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Documentation of pilots

Virtual Prototyping, UCN

Spring, 2020

With the support of the Erasmus+ Programme of the European Union

Introduction

This document contain the documentation of Virtual Prototyping, spring 2020. The document contains a description of the settings and the motivation of the case, as well as an overview of the key performance indicators (KPIs) for the pilot. The execution and documentation of pilots are part of larger process, named Educational Framework, aimed at transforming educational programmes for future Industry 4.0 capabilities. The case/pilot is chosen based on two initial analysis, respectively focused at industry and the institution. For further information regarding the overall process, please see the document 'Educational Framework'.

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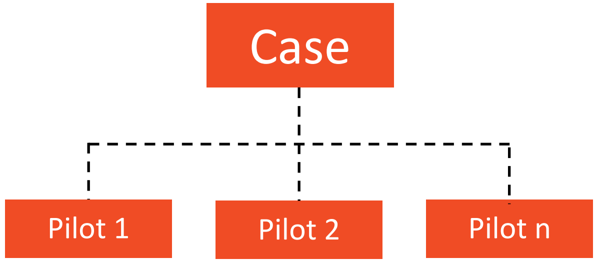

Fig. 1. The figure shows the relationship between the two terms: *case* and *pilot*.

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Description of the pilot (summary)

This pilot at UCN is a course at the educational programme “Product Development and Technical Integration”. Students from manufacturing, IT and automation (EQF level 5) can enrol into the education. The education is at EQF level 6, with a total extent of 90 ECTS. This pilot is a 5 ECTS course, during the first semester (3 semesters in total).

In this pilot, our aim is to increase the knowledge of the automation- and IT-students on the topic manufacturing, namely on product documentation generated and tested as a virtual prototype. Each lecture consists of an introduction to the theory, and a research paper, introduced by the lecturer. The students give inputs and bring a) examples from their profession and b) literature to share with the class.

The success criterion of the pilot is to enhance the interdisciplinary manufacturing knowledge for the automation and IT students and at the same time, increase the domain-specific skills of the manufacturing students. The competencies among the manufacturing students should still be expanded, with topics that they were not familiar with beforehand, while also bridging the knowledge gaps between the other fields.

To achieve these two success criteria, the awareness of learning competencies among the students must be enhanced. By a higher consciousness, the students will be able to pinpoint their own learning needs, and thereby increase their ability to bridge knowledge gaps with related fields.

This goal corresponds with the industrial analysis, which pointed towards interdisciplinary knowledge as a necessity, where interdisciplinary is the enabler of implementing integrated systems rather than isolated stand-alone solutions. Furthermore, the digital mindset of the manufacturing students can expand by the integration between a 3D model and other IT systems.

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Description of the pilot (summary)

The course, Virtual Prototyping, is based on the following learning goals from the curriculum:

Knowledge:

- Applied theory and methods for product development and innovation, concerning the enterprise organization and systems, and the ability to reflect up on the business implications of this.
- Development-based knowledge of the practical and theoretical work in project work.

Skills:

- Use tools and methods to identify and analyze the implications of technological issues regarding construction, manufacturing, using this analyze to investigate integration of products and systems.

Competencies:

- Handle innovative, complex and development-oriented problem solutions for design and applications of technology in an industrial setting.
- Identify own learning needs and develop knowledge skills and competences in their own discipline as well as interdisciplinary.

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KPIs and how they are measured

Based on the aim of pilot three focus areas are identified and operationalized, thorough KPIs. The three focus areas are: 1) The student's ability to identify new learning needs related to virtual prototyping, 2) the student's ability to integrate the use of virtual prototyping into their project, and 3) the student's readiness for future jobs.

Identified KPIs and methods for measuring

1. The student's ability to identify new learning needs related to virtual prototyping

   After the course, the students are asked to identify their own learning needs in writing. The students own identified learning needs are afterwards compared to the results of a multiple-choice test held at the end of the course.

2. The student’s ability to integrate the use of virtual prototyping into their project

   During an evaluation/examination after the course, the student's ability to integrate the use of virtual prototyping in the product development process is evaluated by the lecture and an external examiner with experience from industry.

3. The student's readiness for future jobs

   At a mandatory institutional evaluation after the semester, the students are asked to evaluate their own readiness for future jobs.

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Implementation of the Educational Framework

Educational activity sketch

The course will consist of 5 lectures, with a week in between. Each lecture will rely on a flipped-classroom approach, where the students will have to gain knowledge themselves before the lecture, and the lecture will be targeting discussion, reflection and supervision.

In the first lecture, the lecturer introduces the program, including the task. Furthermore, the self-study for all lectures will be presented, consisting of reading materials, videos and audio material.

In the remaining lectures, the students are expected to have prepared for lecture, and the task of the day will be presented. This task will show a detail of the virtual prototyping process, and part of the assignment is to describe how these sub-processes can be applied to their project.

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Implementation of the Educational Framework

Relation to Authentic Task Design

The educational framework is implemented through a case with an ill-defined output, which the students must integrate into the semester project of the students. The course takes place over one month, which lets the students investigate the problem field for several different perspectives and describe and implement relevant course material into their semester projects.

Groups formed by the students solve the task, concerning both personalities (tested by the Insights profile tool) and qualifying EQF 5 education. The case topic is 3D CAD environment product development, which is most familiar for the manufacturing students, but the IT- and automation students will gain the opportunity to implement their domain-specific knowledge into the environment.

The output will be a stand-alone digital representation of a product, which is a finished product on its own. It will be evaluated continuously within each lecture, and reflection upon integration within work-life routines are required. The students will assess each other during the project, allowing for competing products.

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Implementation of the Educational Framework

Elements

The learning process is iterative, as the students will get an overview in the first lecture, and the knowledge will be expanded in each lecture in the same topics.

Blended learning and flipped classroom – the students will receive learning content online for completion out of class. This gives room for more reflective feedback.

Supervision and feedback – The reflection will be facilitated through feedback, both in class, but also in an extended, online session with written or audio feedback available in extended timeslots.

Simulation with context – The students will meet the context either physically, or in the flipped classroom environment.

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Results and Evaluation

[A description of the results (KPIs) and an overall evaluation of the pilot. This is filled in after the pilot is executed]

The pilot was conducted according to the plan, though with minor modifications. The only change was, due to the COVID-19 lockdown of our institution, an online flipped classroom setting. The students reported positively towards both the content and the organisation of the course and the use of open assignments where they could implement their solutions to a real case (authentic tasks). The mixed technical educational backgrounds of the students allowed, e.g., the IT and automation students to gain insights into the 3D CAD environment from the students within manufacturing. At the same time, the more programming-oriented approach of parametric design allowed a discussion of principles and tasks among the entire class.

The students reported several learning-needs both within parametric drawing as well as FEM simulation, CAM and implementation approaches. At the same time, the multiple-choice test revealed that the students were confident that they could contribute to the digital product development process in the future. Furthermore, they reflected on their barriers for virtual prototyping within their own work-life and hence demonstrated digital awareness of the interaction between the organisation and technology.

The virtual prototyping technology was the main topic within 4 of the 18 student projects during the semester and was furthermore touched upon in an additional four of the student projects. The student projects demonstrated an increased capability to use the presented material, compared to the earlier semester where only 1-2 projects would include the technology, and this to a minor degree. Moreover, projects not directly concerning virtual prototyping technology was also to a higher extend digitally minded, especially towards data management, and hence, the digital mindset of the students have overall been expanded.

The students have reported high confidence for job readiness. They feel an increased capability to connect the digital tools to the real problems (authentic tasks) which exist both within and outside of the education.

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Results and Evaluation

The identified learning needs for the production students included:

> "I need more routine with the construction tasks but have a general overview of the possibilities with virtual prototyping".
>
> "I need to investigate how to implement this in daily operation at my employers company"
>
> "I need to look into generative design, and the possibilities that the algorithms provide towards shape optimisation"

The identified learning needs for the IT and Automation students included:

> "As an IT professional, I would like to understand the industrial processes within virtual prototyping, which also allows me to gain further insights into other knowledge areas. I will look more into broadening of my knowledge in the future.
>
> "I need to practise more, and perform more advanced exercises"

In combination, these statements demonstrate that the students have been able to sensitize learning needs based on the course activity. Hence, their digital mindset have expanded, as they are both able to acknowledge their obtained knowledge and reflect upon further learning requirements.

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