Acquisition of practical skills in the protected learning space of a scientific community

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ABSTRACT

Digitalization is constantly forcing companies to refine their products, services and business models. To shape this change, companies expect not only knowledge of the technologies from the graduates of the respective study programs, but also comprehensive methodological and social competences. For this purpose, we describe the concept of a project semester in an Enterprise Computing study programme, which imparts the required skills. The task set by a partner in the industry allows the achievement of different goals and integrates the various dimensions. On this basis, we describe the best practices in the areas of project management, knowledge building, administration and dealing with customers and other stakeholders. The description of actually carried out projects shows the application of our concept and allows the reader to transfer the best practices to his own needs. Finally, we point out the advantages for the project participants and outline expansion potential.

CCS CONCEPTS

• **Applied computing** → *Education*;

KEYWORDS

teaching, project management, education, students competences, best practices

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1 INTRODUCTION

1.1 Initial situation

Meanwhile, information technology permeates all areas of life and work. Digitalization is progressing rapidly. As part of the digital transformation, companies are required to integrate the developments into their products and services and, at the same time, to broadly redesign their business models [3, 14, 13]. The implementation projects to be carried out increasingly do not only require technical competences but also the ability to survey and to integrate various disciplines in project teams, and to find solutions to complex tasks [2]. Emerging and changing technologies also require the ability to learn and value something new quickly. Justly, companies expect that graduates are prepared for these changes [23]. To ensure this, universities must try to integrate these competences and not only technical knowledge into the study programmes.

This leads to the following questions:

- How do lecturers best teach students practice-orientated things at a university so that they can gain broad experiences in a protected environment and acquire the competences required by the companies? For this purpose, we present the concept of our project semester.
- Which framework conditions are to be met so the project semester with all its participants — students, university and corporate partners — will be successful? How do the participants benefit from using the concept?
- Which methods have proven themselves and can be used as best practices by other universities and also be adapted as needed?

1.2 Goals

This paper describes the concept and experiences of a project in the fourth semester of the bachelor programme Enterprise Computing at the Department of Computer Science at the Mannheim University of Applied Sciences. Familiarity with teamwork, social competences and the ability to communicate on many levels are demanded of the graduates, in addition to technical knowledge. In our opinion, these can only be imparted through lived experiences in real contexts. Therefore, in our teaching concept, we offer a protected space where realistic scenarios can be experienced without economic conditions. In our opinion, these can best be imparted through lived experiences in real contexts.

Based on the description and the resulting best practices, we aim for other universities to adapt the concept and to ensure practical education. The experiences of several semesters with different subjects prove that the methods work. This paper also addresses companies and potential customers. Knowing the conditions and requirements, you may apply as corporate partner and derive your obligations and expectations.

It is obvious that almost all universities place value on practical education. Independent working on problems is therefore taken up in many methodological approaches, such as problem-based learning, research-based learning, learning by teaching and many more. Many elements of these methods have some influence on

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our concept. This paper does not provide detailed distinction and discussion since the concrete success of these methods is widely seen [10, 17, 7, 2]. It is difficult to measure the competences acquired by the students [16]. In particular, the quantitative measurement and comparability of the acquisition of competences across several projects we consider as given only in some areas, since the content of the projects and framework conditions is very different over the semesters.

1.3 Approach

To answer the questions listed in section 1, we first introduce our concept in section 2. Based on the aims, we explain the organisational structure and process organisation. Furthermore, section 2 describes the different dimensions which are beyond the scope of professional and technical aspects. It also emphasizes the integrative approach. Section 3 summarizes our experiences in the form of methods and measures. These best practices can be transferred easily to other universities. In section 4 several project descriptions from the last semesters show the concrete application of our concept. On this basis, the advantages can be worked out from the project participants' — students, corporate partners and university — point of view before a final conclusion.

2 CONCEPT

According to a statement on its self-conception and its basic principles which goes along with its mission statement, the Mannheim University of Applied Sciences sees its primary mission as "the training of highly-qualified, responsible, independently-minded and critical graduates who are able to present, discuss and implement solutions." [6]

According to the Business Motivation Model (BMM), which provides a schema for the design and communication of business models and business strategies, and which documents the mission statements of mission and vision, companies must distinguish between the areas of "End" (aim or purpose) and "Means" of implementation or achievement of objectives [4]. While the mission statement of the university outlines the End area, the design of the specified mission and the approach to achieve the goals (Courses of Action) belong to the Means area, so to the departments and study programmes.

With its bachelor programme Enterprise Computing, the Department of Computer Science pursues a practice-oriented training approach. On the one hand, students should acquire profound technical knowledge on the basic pillars of computer science, enterprise computing and business administration [17]. At the same time, from the first semester onwards, they should establish contacts with regional companies to get to know the problems in practice and to explore their aptitudes and preferences with regard to their future professional career. The first contacts are made through guest lectures of the companies in particular lectures. They are intensified by company excursions. A special milestone is the 4th semester, where all participants work together full-time over a period of about three months on a practical task set by a company as a customer and stakeholder. During the project semester the students slip into the roles of IT consultants, business analysts and software engineers in the broadest sense. Largely independent, they work on the solution under the guidance of the coaching professors and coached by tutors, i.e. advanced students who have already completed the project successfully.

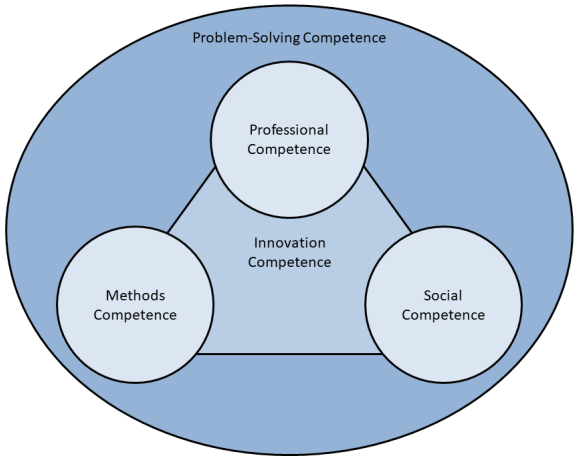

Figure 1: Areas of competence

2.1 Objectives of the course

The central goal of the study programme is to impart students a wide range of competences in the project semester:

- Professional competences: Depending on the customer's field and the task, there are preceding block lessons based on the basic skills and methods acquired in the previous semesters. These give the students an understanding of current challenges in the industry, the special issues of the corporate partner and other possible stakeholders, as well as the methods and tools used there.
- Methods competences: In order to work on the project in a structured and successful way, participants need knowledge on the aims, tasks and methods of project management. These are imparted through project management workshops at the beginning of the semester. Among other things, the participants learn about the organisational, informative, planning, controlling and monitoring tasks as well as the motivational efforts and the decision-making activities of project management [7].
- Social competences: Since project processing is teamwork, the project starts with a team building workshop where the students learn about and experience the four phases of team building. Together with the coaching professors, experienced coaches divide the participants into sub-teams, for example based on the Belbin team roles [1]. Following this, the teams get to know each other through small team challenges.

These three pillars are the basis for innovation approaches. For the impartation of innovation competences, the Design Thinking method has proved to be successful. It shows the participants along which process innovative solutions can be found [11]. Together, these areas of competence lead to the central aim of acquiring problem-solving competences. Figure 1 summarizes the impartation of the competences.

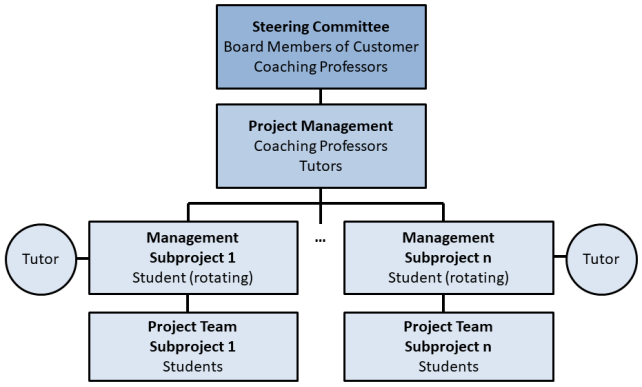

Figure 2: Organisational structure

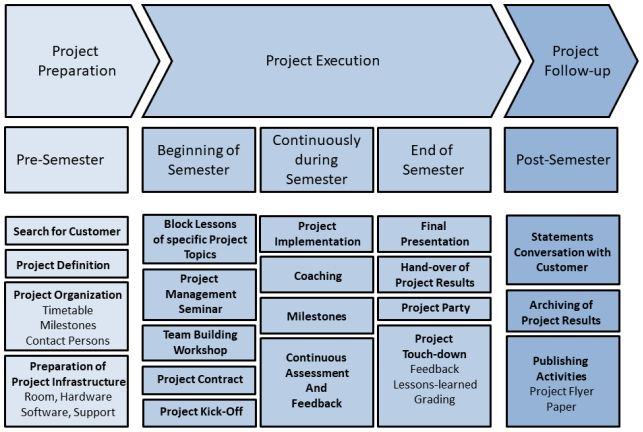

Figure 3: Process organisation

What is special about this course compared to conventional courses is the integration. The project goal can only be achieved if the students succeed with the meaningful interaction of all these aspects in such a way that all competences in the team are balanced and, at the same time, integrated meaningfully. Usually, this requires an expansion of all considered areas of competence. The combination and the experience but also mastering these heterogeneous tasks is an enormous challenge in many ways. Nevertheless, in retrospect students and graduates consider this a very defining experience throughout their studies.

2.2 Organisation of the course

Since the project intends to empower students to implement IT projects successfully, the coaching professors provide a clear organisational structure and a rough process organisation. The organisational structure is a line-staff organisation structure chaired by the steering committee with board members of the customer and the coaching professors. The latter also undertake the project management tasks internally together with tutors, i.e. advanced students. The professors divide the overall task into subprojects (cf. figure 2), whereas organising and structuring the teams is the project participant's responsibility. Tutors are assigned to the teams as advisory staff. Based on the experience gained in completing the project semester course on their own, the consulting can refer to all areas of competence.

Alternately, the project participants play different roles. The specific role depends on both, the task specified by the external customer and the project management method that can be chosen by the teams themselves within certain limits. Typically, the role of IT consultants is played by all participants. Explicitly, and sometimes implicitly, it turns out who plays the roles of team leader and project spokesperson. Other frequently encountered roles include quality manager, test manager and usability specialist. If the students choose an agile approach, positions as scrum master and product owner must also be filled.

The process organisation structures the project into several phases which can extend over several semesters (cf. figure 3). The search for a suitable partner company and an innovative task which matches the semester scope begins already before the beginning

Figure 4: Project room with group tables

of the semester. The project definition is followed by the determination of the project organisation with a rough timetable, phases, milestones and contact persons of the company. Finally, there is a project room which is exclusively available to the teams. Before the start of the project, the room is equipped with the required hardware and software, as well as work equipment such as flipcharts, moderation suitcases or electronic whiteboards (cf. figure 4). We intend that the students make a binding commitment to participate in the project semester, already at the end of the previous semester. This allows us to provide the students with material, which they can use to become acquainted with the regularly present unfamiliar subjects, already before the actual processing phase in the semester.

The semester begins with block lessons of specific project topics, a project management seminar and a team building workshop. The project starts with a kick-off and an explicit project order. Professors, tutors and the contact persons within the company coach the students, give feedback and assess the project results consecutively and particularly at the milestones. Finally, at the end of the semester, the project team hands over the project results as part of the final presentation, followed by a project party. Internally, the students get a last detailed feedback and their grades in the last week of the semester. Together, all participants record the lessons learned. The in practice often neglected orderly project closure is

of particular importance to the students in the context of a lasting learning effect since they reflect on their own role.

After the semester, there is a statements conversation with the customer in order to retain the experience gained, before the project management archives all project results. The summarized project results are documented in a project flyer. In addition, the professors look for possible ways to publish the developed concepts and results as a scientific publication, together with the students.

2.3 Integration of different dimensions

Working on the project task, there is an interaction of many dimensions in the sphere of problem-solving. The organisational dimension is related to the methodology of project management, which has different perspectives itself. That way, in order to advance the technical solution of the task, the project management complements the view on the limited project resources, especially regarding the dealing with time, deadlines and a meaningful division of the project period into phases and milestones.

On the one hand, the communicative dimension focuses inwardly, where the participants exchange information within their team as well as with other teams, having to agree on cross-cutting issues. Outwardly, it is a challenge to communicate with the stakeholders, since the contact persons often do not have clear ideas, or they have different ideas, about the solution and need a range of suggestions from which to choose. Accordingly, coordination meetings must be well prepared. Due to lack of time on the part of the contact persons, questions must be accurate and concise and still remain flexible in the process in case the customer changes his mind at short notice. Presentation formats, such as Pecha Kucha, with 20 slides, each shown for 20 seconds, thus limiting the entire presentation to 6 minutes 40 seconds, are helpful for a successful customer communication [22].

The technical dimension indicates that the familiarisation with an unknown task field as well as a new industry with its characteristics is a further difficulty for the participants. Introductory lectures provide some basics, but not all the knowledge needed to solve the problem can be taught in advance. Thus, the students train the ability to familiarise themselves independently with relevant topics in practice, which prepares them realistically for eventual professional careers and scenarios.

3 BEST PRACTICES

As mentioned previously, the challenge for the project and those involved consists especially in the integration of the various aspects and dimensions in a balanced way. Only if this integration succeeds to its full extent, the project can be successful in terms of results, experiences and learning effects. Years of experience allow us to name best practices that, in our opinion, are crucial for the success of the project, and that address the different dimensions, assist or just set appropriate conditions. Following, some successfully established methods and measures on the aspects of project management, project content as well as dealing with customers and other stakeholders are described, which, of course, have to be adapted to the specific project.

3.1 Project management

The professors in charge of the project leave it to the respective teams to choose the project management method. Ideally, the basics of project management and an overview on methods are already familiar from previous courses. Alternatively, simultaneously to the project processing, it is possible to introduce individual methods or to intervene in case of difficulties and to treat suitable methods in practice, after a preceding block lesson on project management. Due to the lack of experience on the part of the students, the project management tends to take a lot of time and effort, so we recommend concentrating on the core elements. We attach particular importance to risk management, time management and effort estimation. In our experience, the popular and established agile methods such as Scrum should be used with caution. On the one hand, as a team the students are rather homogenous and mostly inexperienced, resulting in an unclean use of the methods. On the other hand, the stakeholders, who are important for the frequent exchange and because of the requirements, are usually not available as required.

In general, we think it is useful for the teams to work on an overarching task including one or more delimiting aspects. For instance, this may be the creation of a solution with different products or technologies, the use of different methods, the division of an entire process that is to be optimized into sub-processes, or problem solutions for different user groups of the customer. A motivating and healthy competition of ideas and solutions is conducive to productivity and results. At the students' suggestion, we established so-called virtual teams for cross-team issues. Each team usually delegates one person there. The virtual teams deal with dedicated and delimited tasks, such as the standardisation of documents or their structure, customer communications or making results comparable, which may be incurred in the context of performance investigations.

The project marketing becomes increasingly important during the project duration. On the one hand, the students are supposed to position themselves in terms of a personal marketing, to find their role and to assert it. Since in later professional life self-marketing is of importance, "to show oneself" is desirable not least for grading. On the other hand, intermediate and final results of the project are to be presented in various ways. We demand a variety of presentations for different addressees. The above-mentioned Pecha-Kucha-format is only one variant, which is of high practical relevance. The preparation of the project results in form of an exhibition booth proved to be very motivating (cf. figure 5). For this purpose, different materials such as flyers, posters, product descriptions, explanatory videos or an executable product or prototype have to be made, what trains different skills. By involving external stakeholders, the students make a special effort and often deliver very professional results.

3.2 Building up and applying knowledge

In each project, the technical basics must be established first. Since even the professors cannot master the subject in sufficient depth, a mixture of different methods is necessary to ensure the acquisition of knowledge. Customer-specific know-how is imparted in workshops held by the customer himself. In several cases we have resorted to online courses. In one case, simultaneously to the project duration, a Massive Open Online Course (MOOC) on the subject of

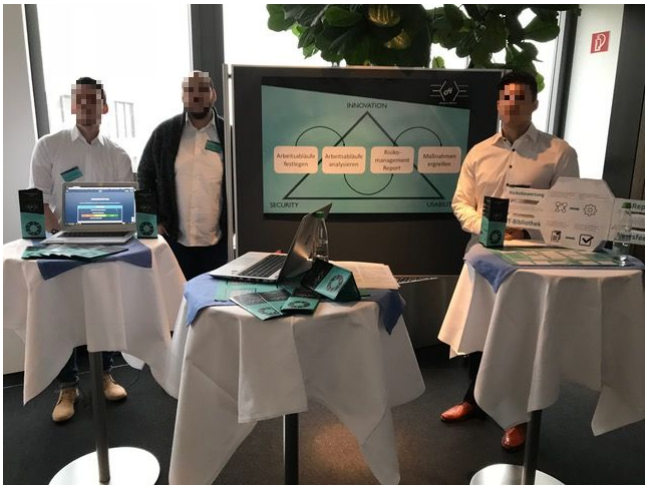

Figure 5: Exhibition booth for the presentation of the project results in form of the product

process mining was used to impart knowledge. In addition, product training and self-study are conceivable. Here, the roles of the professors change from imparters of knowledge to curators, whose job it is to choose appropriate ways to impart knowledge from the large number of possibilities and to organise them.

For many customers, the attraction of working with the university is that the students have an unprejudiced and unconventional sight. There is even the expectation to work on the problem with innovative and unexpected approaches. We have used the method of Design Thinking several times. The cooperation with the SAP company and the offered innovation platform Next-Gen was of great benefit [15]. SAP employees have already imparted the basics of the method of Design Thinking to several project teams before it was applied to the project challenge. For this purpose, resources are available at the Mannheim University of Applied Sciences in a Design Thinking laboratory [5].

In addition to the use of know-how, the final and intermediate results must be documented properly. Here we address a wide range of target groups and formats. In addition to the already mentioned materials in the section of project management and project marketing, it is important to meet the requirements for compact but meaningful documentation. We recommend common, tried-and-tested templates, such as arc42 [19] for the development and description of software architectures. In the area of documentation, there are numerous cross-relations to project management, for example regarding versioning of documents and configuration management.

3.3 Administration

The choice of an appropriate task is crucial: The project task should be set in order that, after a rough effort estimation, the processing of the project should be realisable in about three months. Thereby, it has to be taken into account that introductory lectures and workshops dominate the first phase of the project. It also must be assumed that, due to the lack of experience, students will take longer to develop the solution than consultants in practice. This can be compensated, for example, by buffer times and optional solution components in the project order. Furthermore, it must be ensured that even with only partial processing due to lack of time or technical difficulties, there is no risk of sales shortfall for the company. We also never act as subcontractors involved in a customer project of the company.

From an organisational point of view, certainly, it facilitates the cooperation with the customer if the company or the contact persons are located close to the university. Due to the lack of experience, at the beginning of the processing, students are often insecure in dealing with stakeholders in terms of intensity and form. Therefore, the university should grant the possibility to establish personal contacts and explicitly insist on a time budget of the contact persons with decision and statement authority. After establishing a personal relationship, virtual contacts and communication are also very practical. Visiting companies, where also the observational method is practiced in the determination of requirements [12], proved to be very helpful for the students. During a visit, students get a taste of practical experience during an appointment at the customer's premises and get to know the work climate there. In addition to an investment of time, we expect the customer to host a project closure party to motivate our participants.

The provision of the hardware and software required for project processing should be clarified early. The students work primarily at the university, but the equipment is limited to standard software and hardware. In many cases, affordable or even free academic software licenses can be provided. Here, however, the terms of use must be clarified. All other resources are to be provided by the customer.

The grading of the participants is a great challenge. Justly, the students demand that the criteria for grading are announced early and transparently. At the same time, the final grade results from a large number of individual impressions and achievements which ultimately reflect the complexity of the real project processing and the integration of the above-mentioned dimensions. The project results in the form of different artefacts (e.g. software, documents) can be graded relatively easily. In order to estimate the proportion of the individual project members, we have at least two one-on-one conversations, one after about half of the project duration and one at the end of the project. The professors visit the project teams on an irregular basis. They can assist and gather impressions recurrently. The students have to keep a personal project journal daily. However, here the focus is less on grading than on the idea that a self-reflection [2] over the accomplishments and experiences of the day takes place.

3.4 Dealing with customers and other stakeholders

For a long time, studies have shown the importance of a "good" raising of requirements for a (software) project [20]. Students should be aware that the requirements must be raised by and agreed with the customer. The professors cannot relieve them of this task, but they can encourage them to play a very active role in terms of an (IT) consultant towards the customer. We consider such a consulting competence as very important for the future professional life.

We attach particular importance to executing the projects under realistic conditions. Often, it surprises the students that not all contact persons are of the same opinion. Although we keep the number of stakeholders manageable, there are situations where other people (e.g. clients of the customer) are involved, provide information and feedback. It is a defined learning objective to deal with diverging, contradictory and changing statements, difficult-to-reach contact persons as well as changing positions. If confusion leads to stagnation in the processing, the professors are required to intervene and clarify the situation. Since the end of the project is firmly linked to the semester, there is, in contrast to projects in practice, no option for extension.

4 PROJECT EXAMPLES

Based on various examples of different character, this section shows in which scenarios we implemented the described concept of the project semester. The differences cover thematic priorities, the focusing on individual phases of an analysis, consulting or software development project, and, not least, the variability in the selection of technologies and tools. It also underlines how at the same time the teams work on the same topic but yet are effectively separated from each other, so that there must always be a team-individual prioritisation. Each project has its peculiarities which are to be considered in planning but also often ad-hoc. However, it should be noted that this is an exciting and varied course for the coaching professors, too.

The students of the project semester in the summer semester 2017 have processed an order for Movilizer GmbH, Mannheim. The task included the conception and prototypical development of a Graphical Movelet Editor (GME). Movelets are building blocks of Movilizer Mobile Apps, which consist of a sequence of screens of data flows, business rules and business logic. The editor allows consultants to model Movelets without programming and then to generate the code needed for the Movilizer Cloud, implemented in MEL (Movilizer Expression Language). Consultants can manually compose Movelets from individual screens or use templates and further develop them. This makes it possible for the consulting to create live Movelets for customers and so to demonstrate the possibilities of the Movilizer solution by implementing customer processes ad-hoc. Also, for the development at Movilizer, the GME offers a variety of applications such as the visualisation of Movelet processes in real time as well as an aid in debugging or by expanding the template creation to a template marketplace, where partners and customers can reuse templates and upload new processes. The particular technical challenge of the project lies in the subject matter of the order since mobile applications first appear in the curriculum of advanced semesters. Therefore, the participants had no prior knowledge in the field of mobile business. Initially, the four teams analysed different mobile business processes supported by Movilizer: Pickup & delivery, direct store delivery, installed base management and field service sales. Then, they standardised the sub-processes in an integrated process model. The project required particular flexibility on the part of the students since, after completing the research and analysis phase, the teams had to redistribute and form groups to handle various task packages in the areas of system architecture, template design, prototype implementation, and documentation.

In the winter semester 2016/2017 various NoSQL technologies and products were examined. Starting point was an application managed by SP Consulting GmbH, Ludwigshafen am Rhein, which calculated forecasts in the sales sector. The relational database technology applied so far did not provide the desired performance of response times in seconds range when aggregating and pivoting the data sets. To work on the resulting task "Evaluation and Performance Optimisation of Forecast Applications by NoSQL technologies", a preselection of four suitable systems out of twelve alternative database technologies was made: The column-based databases HBase and Cassandra as well as the document-based databases MongoDB and Couchbase. In detail, the criteria of installation effort, performance, scalability and usability were examined. In doing so, the students acquired important competences with regard to situations that frequently occur in practice, where products on the market must be compared and prioritised based on a variety of criteria. The technological challenge for the teams was to migrate the relevant query algorithms to the systems to be examined. In this project the above-mentioned virtual teams played an important role in having the job to prepare performance tests on a comparable basis, to perform and to evaluate them.

For the corporate partner MLP Finanzdienstleistungen (financial services) AG, Wiesloch, in the winter semester 2015/2016, a Change Management Process was analysed. As a methodology in the field of business process management, process mining reconstructs and analyses business processes based on digital traces in IT systems. Unlike traditional business process analysis, process mining generates a process model automatically based on so-called event logs. This offers a detailed overview of all process instances. The analysis covers possible bottlenecks in the process flow. Since the students had no prior knowledge of process mining, the imparting of this methodology right at the beginning was of key importance. This shows the possibility, how the supervisors at the university have to acquire know-how relatively quickly by using often very readily available external resources. In the particular case, a free MOOC (Massive Open Online Course) and a product training on the process mining tool Celonis were used to impart the knowledge. In the further course of the project, hitherto unknown analytical findings could be delivered to the customer, although compared to the simplified training data, the data from experience of the corporate partner was significantly more complex and more difficult to analyse. Even though applying the tools focused on the business unit was a difficulty, there was a high motivation during the processing since the results were of direct practical relevance to the customer.

In the project of the summer semester 2015, the participants worked on a task for the SAP SE. The task was to design the Future Workspace@SAP for developers, consultants and administrative staff. The students examined topics including place of work, technologies, requirements, workload, teamwork, reconciliation of family and work as well as technical equipment. Using the Design Thinking method, the students worked on arranging a set of elements that, in the future, will make a significant contribution to the possibilities of employees to access their potential, to be motivated and satisfied as well as to keep healthy. There were three scenarios for workspace design, for example flexible room islands,

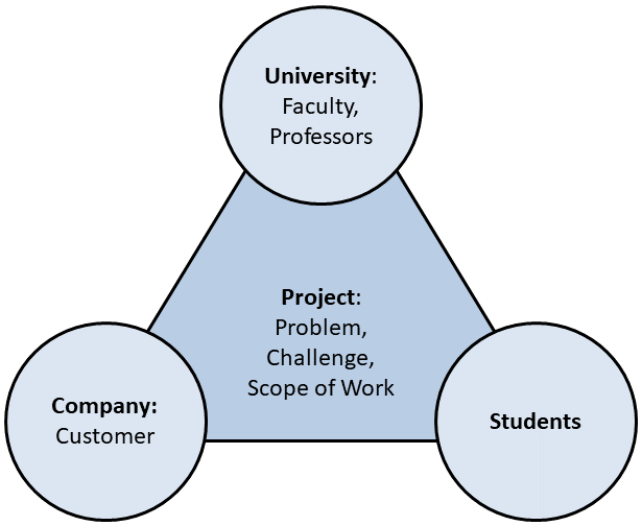

Figure 6: Triangle of the project participants

personal digital assistants and new ideas for using the travel time to the company for team communication. In this project, the students were particularly excited about the opportunity to travel to the nearby city of Walldorf and to experience the application of Design Thinking at first-hand at the customer's premises. Another advantage of the regional proximity was the broad range of feedback possibilities which the participants could get directly from the future users of the project results interviewing them. The project teams were particularly challenged in their creativity since they had to distinguish themselves from each other with their ideas at the final presentation before jurors from the upper management level of the SAP SE, including a member of the Executive Board. They chose different forms of presentation with video scribbling, avatars, Pecha Kucha and self-created animations.

5 EVALUATION FROM THE PARTICIPANTS' POINT OF VIEW

Figure 6 illustrates the different stakeholders. Subsequent, we work out the benefits for each participant.

5.1 Competences for students

Experience has shown that students participate in these real projects with great motivation. This can be partly explained by the fact that for the first time in their studies an elaborated result is not only acknowledged within the university but also attracts attention in the corporate world. In particular, the participants consider the final presentation, which is usually also attended by the management level of the customer, an important milestone of their studies. They use the opportunity to establish business contacts, to initiate student jobs, internships as well as final theses within the company. To benefit from these advantages, we advise against internal customers within the university and the departments.

At the beginning of the project, the participants often find the change from the close examination of the work results in the previous lectures to self-responsible work in the project difficult [24]. Usually, in the first weeks, the participants feel like "thrown in the deep end", they are uncertain which tasks they should approach and how to distribute responsibilities. During this time, both professors and tutors assist with hints but avoid specifying concrete activities. After about one third of the semester, it can be observed that the participants are more or less "surpassing themselves", taking responsibility, thinking outside the box and communicating naturally both internally and with the customer in order to advance the project.

We claim that in no other semester the level of competence on the part of the students increases as much between the beginning and the end of the semester as in the project semester. This is proven by feedback from students after the project semester. Even years after graduation, graduates often report on the formative and beneficial experiences gained from these learning scenarios. Likewise, we receive feedback from companies where project participants complete an internship semester after project completion. Companies report that project graduates have more varied and in-depth competences than students from other universities where there is no project semester [18].

Since the participants play different roles during the project processing and are project managers, team spokesmen, consultants, quality managers and IT architects each for a couple of weeks, they get to know the tasks of the respective professional fields and can decide which kind of professional activity suits them. The team development workshop also helps the participants to better self-assess and to be aware of whether they are more of a thinking-, action- or rather people-focused personality [8]. The regular feedback helps to get to know the own strengths and to work on the weaknesses.

5.2 Benefits for companies

The partner companies also benefit from the cooperation with the university. On the one hand, they become known to the students and can present themselves as attractive employers in terms of an employer branding and stand out from competitors favourably. Since in computer science the number of graduates is below demand from industry [9], here is the opportunity for early contact with the future graduates. Many companies use the project to get to know suitable candidates personally so that, after the end of the project, they can retain them in the company for an internship semester or as working students.

On the other hand, the customers receive an innovative state-of-the-art solution which they can develop, add to their product portfolio or use internally. The universities thus make a contribution to the often required transfer of knowledge to the companies. The students apply their knowledge acquired in lectures to the solution design as well as methods, concepts and technologies that the company may not yet have discovered for themselves. Companies particularly appreciate that the students approach the analysis of the problem with own ideas, disregard conventions of the company and, with an unadulterated view from the outside, open up other solution spaces than employees of the company. This neutral view from the outside also represents a frequently mentioned advantage in the commissioning of business consultancies and can be tested as part of a student project with little effort.

In several semesters we have made an interesting observation: Compared to the commissioning of a professional external service provider, a closer supervision is required by the customer during the development of the topic by inexperienced students. This supposed additional effort leads to a better fit with the requirements. This is due to the more intensive exchange. The customer knows that he has to provide more support and feedback. He cannot take the attitude of "I pay for it, so deliver!".

5.3 Benefits for the university

With the pursued concept, the university can achieve its strategic goal of a practical apprenticeship approach. The effort is indisputably high for the university and the professors involved. Each semester brings new challenges and problems. At the same time, the project semester tremendously enriches everyday teaching.

There are various other aspects that are beneficial to the university. While the companies benefit from the transfer of knowledge, the participants of the university get insights into current topics and practice related problems. Often, close contacts with the partners in the industry come along which are available beyond the project semester as partners for the application for research projects. The Universities of Applied Sciences stand for application-oriented research, so that many organisations demand a partner for the application. The close cooperation also offers opportunities for professors to do their research semester (sabbatical term) in partner companies. In doing so, joint publications result, what in turn is beneficial to the overall performance of the university.

6 CONCLUSION

The concept we presented is successfully practiced in several study programmes. The feedback from all involved is consistently positive. It can be considered as virtually proven that the learning objectives are achieved. We ensure the achievement of the learning objectives through various measures. In addition to the retrospectives provided by Scrum, the students weekly present their project progress and observations, and the resulting improvements to their own work processes. These improvements should result from team-internal reflections [2]. In addition to the documentation for the customer, we request a progress report and a description of the lessons learned, based on experiences of the teams and related to each individual participant. More space for open feedback and discussion is given after the grading in the feedback workshop called "Touch Down". Within this workshop positive and negative experiences and impressions are collected and discussed, by both the students and the project supervisors (tutors and lecturers).

The concept can serve as a framework to be adapted by other universities. The sometimes appropriate argument that not all lectures considered important find a place in the curriculum while one entire semester is used for one project work should be taken seriously. At a time when artificial intelligence and automation are threatening many jobs, from our perspective, in the long term it must be given priority to competences that are not easily accessible to automation. This is exactly what we address with the described concept.

The project semester can be further developed in many ways. To strengthen the interdisciplinary character, students from other departments can be involved. In the context of Industry 4.0, engineering study programmes are suitable. The reference to the increasingly important usability is established by students from the design field.

Still at the very beginning there are considerations about the measurability of the actual learning success. The feedback of the participating students is consistently positive, especially after some time passes. However, there are still major difficulties in the quantification of the progress of the students [21]. This is mainly due to the fact that although all projects use the same basic concept, they differ considerably in their specific characteristics, therefore a detailed unified measurement method is not applicable.

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