demonstrated open-mindedness towards adopting new tools and methodologies to improve learning and teamwork practices. However, setting a framework for team design is complicated and requires further research.

Keywords

Collaborative projects, higher education, business, students, team design, data, data mining, data clustering, matchmaking

Contents

Appendices

Appendix 1. Open questions to LUT staff

Appendix 2. Methods to improve collaborative learning

1 Introduction

1.1 Research background

Digital transformation involves technology, data, and processes. Organizations must be flexible and iterative and enable learning and testing. As with the global pandemic, remote work and virtual teams are the norms. The time spent on collaborative projects increases. The popularity of agile working methodologies grows. Networks and cross-collaborations are valued better. If businesses want to succeed in this shift, they must respond fast to the changes, approach open innovation processes, and team up the right talents. (Santonen 2011, 8-9; Albaharna et al. 2020; Davenport & Redman 2020.)

Teams make decisions and become drivers of business innovation. Successful teams include diverse yet compatible members (IBM Research Editorial Staff 2018). However, to optimize their performance, team members must feel psychologically safe. Interaction shapes behaviour and psychology and it defines whether a team will be efficient or not (Lehmann-Willenbrock et al. 2017, 520). Individuals and their nature are complex, and managers fail at building up effective teams properly because they lack the knowledge and tools to coordinate human interaction. (Kohlrieser 2012.)

New business models ask for new skills and expertise (Card & Nelson 2019, 242; Kauppinen et al. 2019, 3888). Usually, businesses find external resources in the innovation environments of universities. However, these two sectors pursue a different focus. Higher education produces and divulges knowledge while training the experts of the future. Companies resolve business problems while trying to keep revenue streams high. (Aversa 2020, 9.) Therefore, employers claim that students do not have enough work-life skills (Card & Nelson 2019, 244). Schools promote collaborative projects to supply this labour demand, but in this approach of learning by doing, teams do not produce the outcomes that companies expect (Aversa 2020, 52; Santonen 2011, 1-3; Saarela et al. 2013, 2).

In innovation-driven economies, the relationship between academia and industry is tight (Saarela et al. 2013, 3; Aversa 2020, 9-10). Having a structured, effective, and integrative information system could support this relationship even further. Schools may have limited resources to develop a new system infrastructure and improve practices. Thus, artificial intelligence may provide a solution. (Saarela et al. 2013, 10; Heikkilä et al. 2018, 58.) Automation allows asset integration and efficient use of data, and it optimizes processes and maximizes results (Perera et al. 2009, 1; Abdous et al. 2012, 77; Birkeland et al. 2015, 239; Manjunath et al. 2016, 2125; Mahnane 2017, 22; Moreno et al. 2017, 996; Yalcin & Kutlu

2019, 2427). Understanding students' backgrounds is a long process for teachers (Mortiboys 2010, 111-123). It may require resources that they do not have. Currently, only learning management systems help teachers and students to work together.

Scholars of behavioural sciences and computer science study new practices to improve team building. However, the two disciplines assume diverse procedures. Social sciences scholars collect data through social experiments, while computer science scholars use automation. It is hard to extract valuable data from these two approaches when they are carried per se. Hence, studies on this matter should be interdisciplinary. (Buengeler et al. 2017, 603-604; Lehmann-Willenbrock et al. 2017, 525.)

The education sector is the perfect testbed for a comprehensive study on automated team design. The present study aims to provide tools to help improve teamwork efficiency in collaborative projects in higher education. The proposed model may be also adapted to the lower levels of education, to analyse student's interactions and tackle negative episodes such as bullying at school. It is also possible to implement the results in the industry sector since it can provide human resources and strategic management with a tool to manage change and teams, and support staff reskilling.

1.2 Thesis objectives and limitations

The primary objective of the research is to propose a model of system integration for effective team design in the context of collaborative projects, to help teachers to monitor teamwork and measure team performance and learning. The model also aims to support LAB's strategy, to increase satisfaction and engagement of the actors in collaborative environments, but also to contribute to branding and recognition to tighten the relationship between education and industry.

The background research discussed here supports team design in business and professional contexts. Yet, the model refers specifically to collaborative projects in higher education. The case study is limited to the higher education sector in Finland. In particular, the focus is on LAB University of Applied Sciences as part of the LUT Group. Thus, the same model cannot be applied to other institutions, universities, and industries. Information systems' capabilities are a limit, as are their features, access, rights, and terms of use. Time may also limit the thoroughness of the study. Regulations in matters of data sensitivity, protection, and retrieval will not be covered. Furthermore, due to the scarcity of printed material, the sources collected will be electronic.

1.3 Research questions

To allow students to learn and work efficiently, study groups should be as harmonious as possible. This is done by containing the asymmetries between team members. Teachers may lack the tools to design efficient teams and monitor teams' throughput. The present study investigates whether teachers would accept the use of an automated tool to design efficient student teams in the context of collaborative projects where also external partners participate.

To narrow down its focus, the study aims to answer the following research question:

- How are efficient teams designed?

Finding an answer to the first research question is fundamental since it provides insights into what criteria should be considered in the process of team automation. Understanding how the suggested model would be applied, what the core processes are, and what information systems should be used, is part of the development plan. Thus, the second research question is the following:

- Would teachers at LAB University of Applied Sciences accept an automated tool to better design teams and improve collaborative projects with external partners?

Answering the second research question accounts for teachers' perceptions and acceptance of the model and provides insights on whether it is appropriate to continue the research further or not.

1.4 Theoretical framework

The research assumes a comprehensive approach. The study mixes theories, models, and concepts from psychology, team management, education, and information technology. The following concepts create the research framework: algorithm, asymmetry in interaction, digital transformation, distributed systems, experiential learning, resistance to change, teams, technology acceptance model, transient communities. These concepts are defined below.

Algorithms are computational procedures that input datasets, process them, and output results (Cormen et al. 2009, 5).

Asymmetric interaction is the distance of power, dominance, or authority that manifests in the interaction among people (University of Helsinki 2016).

Digital transformation is the process of applying new digital technologies in commercial settings. It changes the nature and the context of work and fuels the fourth industrial revolution. (Kretschmer & Khashabi 2020, 86; Solberg et al. 2020, 105.)

Distributed systems are networks of computers linked to one another that communicate and send information to each other to achieve a goal or reduce a task workload (Puder et al. 2005, 8).

Experiential learning is a learning process where the learner adapts to the given circumstances and creates knowledge through experience. This cycle starts with action and reflection and ends with experience and conceptualization. (Kolb & Kolb 2011, 43-44.)

Resistance to change is the effect of mental models that employees assume when not supporting the changes proposed by the management. It can be caused, for example, by fear of the unknown, or because of different points of view. (Dent & Goldberg 1999, 38-40.)

Teams are small groups of people with complementary skills. Members rely on each other, adopt the same working methods, and are equally committed to pursuing the same goal. (Katzenbach & Smith 1993, 69.)

Technology acceptance model (TAM) (Figure1) is a decision-making model that is used by practitioners to predict whether new information technology will be accepted by its users or not. The model identifies the reasons why a proposed technology may not be accepted and helps with the following decision-making process. (Davis 1989, 999.)

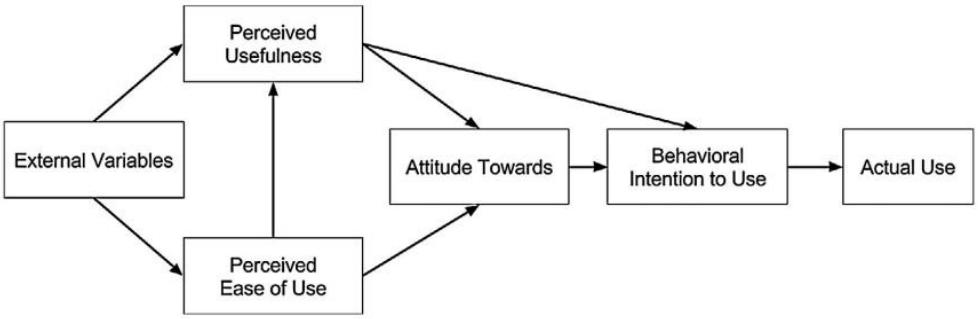

Figure 1. Technology Acceptance Model (Davis et al. 1989, 985)

Transient communities are communities that exist for a defined period and pursue a defined objective. They work under social rules and foster knowledge sharing. (Berlanga et al. 2008, 447-448.)

1.5 Research methodology and data collection

Seen the novelty and complexity of the research topic, the study explores the research area and questions in-depth and leaves room for further investigation, however, it does not provide final or conclusive solutions. Therefore, the research is exploratory and provides a better understanding of the problem otherwise not clearly defined. Because of this approach, the study maintains a level of flexibility and adaptability that allows changes if new insights come across. Nevertheless, the investigation determines what type of research is worth pursuing and settles the ground for future studies. (Dudovskiy 2021.) The first part of the research serves to understand the research topic and research problem in depth. Therefore, it collects qualitative information from secondary data. These data are retrieved from the LUT Primo library, Google Scholar, and search engines and include research papers, articles, books, and theses. The literature review in chapter 2.2.3 answers the first research question. The second part of the study identifies patterns and provides a backbone for the development plan. The theories in the literature review help at understanding what and how primary data should be collected for the empirical part of the study. Thus, primary data are collected through qualitative and quantitative investigations and they are analysed in chapter 3. LUT staff answer open questions regarding information systems and platforms in use, their answers improve the development plan as described in chapter 4. Whilst teachers respond to a survey to investigate their teamwork practices and their acceptance of the model proposed. Data collected from teachers' responses answer the second research question, which can be found in chapter 3.6 and 3.7. Conclusions are generated thereafter. Figure 2 outlines the research approach.

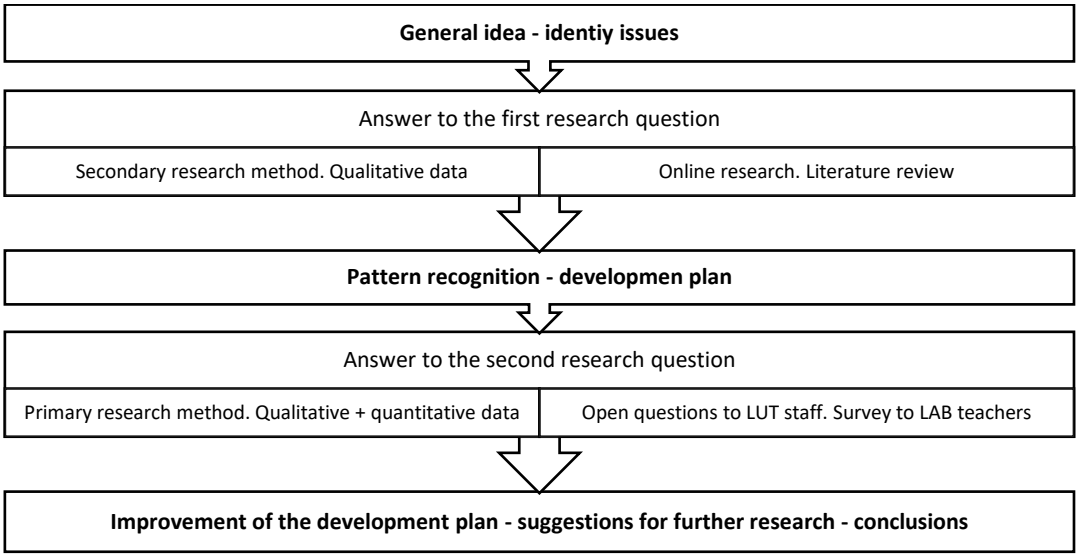

Figure 2. Exploratory approach

1.6 Case: LAB University of Applied Sciences

The case study regards LAB University of Applied Sciences. It is an autonomous educational institution that belongs to the corporate LUT Group. Whereas LUT University is the parent company, LAB is a subsidiary. (LAB 2021a.) LAB operates in Lahti and Lappeenranta and it has over 8,500 students. (LAB 2021b.)

One of the goals of the LUT Group's strategy is to improve the quality of its interaction with society. Scientific and industrial cooperation is the core of this interaction and is supported by the proper use of management services. The strategic plan underlines the need to keep updated and focused on areas of interest, to track feedback and ranking, and to use communication and cooperation to keep a tight relationship with external stakeholders. (LUT Intra 2021d.)

Working life and university have divergent tasks, cultures, goals, and expectations, but LAB exploits the know-how of education to offer partnering companies the most appropriate solutions. When planning collaborative projects, teachers prioritize the business needs and strategies of companies. To deliver the right competencies to the students, teachers let companies comment on course content and tasks. Further success is added when a company representative participates in the same project with the degree students. The representative brings a development task to be solved, producing meaningful outcomes for companies and students. Companies gain a new perspective on their operations and increase their expertise. Students carry assignments at the companies' premises, practice what they have learned in class, gain valuable experience, knowledge, and networks. This collaborative method has strong potential when applied in real business life. Moreover, when collaboration is successful, all actors find it empowering, engaging, and enjoyable. (Räsänen & Fifield 2020; Sore 2020; Vainio 2020b.)

Students may lack experience, and teachers are aware of this. To fill this gap, teachers must be present, track students’ activities, and support students. But teachers have limited resources to actively monitor students throughout the projects (Vainio 2020b), especially when there are multiple groups to manage. This results in insufficient attention to single group dynamics, and team inefficiency. Teachers are aware of personal differences that students manifest in learning and interacting with each other. Usually, students divide their teamwork and work independently with the least interaction. This issue can be solved by reinforcing the relationship and communication between teachers and students. (LUT Intra 2021m.) Improving service experience strengthens customers’ relationships. The focus must go on guidance, education, and interaction. (Räsänen & Fifield 2020.)

Student participation is one solution to improve the quality of education. Another suggestion is to further exploit current information systems and platforms in use at LAB. For example, to target the promotion of collaborative projects to the right audience. Vainio (2020a) argues that organizations should deploy digital tools and cut obsolete processes. This is done by reducing expenditure and optimizing the use of resources. The LUT Group, for instance, employs multiple information systems that support students, staff, and external partners. Therefore, the study investigates how these systems are currently integrated and whether it is possible to improve the architecture even further, thus, to use data mining techniques to tackle customer behaviour (Niemelä et al. 2020). Following a list of information systems and platforms in use at LAB University of Applied Sciences that can support the model proposed in the development plan.

Education administration

The information system used for education administration at LAB is called Peppi. The Peppi platform is used for managing curricula and students' information, and it stores information about recognition of prior learning and credit transfer and teaching events. (LAB 2021d; LUT Intra 2021b; LUT Intra 2021f.)

Learning management system

LAB uses the Moodle learning management system. Teachers use Moodle to distribute study material, give assignments and exams. It is also a space to track students' progress, to give and receive feedback, to open discussion forums, and to create study groups. (LUT Intra 2021e.) Study groups are created manually or automatically by group size but also by giving the choice to students (Pulkkinen 2017).

Meetings, conferences, and online lectures

Zoom is a service that allows audio, video, and screen sharing. It is for internal and external meetings, webinars, and it is useful for distance learning. It also allows chat with text, file sharing, display and webcam, vote, draw on a board, and record the meeting. It can be connected to Moodle as an external tool. Scheduling of meetings can be saved on Outlook. (Pulkkinen 2020.)

MS Teams is an online classroom provided by Office 365. MS Teams is a cloud space where teachers and students can post, share, and organize files and lecture material. With this tool, teachers create classes and chat with a group or single students. Teachers can provide assignments and give grades. They can also track the activity of students. (Microsoft 2021.)

Lecture capturing

Echo 360 is a lecture capturing system and video library. It records online lectures and can be used to export videos. It can be integrated into Moodle and can record videos from Zoom. (LUT Intra 2021g.)

Microsoft Office programs

Office 365 is a cloud service package available for LUT students. It is used for emails and calendars. It also provides storage space in the Onedrive cloud. Office 365 Groups is for teamwork. Office Online lets multiple users work simultaneously on the same document. Moreover, Office 365 ProPlus applications are available, as well as instant messages through Skype for Business. (LUT Intra 2021i.)

Management of time schedules and reservations of physical spaces

TimeEdit helps with the scheduling and management of events and timetables. It can arrange room reservations and export all the information to the Outlook calendar. (LUT Intra 2021b; LUT Intra 2021h.)

Feedback and inquiry pool

Webropol is the platform used for data collection. It manages surveys and displays results and reports. (LUT Intra 2021b.)

Servicedesk for training and guidance on IT services

Opetushelp is the service desk tool used by the Digital Learning Team at LAB. It is meant to support the staff of LAB and LUT when learning to use tech services. Guiding teachers and staff in using technology is part of LUT Group's digital strategy of education in 2025. (LUT Intra 2021c.)

Professional development for students

JobTeaser is the portal of career services. It is used by the LUT Group. It informs students about employment, internship opportunities, thesis collaborations, and seminars. Students create their profiles, add personal data, and include links to social media and other platforms. Individuals logged on this platform connect through a matchmaking algorithm. (JobTeaser 2018a; LUT Intra 2021a; LUT & LAB Career Services 2021.) JobTeaser is the right environment to promote projects to a targeted audience. The types of user accounts on JobTeaser are:

- Member account for students and graduates seeking opportunities.

- Institution account for the educational institution offering the service to their students.
- Recruiter account for individuals that offer opportunities.
- Company account for legal entities that offer opportunities. (JobTeaser 2018a.)

Social Media

Yammer is the social network used within the organization. It is for individuals belonging to the education environment. The aim is to improve engagement and enhance communication within the organization. Smaller communities are built within this network. (LUT Intra 2021l.)

1.7 Thesis structure

Chapter 1 of this document introduces the study. It covers the background, goals, limitations, concepts, and research methods. It also clarifies the case study and the structure of the thesis.

Chapter 2 presents the literature review. This chapter provides an answer to the first research question. The study starts with a business perspective that, then, moves to the education point of view. It investigates the effects of digital transformation on organizational culture and working methods, especially teamwork. The study emphasises the need for staff reskilling and assumes a gradual approach from learning to work. Hence, it focuses on how organizations can use automation to team up the right talents for collaborative projects. Whereas the first part investigates the interaction between people, the second part examines how systems, data, and information flow, together with data mining techniques and matchmaking, can better support the process of team design.

Chapter 3 focuses on the empirical part of the study. It investigates the LAB environment and circumstances. In this section, data from LUT personnel and LAB teachers are gathered and analysed. Chapter 4 represents the development plan. In this chapter, the model solution is proposed. Chapter 5 concludes the thesis report, with answers to research questions. In this section, the results are also discussed, and further research is suggested. Chapter 6 summarizes the thesis report.

2 Literature review

2.1 Data shapes organizational culture

With technological development, the amount of data produced, stored, and replicated, grows exponentially, and it is expected to reach 175 zettabytes (ZB) by 2025 (Reinsel et al. 2018, 3). In business, data are beneficial for various operations such as value chain management, production management, human resources management, and customer relationship management. Businesses need data to gain a sustainable competitive advantage and generate added value. This is a challenging process. Searching for patterns is not easy, not all information is useful, and a big amount of data may create uncertainty. When structured, data provide meaningful, valuable, useful, and relevant information. Data are the source of knowledge. Thus, processing data helps decision-making, but datasets must be robust and reliable, agile, and flexible, with proper correlations, hierarchies, and multiple data linkages. (Matthias et al. 2015, 37-43.)

Organizations must be dynamic at adapting to market changes, and this is not simple either. Leaders must value change management and build a strong organizational culture. Seventy per cent of innovation programs fail due to the lack of mindset of the people involved. For example, staff that fears losing their jobs resist change, they are afraid of machines replacing them, and this translates into inefficient project outcomes. (Tabrizi et al. 2019.) Effective results need business acumen, decision-making skills, and experiential learning (Card & Nelson 2019, 244). Horizontal hierarchies reduce power differences, create a climate of egalitarianism and team culture (Sinha & Stothard 2020, 396). To reduce resistance to change, thus, to achieve success, inter-organizational consultations should include an internal workforce. Since employees know operational flaws well, they should take part in designing new strategies. (Tabrizi et al. 2019.)

Data management ensures competitive advantage, but it requires resources that, in most cases, companies lack. Talent shortages are a threat to digital transformation. Therefore, firms are opting for staff reskilling. Managers team up with employees and invest in automation. Therefore, teams become learning units of organizations, they adopt agile methodologies and get involved in continuous collective learning. (Card & Nelson 2019, 242- 245; Sinha & Stothard 2020, 391.)

2.2 Learning by doing, a connection between industry and education

Employers are not sure about finding the right experts outside of the companies (Card & Nelson 2019, 242-243). If they cannot research in-house or afford to outsource, they collaborate with universities. By doing so, they get access to young talents and their novelty at no cost, they gain knowledge of new technologies and increase their innovation levels, it is also an opportunity to screen potential employees. In this relationship, universities get recognition, grow their brand reputation, opportunities, and contribute to the social and economic growth of the local community. (Aversa 2020, 12-14.) But, if higher education institutions want to provide students with competencies that satisfy the labour market needs, they must adopt continuous development methods (Luojus et al. 2018, 4547).

Teamwork, communication, and cooperation are the skills that employers expect from students (Ekimova & Kokurin 2014, 854). Multidisciplinary teams are the best place to develop these competencies. The model of learning-by-doing provides a supportive and secure environment for teams. (Luojus et al. 2018, 4547.) When students work with external parties in projects of research and development, they learn the competencies needed for working life. The acquired know-how includes problem-solving, independent thinking, self-regulation, confidence, collaboration, communication, focus, creativity, leadership, and technology skills. (Saarela et al. 2013, 2; Ekimova & Kokurin 2014, 847-850; Kauppinen et al. 2019, 3891.)

However, there are a few obstacles in the collaboration between education and industry. Students lack a deep real working life experience that limits the quality of the work. When the project outcomes do not meet the business requirements, they are not useful in terms of real working life. Moreover, not all the students show commitment and seriousness in the research work. Companies understand that projects are meant for learning, but they expect that students do their best to excel and take the work seriously. (Aversa 2020, 11.) This inefficiency reduces the potential of cooperation.

2.2.1 The differences in teamwork in business and education

Teamwork is one of the most effective group development practices in organizations. Employees are motivated to teamwork if it eases their work without adding pressure. The effectiveness of a team in the work environment is influenced by clear goals, active and informal participation, open communication, some level of disagreement, transparency in assigning roles, diversity, and commitment. Team members must be flexible and prone to collaboration yet show social independence. Effective teams give and receive constant feedback and support. Therefore, success is the result of good team management practices

that start with a correct team design. To have a positive impact, in the first stage of team design, managers evaluate the collective intelligence of a team by accounting for individual differences of members, their learning methods, and communication patterns. (Gantasala 2015, 639-641.)

Teamwork is also a big part of the learning process in higher education. Students' attitude towards teamwork reflects their previous experience. In group tasks, students tend to work separately, they divide parts and work individually on their section, then they meet to prepare and train for the oral group presentation. Some students communicate during the process, comment on separate parts, and adjust the final work, but not everyone gets involved. When the work is complete, students know only their contribution. In this way, there is no value generated from the group work. Therefore, many students learn more from individual work rather than teamwork. (Birkeland et al. 2015, 232-239.) For this reason, teachers must endorse good practices in teamwork. Teammates should share overlapping competencies and similar perspectives since complementary skills promote a team culture of shared knowledge. With synergic action and communication, students gain a sense of responsibility and discipline. Motivation leads to enthusiasm, commitment, and success. While the emotional dimension guides students in interaction. (Bergiel & Gainey 2015, 332-334; Gantasala 2015, 639-641; Buengeler et al. 2017, 602-603; IBM Research Editorial Staff 2018; Kauppinen et al. 2019, 3891.)

There are differences in the motives behind teamwork in business and education. The outputs of business teams are evident in the real life. Moreover, responsibilities reflect one's expertise level. Staff members may receive benefits such as increased salaries, recognition, or upgraded positions. Adults at work give a high value to learning outcomes. Managers and teammates have the time to know each other better. In higher education, instead, team management is a challenge. Students are not enthusiastic about it since it has fewer practical benefits. Usually, students approach teamwork as a means to ease their study load for a certain course. Problems arise due to unbalanced preparation, unclear goals, mismanagement, unequal participation, and lack of leadership and team development. As a result, teams of students often end up in conflict. (Ekimova & Kokurin 2014, 854; Gantasala 2015, 639-640.)

2.2.2 The nature of conflict

The learning experience in a team is affected by individual differences. These can manifest, for example, with mental ability, aggression, and interaction anxiety. Acknowledging these differences means setting boundaries and improving the effectiveness of the team. (Naber et al. 2014, 163.) In the education environment being aware of students' background means

also reducing the negative effect that teamwork may have on their health condition. For instance, conflictual teamwork is correlated to increased depression and anxiety in students. Yet, when students clarify their background, the rates of conflicts and sickness drop. (Zaidi et al. 2016, 6.)

Interpersonal incompatibilities, animosity, tension, or annoyance are some of the sources of conflict (Gantasala 2015, 639). However, disagreements are perceived differently by individuals. When a group of people has divergent opinions about the conflict, it develops a conflict asymmetry. If the conflict asymmetry is high, there is no room for sharing any personal experience, it limits constructive communication and problem resolution. (Yong et al. 2014, 267-273; Bergiel & Gainey 2015, 323-324.) Disagreements diminish group success and the well-being of individuals but can also lead to greater innovation and more effective interpersonal relationships. (Yong et al. 2014, 271-273.) To limit the negative impact of conflicts in teamwork, it is important to understand their roots. According to the narrative (Yong et al. 2014, 266-267; Bergiel & Gainey 2015, 323-324; Gantasala 2015, 639), conflicts in teamwork arise due to tasks and relationships.

Task conflicts

Task conflicts are the outcome of disagreements on how to perform a task. Team members may dispute on task content, on how to do the work, how to assign responsibilities, what resources to use, and so on. Usually, this conflict arises at the storming stage since many ideas animate the discussion. If members do not know each other, they may perceive the debate as a personal attack, at the end of which, members may feel unsatisfied and decide to not commit to the project. (Bergiel & Gainey 2015, 323-324.) When members master certain skills or are specialized in certain areas, the conflict is functional and inevitable. If team members cannot contribute equally as others, inadequacy emerges since they feel intimidated or provoked. In these cases, freedom does not enable autonomy, it is rather a source of procrastination and social loafing. (Gantasala 2015, 640-641.) Task conflicts are beneficial when team members can communicate with each other. This happens when the asymmetries in task conflict are low. Being able to manage these conflicts improves problem solving and cognition, benefits team performance, and improves decision quality. When managed, task conflicts lead to convergent thinking and usefulness. (Yong et al. 2014, 279.)

Relationship conflicts

Relationship conflicts arise due to incompatibilities between members and miscommunication. (Bergiel & Gainey 2015, 323-324.) They are the consequence of personal differences, annoyance, and hostility between individuals. When relationship conflicts emerge, individuals are less cooperative and less interested in performing the task and achieving team

goals. Time goes to solve interpersonal issues. This conflict may be also the source of subgroups or coalitions within the team, this is common in groups that have a higher level of diversity. Subgroups can specialize in their interest areas and interact less with others. This increases the asymmetry in the relationship. This type of conflict has a dual mechanism, while some of the team members focus on generating differences, others may combine them. Thus, managing asymmetries in relationship conflict drives innovation, encourages diversity, and reduces interpersonal tensions. (Yong et al. 2014, 279.)

2.2.3 Designing efficient teams

Teams should be organized in a way that creative disruption occurs naturally, and this happens by including members with specialized expertise in diverse areas. It is positive if subgroups from within the team and that teams experience some level of disagreement. (Yong et al. 2014, 284.) Proactive members may want to finish the task before the deadline. Others may want to take the whole time needed. Some individuals may want to focus on the appearance of the project outputs. Others would argue on how to present the work and what software to use. (Bergiel & Gainey 2015, 333.)

Efficient teams are synergic. Team members account for and integrate priorities and perspectives of each other. (Bergiel & Gainey 2015, 333.) Partners compensate each other with their complementary skills. Highly conscientious team members counteract with less conscientious ones. Responsibilities depend on the nature of the work and the expected outcomes. Thus, the negative manifestations of individual differences are moderate if roles are assigned transparently. (Naber et al. 2014, 164-165.)

Teams should be designed to ensure egalitarianism, the condition under which people interact equally, respecting each other. When egalitarianism lacks, aggressive or stronger members tend to dominate the process. This results in power asymmetries that repress equality in the interaction and hinder learning. High power members are biased towards lower power members that are usually misjudged as scarce in resources and competencies. Therefore, their voice is mistrusted and ignored, they end up missing psychological equality and avoid interaction. This psychological distance reduces feedback and obstructs reflection, interpersonal support, and learning. Thus, the power asymmetry should be reduced. (Sinha & Stothard 2020.)

Team performance is improved when considering individual differences of team members that manifest in learning methods, communication patterns, competencies, but also personality types, emotional dimensions, influences, and attitudes. (Gantasala 2015, 639-640; Buengeler et al. 2017, 602.) Team design is crucial to increase team effectiveness and to

reduce conflict, free riding, and conformity. However, team design alone may not guarantee efficient teamwork. Thus, to achieve the highest benefit, this process should be followed by diversity training. (Buengeler et al. 2017, 610-613.)

2.3 Improving processes through system integration

In the past, organizations adopted information systems just to serve single operations. These procedures generated a series of diverse and separate agents, also called islands of information, that include databases, digital libraries, information retrieval systems, electronic mail systems, and so forth. These agents collect similar, duplicate, yet no standardized data that do not help with long-term sustainability. These systems have their behaviour and rules often causing system inefficiency and poor execution, and they cannot preserve information for the long term. Moreover, maintaining such a diverse infrastructure is costly and increases technical and managerial risks. Current technologies finally solve these issues, by integrating the systems, it is possible to incorporate data, but also applications and communication. (Di Leo et al. 2002, 1-2; Kudrass 2006, 8; Asproth 2007, 95-96; Norshidah et al. 2013, 68-70.) The integration of information systems belongs to the strategy of an organization (Lupu et al. 2008, 481).

A well-structured system integration supports cross-organizational functions and is essential for decision making. It provides accurate, clean, and stable data that turns into better access, understanding, managing, and reporting of information. (Lupu et al. 2008, 481.) Interconnecting entities eases the exchange of information and communication and improves performance, coordination, productivity, innovation, and competitive advantage (Kudrass 2006, 1; Norshidah et al. 2013, 68). However, the complexity of environments grows over time. Thus, to reduce the risks of system outbreaks, systems must be robust and reliable. Procedures of incorporation and development must be standard, as well as the information flow and data warehousing, and the models of information extraction and data processing. (Asproth 2007, 95-96.)

System integration in higher education improves cooperation and teaching, maintains partnerships, and grants new capabilities. It provides students with better learning experiences and interactions. It enables functional self-action, allows content management and publishing, as well as feedback report and statistics, extraction of information from heterogeneous data sources, security, and privacy of data. (Kudrass 2006, 1-2; Lupu et al. 2008, 473.)

2.3.1 The digital footprint as a capital

Managing data lifecycle means establishing standardized methods of storing, accessing, sharing, processing, and analysing data. Managing data produces new business models and generates added value. However, with the increasing number of services and applications, extracting data becomes a complex job. (Alamäki et al. 2018, 2; Kraleva et al. 2018, 117.) Once service components and tools are integrated, organizations reduce the time spent on decision-making and task optimization and focus on achieving their business goals. Managing data involves cross-organizational collaboration. Business units share their datasets and the whole organization becomes a collaborative network. This business model requires an adaptable virtual enterprise information system, a flexible IT platform that supports a dynamic, yet low-cost, integration of resources. (Li & Wei 2014, 450; Alamäki et al. 2018, 11.)

Current technologies optimize the physical infrastructure of organizations and their flow of data and information. However, there is still much to be done concerning the analysis of users' digital footprints within a working environment. Tracking the digital footprint of people working together means acknowledging patterns in their social relationships and their behaviour, with this knowledge, the value of social capital is fully exploited. (Huysman & Wulf 2005, 86-87; Azucar et al. 2018, 150-151; Tadesse et al. 2018, 352.)

Higher education uses a variety of applications that support online teaching and group work. The coordination of information systems is in continuous development. Yet, the education sector has not taken full advantage of the technologies currently available. Educational information technology systems generate a significant amount of unexploited data. Data that show students' dynamics, hidden relationships, patterns, interdependencies, and correlations. Data provide automatic feedback and resolve conflicts, inform about each student's learning experiences and behaviour, such as participation, login frequency, messaging. Information can also be extracted from video streaming, participation, conversations, or e-mails. The analysis of the student digital footprint can predict performance and provide students with an improved personalized learning experience. (Perera et al. 2009, 1-3; Abdous et al. 2012, 85-86; Manjunath et al. 2016, 2125; Villanueva et al. 2018, 249.) This information is useful to build profiles of students for teamwork purposes. However, educational data are temporal, noisy, correlated, incomplete, not standardized, and may lack enough samples for the same tasks. Valuing data mining from raw institutional data is just a recent discovery for education. Thus, the methods of extraction and analysis of data for educational purposes are not optimal yet. (Perera et al. 2009, 2.)

2.3.2 Data mining to improve the learning experience

One's personality is defined by behaviours and emotions that are evoked by environmental and biological factors. The traits that characterize personality are consistency along with the situations, stability on basis of time, and individual difference. Different theories help understanding one's personality, some of them are Big Five, MBTI, DiSC, and 16PF Trait Theory. (Perera et al. 2009, 1-3; Piedboeuf et al. 2019, 11; Vora et al. 2020, 352-353.) Measuring one's personality is a dense and long process. Gathering structured data may be time-consuming and produce inefficient results. To access the personality of users, service providers can ask them to respond to questionnaires, or ask if they know already their personality traits. However, these procedures are subject to errors, biased self-evaluations, and they are not consistent in the long term since one's personality trait changes over time. Algorithms can perform the same task, with less time and fewer errors, thus, a solution to understand users' personality is to use automated systems. (Farnadi et al. 2016, 1-2; Vora et al. 2020, 356.)

In educational environments, student information is usually collected through surveys, interviews, focus groups, and classroom activities. But these methods are time-consuming, and the responses may be filtered and not objective. Moreover, it is not sustainable to perform the research frequently. Considering the effects of social media on students' learning experience, little has been done to understand students' experiences from their behaviour and their conversations online. These conversations provide subtle, non-obvious, authentic, and unfiltered insights about students' experiences that cannot be seen in class. Hence, using data mining techniques to gain a deeper understanding of students' behaviour allows for education reengineering. (Chen et al. 2014, 246-248.)

Social media is a reliable source to define the personality of users. On social media, users' behaviour is extracted through personality prediction, whilst users' emotions are explored through sentiment analysis. (Perera et al. 2009, 1-3; Piedboeuf et al. 2019, 11; Vora et al. 2020, 352-353.) Information regarding online users' behaviour and preferences is collected from their likes, comments, shares, public information, as well as private conversations, e-mails, and even phone calls. Unstructured data are extracted and transformed into structured data. This process of data clustering supports predictive performance. Accessing users' personalities helps service providers to employ adaptive systems and deliver users customized experiences and tailored recommendations. (Adedoyin-Olowe et al. 2014, 1-5; Nie et al. 2014, 158; Farnadi et al. 2016, 4; Pednekar & Dubey 2016, 489–491; Tadesse et al. 2018, 352-353; Villanueva et al. 2018, 236-237.)

2.3.3 Learning moves from learning management systems to social media

Digital technology does not necessarily lead to advances in learning processes, but it can help students in collaborating, solving tasks, and participating better. Education providers should think about redesigning the learning practices to take full advantage of the current technologies. (Birkeland et al. 2015, 239.)

Students' behaviour is influenced by the user interface, but also by their level of computer self-efficacy, cognitive absorption, and social norms. Students are also influenced by other students and teachers. Learning management system supports students' learning, students use it if they find it useful and easy to use. However, the learning management system does not invite students at communicating and collaborating within the environment. (Moreno et al. 2017, 996; Yalcin & Kutlu 2019, 2415.) Typically, students use learning management systems as archives, one-way channels of information from the teacher to them. Students claim that extracting information can be complicated, too many paths produce confusion when looking for specific information. (Birkeland et al. 2015, 232-233.)

For teamwork, students prefer to interact on social media rather than the learning management system. On social media, learning becomes experiential and informal, students overpass their emotional barriers, it becomes easier to access real-world practices and know-how. On social media students engage in brainstorming, reflecting, and give feedback to each other. As a result, they plan their work better, set their study methods, share material, and understand better expectations. (Birkeland et al. 2015, 237-238; Stainbank & Gurr 2016, 337-338; Cook-Sather 2017, 1143; Zhang et al. 2017, 1100; Messer & Kangwoo 2019.) When teachers are also active on social media, they build a trustworthy relationship with students. Managing groups on social media is easier for teachers, as for transferring the management of groups from teacher to teacher. (Harris 2012, 817-820; Smith & Lambert 2013, 362-363)

Social media foster personalized learning and support career guidance. Adopting social networks for learning practices increases participation, openness, conversation, community, and connectedness among students. Through social media, it is easier to create dynamic teams and to acknowledge one's learning style, skills level, and personality. (Stainbank & Gurr 2016, 337-338; Mahnane 2017, 22.) Through social media, it is even possible to perform social network analysis and network visualization, these techniques serve to study social interactions among users. These methods can improve team effectiveness, and even if social network analysis is an intricate task, digital solutions exist. (Becheru et al. 2018, 1.)

2.3.4 Entity resolution and data clustering

When integrating systems, it is important to understand if they store information about the same entities, that can be people or objects, for example. This procedure called entity resolution, record linking, data matching, or de-duplication is the process of analysing whether entities have similar attributes or not. Data matching works on attribute level, reference level, and cluster level. Attribute-level matching works through an algorithm that analyses the similarity between attribute values to find out whether identical attributes exist or not. This process of finding the exact match is often too strict since string characters are subject to misspelling and mistyping, this method also may not work due to differences in spacing and letter casing. A way to improve this approach is to use standardization with an approximate “fuzzy” match that uses comparators to address eventual errors in the input data. Reference-level matching includes deterministic rules (when giving the same input, the algorithm produces the same output), and probabilistic rules (increasing similarity between references increases the chances that they are equivalent). Finally, cluster-level matching solves the problem of matching clusters. (Talburt & Yinle 2015, 46-50.)

When trying to match data clusters, the algorithm can analyse the values of the attributes but also data into the cluster. If there is no match between the input reference and the references within a cluster, then the algorithm outputs a no match. If the input matches with at least one of the references within the cluster, then there is a match. However, the requirement for a match to happen may be set to more than one within the cluster. The matching algorithm can also compare each reference from one cluster to each possible projection for a second cluster, and so forth. When the match between references happens, they are merged into one single cluster and the same link value is assigned to each reference belonging to the cluster. When an input reference matches two or more clusters, all the clusters that match the input reference are merged into a single cluster called glue record. (Talburt & Yinle 2015, 125-126.)

An efficient algorithm should find all the possible matches, select, and compare references and clusters according to the given rule. It should be efficient, the number of comparisons attempted should be minimal, but it should not lose matches. It should not spend time on comparisons that will not produce matching results. It should be sequence neutral, the algorithm should create a cluster regardless of the processing order of the input references. (Talburt & Yinle 2015, 126.)

2.3.5 Matchmaking

When an environment has a large, diverse, and dynamic set of entities, the most suitable matchmaking algorithm would be centralized. Centralized matchmaking is a data model that manages entities within a network. The algorithm operates through queries. Entities share their features, whether they provide or need resources. Input data are stored in a database located in a central node. The algorithm informs the matchmaker of the query. The matchmaker then accesses the database to find compatible entities to fulfil the queries. The algorithm informs the entities about the match. Then, it is the entities' responsibility to establish contact and cooperate. If the match goes through, the algorithm assigns tasks and keeps track of the results. (Raman et al. 1998, 1-2; Santonen 2011, 8; Del Val et al. 2013, 281.)

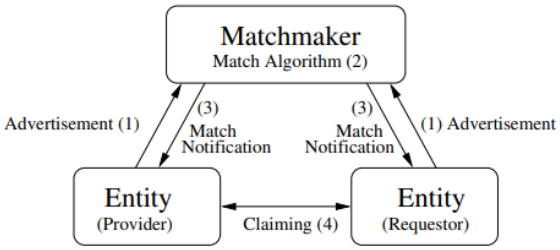

Figure 3. The matchmaking process (Raman et al. 1988, 4)

A distributed system is constituted by a large number of diverse entities that adapt to changing conditions. These systems are adaptive, hence, self-operating, and self-regulating. In such systems, entities join and leave the environment, and dynamically adjust their role. Entities are querents, resources, and matchmakers that interact to achieve the goal of resource sharing. With this model the workload for the entities that are overloaded is reduced, this approach optimizes entities' work, but is a rather complex task. (Del Val et al. 2013, 281; Sidgel et al. 2005, 1.) In the context of teamwork, matchmaking algorithms are useful to solve problems of resource allocation and scheduling, as they help with finding entities for collaboration, as well as matching their course timetables and tasks. (Raman et al. 1998, 1; Santonen 2011, 8.)

3 Empirical study

As Aversa (2020, 55) describes, in a project, there should be a person responsible to improve the interaction among people involved, foster communication, and build a shared vision. Teachers are the most reliable sources to perform this task, but this process could be supported with proper tools and technologies. Hence, the following section examines what systems and processes can contribute to team design automation at LAB University of Applied Sciences and summarises teachers' perceptions regarding the proposed model. The goal of the empirical study is to understand how teachers may approach the technology and the likelihood of adopting such tools in their teaching practices.

3.1 Analysis of data

For the first part of the empirical study, ten emails were sent to LAB and LUT staff members that have hands-on various information systems. An explanatory video with a description of the model was also sent to them, together with open questions. However, with a responsive rate of 11%, only one response was collected. It can be found in Appendix 1. The information gathered from this email was used to improve the proposed model for teachers, as is discussed in the following sections.

To collect data from LAB teachers, a survey was created using Webropol, an online survey tool. Finding a mailing list for teachers was not possible, so the survey was first linked to the Yammer group "LAB: All Staff", and then faculty deans and education managers were contacted by email and asked to forward the link to other teachers. The survey was opened by 64 respondents, but only 22 responses were collected accounting for a response rate of 34%. From the survey, qualitative and quantitative data were collected. Results were analysed and provided an answer to the second research question.

3.2 Promoting projects

As discussed in chapter 2.2, collaborative projects between education and industry face some challenges. Companies think that students lack business experience and seriousness in the project. (Aversa 2020, 11.) To improve the learning experience, and therefore the satisfaction of all the actors in collaborative projects, it is important to recognize their different needs and motives (Ekimova & Kokurin 2014, 854; Gantasala 2015, 639-640).

A solution to improve the quality of education is to perform a targeted promotion of collaborative projects to the right audience. This could be done by making efficient use of the platforms available at LAB. JobTeaser is a suitable tool to promote projects to a targeted

audience. JobTeaser is used for employment purposes within the LUT Group, its match-making algorithm is used to match students with companies. Companies have access to a certain Talent Bank to look for fitting candidates. An algorithm sends students information about opportunities and events, and the matching is mainly based on simple search criteria. The same technology can be used to promote collaborative projects to targeted students, therefore enable an education adaptive to the needs and wants of students. However, there are some limitations concerning the use of this platform. Since JobTeaser is a product of a foreign company, LUT staff cannot make any changes to the data fields to add further information. Due to GDPR and other policies, data cannot be transferred from JobTeaser to other sources and vice versa. The links to social media added to JobTeaser are simple connections and do not provide access to users' data. (Appendix1.) JobTeaser is the suggested pool for promoting projects to the right audience, and it is the first suggested solution to adopt if teachers want to improve the participation of students in collaborative projects. Anyway, due to the limitations in the use of the platform, JobTeaser cannot serve the automation model described in the development plan.

3.3 Developing an enterprise architecture

LUT Group provides LAB with numerous information systems and platforms to support students, staff, and external partners (Niemelä et al. 2020). Chapter 2.3 explains that system integration is beneficial for collaborative projects and, in general, in the relationship between education and business. Developing an enterprise architecture allows a better learning experience and improves social interactions. Nevertheless, it makes the data management lifecycle sustainable and secure. (Kudrass 2006, 1-2; Lupu et al. 2008, 473.)

Since 2020 the LUT Group is developing a management model to integrate the current information systems. The enterprise architecture is in line with LUT's strategic plan and supports change management. This new system architecture ensures that information is available and of quality. The architecture aims at improving operations, processes, and services, data, information, but also the information systems and the services they provide. In this new approach, employees and systems become single nodes of a wider network. In this renewed model the process of one node affects and contributes to the process of others. This holistic approach simplifies processes and improves cost efficiency and interoperability. (LUT Intra 2021n.)

The process of developing and maintaining an integrated information management system is in line with the Information Management Act (906/2019) (Finlex 2019). This law concerns public administrative offices in Finland, it regulates how information services should be implemented and managed. For the same purpose, the Ministry of Education and Culture,

together with Finnish higher education institutions, promoted the project RAKETTI. They developed a joint manual for developing the enterprise architecture in higher education, the output is called the Kartturi model. (Eeduni 2016; JHS 2018; LUT Intra 2021n.)

3.4 Data warehousing

Chapter 2.3.1 describes that investigating students' digital footprint can predict performance and provide them with a better-personalized experience. Students' data can be extracted from participation, login frequency, messaging, as well as video streaming, in-class participation, conversations, and e-mails. However, these data are noisy, correlated, incomplete, not standardized, and not sufficient. (Perera et al. 2009, 1-3; Abdous et al. 2012, 85-86; Manjunath et al. 2016, 2125; Villanueva et al. 2018, 249.) Therefore, to optimize data lifecycle management, it is important to introduce a model of data warehousing.

Currently, LUT Group uses two separate data repositories for LUT University and LAB University of Applied Sciences. At the beginning of September 2020, the LUT organization, together with Cerion (Cerion 2021) launched a data warehousing project called LUT Data Platform. The goal of the Data Platform is to create a new, common, and centralized data warehousing solution for LUT Group to report and analyse data about the university processes. Data warehousing is constructed upon an automated data modelling-based implementation through the Azure environment. Such a platform serves data analysis, it helps to find behaviours, patterns, and dependencies among data. Data automation tools reduce the time and manual work required to manage these data. According to the progress timetable for the project, the LUT Data Platform will be finalized by summer 2021. Autumn 2021 will be time to promote new activities of data and reporting that will include students, teachers, and management. When the data warehouse will be completed, the old environments of LUT and LAB will be abandoned. (Sirviö 2021.)

3.5 Data mining from social media

Chapter 2.3.2 compares the traditional methods of data collection with data extraction from social media. Social media is an unexploited pool of data that enables a deeper understanding of students' behaviour and allows for education reengineering. (Chen et al. 2014, 246-248.) As in chapter 2.3.3, social media support career guidance, encourage personalized learning, improve communication, interaction, and teamwork. (Stainbank & Gurr 2016, 337-338; Mahnane 2017, 22.)

However, social media has some limitations too. People adapt their social networking behaviour to the purpose of the platform, this influences the evaluation of their personality (van

de Ven et al. 2016, 418-420). Users intentionally polish their online presence to give a better impression of themselves, it may not be the same as in the real life. In the case of students, for instance, they do not care about their identity online since they consider social media a place distinct from school. Therefore, performing data mining from social media may produce results that cannot be applied to educational purposes. (Chen et al. 2014, 246-248.)

As the response in Appendix 1 explains, mining data from students' social media may be restricted by LAB. Due to the lack of responses from the qualitative research, it is not possible to draw conclusions regarding this step. Thus, the prioritization is to keep the traditional method of letting students respond to surveys and questionnaires and later store their responses into the database.

3.6 Teamwork as a practice for collaborative learning

Chapter 2.2.1 emphasizes the importance of teamwork in education and the complexity of managing teams (Ekimova & Kokurin 2014, 854; Bergiel & Gainey 2015, 332-334; Gantasala 2015, 639-641; Buengeler et al. 2017, 602-603; IBM Research Editorial Staff 2018; Kauppinen et al. 2019, 3891). Teamwork is an important part of learning at LAB university of applied sciences, 55% of the teachers provide courses that involve projects with external companies. Usually, teachers let students choose independently their team partners (76%), in many cases, teachers provide different topics and groups are formed according to students' interest (38%), whilst assessing the attitude and personality of students and group them according to the results is just a small practice (10%).

The time to design teams varies according to the purpose of the teamwork. If some teachers let the team be formed within half an hour, others may take a week. However, most of the respondents spend about two hours teaming up students and they are generally satisfied with the process (67%). Only half of the teachers can supervise teams efficiently during the teamwork (50%), nevertheless, they are satisfied with team results (76%).

Teachers' attitude towards teamwork is positive, and they agree that there are multiple methods to improving collaborative learning (95%). Teachers adopt different methods to improve these processes, but they are aware that the practice is too complex to produce as many efficient results as possible.

Chapter 2.2.3 answers the first research question by discussing how considering individual differences of team members improves team performance as well as adopting training as a consolidating practice for efficient teamwork (Buengeler et al. 2017, 610-613). As confirmed by the respondents to the survey, knowing students' skills, preferences, and learning challenges is useful to improve collaborations (Vainio 2020b). Diversity, combined with a shared

interest, is a strong feature of teamwork. Some students perform well when working in a group whereas others perform well when working independently. Some teachers account for these aspects, therefore they let students choose freely to work in a team or alone. When forming the team, teachers should also account for students' timetables. Students should receive roles and rules for teamwork. (Appendix 2; LUT Intra 2021m.) Anyhow, the limit of time reduces the possibility for teachers to further investigate the background of students, as one of the respondents affirms:

> *Although I wish there was more time to work on putting together student groups (as I have done this in the past according to tests, skills, etc), in my current position I do not have access to the same kinds of information and so this is hard to do. Particularly with a heavy workload, there is just not enough time. (Appendix 2.)*

However, people's behaviour is affected by their personal history and background, but also when they share similarities, people may respond differently to the same stimuli. Thus, if for some teachers investigating students' background requires further resources, for others recognizing students' personality can be an easy task if the human interaction is maintained, as a respondent claim:

> *With in-class teaching I get to know my students: I know who the quieter people are who need to work in a group without a domineering leader; I know who has the patience to deal with the student with communication problems; I know which activities can be done based on friendship groups and when students can be challenged to work with, e.g., fellow students of different nationalities. (Appendix 2.)*

Participation and communication are core aspects of teamwork. There are various online tools to support students in collective writing and presenting. However, the most effective methods of interaction and dialogue are traditional face-to-face meetings. As teachers explain (Appendix 2), students should participate in compulsory meetings, which can happen in the form of workshops, discussion groups, conversation classes, learning cafes, or book clubs. At the end of each meeting, students could make memos and evaluate their team performance. Students should be involved in active communication, perform peer analysis and reflection throughout the process of teamwork and at the end of it.

Teachers have a crucial role in the process of collaborative learning. They have the responsibility to assess the performance of a team, coach students, and motivate them in teamwork. To amplify the benefits of collaborative learning, teachers should promote multiple learning methods, such as collaborative, interactive, problem-based, or simulation-based learning. However, in the case of distance learning, difficulties arise since human interac-

tion, as one of the main elements enhancing team performance, lacks. Nevertheless, teachers are interested in discovering new creative ways to improve these practices, as well as engaging in teacher-teacher learning or workshops to improve collaborative learning. (Appendix 2.)

3.7 How teachers would accept the model

The development plan advances a model of system integration and data mining that serves to team up students with complementary skills, enhancing diversity, synergy, and egalitarianism. To understand whether teachers would accept the adoption of such a model they were asked to give a score from zero (very unlikely) to ten (very likely) to statements based on the Technology Acceptance Model (TAM) (Davis 1989). The statements are reported in the tables below.

Perceived usefulness

Teachers perceive the model as useful (Table1). They think is a good idea to team up students according to their background information, as well as their learning history, personality, and attitude. Teachers think that the model may improve students' performance and productivity in a team.

Statement	**Score**
It is a good idea to team up students considering their background, learning history, personality, and attitude.	8
The proposed model helps teachers to save their effort and time.	6
The proposed model helps teachers to better assess teamwork.	6
The proposed model improves the quality of teaching.	6
The proposed model improves students' learning methods.	6
The proposed model improves students' performance and productivity in a team.	7
TOTAL SCORE	**7**

Table 1. Perceived usefulness

Attitude of usability

Teachers show a good attitude towards the model (Table 2). Of course, they expect the functions to be well integrated with the current systems and technology in use.

Statement	**Score**
Using such a platform is a good idea.	7
I am well-intentioned to use the platform.	6
I would access this platform also with smart and mobile devices.	5
I expect the functions to be well integrated with the learning management system and other e-learning services.	8
I will take full advantage of such a platform for my courses.	6
TOTAL SCORE	**6**

Table 2. Attitude of usability

Social influence

Teachers' intention to use the model is not strongly influenced by the behaviour of their colleagues (Table 3). However, their intentions can be influenced by the behaviour of students and by the impact that the model may have in real working life and the future.

Statement	**Score**
My decision about using the platform is influenced by students' behaviour.	6
My decision about using the platform is influenced by my colleagues' behaviour.	5
I think that this model has beneficial effects if applied to real working life and in the future.	6
TOTAL SCORE	**6**

Table 3. Social influence

Facilitating conditions

Teachers require facilitating conditions (Table 4), in other words, a figure to refer to when needing support with the system.

Statement	**Score**
I expect a designated person I can call or e-mail when I need help with using the system.	8
TOTAL SCORE	**8**

Table 4. Facilitating conditions

Privacy

Teachers require to maintain a certain degree of privacy (Table 5).

Statement	**Score**
The system should not gather public information from social media.	7
TOTAL SCORE	**7**

Table 5. Privacy

4 Development plan

In the university environment, development projects can be launched only if they are coherent with the enterprise architecture framework. Operational requirements must comply with the university's strategy and provide different IT solutions. The development must be cost-effective. Practices should be harmonious, they should involve cooperation among parties, and improve commitment to satisfy common interests. (Eeduni 2016.)

Universities apply the principle of open data. Thus, they provide information for their own needs, but also, they allow external use of data, considering regulations in the matter of data protection. If data are not stated to be secret, then they are public. In this case, data are available, free of charge, reusable, discoverable, and comprehensible. Data management must reduce costs and resource utilization. Hence, the same data can be exploited by different units. To do so, data integrity, availability, and quality must be key prerequisites for operational efficiency and excellence. (Eeduni 2016.)

Further requirements avoid direct links between systems but invite the use of shared integrated solutions. System solutions should have an independent technology. Server and database platforms must be as replaceable as possible. (Eeduni 2016.) A system infrastructure must be scalable, dynamic, flexible, efficient, and robust. If the system grows, it should not lessen performance or administrative complexity. The system should adapt if there are changes and allow network restructuring. The infrastructure must be efficient if the network grows, and it should stand minor disruptions or system outbreaks. Vice versa, if there is an excessive number of clients or entities, the system must shrink. Since the environment requires clients to communicate and cooperate effectively, a supporting infrastructure should include hierarchies to better share responsibilities. Each node monitors and manages its resources and visualizes job queues and tasks already processed. The matchmaker manages the lists of clients requiring support or providing it. Whenever a client requests or offers new resources, or when resources are timed out or not available anymore, the matchmaker is responsible to update the lists. (Sidgel et al. 2005, 7.)

In the current chapter, it is proposed a method to implement an automated tool for team design (Figure 4). The plan firstly describes the process flow and what kind of architecture to adopt. It follows the identification of key stakeholders. Their roles and contribution to the system are explained, as well as their relationships. Initially, the plan illustrates the data workflow, from the process of data mining until data analysis and implementation. The plan then explains how information about key stakeholders is stored in the database so that they become entities. After, it discusses the database structure and data map. Finally, a description of the clustering model and the matchmaking process.

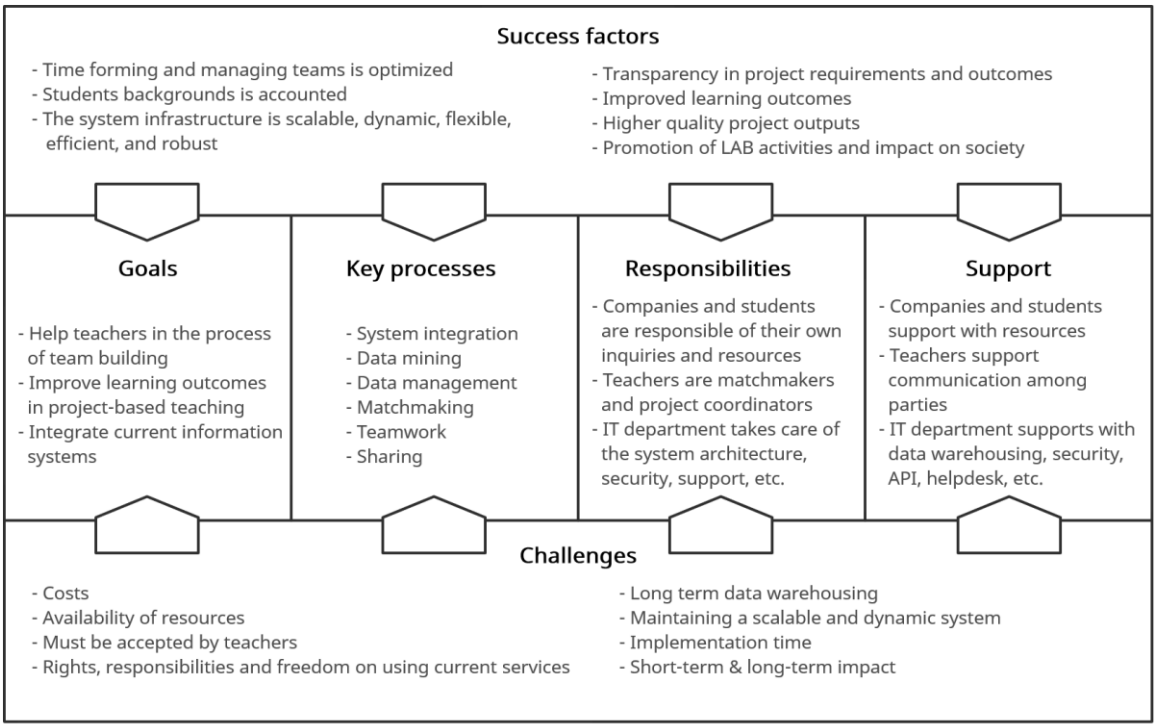

Figure 4. Conceptual framework of the operating model

4.1 The process

When students enrol on a course, they have few expectations and goals, but they may not understand the course content. This lack of awareness adds challenges to the implementation of the collaborative process. (Santonen 2011, 7.) At LAB information about courses is available on Opinto-opas (LAB 2021c), and the enrolment happens through Peppi (LAB 2021d) and Moodle (LUT Intra 2021e). When a course assignment includes a collaboration with companies, JobTeaser could be a further channel to promote the course. For instance, JobTeaser matchmaking algorithm can connect companies and students. This allows the course to be reached by a targeted audience, as it would be a starting point to collect the right pool of students for a specific project, but it is not enough.

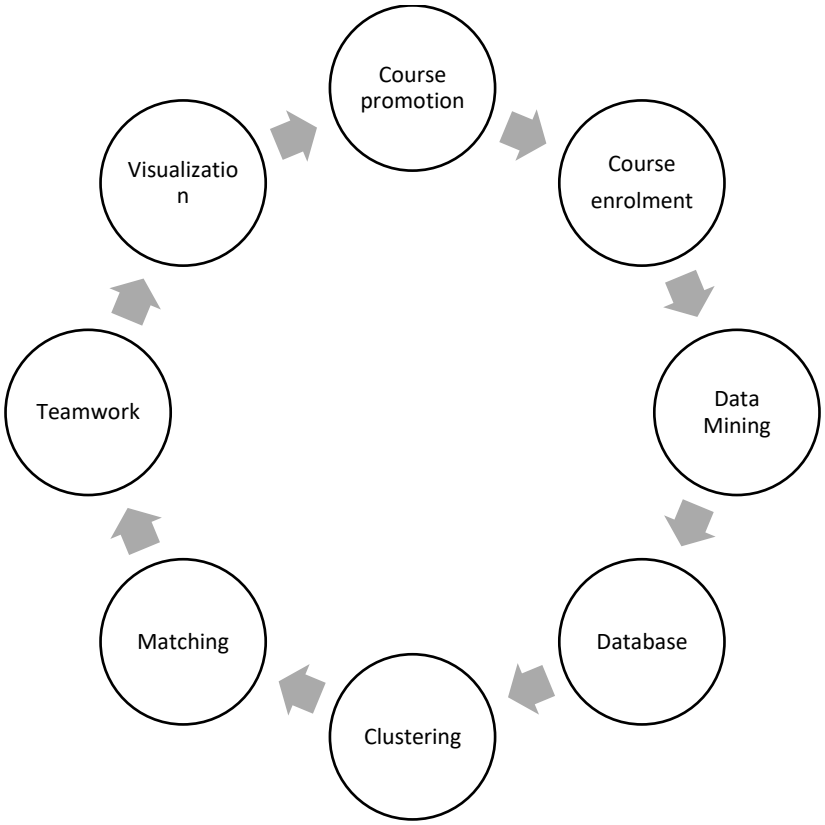

Figure 5. The process workflow is circular

With the proposed model, the teaching method stays intact, but the lecture is enriched by a tracking tool that produces multiple benefits for the course participants. The model fosters social interaction and self-organization, it engages students in communication, collaboration, and interaction within the learning management system. This tracking system works through system integration. Integrating the current education information systems allows the collection of students' learning history, portfolio, references, and contact information, while data mining techniques extract students' personality and behaviour. Once the teacher approves students' participation in a course, the system analyses the list of participants to the course, therefore, a clustering algorithm teams up transient communities of students. The algorithm makes sure that asymmetries in teams are contained. (Kester et al. 2007; Abdous et al. 2012, 77.) Then a matchmaking algorithm connects teams with companies.

Collaborative innovation is effective when students show willingness, passion, and commitment. Students value new viewpoints, sharing knowledge, and developing their visions. Thus, further motivation comes when students receive good feedback and when their insights are visible. (Santonen 2011, 8.) To increase the potential behind giving and receiving feedback, and to promote referencing, project outcomes could be published on the application interface. The application interface would be the environment that fosters interaction,

communication, and sharing. It builds up the student portfolio, contributes to improving the data mining performance, links resources to external platforms and social networks, and provides marketing material for LAB collaborative projects. Taking the success stories of LAB collaborative projects to the outer environment may produce a positive impact on LAB branding strategy and give confidence to local businesses to actively offer and take part in projects.

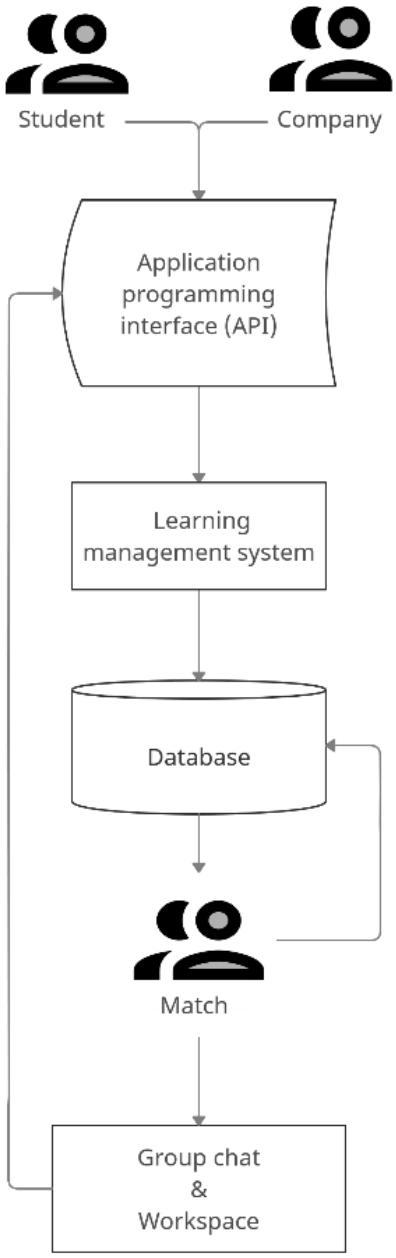

Figure 6. System architecture

4.2 Key stakeholders

The three main stakeholders in this process are students, companies, and teachers. They are natural persons with roles and responsibilities, their actions affect the efficiency of the process.

Student

A student is a natural person enrolled at the university. On JobTeaser, students update their profiles, link external platforms such as blogs, websites, social media, their portfolios, and references. Through the match on JobTeaser, they receive notification of upcoming projects that fit their search criteria. Students enrol on a course through Peppi and Moodle. Information about students is collected from current information systems. Students also respond to questionnaires and provide information concerning their personality traits and attitudes. This information is displayed on the application interface and is used to design teams for a project. At the end of the project, students give feedback on each other, the course, and the teamwork. This information is useful to perform network analysis, to then have a visual representation of their overall performance and interaction. From here, students are guided to self-reflection and improvement of teamwork. The output information is stored and used for upgrading the model.

Company

A company can be a legal entity but also a natural person participating in a collaborative project with the university of applied sciences. Companies set up their profiles on JobTeaser and link external platforms such as blogs, websites, and social media. On the JobTeaser platform, they offer students jobs, internships, and thesis collaboration, but also opportunities to collaborate on a project. Companies participating in collaborative projects must fill a standard form. They must specify the requirement, goals, and expectations of the project. These criteria are used as references for the matchmaker to connect teams of students with the companies.

Teacher

Teachers are natural people. Their responsibility is to manage and promote projects on different platforms. They accept students to the course, provide teaching, and guide in teamwork. Teachers access students' information and account for the requirements provided by the collaborating companies. Therefore, they make decisions according to the matches suggested by the algorithm. They are brokers or matchmakers between students and companies since they coordinate the process of team design. Through the application

interface, teachers monitor students' progress, perform network analysis, and give feedback on students' teamwork practices.

4.3 Data workflow

If teachers want to know more about students' backgrounds and personalities, extracting data from social media is the best alternative to traditional surveys, interviews, focus groups, and classroom activities. Information about students' knowledge, learning history, preferences, and other personal information can be extracted from educational information systems. These data allow education providers to predict students' performance and provide a personalized learning experience. (Perera et al. 2009, 12-13) Implementing these processes of data mining has potential, it can be used for improving decision-making practices, and can be beneficial at the educational level. As Figure 7 shows, data are collected and stored in a database, where they are sampled and divided into datasets. A report is filled after performing a qualitative analysis of these datasets. The report is a meaningful reference for building models, and training material, but also for setting key performance indicators and metric evaluation. At the end of the project, students and companies provide feedback, the project outcome contributes to assessing the process and the efficiency of the model. After, a quantitative analysis is performed, and adaptations are suggested. The information is stored in the database, data clusters are updated, and results are used to improve the data mining approach. At the same time, information concerning the results is delivered to the teachers and project managers, that will take care of improving project settings and working methods. The changes implemented will be reported and used for the new stage of model building. (Aswini & Krishnamoorty 2016, 215.)

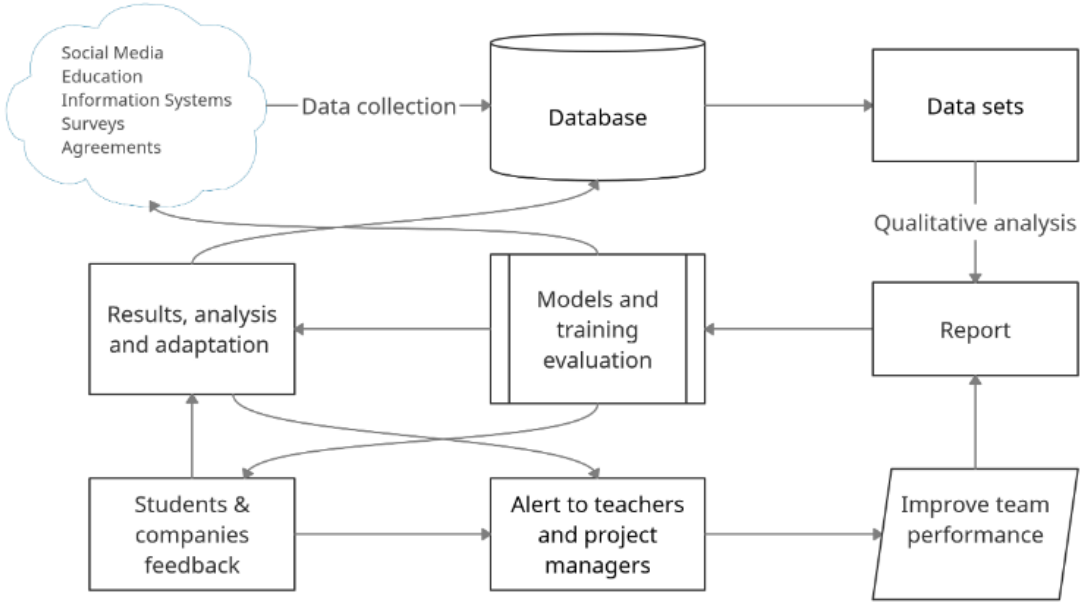

Figure 7. Data workflow

4.3.1 Data management architecture

A registry architecture is an appropriate structure to manage large volumes of input data. In such architecture, each entity contains a collection of attribute values and an identifier that serves the identification of the entity across all the systems. With this solution, the systems refer to a central hub that mediates the transmission of information. This is useful when external systems hold information about entities known to other systems, and when systems allow collaboration and sharing of information but provide limited access to it. (Talburt & Yinle 2015, 61-63.)

The registry architecture must collect enough information so that, when a new record is introduced, it can define if it has been created previously, hence, whether it carries additional information, or it is a new one. If the source record has both current and previous information regarding an entity, a new entity record is created with a new identifier, the new and old records are merged, and the old entity identifier is then retired. Each system contributing to the new architecture is responsible to synchronize its registry and keep it updated. A trusted broker may help with entity resolution if issues within several systems occur. The broker can also manage information for certain entities that are unique within specific systems. (Talburt & Yinle 2015, 61-63.)

However, before a new record is loaded into the database it should go through a process of cleaning and standardization. New records are matched with old records. If there is no match with the input record, the system creates a new entity with the information that it carries. If the input record matches one entity, the old entity is updated with the new information. If the input reference matches multiple entities, all the entities matching with the input reference are merged into a single entity (cluster) and a new identifier is assigned to it. At the end of every update, the system generates statistics for the events. (Talburt & Yinle 2015, 66-67)

When heterogeneous entities join and leave the system, the system is dynamic. A dynamic system, to be efficient, should keep up-to-date information about available entities and their resources, thus, manage and allocate them. The system should have a search mechanism that:

- Provides scalability and robustness when entities change (e.g., a decentralized system, entities manage their information, entities search for each other).
- Assigns resources only considering local information (e.g., specific course/project, skills required).
- Adapts to the changing environment (e.g., attendees joining and/or leaving the project, collaboration changes, changing requirements).
- Manages heterogeneous data, thus different types of information (e.g., using standard models to translate unstructured data and support entity integration).
- Integrates functional and nonfunctional information (e.g., avoid confusion by using information that can differentiate entities with similar attributes). (Del Val et al. 2013, 307.)

Accessing the dataset may happen at the background and foreground levels. At the background level, the database stores periodic updates. In the foreground level, the access may be interactive and allowed through an application programming interface. The operation in the background and foreground may be alternate so that the background updates would happen overnight, while the access to interactive operations may happen during the business day. (Talburt & Yinle 2015, 50-60.)

4.3.2 Entities and their attributes

The database stores data extracted from information systems currently in use, surveys, and agreements with external partners. Further data could be mined from social networks, webpages, or other databases. However, a good amount of these data are unstructured

and complex, it requires human interpretation and standard practices. Managing data provides numerous advantages and insights for decision-making since it shows dynamics, hidden relationships, patterns, interdependencies, and correlations.

As Perera et al. (2009, 3) argue, it is essential to refer to the main stakeholders as the first step for building the database. Therefore, students, companies, and teachers are referred to as entities in the database (Figure 8). They have their attributes and relations, as described below.

Student

The entity “Student” refers to an individual learner. He/she knows about their skills, goals, activities, and ability to work in a team. To “Student” entities belong the following attributes:

- “Student ID” is a nonfunctional attribute that helps at managing duplicates, conflicts, and identifying the resource. It is a unique identifier automatically assigned to students when their record is added to the database.
- “Name”, “Surname” and “Age” are functional attributes that define a user/persona. They can be extracted from information systems already in use.
- “Email” is a functional attribute essential for managing communication. This attribute is added when students set up their profiles into the application, or it can be extracted from current information systems.
- “Learning history” is a functional attribute that serves the clustering algorithm. It is constituted by:
    - “Study program” is a functional attribute, fundamental for the process of team design, especially when teams should be multidisciplinary. This attribute is added when students set up their profiles into the application, or it can be extracted from current information systems.
    - “Year of study” is a functional attribute that serves decision-making. First-year students do not have the same experience in teamwork as students in the third or fourth year of study. This attribute is added when students set up their profiles into the application, or it is extracted from current information systems.
    - “GPA” is a functional attribute that serves the decision-making process. It is an indicator of students’ performance. This attribute is extracted from the system Peppi.
    - “Course completion” is a functional attribute for the decision-making process. This attribute informs what courses have been completed by the student. It is extracted from the system Peppi.

- “Seek opportunities” is a functional attribute that serves the decision-making process. This attribute informs whether a student is looking for an internship to complete their studies or a thesis collaboration. This information is provided by the student from their profile.
- “Topics of interest” are functional attributes for decision-making. These attributes serve the categorization of student interest, provide him/her the best solution, and further apply such information to the clustering algorithm.
- “Metaskills” are functional attributes for decision-making. These attributes are added by the student when setting up their account on the application. They are the result of students’ reflections about what practical skills they have gained throughout their studies. Metaskills are also updated when a student completes a course, with default attributes implemented by the teacher. Students can also add skills that are acquired out from the school environment, but that can be resourceful for teamwork.
- “Resources” are functional attributes that serve the decision-making process. These attributes are added by the student when setting up their account on the application. Students list what kind of resources they got, such as devices, tools, applications, and instruments that can support teamwork.
- “Time availability” is a functional attribute, it serves the decision-making process. This attribute is calculated after extracting information from the time scheduling system in use.
- “Success in a team” is a functional attribute that serves further decision-making and contributes to the student's final grade for the project. It is calculated at the end of a project when students give grades to each other contribution to the team, it is the arithmetic mean of grades received by peers.
- “Personality type” is a functional attribute for decision-making. This information is stored after asking the student to respond to a questionnaire. A more effective solution could be to mine this information from students’ social media account, but this requires further investigation. However, personality changes over time (Vora et al. 2020, 356), so it is important to maintain data from the past, but also to ask students to regularly update their data by inviting them to respond to personality tests.
- “Emotional dimension” is a functional attribute that serves the decision-making process. This information is stored after asking the student to respond to a questionnaire. Also in this case, it is important to ask students to regularly update their data by inviting them to respond to tests and to let the system keep data from the past.
- “Influence” is a functional attribute for the process of decision-making that serves the clustering phase. This attribute shows how a student performs when working

with certain peers. This value is implemented after a network analysis at the end of the project.

These observations serve the data clustering process when a defined amount of entities “Student” is grouped to form the cluster “Team”. Students are teamed up together to work on a project and are responsible for the project outcomes, such as the publication. Students, as a team of learners, must be aware of their collective skills, this is displayed in the application interface. Calculating the attribute values of the “Team” cluster, through a weighted average, serves the matchmaker when assigning a team to a company. At the end of the project students provide a peer-review, they receive their final grades from the “Teacher”, but they may also receive other opportunities from the “Company”, such as internship or thesis collaboration.

Company

The entity “Company” refers to an external partner and collaborator. A “Company” knows their industry field, is specialized in their business area, and has a specific reason to collaborate with the university of applied sciences. To “Company” entities belong the following attributes:

- “Company ID” is a nonfunctional attribute that helps at managing duplicates, conflicts, and identifying the resource into the database. It is a unique identifier automatically assigned to a company when it sets up an account in the application.
- “Name of the company” is a functional attribute that identifies the company. This attribute is extracted from the system when the company sets up the profiles in the application.
- “Contact person”, “Email” and “Phone number” are functional attributes essential for managing communication. The contact person is the reference person for students and teachers. These attributes are added when a company sets up its profiles in the application.
- “Business field” is a functional attribute for decision-making. This value is important for matchmaking since it can be discriminant. Therefore, this attribute can ease the selection process when teaming up students based on their study program, metaskills, and/or resources. This attribute is added when a company sets up its profiles in the application.
- “Case study name” is a nonfunctional attribute that identifies a certain project when a company participates in multiple projects with the university of applied sciences. This attribute is added by the teacher.

- “Requirements” are functional attributes essential for decision-making. These values serve the matchmaking algorithm since are discriminant. They define the goals of a project and the skills required from the team. These attributes ease the selection process when selecting a team. Requirements can be unstructured, carried via communication, networking, email, and so forth. But after agreeing to the project, the company sets up its profile and fills a standard electronic form. This process eases the extraction of structured data that is uploaded into the database automatically.
- “Award” is a functional attribute for decision-making. This attribute informs whether the company may award an internship to students or it is interested in a thesis collaboration. This attribute is updated when the company sets up its profile on the application.

The “Company” gets involved in projects to gain new insights and new knowledge. It refers to the cluster “Team” when interested to follow up on the project.

Teacher

The entity “Teacher” refers to an individual teacher that also covers the role of matchmaker. The “Teacher” has control over the team-building process and monitors team progress according to the project requirements. To “Teacher” entities belong the attributes:

- “Teacher ID” is a nonfunctional attribute that helps at managing duplicates, conflicts, and identifying the resource within the database. It is a unique identifier automatically assigned to the teacher when he/she sets up the account in the application.
- “Name” and “Surname” are functional parameters that define the teacher persona. It can be extracted from the current information systems.
- “Email” is a functional attribute for managing communication. It can be extracted from the current information systems.
- “Study program” is a nonfunctional attribute that identifies teachers according to the program of studies where they teach. It can be extracted from the current information systems.
- “Course” is a functional attribute that is associated with the “Company” case study. It can be extracted from the current information systems.
- “Metaskills” are functional attributes that explain more about the “Course” and are discriminant for the decision-making process. Metaskills added by the teacher are a default list of keywords that explain what practical knowledge and tools each “Student” learns to apply throughout the project. These also serve the “Company” case study, as they respond to some of the requirements previously set up with the external partner.

These attributes represent the business card of the “Teacher” and provide clear information about the course. Teacher contact information, study program, course, and metaskills are displayed to the “Student”.

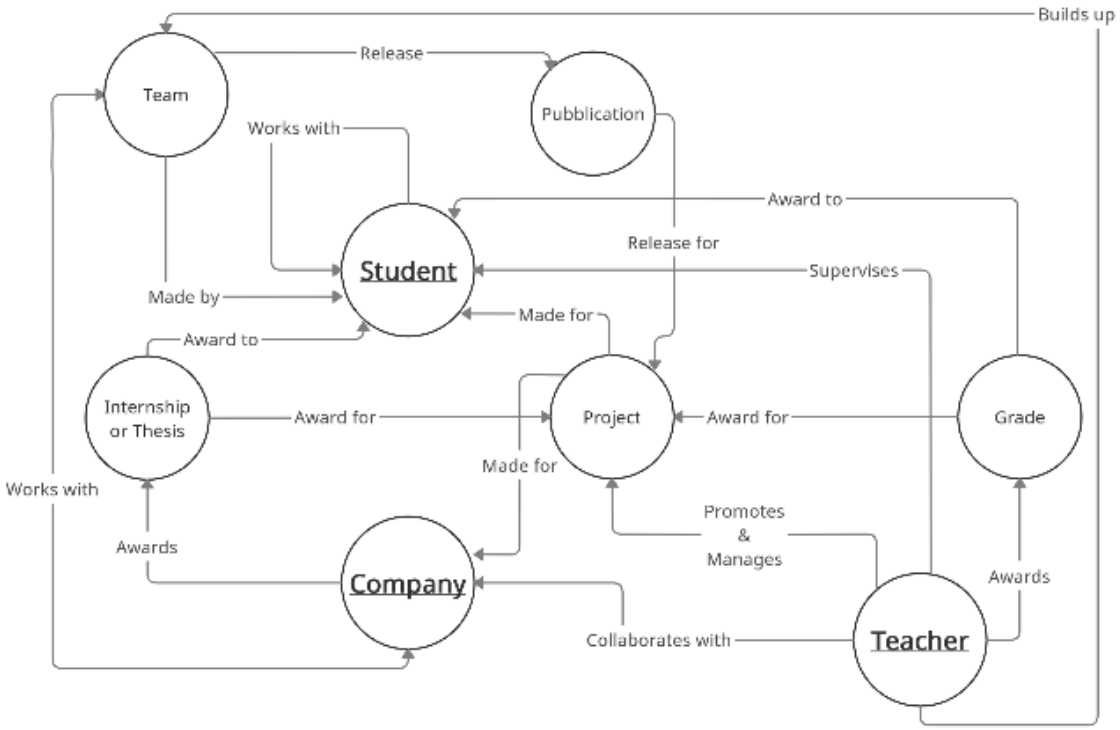

Figure 8. Data map for the database

4.3.3 Forming a team

Each attribute of entities within the database is weighted. This process helps with entity resolution, in case of a duplicate, but also serves the process of data clustering. To optimize this process, the model accounts for:

- Collaboration issues, hence, the collaboration history among entities that belong to the same system. This information is extracted from the student “Influence” attribute and the network analysis. When entities find each other, they can isolate themselves, so they will not appear on the search and the process would become more efficient. (Del Val et al. 2013, 307.)
- Reputation. The peer-review determines whether a student is suitable for the project or not, for this, the attributes “Success in a team” and “Influence” are evaluated. At

the end of the project, the system lets students rate each other level of trustworthiness. By evaluating each other quality of contribution to the project, students understand how successful they were at sharing their expertise with their peers. This would motivate students to be engaged and committed. (Kester et al. 2007; Del Val et al. 2013, 308.)

- Using functional and nonfunctional parameters. When in a database there are several entities, adding nonfunctional attributes eases the selection of the best entity. (Del Val et al. 2013, 308.) The algorithm firstly accounts if students “Seek opportunities”, at least one student seeking an opportunity is assigned to each cluster. The system accounts for individual differences and selects members according to their complementary skills. To reduce task conflict, team members must be selected so that they can equally contribute to the project. Hence, the clustering algorithm accounts for each student's “Learning history”, “Topics of interest”, “Metaskills”, and “Resources”. To reduce relationship conflict, the algorithm considers their “Personality type”, “Emotional dimension” and “Influence”. Finally, the availability of team members is defined in terms of “Time availability”. (Kester et al. 2007; Naber et al. 2014, 172-174; Yong et al. 2014, 269; Bergiel & Gainey 2015, 334; Gantasala 2015, 639-640; Buengeler et al. 2017, 602-604; Sinha & Stothard 2020.)
- Entities are agents. Students in the system are also agents with complex capabilities that interact with others to achieve goals. By being agents, students are also aware of the situation around them and respond to the changes. They are responsible to keep the information up to date within the system and inform peers, company, and teachers if external influences are affecting the teamwork. Therefore, through their “Learning history”, “Reputation”, “Influences” and “Success in a team”, they can gain badges and become centroids for future clustering practices. (Del Val et al. 2013, 308.)

To build datasets the algorithm accounts:

- Data characteristics such as team size, connectivity, and homogeneity among students.
- Type of task, for example, if there is a relational dependence among tasks and type of task that students can perform.
- Model representation and learning, hence, type of model, evaluation of attributes, and use of background knowledge.
- Statistical issues, therefore, the algorithm measures the linkage among entities, but also the level of disparity, relational correlation among entities, or even consider if

any biased feature has been selected as reference for the cluster. (Jensen & Neville 2002, 7-12.)

For the proposed architecture, the most appropriate approach to clustering is with the centroid model. Centroid algorithms are iterative, they select entities that have a degree of similarity with a central one. An appropriate algorithm that works with this model is the K-Means, widely used for pattern recognition. (Uppada 2014, 7310.) This algorithm accounts for entities and their attributes. For each student, each attribute value is measured and weighted. The values are stored in arrays. It is important to know the number of entities within the database, with this knowledge the number of clusters to be outputted is also known. So, given several students enrolled in the project, the teacher defines how many groups the algorithm must create. However, if the number of team members is high, there is limited space for interaction and individual accountability. Thus, the optimal group size should count about five people. (Kester et al. 2007.) Next, the teacher assigns the centroid, a reference student (e.g., a team mediator, or a team leader), to each group. The algorithm first calculates the weighted sum of attribute values for each student, then defines the difference between these values and the value of each centroid. Hence, the algorithm creates teams by assigning students to the closest reference point in term of attribute value weights. When a student is assigned to a team, he/she receives a notification that must be accepted or declined. If the student accepts, he/she belongs to the team, so a link to the workspace is forwarded to him/her. If the student declines, then goes in the queue and waits for the next team to be formed. Such information is stored in the database under the “Influence” attribute and used for further studies. The process repeats itself until no improvements are possible. (Kaushik 2016; Hurra 2020.)

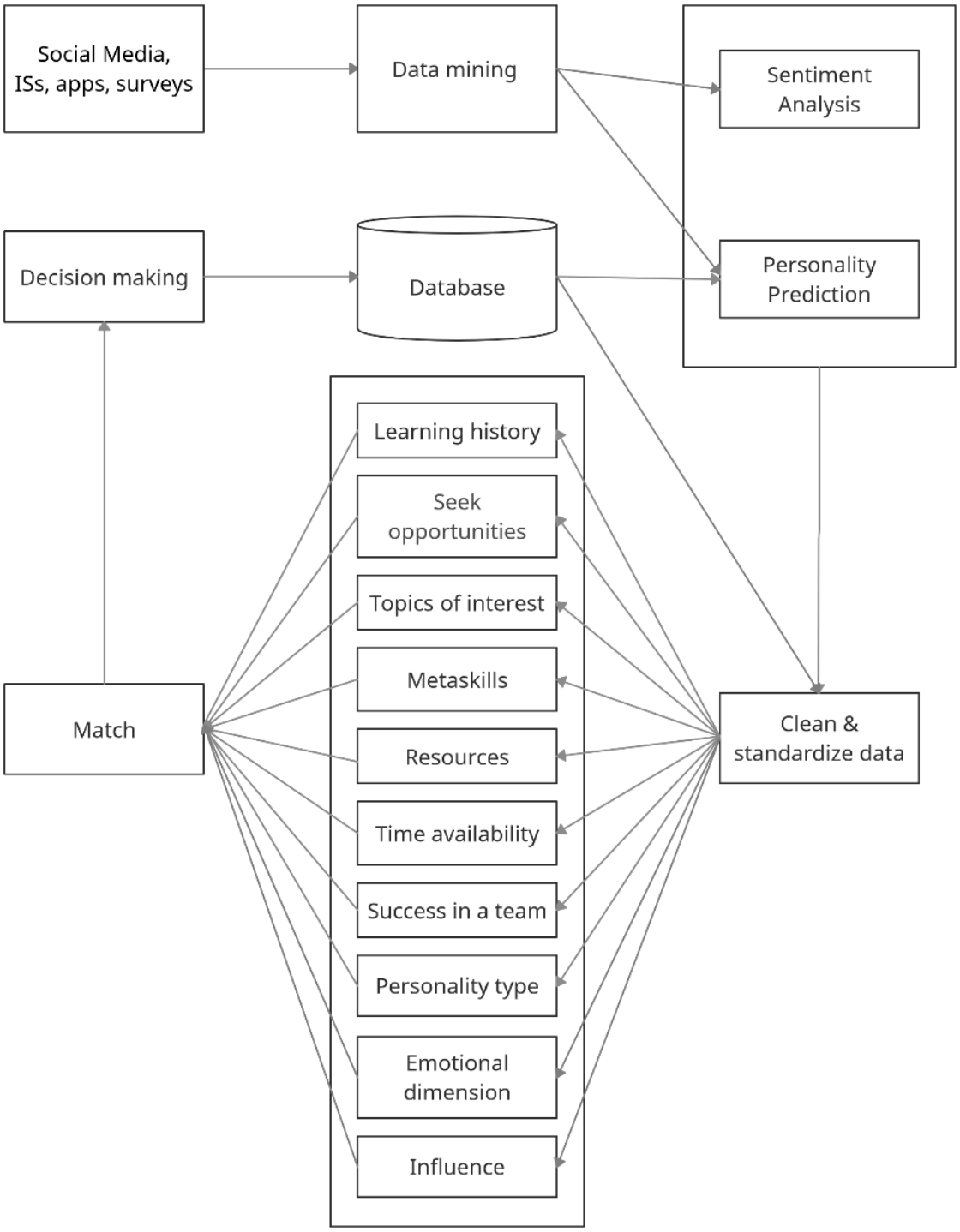

Figure 9. Data clustering approach

4.3.4 Matching the team with the company and assigning roles

To match the cluster “Team” with the “Company”, the system determines the sharing competencies of the team. To do so, the algorithm accounts for each attribute value of each

“Student” entity within a cluster, then calculates the weighted average for the cluster “Team”. (Chen et al. 2017.) The entity “Company” is considered as a requestor for the matchmaker, while the cluster “Team” is a provider. The requirements of the company are now used as discriminants for the selection of the right team. In this process, the “Teacher” is the matchmaker.

The matchmaking algorithm consists of different modules:

- A request module that informs entities and clusters about the match, the time limit for them to provide an answer, and the content of the inquiry.
- A population module that defines the selection criteria of “Teams”.
- A community module that retrieves data from the database. (Kester et al. 2007.)

Once teams and companies have been matched, a role is assigned to each team member. Students can request to cover certain responsibilities, but this increases the complexity of the algorithm, especially when the time is limited and/or multiple members want to be in the same position. If the teacher wants to create fair teams, the role-based query is not the best. To solve this issue, the system could ask beforehand what roles students want to take. (Alman & McKay 2017.)

5 Conclusions

Digitalization is changing businesses and work life. To be successful, companies must adapt rapidly to the digital transformation. (Davenport & Redman 2020.) The trend is pressing organizations for a fast adaptation, but most of their innovation programs fail due to the lack of mindset of the people involved (Tabrizi et al. 2019). A solution to reduce resistance to change is to involve staff in planning the operations, however, this requires them to have new skills and expertise. If managers have limited resources to find these experts outside of the companies, they could opt for staff reskilling, or collaboration with universities. (Card & Nelson 2019, 242-243; Kauppinen et al. 2019, 3888; Aversa 2020, 12-14.)

As a result, in innovation-driven economies, academia and industry have a close relationship (Saarela et al. 2013, 3; Aversa 2020, 9-14). Universities of applied sciences, as in the case of LAB, invite local businesses to participate in and suggest collaborative opportunities. However, the lack of experience and seriousness of students may reduce the potential of these projects as well as the different point of views, methods, and goals of the organizations. (Ekimova & Kokurin 2014, 854; Gantasala 2015, 639-640; Card & Nelson 2019, 244; Aversa 2020, 11; Räsänen & Fifield 2020; Sore 2020; Vainio 2020b.) Solutions to improve the outcomes of collaborative projects is to implement new methods and tools of teamwork, starting by the selection of team members, but also to improve the level of participation in the events, by promoting them to a targeted audience. (Ekimova & Kokurin 2014, 854; Bergiel & Gainey 2015, 332-334; Gantasala 2015, 639-641; Buengeler et al. 2017, 602-603; IBM Research Editorial Staff 2018; Kauppinen et al. 2019, 3891; Vainio 2020b.)

Teamwork is one of the most important skills that are required in business life (Ekimova & Kokurin 2014, 854; Birkeland et al. 2015, 232-239; Gantasala 2015, 639-641). However, teamwork in higher education can be challenging due to students' individualities that results in unproductive conflicts, social loafing, low team efficiency, and even health issues (Ekimova & Kokurin 2014, 854; Naber et al. 2014, 163; Gantasala 2015, 639-640; Zaidi et al. 2016, 6). Experiencing conflict and learning to manage it is an essential part of developing teamwork skills, but in the context of collaborative projects, the goal should be on producing valuable businesses solutions. This focus would attain and retain collaborating companies and contribute to the recognition of the educational institution in the territory, as well as providing students with more opportunities to apply their knowledge to work-life. (Aversa 2020, 52; Santonen 2011, 1-3; Saarela et al. 2013, 2; Räsänen & Fifield 2020; LUT Intra 2021d.) Therefore, to improve the results of teamwork in the context of collaborative projects, it is essential to consider the goals and requirements of the projects, as well as to

design teams that are efficient in achieving the expected results. (Saarela et al. 2013, 2; Ekimova & Kokurin 2014, 847-850; Gantasala 2015, 639-640; Luojus et al. 2018, 4547; Kauppinen et al. 2019, 3891.) A way to optimise these processes is to make proper use of resources and technologies available (Lupu et al. 2008, 481; Niemelä et al. 2020).

For any organization that operates with diverse digital tools and platforms, as in the case of LAB, system integration is an essential support to the strategy, but to be sustainable, it must be centred on data (Lupu et al. 2008, 481; Matthias et al. 2015, 37-43; Niemelä et al. 2020; Vainio 2020b). Higher education is highly reliant on instruments that support online teaching and teamwork, but it has not exploited the full advantage, yet. For example, analysing students' footprint within the school digital environments may enable processes of data mining. This allows the education services to deliver students a personalized learning experience. (Perera et al. 2009, 1-3; Abdous et al. 2012, 85-86; Manjunath et al. 2016, 2125; Villanueva et al. 2018, 249.) This also requires managers to set standard rules for an appropriate data lifecycle management plan (Talburt & Yinle 2015, 61-67; Eeduni 2016). However, as chapters 3.3 and 3.4 affirm, LAB is already working on the implementation of an enterprise architecture and data warehousing. This demonstrates that LAB experts are aware of the organizational capabilities that can be obtained with system integration, therefore, the current study is topical. The first part of the empirical research involved a qualitative investigation among LUT staff members that contributed to the understanding of the functionalities of certain digital tools and how these could contribute to the efficiency of the model.

The discussion on students' behaviour and adoption of social media for learning raised the attention on the possibility of mining student data from their social media (Birkeland et al. 2015, 237-238; Becheru et al. 2018, 1; Stainbank & Gurr 2016, 337-338; Cook-Sather 2017, 1143; Zhang et al. 2017, 1100; Messer & Kangwoo 2019). This process could optimize the use of time and resources when predicting students' personalities as this information would be essential for the clustering system illustrated in chapter 4.3.3. However, as described in chapter 3.5, the most appropriate solution to gain information regarding students' personalities is, at this current stage, to ask them to respond to surveys and questionnaires and later store their responses into the database.

The issue of promoting projects to the right students is clarified in chapter 3.2. The suggested platform JobTeaser does not add any value to the model solution. However, JobTeaser is the most appropriate tool that teachers can adopt as a first step to promote collaborative projects, courses, seminars, and other events to a targeted audience. Therefore, to improve the participation of both students and companies in projects.

The model solution to further facilitate collaborative projects between education and industry is proposed in chapter 4. The development plan includes a description of how the processes flow throughout the information systems and system architecture. It explains the roles of students, companies, and teachers, how they would operate, and how their functions would be related to the system. This section also describes the process of data mining from current information systems, data collection, data clustering, data analysis, and implementation. It also clarifies how users' information is stored in the database and provides a data map. In conclusion, the development plan explains the clustering model to team students and the matchmaking process to match students and companies. Such a solution, if well implemented, can support collaboration, participation, and education (Birkeland et al. 2015, 239; Buengeler et al. 2017, 610-613).

The second part of the empirical research focused on teachers practices for teamwork. While answering the survey teachers could read about the model and provide feedback. Teachers' responses answered the second research question, and they are summarized in chapter 3.6 and 3.7. Gathering this evidence served the exploratory study to better clarify the research problem and set the ground for future studies (Dudovskiy 2021).

5.1 Answers to the research questions

The main objective of the research was to propose a model for effective team design that could help teachers monitoring teamwork and supporting students' performance and learning in the context of collaborative projects with external businesses. Following the answer to the first research questions.

How are efficient teams designed?

Team design cannot follow a unique and standardized method since it must respond to the singularity of each project. But in general, there are two main goals for collaborative projects between education and industry, the first one is learning, the second one is producing outputs that are useful for real business life. In the first case, conflict should be considered a fundamental part of the learning process. Therefore, teamwork practices should include managing different types of conflict. In the second case, conflict should not deteriorate the efficiency of teamwork. Consequently, teams should be designed so that members feel psychologically safe to interact and cooperate effectively. In both cases, to exploit the potential behind conflict and design efficient teams, individual differences of team members should be acknowledged, roles should be assigned with transparency, and responsibilities should be set at the beginning of the teamwork. These aspects are better defined in the literature review in chapter 2.2.3. However, to design efficient teams, it must be accounted

for members' learning methods, competencies, but also personality types, emotional dimensions, and influences. This knowledge allows to maintain a degree of diversity within the team and manage high-level asymmetries.

The answer to the first research question serves the clustering model for team design automation since it lists the criteria to be accounted for in the algorithm to produce results. The answer to the second research question acknowledges how teachers perceive the model and on what level they would adopt it. Responding to the second research question is important since it validates whether it is worth continuing the studies further or not. Below is the answer to the second research question.

Would teachers at LAB University of Applied Sciences accept an automated tool to better design teams and improve collaborative projects with external partners?

As described in chapters 3.6 and 3.7, teachers show an open mind towards adopting new methods and models to improve learning, communication, reflection, and, generally, human interaction. Most of them agree that teaming up students according to their background, learning history, personality, and attitude is a good idea. Teachers find the proposed model useful and have an attitude towards it that is above the average. The solution may support team performance and productivity. The use they would do of the application would be justified by the behaviour of students and the effect that it can have in real working life and the future. Teachers have a responsibility to assess team performance, guide students, and promote teamwork. For some teachers accessing the right information regarding team members may be limited, especially because of lack of time. For this instance, the proposed model helps teachers making better use of time. Of course, teachers require facilitating conditions, such as technical support, and a certain level of privacy. However, ensuring that teams are efficient only by carefully designing them is not enough. To build successful practices the process of team design should be further supported by a team management program that is centred on human interaction.

5.2 Validity and reliability

The current subchapter assesses the quality of the research through validity and reliability. The current study was exploratory. Therefore a few negative aspects affect the validity and reliability of the research, and the possibility of putting the findings into practice. (Dudovskiy 2021.)

Validity indicates the accuracy of a measure. It describes whether there is consistency between results, theories used, measures, and research methods. (Middleton 2019.) Teacher responses gathered in the empirical part are consistent and confirm many of the findings

collected throughout the literature review, and almost all the respondents agreed with the suggested solution. However, interpreting qualitative information is subject to the bias of the author. Moreover, the sample does not represent adequately the target population. (Dudovskiy 2021.) Anyway, the validity of the research has been limited by the poor response rate of LUT staff members, which did not allow further implementation of the development plan and model solution for the specific case of LAB University of Applied Sciences. Therefore, the validity of the study is low.

Reliability indicates the consistency of a measure. It describes the extent to which the results can be reproduced if the research is repeated under the same conditions. (Middleton 2019.) The focus of the research was on understanding teachers' expectations and acceptance of the new technology in favour of solving the issue of improving team efficiency in the context of collaborative projects between LAB and local companies. Teachers' responses were even, from this comes the expectation that the results would have been similar and conform even if the response rate would have been higher. Hence, the report can be considered reliable.

5.3 Suggestions for further research

The proposed plan provides a model solution to further expand the cooperation between education and industry through efficient teamwork. However, numerous aspects should be studied further.

Firstly, the research could focus on providing standard and technical guidance for software development so to ensure software quality (McCall et al. 1977, 10-11). Further research could improve the correctness, usability, and integrity of the model. It is important to investigate the organizational requirements concerning data integration and the possibility to gather data from information systems already in use. The system should be able to handle a good amount of data efficiently and over a long period. This aspect raises the question concerning sustainability. Additional studies could build data structures and develop an appropriate data clustering algorithm. This would improve the system reliability, and efficiency. Therefore, more focus needs to be directed into the legal and ethical aspects of data lifecycle management and data mining for education from external resources, as well as the collection and mining of sensitive data, thus, matters of data security. (McCall et al. 1977, 29.)

The model must be maintainable, flexible, and testable. Additional studies should introduce detailed documentation of the system that would make the model concise and simple to understand. Studies should ensure that the model is independent of hardware and software.

Moreover, the solution should be customizable and adaptable to user requirements. Therefore, findings should advance a prototype for the application programming interface. (McCall et al. 1977, 29.)

Further investigation could analyse whether the proposed model is portable, reusable, and interoperable. The system must be complex and consistent, yet able to adapt to the dynamic changes that occur in multiagent systems and expand if agents join or shrink if they leave. It is also essential to maintain an effective flow of information within the system to ensure good communication. (McCall et al. 1977, 29.)

Studies could observe the effects of the proposed model on users' behaviour. Modelling team design is a complex task that requires continuous monitoring and development. Therefore, examination of team dynamics should differentiate between teams that have to learn as their main goal, and teams that must solve a real business case as their main goal. In the first case, conflict is an essential aspect of the learning experience, thus it should be cherished and, eventually fostered. For instance, the model could support users in acknowledging the conflict and managing it. In the second case, the goal is to produce results that are useful for the case company. Thus, the model could consider whether conflicts deteriorate the quality of teamwork. For this reason, the model should be tested with various team environments.

Finally, further analysis could collect information from user expectations from the point of view of students and companies, design the user interface for each user group, and investigate how to improve the overall user experience.

6 Summary

The study proposes a model solution for improving the practices of team design through automation. Therefore, it advances a tool for enhancing the relationship between LAB University of Applied Sciences and industry in the context of collaborative projects.

The research is exploratory. Secondary data are collected from electronic sources. Primary data are gathered through a qualitative and quantitative investigation carried out among LUT staff and LAB teachers. Therefore, the development plan is implemented and suggestions for further studies are presented.

The theoretical part of the research underlines the need for organizations to improve their practices of change management and how digitalization affects working methods. However, to facilitate the processes of digital transformation and staff reskilling, the emphasis goes on the importance of a tight relationship between industry and education. Since teamwork is a crucial element for both working and learning practices, the theoretical part covers aspects of human interaction, and how conflicts are a central part of learning and developing novel solutions. This section answers the first research question, on how efficient teams are designed. At the same time, the theoretical part dives deeper into concepts of enterprise architecture, system integration, and data lifecycle management provides practical insights on how current technologies can deliver practical solutions to solve specific problems.

The empirical part of the study collects information from LUT staff members and LAB teachers. Performing qualitative research among LUT staff serves the implementation of the model solution as described in the development plan. Whilst a qualitative and quantitative investigation clarifies how teachers would accept such a model and whether it is worth continuing the study further or not. Understanding the acceptance level of the teachers provides the answer to the second research question.

The development plan includes a suggestion for system integration of information systems currently adopted by LAB, a data mining and clustering model for teaming up students, and method for matching study groups with companies. The plan identifies key stakeholders, how data are processed and flow throughout the systems, and how these data can be used to improve teamwork efficiency in the context of collaborative projects between LAB University of Applied Sciences and local businesses.

In conclusion, the study answers to the research questions, reflects on validity and reliability, and suggests further research.

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Appendix 1. Open questions to LUT staff

Is it possible for LUT personnel to change profile setting and let JobTeaser users add further personal information?

> *"As you already know, JobTeaser is a product of a French company and unfortunately we are not able to make any changes to the data fields."*

Can you describe the matchmaking process on JobTeaser (e.g., centralized or peer-to-peer, the criteria for a match to happen, and so forth)?

> *"The matchmaking at JobTeaser is very simple. It enables students to look for interesting jobs / companies and contact them. The companies can look for suitable candidates if they have access to a certain Talent Bank. As far as I'm aware, the matching is mainly based on simple search criteria. Some information about opportunities and events are presented to the student based on some algorithms."*

Is it possible to extract data about users' personality through the links to social media saved by JobTeaser users? And what about users' professional skills?

> *"The links for the social media are just links. Data is not transferred from social media to JobTeaser profile or vice versa. Data is not transferred to other sources from JobTeaser either."*

How reliable and correct is the data extracted through JobTeaser?

> *"The reliability of the data in JobTeaser is purely based on the users. Currently, the data is quite reliable as the system is new. However, this will change in time as the users might enter their CV and profile information at the beginning of their studies and forget to update them. Naturally, we will send reminders to update the info once in a while. JobTeaser will remove profiles automatically if they are not used in two (?) years."*

What do you think about this solution? Is there anything that you would like to add, or criticize?

> *"Concerning JobTeaser, the JobTeaser is the platform providing the GDPR information. I doubt that we would be able to transfer user information from the system to another database.*
>
> *In addition to Student, Teacher and Company, we also have Firmatiimi dealing with this theme. This function was not taken into account in your plan.*

You also had the idea of using PEPPI / SISU as part of your plan. Have you already contacted the persons responsible for these systems? How did they react? I think your timing might be quite challenging for them as they currently have their hands loaded with integrating these new systems for our other current information systems.

According to your plan the IT services would be responsible for maintaining the system. Have you already contacted them? What was their response? I know we have quite strict IT architecture policies concerning any new systems or applications."

Appendix 2. Methods to improve collaborative learning

Teachers' responses
Teacher involvement and supervision. Tools that support collaborative work, e.g., collaborative writing via Google Docs. Trello and others.
Simulations
There is plenty of different team learning methods. Of course, all of them cannot be used as efficiently or good as possible.
There are always possibilities, depending on the situation
Joint problem solving, discussions, dividing roles, collaborative writing, presenting
More compulsory meetings.
Certainly, there are always ways to improve, and I would be happy to get new ideas and learn from others
Although I wish there was more time to work on putting together student groups (as I have done this in the past according to tests, skills etc), in my current position I do not have access to the same kinds of information and so this is hard to do. Particularly with a heavy workload there is just not enough time. I mentioned above that even though I do not always feel I am able to supervise teams efficiently, students overall seem to produce good work when they choose their own teams and work independently. However, in my opinion they could benefit from working with other students as this more reflects working life. As to methods for improving collaborative learning, greater information on students' skills, preferences and challenges with regards to learning would be useful to have. I think there could also be more in-depth workshops for teachers on how to improve collaborative learning and hear from one another on things that have worked or at least been attempted (teacher-teacher learning). Clearly, collaborating online has been a challenge in the current pandemic, but again, more information on creative ways of doing this (outside of Moodle) would be useful to provide to teachers.
There are quite a lot actually ranging from basic dialogue to different group exercises.
Team coaching and learning process. There the teacher is a coach. this requires the students would also have time from their other courses (not to much overlapping) inb order to concentrate on delivering the project results.
Lively and inspiring tools used online, the best way would be to be face-to-face, using varying methods in boosting interaction, like dialogue and continuous feedback.
making the rules for the teams in the beginning, creating open atmosphere, ask the team to make memos of the team meetings (if I'm not present in them), evaluating the team performance after each meeting and in the end of the course.
Interactive, problem-based learning methods, simulation-based learning, dialogue, open dialogue etc. Facts are not the solution, rarely are, key to learning and getting epiphanies is to find shared interest and be present to openly discuss about the topic in discussion. Diversity in team is strength but undervalued and underestimated in team building. Diversity combined with shared interest is

solid starting point for excellent team and collaborative learning. Surely many other methods could be applied depending on the situation.
Collaborative learning is improved by the human interaction skills of the teacher. The teacher needs to assess, based on student reactions, how the team is functioning. Then, the teacher needs to know when to drop in a little joke here or a pointer in the right direction there. The aim is to ensure beneficial group dynamics. Every person is an individual with a multifaceted personal history and background. Thus, two people may have the same qualifications, age, work experience but behave in completely different ways. Teamwork is about the humans not the systems. With in-class teaching I get to know my students: I know who the quieter people are who need to work in a group without a domineering leader; I know who has the patience to deal with the student with communication problems; I know which activities can be done based on friendship groups and when students can be challenged to work with, e.g., fellow students of different nationalities. Distance learning fails, among many reasons, because the human element that spurs performance is missing. Your proposed AI-based team-generating system sounds similar to a dating application. Most of the time such apps fail completely, although once in a while thing work out. A further problem with AI-generated teams is that the teacher does not know the underlying logic used to generate the team. If the teacher has decided the team him/herself, he/she knows the thinking behind the grouping. Thus, if things are going badly, it is easier to think of remedial actions to improve the situation. Systems thinking and reductionist models turning humans into mere numbers removes humanity from interactions. Without humanity, life is truly inhuman. I wish you good luck with your project.
Well, I teach languages, and I do use collaborative problem solving as a means of language practice. That's where teamwork would come in. However, collaborative practice could be improved with guided sessions of communication, such as book clubs or conversation classes.
Peer analysis, reflection
Face to face working. Practical work.
My lectures involve a lot of calculation and some students benefit greatly if they practice together as a group whereas others may benefit from working alone. I encourage student to build "teams" but I do not force it.
Project based learning Co-design Workshop working Learning cafe Discussion groups