Sustainable transportation: Leveraging student exchange for the development of online courses

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Guide Book abstract

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Scientific teaching design and the creation of educational materials, though effective, are underused, particularly in rapidly evolving technological fields. This project, focusing on automotive and educational technology, aims to adopt design science in teaching these subjects. Recent advances in digital and virtual reality technologies, alongside the need for eco-friendly vehicle technology, necessitate new teaching methods. The project will develop assessment tools and a new pedagogical approach, culminating in a manual to guide teachers in technology education, with a focus on vehicle technology. The guide addresses technology teaching's unique aspects and targets both vehicle technology educators and others in the field. Additional materials will be provided, enhancing access to the developed learning content and course format. The ultimate goal is to update teaching models to better suit current needs, including student involvement in planning.

Guide book is created as a result of Sustainable transportation – SusTra project funded by Erasmus+. Its objectives are to develop bachelor-level training in Sustainable Transportation to meet the automotive industry's environmental and CO2 reduction requirements. It focuses on implementing a design science approach for creating new curricula, course modules, and learning environments, while enhancing teachers' capabilities in automotive technology and novel teaching methods.

[1] Keywords: Design Science, Online Learning, Automotive Education

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Terms and Abbreviations

BIP	Blended Intensive Programme
ECTS	European Credit Transfer and Accumulation System
HEI	Higher Education Institution

1 SUSTAINABLE TRANSPORTATION PROJECT

1.1 Editorial notes

This guidebook is a resource for educators and institutions teaching sustainable transportation. It addresses the need for innovative teaching methods in automotive and educational technology, given rapid technological advancements and environmental challenges.

The guidebook provides practical strategies for integrating design science methodologies into course development, ensuring relevance and impact. It focuses on real-world industry challenges like CO2 reduction and eco-friendly vehicle technologies. Developed collaboratively through international partnerships with educators, industry professionals, and students, the content benefited from research, pilot implementations, and feedback-driven improvements. Key project partners, whose expertise is detailed in the project plan, authored this guidebook.

The SusTra project was funded by Erasmus+, enabling collaboration between Seinäjoki University of Applied Sciences, Škoda Auto University, Ostbayerische Technische Hochschule Regensburg, and Thomas More University of Applied Sciences.

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1.2 Project introduction

Sustainable transportation – SusTra project is coordinated by SeAMK with partners including Škoda Auto University (CZE), Ostbayerische Technische Hochschule Regensburg (GER), and Thomas More Mechelen-Antwerp (BEL). Project is funded by Erasmus+. Its objectives are to develop bachelor-level training in Sustainable Transportation to meet the automotive industry's environmental and CO2 reduction requirements. It focuses on implementing a design science approach for creating new curricula, course modules, and learning environments, while enhancing teachers' capabilities in automotive technology and novel teaching methods. The project aims for international collaboration at the department level among partner Higher Education Institutions (HEIs). Key results include a new sustainable transportation curriculum with 3 study modules totalling 15 ECTS, training for 11 teachers and 100 students through 3 intensive programmes and 6 online courses, improved teacher skills in course development, and facilitation of future student and teacher exchanges.

The project addresses the need for sustainable transportation to support the European Green Deal and CO2 emission reduction targets. It focuses on developing the automotive power train, including hybrid and electric cars, and exploring alternative energy sources like hydrogen power. Given the increased automation in cars and the complexity of higher-level autonomous driving technology, there's a growing need for new skills in the automotive sector. The project's goals are to develop bachelor-level Sustainable Transportation training, adopt a design science approach for new curricula and learning environments, enhance teacher capabilities in automotive technology and teaching methods, and foster international collaboration among partner Higher Education Institutions.

This project aims to modernize and internationalize automotive sector education, starting with partner Higher Education Institutions (HEIs) and later expanding to a broader network. It addresses the educational challenges posed by automotive technology reforms, requiring new competencies from professionals. The project involves developing a new curriculum and training materials for sustainable transportation, embracing new teaching methods and technologies. It also emphasizes the potential of e-learning in a virtual international setting, enhancing online teaching collaboration. The primary beneficiaries are automotive sector students across participating universities, with the project significantly improving their education and modernizing automotive technology teaching.

To achieve its objectives, the project involves several key activities: co-designing, developing, and updating curricula with three new EQF level 6 course modules, each worth 5 ECTS; creating new training materials for modules on sustainable vehicle design, energy sources, intelligent driving, maintenance, repair, and the circular economy; establishing a joint training platform using a collaborative virtual reality environment like Altspace VR for synchronized collaborative work; and training 11 teachers and 100 students through 3 intensive programmes and 6 online courses.

The project expects to achieve various outcomes, including the development and partial joint delivery of joint study courses, facilitating future student and teacher exchanges. It aims to enhance teachers' abilities to use new teaching technologies and methods. Key results include training 11 teachers and 100 students, developing a 15 ECTS study module, and setting up an online platform for material sharing and teaching experience among educators. This initiative will also lead to the creation of a digital learning environment for automotive technology, utilizing modern teaching technologies, thus comprehensively reforming teaching and incorporating international aspects into the curriculum.

1.3 Introduction to project organization

1.3.1 Seinäjoki University of Applied Sciences

Seinäjoki University of Applied Sciences (SeAMK) is a multidisciplinary higher education institution in Finland, with approximately 4,700 students and 350 staff members. SeAMK aims to promote well-being in South Ostrobothnia and nationally, aspiring to be an international university noted for its entrepreneurial spirit and student-centered approach. As a non-profit, government-dependent entity and a limited company, it houses four faculties: Technology, Food and Agriculture, Business and Culture, and Health Care and Social Work.

SeAMK is particularly active in Research, Development, and Innovation (RDI), focusing on practical applications to enhance teaching and support regional development, especially for Small and Medium-sized Enterprises (SMEs). In 2020, SeAMK executed 115 RDI projects, a quarter involving international collaboration, with an annual RDI budget of about 7 million euros.

The university's RDI efforts concentrate on areas like growth entrepreneurship, business transfers, digital manufacturing, the industrial Internet, wellbeing technology, and food safety. The emerging focus on circular economy and sustainability highlights SeAMK's commitment to environmental stewardship. SeAMK's research in the development of entrepreneurial intentions among students is notable internationally.

SeAMK also prides itself on its expertise in manufacturing simulation and virtual reality, with over 20 years of experience and numerous commercial applications developed annually. The university's extensive knowledge in Finland's food chain, covering a range of facilities from laboratories to an educational restaurant, underscores its comprehensive approach to sustainability and wellbeing technologies.

Emphasizing the importance of climate protection, carbon neutrality, and biodiversity, SeAMK is dedicated to being a leader in sustainability expertise, integrating these values across various sectors and industries.

1.3.2 Škoda Auto University

Škoda Auto Vysoká škola o.p.s. (Škoda Auto University) was founded in 2000 as the first and the only company university in the Czech Republic. Its founder, ŠKODA AUTO, is one of the most important and most dynamically evolving companies in the Czech Republic, one of the largest brands of the VW Group. ŠKODA AUTO University offers its 1200 students unique study programs, nationally and internationally (ACBSP) accredited, which reflect needs of the industry and includes technical core, blend in practical experience in the international environment and meet high academic standards. The University takes part through expertise of its academic staff in national and international research and development projects.

Škoda Auto University separates itself from the local competition by being most likely the only tertiary education institution in the country, which requires its students to take obligatory internships and also being the only tertiary education institution, in which the standard duration of the bachelor’s degree program is 3.5 years. The University has also been recognized through its extraordinary emphasis on internationalization, half of master graduates have at least one semester long international experience. The intensity of exchange study periods and international internships puts the University on the forefront among all tertiary education institutions in the Czech Republic.

An indivisible part of the fulltime bachelor study program is the internship in the fifth semester and is undertaken at Škoda Auto a.s., its suppliers, or other significant industrial corporations. Students of the follow-on master´s degree program participate in internships whilst studying, thus gaining not only theoretical expertise, but also relevant work experience.

Close cooperation with industrial companies reflects in research and applied projects, curricula development, experts from companies participating in the teaching/learning process, bachelor papers and master thesis topics.

In 2022 a new project was implemented reflecting the needs of technical education. In a new premises laboratories and classrooms aiming at technical education were developed, fully equipped and opened. Regular lessons and laboratories have been delivered and organised there since September 2023. What is more, the courses and trainings for pupils, students, managers and wider public are being organised as well. The Educational Technical Centre of Škoda Auto University is designed as a small factory and represents a significant movement forward in education, research and innovations. The mission of the ETC is to link education, research, development and innovations through high technology, to strengthen students´ practical skills, and to create an environment for students, academia, public and partners to face new challenges together.

The following laboratories are currently open and in use:

- Production and logistics
- Physics Laboratory
- Virtual prototyping and simulation laboratory
- Mechanical and Electrical Engineering Research Laboratory
- Virtual reality laboratory
- Educational computer lab
- Electrical Engineering and Automation Laboratory
- KI Data Centre
- Practical Informatics Laboratory
- 3D printing
- Laboratory of electromobility and industry

International Scope

The quality of studies is certified not only by Czech accreditation (as of 2024, Škoda Auto University holds Institutional Accreditation from the National Accreditation Bureau for Higher Education in the Czech Republic) but also by the ACBSP accreditation obtained in 2014. This certification brings more opportunities for our students and graduates in other job markets, especially outside Europe.

The University has more than 50 HEIs partner institutions and more than 35 cooperating companies worldwide, which increases the need of proper training of students, graduates and also staff in the different fields. Together with the fact, that 20 % of the University students are foreigners in regular Czech or English programmes, innovations and development of the programmes are inevitable.

1.3.3 Ostbayerische Technische Hochschule Regensburg

Ostbayerische Technische Hochschule Regensburg (OTH Regensburg) is a public technical university of applied science controlled by the Bavarian State Government, offering its approx. 11000 students teaching in over 40 Bachelor and Master degree programmes in engineering, business, design, health and social science at a high level of quality in both teaching and research. Research has become an increasing activity for the more than 250 professors with now 77 doctoral students. Modern service facilities, an award-winning library and 120 laboratories provide support for successful dissertations at OTH Regensburg. Further education courses are based at the Centre for Continuing Education. With its research support department “IAFW” it owns the infrastructure and experience to participate in EU-funded and multinational projects. Currently the IAFW simultaneously administers at the OTH Regensburg six projects with EU funding, 28 federal projects, 15 Bavarian projects (state level) and 5 projects funded by external foundations. OTH offers a Master program in logistics and is based in a region with many companies that are active in the automotive industry like BMW, Continental or Osram.

1.3.4 Thomas More Mechelen-antwerp

Thomas More University of Applied Sciences, established in 2012, is the largest university of applied sciences in Flanders (Belgium), offering more than 40 Dutch-taught and a range of English-taught bachelor degree programs in the province of Antwerp (10 locations). In total, nearly 20.000 students study at Thomas More. Through its excellent professional higher education, practice oriented research and scientific consultancy, Thomas More is an important engine of regional development and innovation. The university of applied sciences has an international reputation and participates actively in international networks and projects in accordance with its different degree programs and research fields. Thomas More is a union of Thomas More Mechelen-Antwerpen vzw and Thomas More Kempen vzw and part of the KU Leuven Association, an open and dynamic network linking universities of applied sciences across Flanders and Brussels with the KU Leuven. Together, they hold a prominent and influential position in Flemish and European Higher Education. The KU Leuven Association was founded in 2002 in response to the Bologna Declaration of 1999, which sought to increase synchronization of higher education in Europe. The members of the KU Leuven association strengthen each other by exchanging expertise, promoting a joint agenda and pooling resources. To realise their goals, the Association has set up a unified governing structure for itself and all of its members

Thomas More aims to bridge the gap between research and practice, by transferring scientific evidence and knowledge into tangible and practical solutions or advice. Research is focused on tackling societal challenges and creating real societal and/or economic impact. Research activities often have a multidisciplinary approach and are carried out in close cooperation with companies, non-profit or social profit organizations and our educational programs.

1.4 Implementation of the Erasmus+ project

The implementation of the project is divided into five work packages, each led by the team manager who is responsible for delivering the outputs of their work package at the required quality, on time and within budget. The project structure is illustrated in Figure 1.

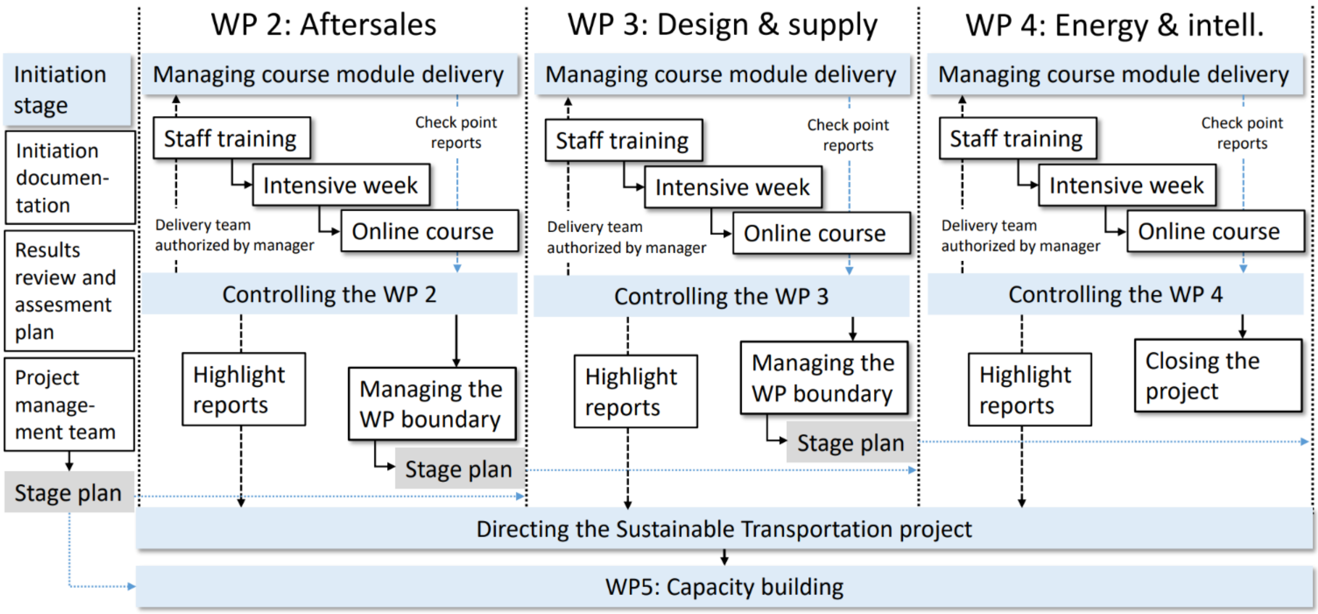


Figure 1. Project structure.

Work Package 1 (WP1) focused on Project Management and Coordination, led by SeAMK. This work package encompassed the coordination of transnational meetings, including the kick-off, mid-term evaluation, and final project meetings. WP1 provided the necessary oversight to ensure that all work packages operated cohesively towards achieving the project's overarching targets.

Work Package 2 (WP2), led by SeAMK, was dedicated to Sustainable Aftersales: Maintenance, Repair, and Circular Economy. This work package involved extensive research and collaboration to develop a course on sustainable aftersales practices. Students participated in preliminary assignments and an intensive program (IP) week, where they collaborated across partner institutions to co-create course content. The course was then piloted and executed online, equipping students with practical skills in sustainable aftersales practices. WP2 set baseline and overall framework for the future work packages and intensive programmes. After the intensive programme, retrospective discussion was held in order to figure out what went well and what needed development for the next iteration.

Work Package 3 (WP3), led by Škoda Auto University and OTH Regensburg, focused on Sustainable Vehicle Design and Supply Chain Management. This work package delved into researching current trends and challenges in vehicle design and supply chain practices. Students engaged in assignments and IP week activities, collaborating to develop an online course tailored to industry needs.

Work Package 4 (WP4), under the leadership of Thomas More University (ThM), centered on Sustainable Use, Energy Sources, and Intelligent Driving. This work package explored sustainable energy technologies and intelligent driving systems through research and collaboration. Students contributed to course development during assignments and IP week activities, leading to the execution of an online course that promoted awareness and innovation in sustainable energy and intelligent driving.

Work Package 5 (WP5), managed by SeAMK, focused on Capacity Building within the project. This work package involved the development of learning materials, teaching methodologies, and a guidebook based on outcomes from other work packages. A virtual learning environment (VLE) and 3D spaces were tested to enhance collaborative learning experiences. WP5 contributed significantly to enhancing educational resources and methodologies related to sustainable automotive practices, supporting capacity building and knowledge enhancement among educators and students.

Overall, the implementation of each work package had a crucial role in achieving the project's overarching targets of advancing sustainability within the automotive sector through comprehensive educational initiatives and capacity-building activities. By engaging students in collaborative course development and leveraging research findings to address industry challenges, the project successfully contributed to enhancing sustainability practices and fostering innovation in automotive education. The intensive programs (IPs) organized within WP2, WP3, and WP4 provided valuable platforms for students to collaborate, exchange ideas, and develop practical solutions aligned with industry needs, ultimately supporting the project's mission of promoting sustainable transportation practices.

2 PROJECT WORK METHODOLOGY DESCRIPTION

2.1 Introduction

A considerable amount of literature on design science has been written over a relatively long history. The methodology has developed in different stages and expanded to different disciplines. Design science originated in the fields of technology and natural sciences in the early 20th century. Its background was the need to apply scientific principles to the design and development of new technologies and solutions. The focus was on creating artifacts that could solve specific practical problems. The concept of design science research (DSR) began to be more officially recognized in the 1960s and 1970s, especially in the field of computer science and information systems. Herbert Simon's seminal work "The Sciences of the Artificial" published in 1969 played a central role in this. Simon challenged the traditional focus on descriptive sciences and proposed instead a design science that would create artifacts to achieve desired outcomes. Simon later updated and expanded his thinking in later editions of the work (Simon 1996). Anyway, in the 1980s and 1990s, design science began to expand beyond technology and computer science, for example into the fields of business life, management and social sciences. Researchers in these fields began to apply the methods of design science when developing and evaluating systems, models and methods for solving complex problems in organizations and social contexts.

When entering the 21st century, design science research developed significantly methodologically. Frameworks and guidelines were developed for conducting DSR research, which provided researchers with structured approaches to, for example, creating and evaluating artifacts. The most significant articles include Design Science Research Methodology (DSRM) by Peffers et al., which outlined a process model for conducting design science research. Another worth mentioning is the article by Hevner et al. (2004), whose role is central in the formalization of design science research in the field of information systems and provides guidelines and criteria for the implementation of DSR.

In recent years, design science has become increasingly multidisciplinary, with collaborations between computer scientists, engineers, economists, social scientists and others. This has led to cross-disciplinary solutions to complex problems. Nowadays, design science research has been increasingly applied also in the field of education. Educational Design Research

(EDR) combines theory and practice by utilizing design principles to investigate the effectiveness and applicability of learning environments. EDR is characterized by its iterative nature, collaboration between researchers and practitioners, and a focus on solving real educational problems. The goal is to produce usable information that can lead to the improvement of educational practices and policies. For this reason, the Sustainable transportation project has opted for a design science approach as its methodology.

2.2 Operating principle of design science

The operating principle of design science is in many respects similar to the design process of an engineer. Therefore, it is appropriate here to first describe a simplified version of the engineer's design process. The design process is usually an iterative method that engineers use to find solutions to problems. It is the central operating model of engineering work, where new solutions that meet the set requirements and limitations are developed. The process is used in the development of functioning products, systems and processes. Due to its iterative nature, the design process is adaptable to new information and improvements can be made during development.

The design process consists of several steps, each of which is significant in order to generate a valid solution. The number and details of these steps vary somewhat depending on culture. However, the following general principles can be seen as common denominators:

1. Problem definition: This is the first step in the process where needs are identified or a problem needs to be solved. Engineers must clearly define the problem and consider the goals, constraints, and stakeholder needs of the project in question.

2. Research and analysis: In this phase, the problem is given context, and possible solutions, technologies and materials are defined after detailed research. This enables the individual to understand the context of the problem and possible approaches that could be used to solve the problem.

3. Definition of needs: Engineers define the criteria and limitations of their solution; this means, from a technical point of view, they define requirements, constraints, costs, sustainability considerations and user needs.

4. Conceptualization and Design: In the conceptualization phase, engineers develop identified ideas, select the best idea, and then develop the selected best idea by making or otherwise creating something, which is usually done through models and simulations.

5. Prototyping: Engineers develop prototypes or models of their designs. Prototyping is important in testing the functionality of any design as it allows room for changes and improvements.

6. Testing and evaluation: The process involves testing the prototype under different conditions to know its performance. Data must be collected and compared to the criteria required in the design.

7. Iteration: Engineers refine and improve the design based on the results of testing. This can be an iterative process of prototyping, testing and evaluating multiple times to find the best solution.

8. Implementation: When the design meets all requirements, it is transferred to production. During production, engineers must monitor the process and ensure that the end product matches the designed product or solution.

9. Post-implementation review: After the implementation is successful, engineers evaluate the project's success holistically through the performance of the solution and the impact on the target problem.

While engineer’s design process is typically iterative in nature and contains research and analysis steps, the design science process is more iterative. The latter pays more attention to relevance of the problem and rigor of the solution as well as of the applied methodology. Therefore, the relevance and rigor analyses can be viewed as simultaneous but in some sense separate cycles. The process is illustrated in Figure 2.

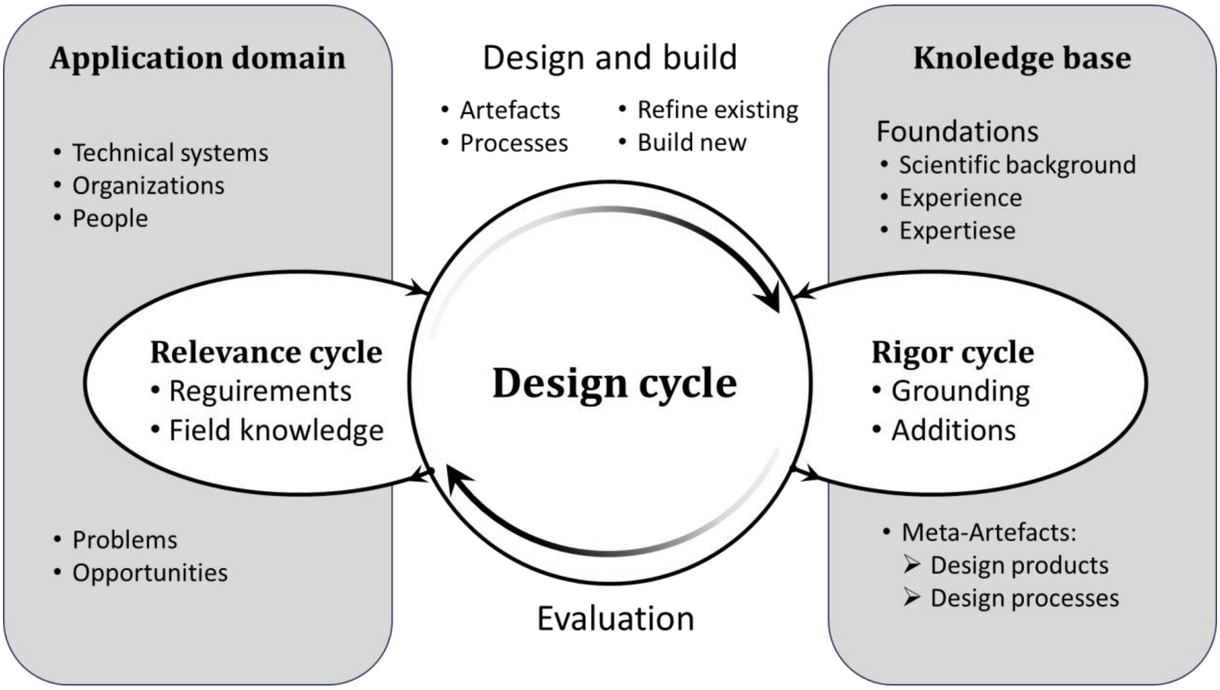


Figure 2. The design science process.

Comparing the normal design process and the design science view highlights the differences in focus, methodology, end goals and evaluation criteria, although both seek to solve complex problems. The traditional design process focuses primarily on the application of scientific principles in the design and development of practical solutions. It relies on established techniques to solve specific problems. On the other hand, design science research strongly emphasizes innovation and the creation of new knowledge through the development of artifacts. This approach aims not only to solve problems, but also to expand the understanding and methods of the field.

The methods used in these two approaches also differ significantly. The design process is characterized by its structured and sequential steps from problem definition to implementation and evaluation. The goal of this progression is to ensure that every part of the solution is carefully planned and implemented. In contrast, design science research is inherently more iterative and promotes iteration between the design, creation and evaluation of artefacts. These cycles allow for continuous refinement and adaptation based on insights gained during the process.

In terms of end goals, the goal of traditional design is to produce reliable and efficient solutions that meet predefined specifications and standards. The success of a design project is often measured by its practicality, efficiency and adherence to these standards. Design science research, however, strives not only to offer effective solutions to problems, but also to meaningfully bring know-how. Creating innovative objects is seen as a way to challenge and expand existing methods and insights in the field. The evaluation criteria of these two approaches also differ due to different goals. Traditional design processes usually emphasize testing solutions against specifications and standards and ensuring that they work as intended. Design science, on the other hand, evaluates artifacts based on how effectively they solve the problem at hand and how they can contribute to a broader knowledge base. This includes assessing the effect of the artefact on both a practical and a theoretical level.

Overall, although both the normal design process and the design science approach aim at problem solving, they do so with different priorities and strategies. Design focuses on applying existing knowledge to create practical solutions, while design science seeks to innovate and expand understanding of the field by creating new objects and methods.

3 CASE STUDIES

The case studies are divided according to the work packages, with case study 1 in WP2, case study 2 in WP3, and case study 3 in WP4. Figure 3 illustrates the positioning of the work packages, i.e., the case studies, on the project timeline, as well as the application of project management and design science frameworks in the implementation of the project.

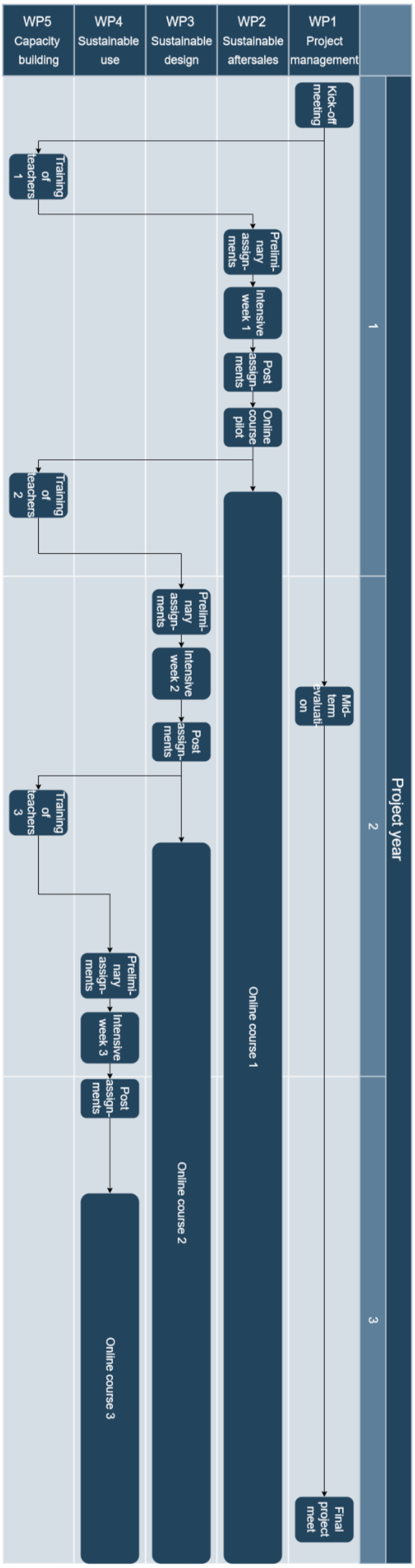


Figure 3. Project timeline divided by workpackages

3.1 CASE 1

This chapter presents a project case implemented at Seinäjoki University of Applied Sciences. Seinäjoki University of Applied Sciences was the lead partner in the project and thus initiated the organisation of three different cases.

3.1.1 Introduction to the topic

Today, everyone should strive to reduce their emissions and make sustainable choices in their daily lives. Mobility is a fundamental human right and a necessity in the modern world. It should be possible to control emissions from mobility to uphold the fundamental right itself. Emissions from the vehicles themselves can be divided into three distinct phases: vehicle manufacture, vehicle use and recycling (ELV, End-of-Life Vehicles).

The sustainability of vehicle manufacturing must take into account the production of raw materials, logistics and the manufacturing process itself. In the use of vehicles, sustainability can be addressed in many different ways. However, sustainability can almost always be interpreted as the idea of driving efficiency. Aftermarket services for vehicles are also part of the sustainability chain. For example, maintenance and repair measures can keep vehicles in working order and thus increase their overall efficiency. At some point in their life cycle, vehicles have to be taken out of service. What happens to them at that point will affect their lifecycle emissions.

The first case dealt with the functions and sustainability of the aftermarket and vehicle recycling. In the aftermarket sector, the focus was on repair and maintenance companies and inspection activities. In the aftermarket, sustainability takes many forms. First, it is important that the business is doing well. This means a steady flow of customers and a healthy cost structure. Secondly, it is important that the company understands the different options for achieving sustainability. In addition to operational efficiency, companies can engage in recycling of parts, recycling of waste, or even influence the energy source or consumption of their own infrastructure.

The sustainability of vehicle recycling depends on the potential of the materials used in the vehicles, which is greatly influenced by decisions made at the design stage of the vehicle. Possible end-of-life vehicle uses include reuse (using the whole vehicle for a different task, e.g. workmachines), dismantling for parts (reusing parts still in good condition in other similar vehicles) and separation and reuse of raw materials, or a combination of the above.

Overall, the automotive aftermarket sector plays an important role in the framework of lifetime vehicle emissions and sustainable development. The development of this sector, especially in the face of the changes that powertrains are experiencing, is very important.

3.1.2 Pre-assignment

The Erasmus+ Programme offers various activities to facilitate student and staff mobility between participating HEIs from different countries. Among these activities is a blended intensive programme (BIP), which was implemented during the SusTra project for course creation.

As per the Erasmus+ Programme Guide (2021), intensive programmes must be organised in collaboration with at least three HEIs. A blended intensive programme should comprise a physical mobility component lasting between 5 and 30 days, coupled with a virtual mobility component that facilitates collaborative online learning exchanges and teamwork. The BIP must correspond to at least 3 ECTS and have a student participation of at least 15.

Partner HEIs were involved in planning of the first BIP during the months proceeding the actual programme in spring 2022. However, SeAMK as the hosting organisation inherently held the primary responsibility. Six students from each HEI were selected to participate in the blended intensive programme, totalling 24 students. BIP was designed to award 5 ECTS to students, totalling 120 ECTS.

In spring 2022 the first BIP of SusTra was organised starting with the virtual component in February. This virtual component was a preliminary task for the physical mobility, the purpose of which was for the students to become familiar with topics and structure regarding automotive aftersales sector in their country of study. At the same time the raw material for the course started to collect from four different countries. The preliminary task covered three areas of interest: structure of vehicle population, regulatory guidance and energy distribution network, and structure of the aftersales sector. This first virtual component equalled 2 ECTS.

3.1.3 Intensive week

The physical mobility of students and staff was carried out at SeAMK campus in 4 - 8 April 2022. As the name suggests, it was an intensive week with a full schedule from Monday morning to Friday afternoon. At the beginning of the week, students were introduced to the theme with staff and guest lectures. The results of the pre-assignments were also presented to give students an insight into differences between countries. Students and staff participating in the intensive week are posing for a photo in Figure 4.

Figure 4. Students and staff participating in intensive week 1.

During their pre-assignments, students operated in groups of six based on their country of study. However, for the duration of the week students would work in six different groups with a student member from each partner HEI. Each group had a different focus point in automotive aftersales. Together these groups would form an overall view of automotive aftersales sector with a few intentional topics left out, such as retrofitting and spare parts sales. The group topics were the following:

- Passenger car repair shop processes
- Passenger car repair shop equipment
- Truck and work machine repair shops
- Body repair shops
- Vehicle inspection & EV charging
- Vehicle recycling and tire shops

All groups aimed to gather useful information on their topic to be later used as building blocks for the final course. Working life cooperation was realised with company visits and expert interviews – each group visited at least one company during the week. Many groups also visited SeAMK Automotive technology laboratory to, for example, learn about and document how to use automotive equipment. Guided by staff, the students prepared questions for the companies that would bring relevant information to the topic. In addition to interviews, the students also collected other types of information, such as photos and videos. Company and laboratory visits were carried out during Tuesday and Wednesday.

On Thursday, students were introduced to learning management system Moodle and basics of different ways of learning. The rest of the day and Friday morning were dedicated to organising the material and making suggestions for learning activities and other preparations for the final course. At the end of the week, each group presented the key findings and their proposals for the course. More detailed schedule is described in Figure 5.

	Monday 4.4	Tuesday 5.4	Wednesday 6.4	Thursday 7.4	Friday 8.4
Topic	**IP week start, preparation material for groups Go through prework materials**	**Company visit preparation Company visits Collect material from companies**	**Company visits Collect material from companies**	**Edit materials**	**Presentations during Friday End seminar Feedback**
Morning (8-11.30)	Auditorium -Start and introduction of IP-week Jukka, Heikki R. -SeAMK Info → Pasi -University presentations → Teachers - Short summary of current status of aftersales market → Pasi	Auditorium -Lecture: Situation of automotive aftersales in Finland → Kalaja 9:30 -Instructions and preparation for company visits / lab. Work G1 & G3 – Auditorium (JA) G2 & G4 – H206 (HY) G5 & G6 – A310.7 (HJ)	Auditorium -Lessons learned -Laboratory data analysis -Company data analysis G1 & G3 – H206 (JA) G2 & G4 – F7.Taivas (HY) G5 & G6 – F308 (HJ)	-Laboratory data analysis -Company data analysis G1 & G3 – F311 (HY) G2 & G4 – F308 (JA) G5 & G6 – H206 (HJ) 11:00 Auditorium -Lessons learned	-Small group work -Finishing the material and preparation for results seminar G1 & G3 – F313 (HY) G2 & G4 – F308 (JA) G5 & G6 – H206 (HJ)
			Lunch (11.30-12.15)		
Afternoon (12.15-16)	-Preliminary task presentations -Generation of an overall picture of aftersales sector → Heikki -Theme introductions → Heikki, Hannu, Jarno -Instructions and preparation for company visits / lab. Work →	Gather at laboratory 12:15 -Laboratory works (HY / RK / HJ) - G2, G4, G6, G5 -Company visits (JM / JA / PJ) - G1, G3	Gather at laboratory 12:15 -Laboratory works (RK / MN) - G1, G3 -Company visits (JM / HJ / JA / HY / JY) - G2, G4, G6, G5 (Prius)	Auditorium -Designing study material and learning activities (JA) -Moodle course structure introduction 14:00 -Forming online course basic structure and learning activities G1 & G3 – F311 (HY) G2 & G4 – F308 (JA) G5 & G6 – H206 (HJ)	Auditorium -Results seminar 15:00 -Feedback -End of IP-week
Evening	-Preliminary task poster session, student and teachers get together -Forming the student workgroups (klo 17 – 19, H124)		-Evening activities	-Small group work G1 & G3 – F311 (HY) G2 & G4 – F308 (JA) G5 & G6 – H206 (HJ)	

Figure 5. Intensive week program.

3.1.4 Post-assignment

After the physical mobility and a great amount of newly gained knowledge, students travelled back to their countries of study. They formed again groups of six students, who now each had a different point of view on automotive aftersales. As a post-assignment, students in each country searched for and arranged a meeting with a medium-sized car service company to evaluate their processes from a sustainability perspective. Group members, each with their own focus areas, conducted investigations into various aspects, such as the company's business model, work processes, workshop layout and equipment, waste management practices, and potential collaborations with vehicle inspection services. Company visit also served the purpose of field testing the previously acquired information in the application domain, i.e. an aftersales company.

The aim of the post-assignment exercise was to enable students who had studied different topics in the post-market sector to share the knowledge they had acquired during the IP week with other students from the same country. In this way, we can talk about collective learning, the purpose being to share knowledge as effectively as possible.

3.1.5 Course

During the entire blended intensive programme, students gathered a substantial amount of information from various aspects of the automotive aftermarket sector. The pre-assignment, implemented as virtual mobility, provided an overview of the vehicle fleet in four different countries, as well as the size and structure of the automotive aftermarket sector. Despite the objective, the results were not entirely comparable due to variations e.g., in the classification of vehicle types, in databases in different countries. Furthermore, original data in statistics were collected at different time points, which impacted, for instance, the comparison of fuel prices. Certain difficulties arose from the fact that some of the information sources were subject to fees. Additionally, variations were observed in the results concerning the extent of effort invested in data retrieval on a country-specific basis. Eventually, a significant portion of the information was reacquired when designing the actual course curriculum to ensure comparability among the datasets.

Throughout the intensive week, students worked diligently, gathering valuable insights about the automotive aftermarket sector by engaging with company staff and conducting research within the companies themselves. Students worked in groups, each consisting of one student from every participating country. This approach played a crucial role in achieving uniformity in the outcomes across the groups. Each company had been selected in advance with the aim of providing a comprehensive overview of a specific aspect of the aftermarket sector. However, individual companies naturally offer a somewhat limited perspective, and not all questions could be addressed by every company.

After the conclusion of the comprehensive blended intensive program, it was time for the collected raw material to be assessed. The automotive aftersales sector, known for its size, had yielded a substantial amount of information gathered by the students. Upon more precise examination, it became evident that not all of the information could be effectively utilized as foundational elements for the course. This, to some extent, was due to the lack of sufficiently precise prior instructions and guidance provided to the students. Nonetheless, it was discerned that the originally budgeted staff resources were insufficient to render the course ready.

The course pilot was executed as a partially virtual course at SeAMK in the fall 2022. Student feedback was collected to improve both course content and technical functionality of Moodle course structure. Based on the pilot feedback, some content and functional improvements were made. The course was structured around five topics: Overview of vehicle aftersales, regulatory guidance, workshop processes, workshop equipment and infrastructure and ELV recycling as shown in Figure 6. These themes were in turn divided into their own sub-themes, which contain their own activities.

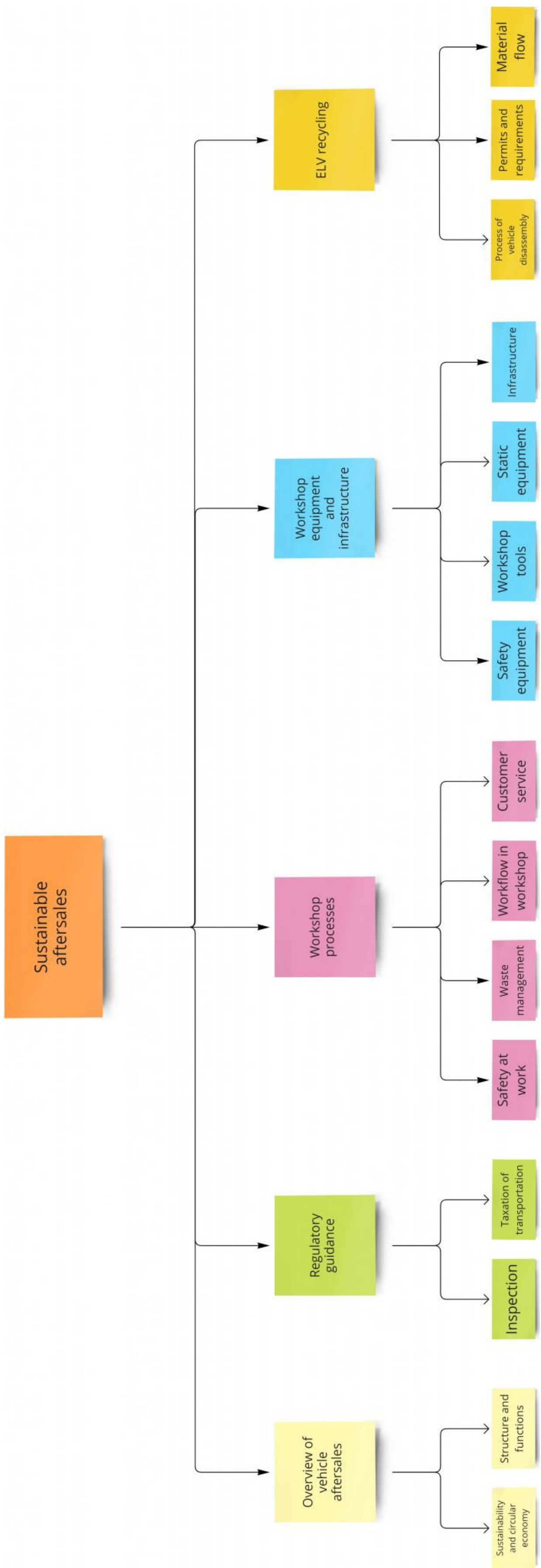


Figure 6. Structure of Sustainable aftersales course.

3.1.6 Learnings

The lesson of the first intensive week was that students should have a clearer understanding of the task at hand and its purpose right from the start. In other words, they should have an idea of what their work will be used for, so that they can formulate it appropriately. This may seem obvious, but the level of detail the students ultimately needed came as a bit of a surprise. The role of the pre-task in the work package should be carefully considered. The pre-task in the first work package was reasonably successful. The students gained a good understanding of the aftermarket sector and the vehicle fleet in their own country and the legislation governing vehicles. How well this task served the purpose of creating the course is debatable.

The objectives of the intensive week should also be more clearly defined. The aim of the first intensive week was to gather as much material as possible from the aftermarket sector, which could then be used to create learning modules for the e-learning course. In reality, the students made a huge effort to collect a variety of materials from the laboratory environment, companies and literature. Only a very small part of these materials could be used directly for the course. Visual materials such as 360 images and environments were the most useful. Some reports could also be partially used as such.

The role of the post-assignment should be carefully considered. However, the first iteration perhaps thought too much about student learning during this work package, when the focus could have been more deeply turned to what kind of material was needed for the course. This means that the pre-planning of the course should be much more comprehensive before the actual student work begins. Post-assignments can play many different roles, as can be seen in future work packages.

3.2 CASE 2

This chapter presents a project case implemented at Škoda Auto University in cooperation with OTH Regensburg. Škoda Auto University was a leader and a host of this work package and the OTH Regensburg provided the assistance and took responsibility for the part of work package.

3.2.1 Introduction to the topic

As the global emphasis on reducing emissions and adopting sustainable practices intensifies, the automotive industry faces the critical challenge of integrating sustainability into vehicle design and supply chain management. This course on Sustainable Vehicle Design and Supply Chain Management is designed to address this challenge by providing a comprehensive exploration of sustainable practices throughout the vehicle's lifecycle.

The course begins by examining innovative materials and technologies that contribute to sustainable vehicle design. It covers the selection and application of advanced materials and technologies that enhance both the environmental performance and efficiency of vehicles. The focus then shifts to sustainable product quality, where students will learn how to integrate sustainability considerations into quality planning and control processes, using methods and tools that support continuous improvement.

A key component of the course is the exploration of systems thinking in automotive supply chain management. This section emphasizes the importance of a holistic approach and the role of stakeholder mindsets in driving sustainable innovations. By understanding the interplay between systems thinking and supply chain management, students will gain insights into how a purposeful mindset can accelerate sustainability-driven advancements.

The course also delves into green logistics and sustainable manufacturing practices. It covers the principles of environmentally responsible logistics and explores best practices in sustainable manufacturing, highlighting how these practices contribute to overall sustainability goals. Sustainability reporting and procurement practices are also integral parts of the curriculum, offering students a complete view of how to communicate and implement sustainable practices effectively within the industry.

Through a combination of theoretical lessons, practical activities, and real-world examples, this course aims to equip students with the knowledge and skills necessary to drive sustainability in vehicle design and supply chain management. By the end of the course, students will be prepared to contribute to the development and implementation of innovative, sustainable practices that balance the need for mobility with environmental stewardship. Figure 7 illustrates the different stages of case study 2.

Figure 7. Phases/stages of case study 2.

3.2.2 Pre-assignment

The structure of the pre-assignment was based on a proven procedure that had previously been implemented in Project Case Study 1.

The students were once more given approximately one month to complete the assignments in the form of a collaborative BIP. As with the initial project case study, students were required to prepare a final report in the form of an MS Word document and a PowerPoint presentation, which was to be used to present the content and outcomes of the final report. The presentations were scheduled to take place on the first day of IP Week. In addition students were required to prepare a poster that would serve as the foundation for the discussion within the poster section, scheduled to take place on the first day.

Given the extensive scope of the prepared course, a distinct methodology was adopted for the team-building activities during the pre-assignment. In contrast to Project Case Study 1, where students were divided into four national teams and collaborated locally in each participating country to prepare the pre-assignments. For Project Case Study 2, the students were divided into six international teams, each comprising four members and including one representative from each country. The teams were constituted in accordance with the six principal thematic blocks of the forthcoming course, and were assigned distinctive tasks that were closely aligned with the anticipated content of the planned thematic module. This new approach to student team formation facilitated more comprehensive coverage of each topic, enhanced networking and team-building opportunities, more effective collaboration, and greater operational efficacy across all teams. The students were divided into six topic teams based on their predefined preferences using matching methods from the field of operations research. This approach enabled the achievement of maximum collective benefit and allowed the students to focus on the topics that were of greatest interest to them. The themes of each student group were as follows:

Sustainable vehicle design and development

- Group 1: Sustainable vehicle design
- Group 2: Sustainable product quality

Sustainable automotive supply chain management

- Group 3: Systems thinking in automotive SDCM
- Group 4: Green Logistics and Manufacturing

Sustainability performance management in automotive supply chains

- Group 5: Sustainable reporting
- Group 6: Sustainable procurement

Following the formation of the teams, an online kick-off meeting was held in MS Teams, during which the coordinator for ŠAU introduced the structure, format and expected outcomes of the pre-assignment to the students. During the meeting, the students were presented with the mandatory templates for the preparation of all three documents. This was done in order to ensure a consistent visual style and formality, which would facilitate the subsequent processing of the student output by the tutors. The template for the poster is presented in Figure 8 and an example of one of the student-made posters is presented in Figure 9 for reference.

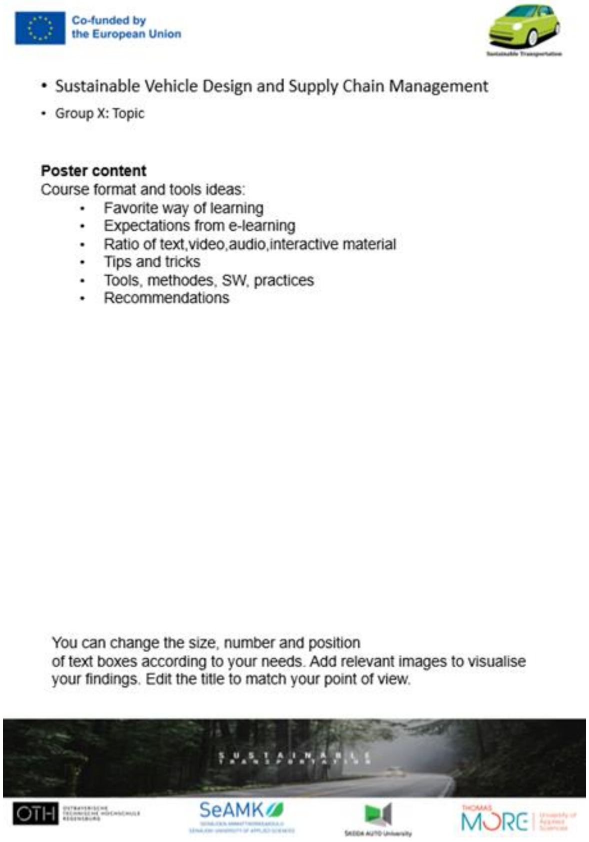


Figure 8. Poster template.

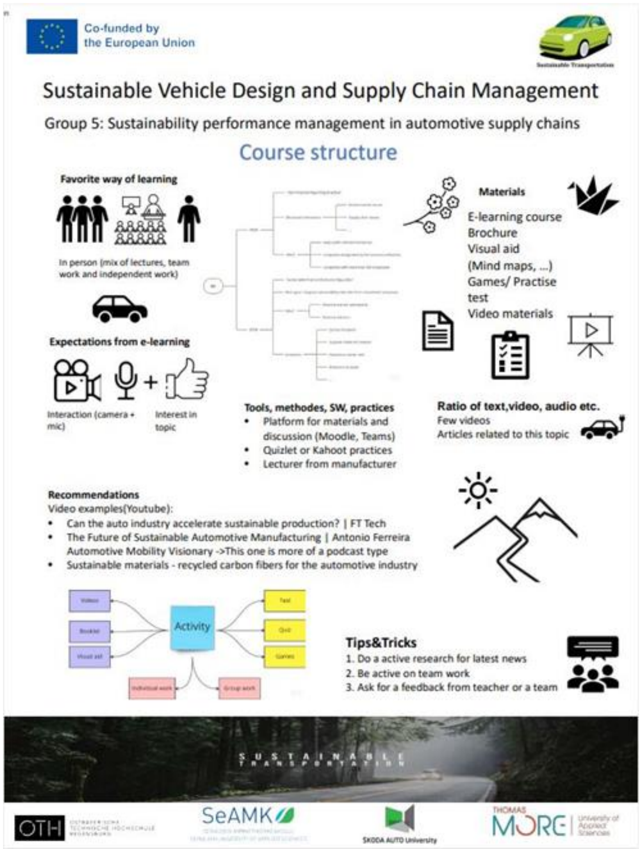


Figure 9. An example of a student-made poster.

Following the kick-off meeting, sub-channels were established within the primary MS Teams group for students to organise sub-meetings and share the preliminary outcomes of their work. At the same time all teams were linked to the topic supervisors, who offered assistance and consultation during the pre-assignment phase. This individualised approach circumvented any potential for non-deliberation and inconsistency regarding the assignment and its anticipated outcomes. In summary, it proved challenging to accurately delineate the pre-assignment's objectives and outcomes, given the presence of two partially conflicting objectives. The initial objective of the pre-assignment was to equip participating students with a comprehensive understanding of the subject matter, thereby ensuring that they would arrive at IP Week with the requisite background knowledge to effectively address the specific challenges. This was necessary due to the disparate backgrounds and fields of study of the participants. The second objective, which was pivotal to the project, was to develop pre-assignment materials that could be directly transferred and utilised for the construction of the final course to be studied by other students in the future. In general, this constituted a significant challenge in the overall management of the project. It was necessary to establish a balance between the experience and benefit for participating students and the benefit and value for the course being created and for future students.

3.2.3 Intensive week

Škoda Auto University hosted the 2nd IP week of Erasmus+ Sustainable Transportation project from March 27th to March 31st, 2023. ŠAU hosted representatives from the Finnish Seinäjoki University of Applied Sciences, the German Ostbayerische Technische Hochschule Regensburg and the Belgian Thomas More University of Mechelen-Antwerp.

The intensive week began with a tour of the Na Karmeli Educational Centre, the campus of the Škoda Auto University in Mladá Boleslav. During the tour, the guests were able to visit both parts of the building, modern and historical. The week-long meeting was held in the modern part, namely in the Innocube area. The meeting started with a presentation of the universities, study programmes and opportunities, and an introduction of the countries involved in the project. Students and staff participating in the intensive week are posing for a photo in Figure 10.

Figure 10. Students and staff participating in intensive week 2.

The morning programme continued with an invited lecture on Introduction to Sustainability, held by Libor Boček from Škoda Auto a.s., who is a leading person in sustainable strategy management at Škoda Auto a.s.

After the lecture, there were presentations from project lecturers and coordinators highlighting and reminding the main project goals, overall framework and expected IP week results. This was an important addition to the programme in comparison to the IP week 1, where we have find out quite late into the week, that the goal of the project and the IP week itself was still bit unclear to some students, which had ultimately shown in their approach to the outputs. After the initial round of lectures it was students turn to present the results of the pre-assignment and afterwards took place the poster section. A further notable alteration to the organizational structure was the introduction of a revised concept for the poster assignments that formed part of the pre-assignment phase. In contrast to the approach taken in Case Study 1, where the posters were used to summarize the outcomes of the entire pre-assignment phase, the aim was to present ideas and visions about learning styles, ideal e-learning material formats and innovative approaches to e-learning. This change was implemented because, following the initial student presentations of the pre-assignment outcomes, including them in the posters proved to be both duplicative and ineffective. The first day of the IP week ended with a social evening where traditional delicacies from German, Belgian, Finnish and Czech were tasted.

The second day focused on invited lectures given by experts from Škoda Auto a.s. Jiří Machuta spoke about the modern industrial production of components in the Czech Republic. Helena Kolajtová presented the topic of green logistics, and Pavla Kozderková talked about sustainable purchasing. Morning section of lectures for plenary as we wanted to provide an general overview of all the subtopics to each participant. In the afternoon the students were divided to preassigned teams and each team had an individual programme related to their topics. The afternoon programme included a series of company visit to Škoda Auto a.s. production plant in Mladá Boleslav, where participants were able to visit an aluminium foundry, an electric motor production line, quality control laboratories, and an expedition centre. Two groups did not participate in company visits and instead held a rather traditional workshop in a classroom. This was given by the nature of their topic and assigned tasks.

The third day was dedicated to individual group work, which were specific for each group. For example Group 4: Green Logistics and Manufacturing in Automotive Industry spent the day in the Production and Logistics Laboratories of the Škoda Auto University in the newly built technological campus H-Park. There they had lectures about LEAN principles and green logistics, which were combined with interactive learning games. In the afternoon students have been tasked to prepare an instructional video for one of the games in order to provide this experience to future on-line students.

The fourth day continued with a plenary Škoda Auto a.s production plant visit during, which the participants visited a press shop, a welding shop, and the Škoda Auto MUSEUM depository. Afterwards, the programme continued with a presentation of Enyaq cars and the student project Afriq in the atrium of the headquarters of the Škoda Auto University Na

Karmeli. The afternoon program featured an invited lecture delivered by Jarno Arkko from Seinäjoki University of Applied Sciences. He spoke about the designing of study materials, and learning activities. Rest of the day was left for the individual group work sessions during, which students had time to finalize their tasks from previous days.

The fifth day was dedicated to the student presentations of the results of the IP week. Whole morning was scheduled for individual group work, where students worked independently on the fine tuning of their outputs and on the preparation of the final presentation. The supervisors were available for the consultations and feedback for each group. In the afternoon the final presentations took place. These presentations sparked intensive discussions of all participants. Together with the feedback from students on the organization, structure and content of the IP week the upcoming post-assignment was also discussed. Below on Figure 11 there is the IP week 2 detailed schedule for the reference.

	Monday 27.3.	Tuesday 28.3.	Wednesday 29.3.	Thursday 30.3.	Friday31.3.
Topic	**IP week start, preparation material for groups Go through pre-assignment materials**	**Invited guest lectures Company visits**	**Group work**	**Group work ŠKODA AUTO MUZEUM and PLANT VISIT Designing study material**	**Presentations End seminar Feedback**
Morning (8:30-11.30)	Innocube -Start and introduction of IP-week -ŠAVŠ Info / ŠAVŠ tour -University presentations → Teachers **10:00** Introduction into Sustainability-guest lecture ŠA - Libor Boček	Innocube **Invited guest lectures:** 1. **8:30** Modern industrial production of components in Czech Republic-Jiří Machuta 2. **9:30** Green logistics - Vojtěch Kosina 3. **10:30** Sustainable purchasing – Pavel Odstrčil	Group work **G1,G2:** H-Park-Laboratories (3D printing, Virtual reality) **G3,G4:** H-Park-Laboratories (NLK/beergame) **G5:** Small group work (room A-104) **G6:** Sustainability assessment - shadowing in ŠA / case study (room A-103)	**8:00** Gather at ŠAVŠ ŠKODA AUTO PLANT VISIT (all groups) **10:30** Introduction of cars (Eniaq, Afriq)-Atrium	Innocube/Group work -Group work -Finishing the material and preparation for results seminar
Lunch (11.30-12.15)					
Afternoon (12.15-16:00)	Innocube -Introduction of PROJECT GOALS -Overall project framework -Expected outputs of IP WEEK -Pre-assignment presentations Instructions and preparation for company visits / lab. Work -Individual groups topics introduction	Innocube/Group work **G1,G2:** Aluminium foundry H3, production of cylinder blocks. Quality testing laboratories **12:30 odjzed G3,G4:** Sustainable automotive supply chain management - company visit M1,M6,CKD **G5:** Small group work (room A-104) **G6:** Sustainability assessment - shadowing in ŠA (room A-103)	Group work **G1,G2:** H-Park-Laboratories **G3,G4:** H-Park-Laboratories **G5:** Interview with ŠA managers 12:15-13:15 (innocube) **G6:** Small group work (room A-104) -Independent group work	H-park - room H02 -Designing study material and learning activities-Moodle course structure introduction (all groups) **15:00** -Independent group work -Forming online course basic structure and learning activities **15:00 G5:** Feedback (innocube)	Innocube -Results seminar -Group work presentation **15:00** -Feedback -End of IP-week
Evening	Innocube -Pre-assignment poster session, -Social evening/international event		-Evening activities -Teachers diner	-Independent group work	

Figure 11. IP week 2 detailed schedule.

3.2.4 Post-assignment

A period of 14 days was allocated for the processing and evaluation of the outputs generated by the IP Week. Based on the results of the evaluation, a unified post-assignment structure was devised. The specific tasks were tailored to align with the particular requirements of each group and the objectives set forth by the supervisors. However, two principal tasks were agreed upon as common:

1. Repair/revise/complete the MS Word final report from the pre-assignment, primarily involving work with sources and alignment of all chapters according to the template.

2. Completion and expansion of the IP Week deliverables, primarily comprising a more thorough elaboration of the proposed e-learning tools, for example, the elaboration of the entire test or case study.

The students were given a period of three weeks for completion of the post-assignment. The students worked in their original teams, but did so remotely online via the MS Teams platform. During the post-assignment, supervisors were available to provide feedback and direct student efforts.

The objective of the post-assignment was to produce as much high-quality learning material as possible, which could then be directly incorporated into the Moodle course.

The required outcomes were twofold and corresponded to the two main tasks of the post-assignment. The first was to refine and improve the final report from the pre-assignment, which was in the form of an MS Word document. This output was to serve as the basis for the creation of the study supports, or so-called lessons, that form the core of the Moodle course. The second component of the post-assignment entailed the creation of an array of self-assessment tools, including ABC quizzes, makeup questions, and selections from the texts. The content of these tests was to be based on the information contained in the final reports. In addition to the preparation of the self-test questions, it was also necessary to introduce attractive forms of self-testing activities/tools. The results were used in the creation of the knowledge-check activities within the Moodle course, with content derived from the lessons and serving as a precursor to the final examination.

Example of the specific post assignment tasks (Group 4):

Modification and extension of pre-assignment report:

- Check the template for the document and correct all formatting accordingly (references, figures, titles, text, lists...)
- Unite the style of the document
- Add more references and in correct style
- Incorporate my comments in reviewed document (most of the commented shortcoming occurs multiple times in the document and I only commented them once or twice, but please check them in whole document)
- BONUS CHAPTER: Examples of good practices in green logistics and sustainable manufacturing
  - each of you have to find 1 local (city/region/country) and 1 global logistic or production company and describe some "green solutions" that they have implemented
  - short description of the company
  - description of the green solutions-status before and after, benefits, impacts..
  - scope is around 1 page per company
  - Please cooperate so you dont describe same companies and solutions

Improvement and finalization of IP week proposals:

- Design full test/quiz/task with +-20 questions
- Combine all of your ideas a/b/c true/false fillin connect...
- The test should serve as self testing benchmarking before the study of our module
- Unite it in one format, propably in Powerpoint but it is your choice
- Create similiar task for Pin game as you have created for the Pyramid game, same scope same style. Try to utilize the potential of the videos

Examples of the outputs of the post-assignment and their future processing into the final knowledge check activity in the model course are illustrated in Figures 12 and 13.

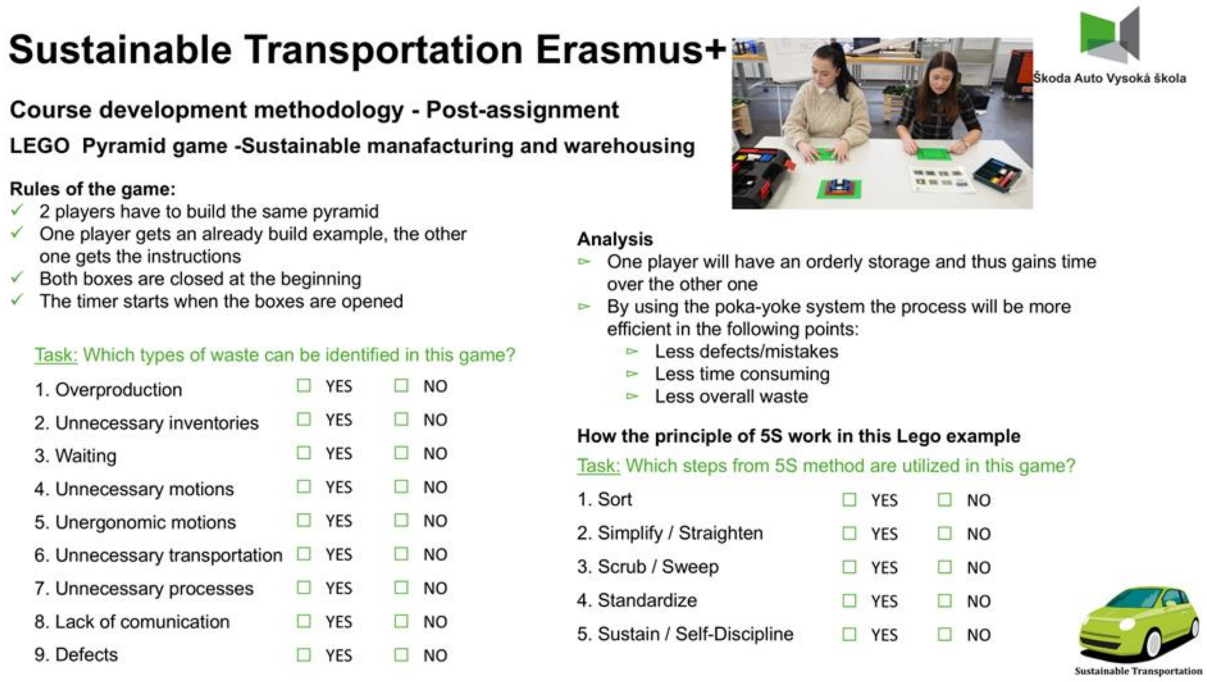


Figure 12. An example of a post-assignment output.

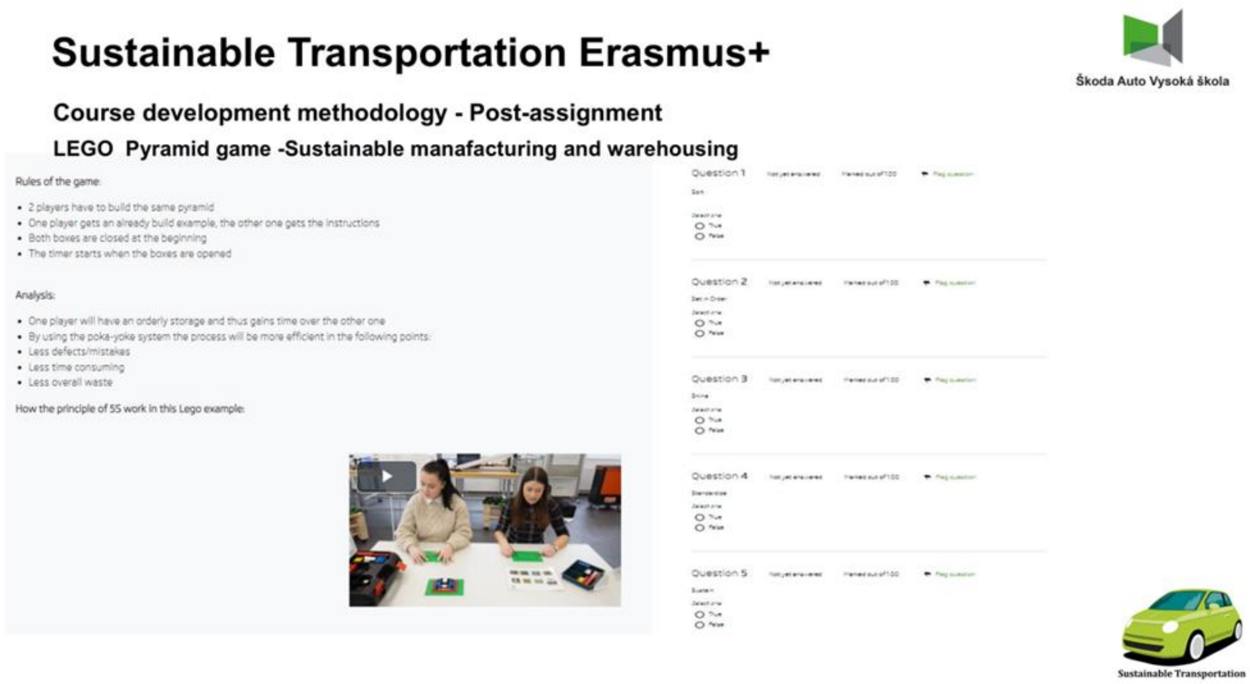


Figure 13. An example of a post-assignment output.

3.2.5 Course

This course provides knowledge and skills from the fields of Sustainable Vehicle Design, Sustainable Product Quality Planning, Systems Thinking in Automotive SDCM, Green Logistics and Manufacturing in Automotive Industry, Sustainability Reporting and Sustainable Procurement.

The design of the e-learning self-study course on the Moodle platform was informed by the findings of Project Case Study 1 and was developed in accordance with established best practices. The structure of the e-learning course was based on an agreed and tested format. The fundamental premise was to apportion the six subject areas among a total of eight lecturers/supervisors. In four cases, individual tutors were responsible for the topics, while in two instances, pairs of tutors were assigned to oversee the material. The course structure and division into six subject areas is illustrated in Figure 14.

A series of discussions and workshops preceded the preparation for the actual IP week and related activities. These took place during project LTT events and internal project meetings. The objective of these preparatory measures was to optimise the utilisation of the expertise and experience accrued from Project Case Study 1. The objective was to identify solutions to the issues and challenges that had been identified in the initial phase of the project. To gain insight from past shortcomings and devise a strategy that circumvents previous inefficiencies. It was of the utmost imprtance to define the structure and format of the final course with the greatest possible precision, in order to ensure that all sub-activities contributed systematically to the desired end product. One might argue that this approach was antithetical to the tenets of design thinking and the original intention to permit students to design a course based on innovative and original ideas. However, in light of the experience gained from project case study 1, it was determined that all student efforts would be more goal-oriented. Consequently, it proved to be a significant challenge to achieve a balance between clearly defined assignment tasks and fostering a creative and innovative approach among the students.

This contradiction was partially resolved by the disparate nature of the various topic blocks. An illustrative example is the distinction between the concept of Group 4 Green logistics and manufacturing and Group 6 Sustainable procurement. The area of green logistics and manufacturing had already been comprehensively addressed by the lecturers in the past, resulting in the availability of a substantial repository of general material. This enabled the utilisation of students to develop bespoke e-learning resources, including videos, self-tests and other materials. Conversely, the domain of sustainable procurement represents a relatively nascent concern, exhibiting a paucity of coverage in both traditional literature sources and conventional learning materials. This circumstance gives rise to a distinctive approach to student engagement, encompassing workshops, case study analysis, and the observation of select professionals from practice.

The stages of course development can thus be distinguished by a unified format for the concept of individual thematic blocks, allowing for a nuanced understanding of specific circumstances and the distinctive demands of diverse research areas.

The student outputs from the pre-assignment, IP Week and post-assignment were of significant value as the initial material for the preparation of the Moodle course. It is regrettable that the quality of the student outputs was highly inconsistent. Consequently, despite the post-assignment focus on improving and refining the existing outputs, it was largely not possible to utilise these materials. Moreover, the majority of the materials were unsuitable for use without substantial editing and proofreading by the lecturers. This was due to the extensive scope of the material covered, which was in contrast to the limited time available for the creation of the materials independently. The lecturers' evolving preconceptions about the form and content of the final course were also a contributing factor. A case in point is the comparison of the approaches of groups 4 and 6, which has already been mentioned. Group 4 created highly specific materials, which were then implemented almost verbatim in the final course. In contrast, the student work outputs from Group 6 did not meet the quality standards set by the lecturers. Additionally, some of the proposed approaches were ineffective, such as shadowing, which did not provide a sufficient sample given the limited hours available during the IP Week.

In conclusion, it must be acknowledged that despite the aforementioned shortcomings of the student outputs, their efforts were invaluable. While in many cases no concrete, usable materials were produced, the actual process of drafts, consultations, discussions, revisions, etc. resulted in a number of findings and awareness on the part of the lecturers regarding different learning types, student thinking and overall working with data and materials that contributed significantly to the quality of the final course.

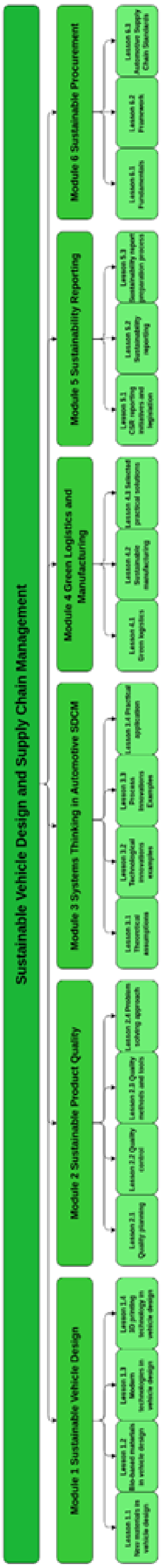
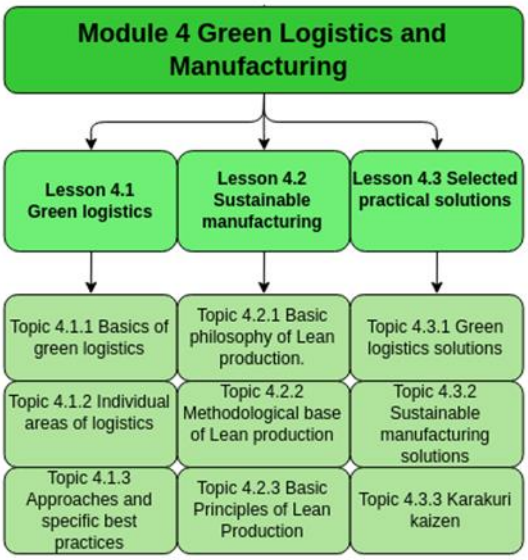
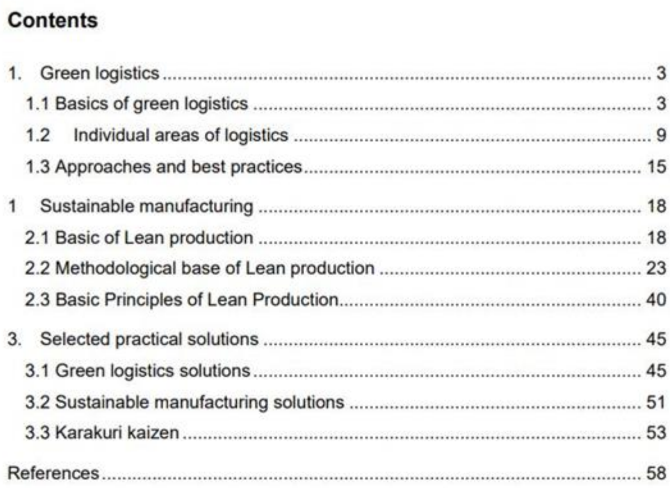


Figure 14. The course structure and division into six subject areas.

The course is designed for individual distance e-learning. The course is divided into six separate modules, which are further divided into lessons and topics (see diagram below). The modules are separate study blocks and can be studied in any order. All six modules have the same content structure. The first is always a PDF file called lessons. This file is the main study material for each module. Studying it is essential for completing the assignments and passing the final test. The structure of the PDF document follows the course structure diagram. This structure is illustrated in Figure 15.





Contents

Figure 15. Module structure of course 2.

Another part of each module is the supplementary materials, which are not mandatory study material. In this section, supplementary materials are uploaded to expand students' knowledge and better understand the lessons. Supplementary materials have different formats: video, PDF, PPT, links etc. Knowledge check activities are an important part of each module. These are a series of different mini-tests and exercises designed to check the level of knowledge and understanding of the lessons. Knowledge check activities are automatically assessed by the Moodle system and allow the student to benchmark their knowledge before the final test. The results of the knowledge check activities are not part of the final classification. The last part of each module is the assignment of a seminar work. The seminar work at the end of each module is part of the final qualification and it is assessed by the module supervisors. The course ends with a final e-test, which is the only part of the course that takes place onsite at the university. Students must come personally to the school like they do at every other course and take the final exam e-test in the computer classroom under the supervision of one of the lecturers. This way the final exam test gains legitimacy and it is ensured that students cannot cheat, which would be very complicated to achieve if they would take the test from their own computers at home. Also this situation provides the opportunity for the gathering of student feedback and also for consultation of some possible misunderstandings regarding the seminary works etc.

Course classification is based on that the graded credit will be rewarded for 6 seminar works and the final e-learning test:

1. Seminar works each for 10 points, a total of 60 points

2. Final e-learning test for 40 points, a minimum of 20 points is required to pass the test

3. There is no minimum for the individual seminar works, but there is an ultimate minimum of 60 points out of 100 to successfully pass the course.

After completing the course, the student will:

- Apply basic principles and tools of sustainable procurement in the automotive industry
- Explain new approaches in vehicle designing and quality management with regard to sustainability
- Explain the concept of sustainable mobility and the sustainable automotive industry
- Identify the difference between invention and innovation in SSCM and understand the basic philosophy of green logistics
- Understand the role of sustainability reporting as an instrument to measure and manage the sustainability performance

The total number of graduates of the e-learning course Sustainable Vehicle Design and Supply Chain Management is as follows:

- IP week = 24
- Winter semester 23/24 = 33
- Summer semester 23/24 = 42
- Summer School2024 = 21
- Winter semester 24/25 = 28 enrolled

The expected total at the end of Winter semester 24/25 is approximately 150.

In addition to the aforementioned official graduates, the Moodle module was also employed as a supplementary teaching tool in the context of other subjects. On occasion, the Moodle course has been made available to students in other related courses as an additional source of course materials or as a substitute for rescheduled or cancelled classes.

During the two semesters in which the course was officially offered as an elective for students at ŠAU, it was also made available to international students from partner universities participating in the project. A number of students from Belgium and Finland availed themselves of this opportunity.

A significant challenge in the implementation of the course was the design of a systematic solution for the administration and recognition of these so-called mini digital mobilities. In accordance with the recommendations of the Study and Foreign Affairs Department, it was proposed that a procedure analogous to that employed for the recognition of credits for participation in the IP Week be followed. Consequently, international students were managed in accordance with the Erasmus programme. They were provided with access ID details to the AIS of ŠAU. The students then completed the entire course by self-study, with the exception of the seminar papers and the final examination. The seminar papers were to be submitted by the students in accordance with the pre-set deadlines, as they were to be corrected by the individual lecturers personally. Due to the size of the team of lecturers, the number of students, and the differing academic schedules in the various countries, a uniform deadline was set for the seminar papers.

The final examination is the sole component of the course that is traditionally conducted in person at the university. In accordance with the established regulations, ŠAU students are required to attend the university on the scheduled examination date and take the e-test on the provided school computers under the supervision of a lecturer. This same requirement applies to international students. The procedure entailed scheduling examination dates in consultation with international students and the relevant project coordinator from their country. On the stipulated dates, the student physically presented themselves at their university, where they took the e-test in the AIS ŠAU environment under the supervision of their lecturer. The e-test was prepared and activated by the SA coordinator. Once all the sub-sections of the course had been completed, the students were issued with the final examination report, which detailed the pre-defined grading conditions. Subsequently, Transcript of Records were issued to the students so that the credits earned at ŠAU could be recognised at their home university.

3.3 CASE 3

This chapter describes the third case of the project implemented at Thomas More University of Applied Sciences. Being the third and last case we’ve implemented the lessons learned from previous cases as much as possible.

3.3.1 Introduction to the topic

As the world looks to eliminate greenhouse gas emissions to create a sustainable future, the automotive industry is implementing alternative fuels to reduce transportation emissions.

It is widely accepted that electric vehicles offer the necessary efficiency improvements to reduce impact of transportation needs. The needed energy can be stored in batteries and used directly to propel the vehicle. Alternatively, hydrogen can be converted to electricity onboard to use the same electric drivetrain.

Together with this change in drivetrain modern vehicles adopt new wireless technologies to become more connected. Advances in sensor technology and image recognition allow for extensive driver aids and open the possibilities create have autonomous driving vehicles in the future.

Both topics have profound impact on the way transportation is used today and the possible improvements in sustainability for the future. This third case study in the project focusses on these topics. There is a great difference in use between personal passenger cars and commercial heavy-duty vehicles. This makes the implementation quite different, so a variation in focus in needed to understand the challenges of the ongoing transformation towards sustainable transportation. As an example, adoption of electric passenger vehicles can be driven by a personal willingness to minimise impact. Whereas commercial vehicles will need a positive business case for a widespread rollout. However, in both cases regulations play a vital role in the adoption.

This is why we designed the course in three divisions.

Energy production: If we want to reduce the global greenhouse gas emissions from transportation, we need to take into account the whole energy chain. The so-called well-wheel method looks at emissions from extraction of crude oil to moving the wheels of a vehicle. Same goes for vehicles with electric drivetrains. The origin of the energy delivered to the vehicle has a great impact on the total emissions the vehicle produces per driven kilometre. In order to reduce the impact of transportation the energy supplied to vehicles needs to come from sustainable sources. Ideally sources with a minimal impact on the environment such as solar, wind, or hydro energy. Preferably the energy is always available, so a nuclear base-load or gas fired peaker plants could be necessary. Each type of generation has a different cost which of course contributes to the TCO of the vehicles.
Using hydrogen as an energy carrier can offer more flexibility. Hydrogen is less expensive to store in large quantities and can be transported over longer distances. Since there is an extra conversion, this means lower efficiency and will have an effect on the TCO as well.

Energy use: In theory there is an abundance of sustainable energy available on earth. However we are currently not able to harvest, store and transport the needed energy for our current living standards. In order to be as sustainable as possible we need to use energy as efficiently as possible. Using less energy overall, using energy at the ideal moment and place has a positive effect on the carbon footprint. This topic of the course investigates the drivetrain part from the so called “well to wheel efficiency” of electric and hydrogen vehicles. Furthermore different drivetrains offer different benefits in production, use and recycling phase of the lifecycle of the vehicle. The students learn about the pros and cons of both sustainable drivetrains through different use cases.

Intelligent driving: Mobility in the future may vary greatly from the applications today. We already see a widespread adoption of driving aids and connected cars through which they can get over the air updates. This allows for continuous software development. For personal vehicles there are demonstrators with carsharing services which benefit from this connectivity. However, it seems general adoption is halted by practical hurdles like for example parking. An increased quality and advances in software promises full autonomous driving which is seen as the holy grail for widespread adoption of ride sharing.

Such autonomous driving technology will also impact road freight on a large scale. Right now, drivers are about 1/3rd of the total cost in road freight. Furthermore 24/7 operation could result in lower speeds which again can have a positive effect on energy consumption of the truck.

3.3.2 Pre-assignment

Again 6 students per HEI were selected to take part in a BIP, consisting of an online pre-assignment to get familiar with the topics and a physical part in Belgium to gain in depth insight and generate content for the later online course.

Each HEI selected 6 students for this BIP. Students selected make multidisciplinary group because their difference in education, but also due of previous experience in the past IP weeks.

One student of each HEI was again placed in a group to make up 6 groups of 4 students. Each group had a specific focus within the three main topics of this course as follows:

- Sustainable energy production
  Group 1: Sustainable production of electricity
  Group 2: Sustainable production of hydrogen

- Sustainable energy **use in transportation**
  Group 3: Sustainable use of electricity
  Group 4: Sustainable use of hydrogen

- Intelligent driving
  Group 5: Intelligent driving for personal vehicles
  Group 6: Intelligent driving for heavy duty vehicles

After the teams were formed, an online kick-off meeting was conducted via MS Teams. During this session, the ThM coordinator introduced the students to the structure, format, and expected outcomes of the pre-assignment. Each group was assigned a responsible lector as a mentor throughout the course. During an online meeting in the sub-groups the lector explained the outline of the specific pre-assignments.

During the pre-assignments we focussed on the past and present situation for each topic. This provides necessary background for the IP-week itself we would focus on the future of these topics.

The pre-assignments consisted of both technical and more business focussed questions so each student could contribute to their strength. Furthermore, the goal was that students shared their specific knowledge with other group members. These learning experiences were vital to the creation of the later course, it highlighted what information was necessary to include in the course.

The previous IP weeks learned that the outcome of this pre-assignment should be simple to focus on the learning experience of the students and avoid overloading them with work which results in a less coherent group. Students tend to divide work and then execute it individually rather than work together online. Therefore, we also opted to use a ‘poster’ as an outcome, it forces the students to focus and select which information is crucial to share about the topic. Figure 16 shows example result of the sustainable energy source group pre-assignment.

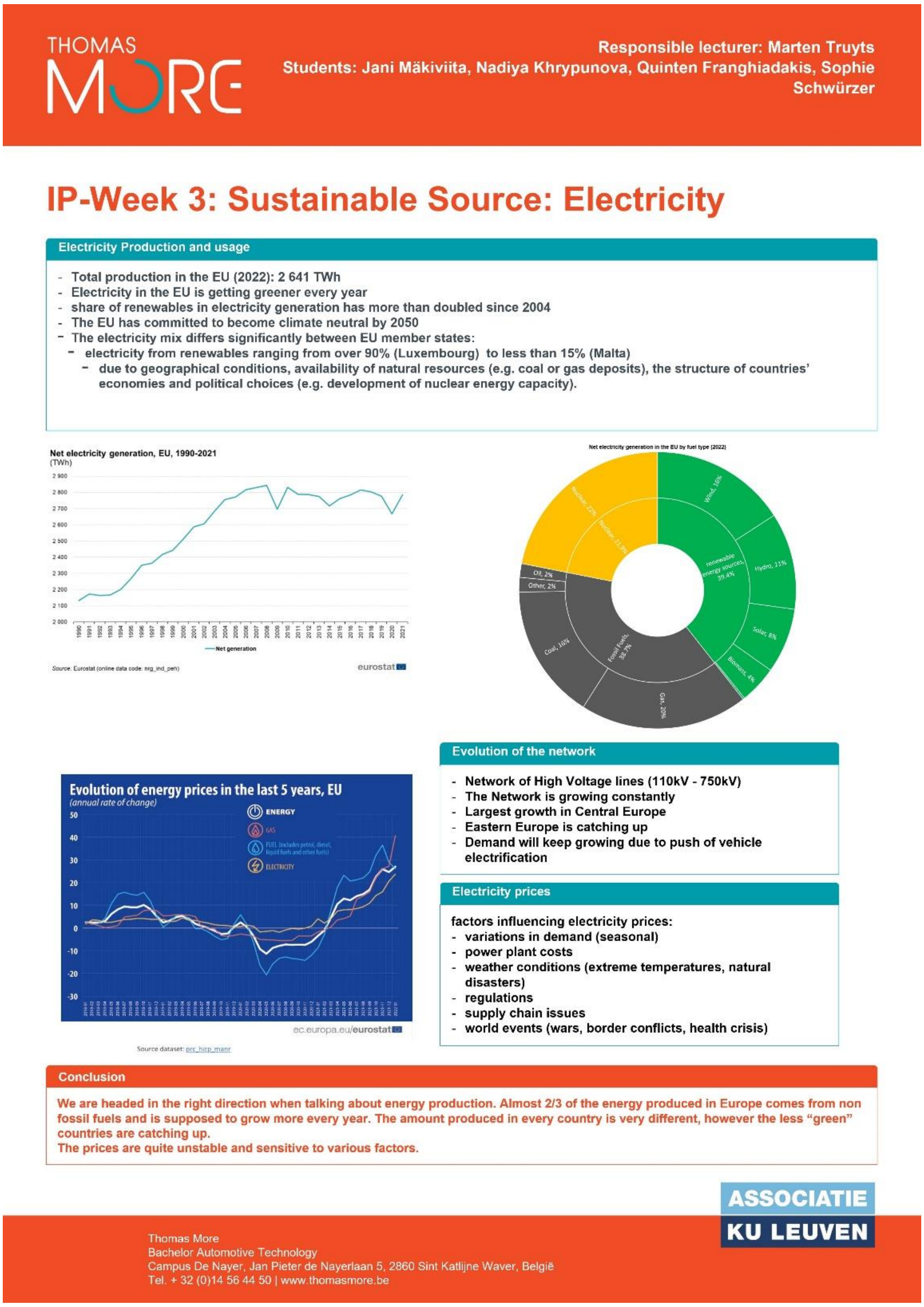


Figure 16. An example result of the sustainable energy source group pre-assignment.

3.3.3 Intensive week

Being the third and last ip week we had the benefit of using the experiences of previous IP weeks to our advantage. Although students have met online it is crucial to break the ice in real life. In order to get the envisioned results students need to be informed about the overall project and goals.

After a welcome by the campus manager we showed the students our campus, their home for the next few days and a casual occasion for students to meet and talk to each other. Next we presented the European mobility goals for the future to show the bigger picture. After lunch we continued by presenting the Sustra project and the outcome of the previous ip weeks to show our expectations towards a result. The final lecture of the day was focused on ‘sustainability’ in itself. It provided background for why we need change.
To conclude the first day students presented their posters (the result of the pre-assignment) to each other. We had learned from previous ip weeks this is the perfect ice breaker for a successful collaboration between the students in the next days.

On the second day we took time to give feedback on the results of the pre-assignment. We clarified and highlighted what should be included in the final course based on the students learning experience. We combined groups to give lectures about the outlook for electric networks, charging infrastructure, hydrogen ambitions and possibilities of autonomous driving. Valid feedback from students in previous IP weeks was that although the goal was to create non-written content they lack specific skills to do this as they are not media students. Therefore in the afternoon we took one student from each group to showcase possible tools and invited them to experiment with them. There were workshops for:

- Canvas, the online learning environment used by TM
- 3D imaging, apps for smartphones to scan and create 3d models
- Prezi, a dynamic presentation tool
- Thinglink, software used for picture, video and 360 images annotation

The rest of the afternoon students were given time to experiment with these tools to use on their pre-assignment and create first content.

As a university of applied sciences, we strongly believe learning is more effective when lectures are assisted by hands-on experience. We put this into practice by having hands-on practice labs for the participants. For the electricity group we had labs were students could measure real energy consumption of an electric vehicle on a rolling road and learn about the efficiency. Furthermore there was a lab using our micro grid on site which consists of PV panels for production, batteries for storage and an EV charging station. The Hydrogen students could test drive and examine a hydrogen fuel cell car and learn about electrolyses and fuel cells through micro set-ups. The Intelligent driving students worked with studens from our

Formula Student team to learn about the self driving basics with miniature programmable vehicles.
These labs were also the perfect occasion for students to gather media materials (pictures, 360 pictures, 3d models, movie clips) to be use later on.
In the afternoon there was time for students to discover the nearby city of Antwerp.

On Thursday we combined 2 groups to have relevant company visits. The electricity groups visited phoenix contact to learn about energy management for buildings. The Hydrogen group visited Colruty HQ to see hydrogen generation and use onsite in a warehouse. The intelligent driving group visited Tesla to experience their version of “self-driving”. Again these visits provided ideal possibilities for students to gather media. Another takeaway from previous IP weeks was to provide ample time for students to create the requested content. Thus the Thursday afternoon and Friday morning students could work in group to create content.

We requested a minimum amount of ‘virtual environments’. Being Prezi’s or Thinglinks but equally important we asked students to create tests for their content. Pushing them to think about the learning outcomes of their materials and implementing the focus in the materials themself.

Friday afternoon students presented their work to the other participants and we had an official closing moment. An overall schedule of the week is illustrated in Figure 17.

Overall Planning

	Monday	Tuesday	Wednesday	Thursday	Friday
Location	*Campus Denayer* *Sint-Katelijne-Waver*	*Campus Kruidtuin* *Mechelen*	*Campus Denayer* *Sint-Katelijne-Waver*	*Campus Denayer* *Sint-Katelijne-Waver*	*Campus Kruidtuin* *Mechelen*
AM	**9h** – Class Room **F110** Welcome at Denayer Lectures Campus Tour	**9h –** Class Room **T113** Feedback pre-assignment **T113 / K107 / K207** Sub group lectures	**9h** – **Main garage ATC** Labs	**TBD per group** Company visits per group	**9h –** Class Room **T203** Group work
PM	**13h30** – Class Room **F110** Lectures	**13h30** – Class Room **T113** Media Workshops Implementation of workshops + group work planning **17h -** End	**14h Antwerp Suikerrui** City game **17h Antwerp Brewery** Brewery visit **xxh -** End	**13h** – Class Room **F028 / L110 / N105 /N011** Group work **17h -** End	**13h –** Class Room **T203** Group presentations Final word **15h -** End
Evening	**18h** – **Main garage ATC** Fries, drinks and poster session. Get to know each other 22h – End				

Figure 17. Schedule for IP week 3.

Students and staff participating in the intensive week are posing for a photo in Figure 18.

Figure 18. The participants of the Thomas More IP week in Belgium.

Student feedback on IP Week 3

Bc. Alexandr Janko, master student at ŠAVŠ:

"As part of the Sustainable Vehicle Design and Supply Chain Management project, I had the opportunity to go to Belgium for an intensive week. Four universities are working on the project and six students from each university participated. At the beginning of the week, we presented what we had found out about our assignments given a month before the trip. During the week, we were able to hear countless lectures on sustainable sources that are the future in powering cars. I worked in an international group that addressed the advantages, disadvantages, and future of cars powered by electricity generated by hydrogen fuel cells. Our topic was also relevant to a tour of the warehouse of the Colruyt Group, which is already using the hydrogen it actually produces to power pallet trucks and lorries. We even had the opportunity to ride in a Hyundai ix35 powered by electricity generated from a hydrogen fuel cell. At the end of the week, we again presented all of our findings from the week and independent work. During the project I met a lot of great people, learned a lot of interesting facts about current and future mobility. I really enjoyed the whole project and I am happy that I was able to participate."

Pavla Vlčková, bachelor student at ŠAVŠ:

"During November, the 3rd phase of the international project Sustainable Transportation took place, this time in Belgium on the campus of Thomas More University. It was an honour for me to represent ŠAVŠ in the last part of the project and to try to create a basis for the study of future graduates of the courses that were created on the basis of this cooperation.

The project focuses on sustainability in the automotive industry and emphasizes the future that sustainable resources can bring us. In this phase of the project, topics such as the use of electricity or hydrogen propulsion instead of existing fuels were addressed. It also addressed the future of autonomous driving.

During the project week I learned how to work more effectively with interactive elements such as Canva or Thinglink, which we used to enhance the virtual environment in which the Moodle course will be studied.

As a participant in all three parts of the project, I have to say that working in an international team has helped me a lot and has moved me forward in many ways. I have developed my skills, gained new perspectives and friends. In addition, I understood the importance of teamwork in solving complex problems. This project has given me valuable experience that I will be able to use in future projects and in my professional life."

Anastasiia Shvets, a student of Bachelor's degree at ŠAVŠ:

"It was a great experience! During the Belgium IP week, besides the daily interesting lectures about sustainable transport of the future, we visited the Tesla showroom and took part in a lesson on programming driverless racing cars. During the week we also met a lot of great people from Belgium, Finland and Germany, with whom we worked together on projects. We are very grateful to our teacher Ing. Tomas Malcic, Ph.D. and the Belgian teachers who hosted this year's IP week. To give you an idea - they ordered a foodtrack for us at the welcome event and arranged a tasting of Belgian beers :)"

Nadiya Khrypunova, student of Bachelor's degree at ŠAVŠ:

"I was in Belgium for IP Week, where I was actively working on a sustainable transport project for the future. During that project I gained a huge amount of experience working in an international team, deepened my knowledge on the topic and participated in many workshops and visits, including PHOENIX CONTACT Belgium. There, many aspects of working with solar panels and charging stations were clearly demonstrated and explained to us. Here I met students from German, Belgian and Finnish universities. Thanks to this trip I was able to improve my English conversation and stop being afraid to express my thoughts in a language I am not 100% fluent in. This opportunity provided me with further motivation to improve myself in many areas and to study topics related to sustainable transport of the future in more depth. I would like to thank Ing. Tomas Malcic, Ph.D. for his valuable help and support, as well as the organizers and professors from Thomas More University in Belgium."

3.3.4 Post-assignment

During the post-assignment the focus was on improving the quality of the content created during the IP week. The post assignment was executed in three phases:

1. *Structure content:* Students were asks to make all created content and tests available in a structured way using our online learning platform Canvas.

2. *Feedback:* Participants completed a full module of another group. Students were well aware of the other topics during the IP week, they were presented twice, the pre-assignment on Monday and the final realisation on Friday. This allowed them to give valuable feedback, not limited to the form and details but also about the content it presented.

3. *Improve:* Each group went over the gathered feedback in an online meeting with their mentor. Specific goals where set to amend, improve or add material to tackle possible issues indicated in the feedback given by other participants.

3.3.5 Course

The goal of the completed course “*Sustainable energy for transportation and intelligent driving”* is to provide an understanding of a possible future regarding mobility. In order to achieve this the courses touches on two alternative energy sources for transportation and the influence of connected and autonomous driving.

The course itself is made up of 3 major subtopics: Electricity, Hydrogen and intelligent driving. These subtopics are illustrated in Figure 18.

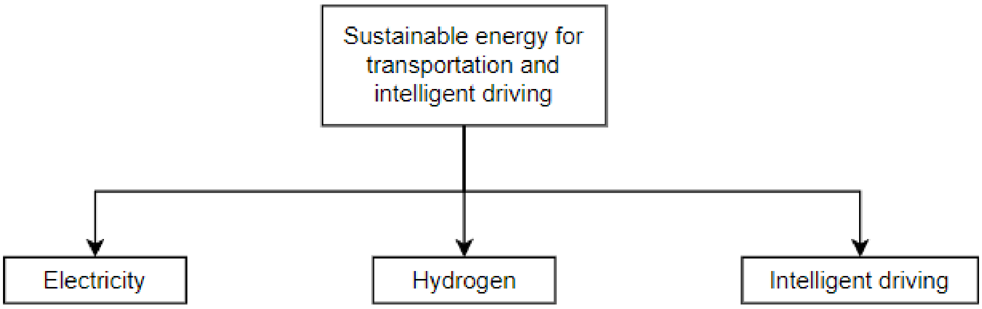


Figure 18. Course division into subtopics.

Although the first two modules have a focus on the technological part of the energy path from well to wheel there is a different focus. The electric module looks at the energy flow with an efficiency focus, the hydrogen module looks at the flow from a cost perspective. The third module is less technological and focuses more on present examples which should allow students to envision a future where these demonstrators are implemented in daily life.

The first module 'Electricity' teaches students about renewable energy production and the challenges of transporting and storing electric energy. Next students will discover how smart charging strategies can be part of the solution to these prior mentioned challenges. Lastly, we'll have a deeper look into electric drivetrains to finally discuss the whole well-to-wheel efficiency of battery electric mobility. The breakdown of topic Electricity is illustrated in Figure 19.

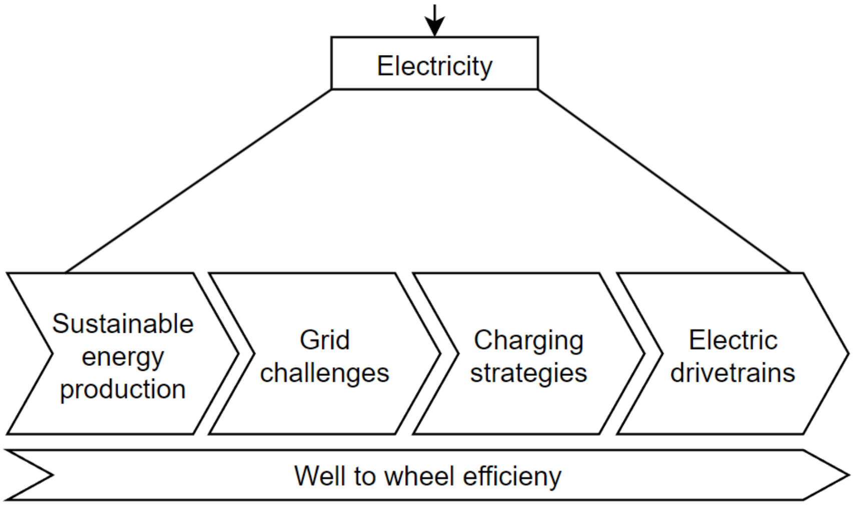


Figure 19. Breakdown of Electricity module into subtopics.

The second module invites students to learn about hydrogen. Although this module has technical aspects as well we look at it from a cost perspective. We look at the production side, and challenges related to storing hydrogen and finally include a part about hydrogen drivetrains and their specific benefits and drawbacks. We conclude the module with a TCO of a hybrid vehicle. The breakdown of topic Hydrogen is illustrated in Figure 20.

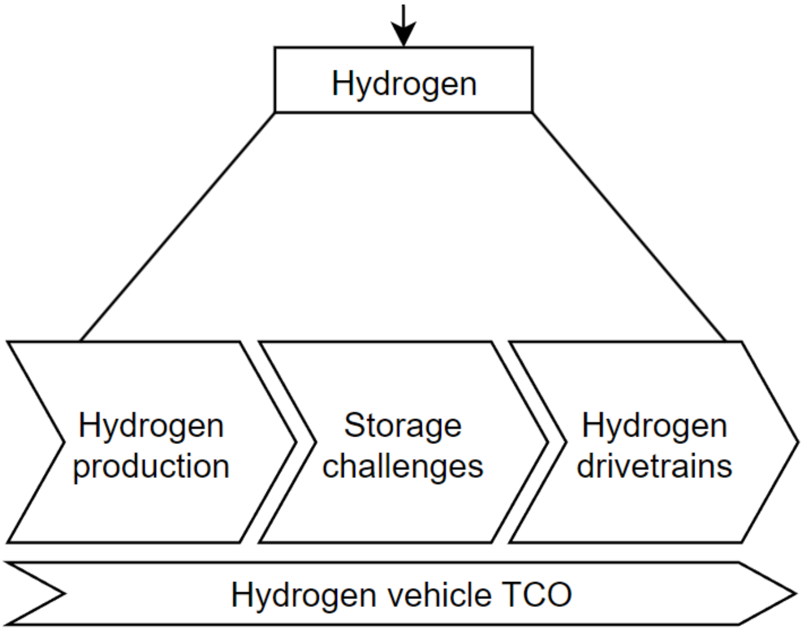


Figure 20. Breakdown of Hydrogen module into subtopics.

A third module allows students to self-educate about the basic sensors needed for autonomous driving. We'll show students state of the art demonstrators for both personal and heavy-duty vehicles. Finally, we welcome learners to envision a future where those demonstrators are widely adopted and implemented. The breakdown of topic Intelligent driving is illustrated in Figure 21.

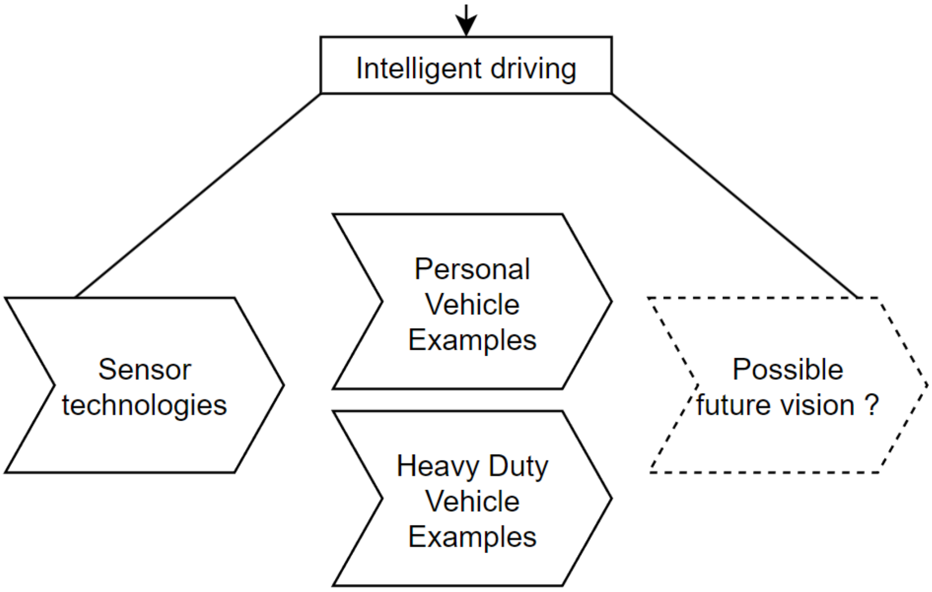


Figure 21. Breakdown of Intelligent driving module into subtopics.

Course Evaluation

In order not to overwhelm starting students a minimum of items is visible when they open the course. More items will be visible after a self-evaluation done via multiple choice. The outcome of the test is not limiting progress, but the test must be done before new modules open.

To pass the course a student will have to also calculate a well to wheel efficiency for an electric vehicle and a TCO for a hybrid vehicle. The outcomes will be automatically assessed.

Students will need to write a short essay about possible future implementation of self-driving vehicles. A lector will evaluate the paper with regard to creative thinking, showcase of the intelligent driving technology and understanding of the examples showed.

To conclude the course we propose an overall multiple choice test consisting of some self evaluation questions and some more in depth. This overall test aims to poll the students retention of information and insights.

4 RESULTS

4.1 Research methodology

The chosen work methodology for the project was design science, and the project structure supported this choice well. Work packages 2–4 were structurally similar, which enabled an iterative approach. In each work package, the goal was to develop one online course, and an iterative process involving student participation was employed in the course development. Naturally, the primary focus in designing the courses was on the teaching staff's planning work, which focused on the overall course design. Space was also given for student design work in smaller subject and content areas. The teaching staff mainly took responsibility for the relevance cycle of the application domain, although company visits during the intensive weeks also served this purpose. Precision cycles oriented toward the knowledge base were implemented through pre-assignments and, in part, through post-assignments following the intensive weeks. Each intensive week involved six student groups, resulting in a total of 18 different student iteration cycles per work package, and 54 throughout the entire project.

There was often room for improvement in utilizing the results produced by the students' iteration cycles. Therefore, it was necessary for the teaching staff to carry out also their own design, relevance, and precision cycles to meet the needs of the project's courses.

The design science methodology was somewhat new to most of the project participants. Therefore, it must also be acknowledged that greater emphasis could have been placed on methodological precision. Additionally, considering the achieved outcome, the approach was likely more labor-intensive to implement than some alternative methods. On the other hand, the attempt to use the design science methodology has been a highly educational experience for both the project staff and the students involved in the project.

4.2 Evaluation of pre-assignments, example case 1

During the project, the purpose and scope of the preliminary tasks varied. For the first topic, the purpose of the pre-assignment was to become acquainted with the vehicle population of the target country and the structure of the aftermarket sector. This preliminary task was meant to give students a view of current situation in vehicle population. Pre-assignment also made clear what kind of businesses aftersales sector consists of and how it is divided into different areas of interests in their own countries.

The pre-assignment was carried out with students from their own country as a group activity and then presented at the beginning of the intensive week. Assignment was divided into three separate main topics: Structure of vehicle population, regulatory guidance and energy distribution network and structure of the aftersales sector. Every main topic included questions of that topic area to be searched and answered. Findings of the pre-assignment were collected into an overall report. Finally, students prepared a presentation and a poster from the assignment to be presented during the first day of the intensive week.

Students received grading based on their report, presentation as well as self and peer review. The report, presentation and reviews each contributed one third of the total. Given grades ranged from 61 to 92 on the scale from 0 to 100.

4.3 Evaluation of intensive weeks, example case 1

Students were asked about their opinion working in intensive week one. The aggregated results can be seen in Table . In the questionnaire, each student was asked to evaluate the activities of their group as well as their own activities. This means that 24 students gave a total of 96 answers to each question, as there were four students in each group. Based on the feedback from the students, the group work during the intensive week went well or very well. The group work was also productive for the most part. Overall, students rated the work of the intensive week as very good. As a general comment, it could be observed that some strong personalities in the groups could reserve more work for themselves, even if there was the possibility of sharing it more evenly among the group. In some cases, there was a slight language barrier, but in the end, this was not a major obstacle.

Table 1. Results from a survey done after intensive week one.

	Excellent	Very good	Good	Satisfactory	Sufficient
Collaboration in group work	31,3%	52,1%	13,5%	1,1%	2,1%

Productivity in group work	35,4%	44,8%	16,7%	1,1%	2,1%
Overall assessment of intensive week	34,4%	52,1%	11,5%	0,0%	2,1%

4.4 Evaluation of post-assignments, example case 1

We received four responses to the post-assignment exercise, describing the processes and sustainability of different aftermarket companies. The students described the activities of the companies based on their own experiences during the IP Week. In general, the students were well received by the companies, with only a few cases where pictures were not allowed, but in these cases a verbal description was included. In general, all the necessary information was collected from businesses. The description of the exercise could have been a little more precise, which would have made it easier to compare the companies' results. Also, as with other tasks at SeAMK, the focus was on learning different things. This did not always mean effective collection and structuring of information. This risk was also realised in the case of the post-assignment; its actual value in terms of course creation remained controversial.

The students were satisfied with their group during the group work. According to the survey, the workload between group members was evenly distributed and everyone was hard-working to achieve the result within the deadline. The free feedback from the survey also showed that most students were satisfied with their output, which could be considered to be in line with the timing of the assignment. Overall, group work in their own country-specific groups seemed to work well. It would be interesting to explore how this type of group work influences networking and further contact between international groups. However, would it be better to do the group work with a different concept and still in international groups? As a follow-up question, can the post-assignment be beneficially used in any other way?

4.5 Evaluation of courses

4.5.1 Evaluation of course 1

The online course on the vehicle aftermarket was therefore designed to cover five topics that are relatively central to the vehicle aftermarket. These topics also contribute to the sustainability and carbon footprint of vehicles. The content of the course was partly built around the media materials from the intensive week. Other materials were also collected after the intensive week. There was only limited use of students' written outputs in the creation of the course. The course uses a reasonably wide range of learning methods and activities, from essay writing to actual report writing, with the simplest tasks being multiple-choice exams.

Before releasing the course for general testing, feedback was collected from two pilot students who completed the course and tested the activities. At the time of writing this guide, the course has been completed by 37 students. At the end of each completed section, there is a feedback activity asking for the time taken to complete the section and free feedback on the section. Feedback was given by 35 students. As an average, little over 14 hours was used to complete the course (Table 1). Feedback was mostly good, pointing out few problems in the activities and giving few constructive tips to improve the sections. Overall, students didn’t like too much of reading the material. Interactive materials were the most appreciated and praised.

Table 1 Time used in aftermarket online course by students.

	Section 1	Section 2	Section 3	Section 4	Section 5
Hours used	1,8h	2,8h	4,7h	3,1h	1,9h

4.5.2 Evaluation of course 2

It was evident that the most crucial assessment is the feedback provided by the students themselves. At ŠAU, a standardized system is integrated into the AIS for the purpose of conducting course evaluations. Student evaluation is comprised of two components:

initially, the student assesses the content, scope, and format of the course in general. In this section, respondents are presented with four questions, each of which is assigned a score on a 1-5 scale, with 5 representing the highest level of satisfaction. Additionally, respondents are invited to provide constructive feedback through an open-ended question. The second part of the assessment concerns the degree to which the course is appropriate to the student's curriculum and the overall context of their discipline. Students are asked to answer three questions, awarding scores from 1 to 5 (5 being the best).

The application allows to evaluate the answers from course evaluations. Respondents can evaluate a course by filling in the survey sheet compiled by the faculty or university management. All answers are anonymous. However, one respondent is ensured to fill in only one survey sheet for a particular course duly attended or taught in the period.

4.5.2.1 Evaluation of the basic part of survey

- Lessons in the subject lead to the achievement of stated learning outcomes.
- Study literature or other study materials were available in the subject in electronic form for self-study, and the materials together covered the content of the subject.
- Continuous assessment during the semester as well as the final assessment (exam) takes place in accordance with the valid syllabus.
- The overall study load in the subject matches the number of subject credits (1 credit = 28 hours of study load).
- Open question: What are your other suggestions and observations on the overall teaching of the subject? Please state your positive experiences as well as critical comments.

4.5.2.2 Evaluation of additional questions for a course to be placed in study programme

- The subject content matches my idea of what should be taught in my study program (with regard to its aims and the graduate profile).
- The subject appropriately builds on and supplements the subjects of the study programme, and its content does not overlap with other subjects.

– The subject content and conditions for passing can be regarded as demanding compared to other subject in the study programme.

The evaluations were collated following the conclusion of IP Week, the Winter semester 23/24, and the Summer semester 23/24. A total of 32 students out of the 134 enrolled provided feedback. Consequently, the completion rate for the questionnaires was 23.8%. The results of the evaluation of the sub-questions pertaining to the single-assessment periods are presented in the following section. The IP Week was evaluated by four students in the system, with an average rating of 4.5 in the core section. With regard to the suitability of the course for the specific degree programme, the average score was 4.42. The inaugural semester during which the course was taught was the winter semester of 2023/2024. Seventeen students evaluated this semester, with an average score of 4.32. In the section on the suitability of the course for a specific degree programme, the average score was 3.96. The last semester for which data is available (SS 23/24) was evaluated by 11 students, who awarded the basic section a score of 4.74. In the section on the suitability of the course for the specific study programme, the average score was 4.45.

4.5.2.3 **Results of classes evaluation:** Evaluation of the basic part of survey

Results of the student evaluation are presented in figures 22 - 24.

Sphere	Total Scale Av. eval.
⊟ Questions focused on the whole subject	4.50
Lessons in the subject lead to the achievement of stated learning outcomes.	5.00
Study literature or other study materials were available in the subject in electronic form for self-study, and the materials together covered the content of the subject.	4.00
Continuous assessment during the semester as well as the final assessment (exam) takes place in accordance with the valid syllabus.	4.75
The overall study load in the subject matches the number of subject credits (1 credit = 28 hours of study load).	4.25
What are your other suggestions and observations on the overall teaching of the subject? Please state your positive experiences as well as critical comments.	0.00

Figure 22. Results of student evaluation: IP Week Summer Semester 22/23.

Sphere	Total Scale Av. eval.
⊟ Questions focused on the whole subject	4.32
Lessons in the subject lead to the achievement of stated learning outcomes.	4.21
Study literature or other study materials were available in the subject in electronic form for self-study, and the materials together covered the content of the subject.	4.27
Continuous assessment during the semester as well as the final assessment (exam) takes place in accordance with the valid syllabus.	4.40
The overall study load in the subject matches the number of subject credits (1 credit = 28 hours of study load).	4.40
What are your other suggestions and observations on the overall teaching of the subject? Please state your positive experiences as well as critical comments.	0.00

Figure 23. Results of student evaluation: Winter Semester 23/24

Sphere	Total Scale Av. eval.
⊟ Questions focused on the whole subject	4.32
Lessons in the subject lead to the achievement of stated learning outcomes.	4.21
Study literature or other study materials were available in the subject in electronic form for self-study, and the materials together covered the content of the subject.	4.27
Continuous assessment during the semester as well as the final assessment (exam) takes place in accordance with the valid syllabus.	4.40
The overall study load in the subject matches the number of subject credits (1 credit = 28 hours of study load).	4.40
What are your other suggestions and observations on the overall teaching of the subject? Please state your positive experiences as well as critical comments.	0.00

Figure 24. Results of student evaluation: Summer Semester 23/24

Furthermore, 20 responses to open-ended questions were collected. These responses are predominantly positive, with recurring comments pertaining to the lack of communication from the lecturers, the scope of the seminar papers and the overall difficulty of the course. These findings are consistent with the results of the discussions and feedback provided by the students during the final examinations. The student responses are presented below.

Results of classes evaluation: Open question

What are your other suggestions and observations on the overall teaching of the subject? Please state your positive experiences as well as critical comments.

- All clear.
- I think most students would appreciate some kind of introductory lesson online or an introductory email as an introduction to the course.
- A very demanding compulsory elective course, consisting of 6 term-long comprehensive papers followed by a final test where a minimum score is given, 3 deadlines are

announced in the morning at the same time in person, although the whole course is online (not suitable for the combi form), and the test consists of questions from about 250 pages of different topics. Moreover, it might also be useful to add feedback for individual presentations and their evaluation to the Moodle, only two of the 6 presentations had even a verbal explanation of the score, with the "10 is maximum" rating not being the best for me either.

- At the beginning of the semester, we did not receive any email about the fact that the sub-papers were available in Moodle. And there was no notification of points being entered in Moodle, so we had to click through to Moodle. Otherwise, the course was interesting in terms of content, though at times difficult to understand in i some passages, but that's a fault on my part.
- The term papers were okay to match the 5 credit grade in terms of complexity.
- This course was taught via the Moodle platform - definitely an interesting format of learning especially suitable for students preferring self-study. I have a complaint about the information about the course - no e-mail was sent from the teacher during the whole semester - it would have been useful to send an e-mail at least at the beginning of the course that the course was made available.
- No email was sent at the beginning of the semester regarding the progress of the semester. As this was an English language course that was an online course and self-study, introductory information would need to be sent next time. The output was 6 term papers on a particular topic, it would be useful to revise the assignment to make it clear what the final output was to be. There were errors in the Moodle b section of the knowledge mini tests.
- I finished the course only to not have to pay 2k to have it removed.
- Anyway, the elaboration of some parts of the term papers was too complex.
- At the same time, it would be nice to complete the test from anywhere, not just from school, but easily from home.
- The course was well prepared, I especially appreciated the wide base of teaching materials in different forms and from different perspectives. However, I would have appreciated the opportunity to consult with individual teachers if there were any uncertainties.
- The positive experience is definitely with the elimination of face-to-face teaching. The term papers themselves could be done by the student in his or her scheduled free time.

- For Prague students, a good opportunity to earn credits for a subject studied in a foreign language without having to go to Mladá Boleslav.
- The subject has clear assignments, clear conditions, everything is sufficient. I give it 5 points.
- Better communication with students.
- Well-divided topics and provided materials. I appreciate the partial quizzes to verify knowledge. On the other hand, I find the individual seminar papers very demanding - for each topic, it is necessary to create a comprehensive presentation, which ultimately makes 6 projects, partial quizzes, and a final test…
- A great advantage of the subject is the individual way of studying - each student can decide when to study it.
- Satisfied.
- I worked on the pre-assignment for almost 3 weeks, the last week really intensively. I didn’t have enough sources to draw information from, how to divide and structure the work.
- Anyway, a great experience working in an international team, an opportunity to learn new things and improve in a foreign language.

5 CONCLUSION

5.1 Organizing of Intensive week

Before starting to plan the actual intensive week, you should be clear about the precise objectives of the course you want to create. In particular, it should be clear what topics the course will cover and what learning tasks it could include. In this way, all the tasks associated with the intensive week will be meaningful and conducive to learning and to the common goal. Choose one environment (or create a strategy) for the Intensive Week where communication, information storage and work can take place internationally among all participants. When selecting students for the intensive week, emphasis should be placed on English language skills (or other working language) and the ability to work cooperatively. Substantive knowledge of the subject area covered may be considered an added value.

To improve the quality of group outputs, groups should be formed in such a way that the members have a wide range of skills. From the very first task, groups should be formed with members from several different countries. Before assigning the actual tasks to the groups, students should be clear about the purpose and objectives of the intensive week. It is also seen as an advantage if the students involved have already participated in similar exercises in the past. It would be a good idea to assign a staff leader to each group. Leader can guide the group during the week.

Two different approaches can be used to create the pre-assignment: a basic knowledge building approach to support the intensive week (completing the basic knowledge requirements before the intensive week) or a course building approach (creating course material). Which approach is used depends strongly on the subject area and the background of the students. In some cases, it may be necessary to carry out a pre-assignment questionnaire to determine the level of knowledge of the students. Assignments can be carried out in groups using virtual collaborative environments and tools.

The timetable for the actual intensive weeks is relatively tight, so students' work needs to have specific objectives. The openness and freedom of the student's work has proved to be too time-consuming and detrimental to the outcome of the intensive week. At the beginning of the intensive week, it is useful to highlight the objectives of the week and to organise lectures on the subject in general. It is useful to use business lecturers or other professionals to help emphasise the importance of the subject.

Courses often cover a variety of topics. It is therefore a good idea to allocate groups for the intensive week to a specific subject area around which to work during the week. Avoid excessive document creation and concentrate on creating specific learning tasks or modules during the week. Producing learning tasks or activity materials can mean creating, for example, videos, tests or interactive environments using different tools.

Timetable that can be used as a guideline, when designing an intensive week can be found as an appendix 1.

The post assignment can be formulated as required. This is because the objectives of the intensive weeks can vary widely. As with other tasks, the objective of the post-task assignment must be clear. For example, it could be a task where learning activities done by other groups are tested and feedback is given to the group, which makes changes according to the feedback. Another option is to do a case study, drawing on the lessons learned during the intensive week, and thus creating an example for the course to use. The case study can be done in country groups, drawing on the experience of all group members in the Intensive Week group work. A third option is to continue the task of the Intensive Week by extending and deepening it, for example by seeking theoretical perspectives on it.

Care should be taken when using data storage methods. Especially novel multimedia storage and visualization services may include subscription plans, without the possibility of transferring data to another service provider. Backup and version management means should be applied in order to avoid loss of data.

Lessons learned during creation of e-learning course

Good practices

- International and interdisciplinary teams
- Cooperation with businesses and professionals
- Content creation oriented IP week
- Specific goals and assignments
- Individual programme for each group during IP week

- Consider involving some of the same students in multiple IP weeks to enhance learning and contribute effectively to course materials.
- Virtual pre and post assignments
- Standardized module structure
- Clear project goals

Focus on These

- Focus on creating course materials effectively while also considering student learning during the IP week to some extent.
- Clearly define output expectations and format.
- Address varying technological skill levels.
- Minimize excessive documentation.
- Decide on working environments at early stage.

5.2 Online course creation

As mentioned earlier, the actual course description, study plan and possible activities should be thought out before the start of the intensive week. The course should feed both internal and external motivation as effectively as possible. External motivation can be driven by grades, different deadlines and expectations from the social environment. The most important task of teaching is to feed internal motivation. Intrinsic motivation means that student's study without any separate rewards or punishments. Intrinsic motivation is supported by an understanding of the relevance of the subject area of the course. This is why the course should start with an explanation of why the course is being studied and why the knowledge it provides is important for the student's future. Intrinsic motivation can be fuelled by assignments that are suitably challenging and provide feedback to the student on their performance. Transparency of the learning process also feeds intrinsic motivation. For example, all deadlines and assignments are visible to the student, the assessment criteria and what they consist of are clearly visible.

The course should provide a method for students to ask questions about the course and receive answers within a reasonable time. This could be done, for example, by having other students answer the question or by having a contact person on the course who is able to answer questions in a comprehensive way. Students should be able to reflect on their own performance independently or in groups. For some, allowing group work also adds meaning to the course. Course completion expectations should be clear. This also applies to the learning activity level. In other words, tasks should have clear objectives and expectations.

Students should be given the opportunity to see their own progress in relation to the course as a whole. The course should include a variety of interim tasks to help create a sense of achievement throughout the course. Especially in an e-learning course involving people from all over the world, the accessibility of different materials should be taken into account. So make sure that, for example, images have alternative descriptions, videos used have subtitles, links are named and fonts and colours make sense in the course. Accessibility is also ensured by the clear and logical structure of the course.

These features should therefore be favoured when creating an e-learning course:

- Clear course description and requirements for completion
- Logical course structure and clear description of the subject area
- Determine transparently what the assessment criteria for the course are. If possible, described in task-specific terms
- Clearly describe when assignments must be returned
- Provide a way for students to track their progress in the course
- Describe to the student why the subject area of the course is important to them
- Provide a variety of learning activities that are appropriately challenging and the materials are accessible
- Give feedback. Feedback should be given not only at the end of the course but also while the course is in progress
- Provide an opportunity for questions and ensure that students get answers to their questions quickly

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APPENDICES

Appendix 1. An example of a preferred intensive week timetable

Appendix 1. An example of a preferred intensive week timetable

	Mon	Tue	Wed	Thu	Fri
Morning session	-Welcome session -Definitions of subject framework	-Guest lectures	-Preparations for activity -Day's activity (eg. Professional interaction, laboratory)	-Preparations for activity -Day's activity	-Preparing output presentations
Afternoon session	-Week objectives -Pre-assignment presentations	-Workshop: learning material creation	-Day's activity -Processing of activity data	-Day's activity -Processing of activity data	-Final output presentations -Farewell session
Evening	-Networking -Grouping		-Recommended group work	-Recommended group work	