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O1. METHODOLOGICAL FRAMEWORK

Report

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INTRODUCTION

The report summarizes information on the Intellectual Output 01 *Methodological framework* of the Wood in Circle project, which was implemented by five higher education institutions from Lithuania, Finland, Latvia, and Italy. The two-year project aimed at delivering innovative student-centred transdisciplinary education in circular economy-based wooden construction to postgraduate students across European countries.

The specific objectives of the Wood in Circle project were:

1) To integrate innovative student-centered phenomenon-based, research-based, blended learning and social leadership approaches into master's degree study programmes.

2) To develop a new course, educate and involve postgraduate students and teachers in scientific research on whole life cycle of wooden construction.

3) To ensure strategic transdisciplinary transnational cooperation among higher education institutions and business enterprises in development of new learning methodology and the course.

4) To increase academic and public awareness and promote sustainability and circular economy in construction sector.

The traditional teaching methods in higher education are teacher-centered. The student gain knowledge from teachers and focuses on memorizing the facts instead of thinking about how to apply the information to real-life problems. These conventional teaching methods do not serve the need of the complex modern era. Hence, the aim of the Intellectual Output 01 was to develop an innovative student-centred methodological framework.

All partner institutions participated in the co-development of the *Methodological framework.* The process was led by Laurea University of Applied Sciences (Finland), and it included four tasks:

- O1/A1. Research on knowledge gaps and required competencies. This activity aimed to identify the knowledge gaps and future competencies in circular wooden construction. The purpose was to find the best teaching approaches to achieve these competencies and distinguish the topics of the e-learning course (the Intellectual Output O2). The partners analyzed and reported the knowledge gaps and future competencies in circular wooden construction at the national and international levels. LAUREA summarized the information, which formed the basis for the next phase: analysis of innovative learning methods.
- O1/A2. Analysis of innovative learning methods. Each partner selected an innovative learning method, which they analyzed and reported. They identified the method's advantages, disadvantages, and application strategies and produced a written report.
- O1/A3. Development of Methodological framework. Laurea summarized the results from the previous task, formulated the Methodological framework, and guided its' application in the development of students competencies.
- O1/A4. Testing and improvement of the Methodological framework. The partners tested the Methodological framework during the Wood in Circle intensive courses in Padasjoki and Palermo. The teachers and students gave feedback after the education, upon which Laurea improved the Methodological framework. Laurea will disseminate the Methodological framework via an article and a congress presentation.

As there is no formal definition of what constitutes a methodological framework nor published guidance on how to develop one, the Wood in Circle project applied the development process defined by McMeekin et al. (2020). According to the authors methodological frameworks are developed through three phases: 1) identifying the evidence to inform a methodological framework, 2) developing the methodological framework, and 3) evaluating and defining the framework.

The first stage of the process had already begun as the project applied for funding. Based on literature reviews and partners´ experiences, the phenomenon-based learning, research-based learning, blended learning, and social leadership approaches were selected for the project. The first three are traditional established pedagogical approaches. “Social leadership” is a developing approach at Laurea UAS. Social leadership emphasises human leadership skills as interaction and trust alongside technical managerial skills. These four approaches formed the basis for the proposed *Methodological framework*.

The report summarizes the Intellectual Output 01 *Methodological framework* according to the development process defined by McMeekin et al. (2020). The first phase includes the Tasks O1/A1 and O1/A2. The second part outlines the methodological framework (Task O1/A3), which is followed by the evaluation and definition of the framework (Task O1/A4). The report ends with discussion and recommendations for future studies and development work.

1. IDENTIFYING THE EVIDENCE TO INFORM A METHODOLOGICAL FRAMEWORK

1.1 Research on knowledge gaps and required competences

The aim of the task O1/A1 was to identify the knowledge gaps and future competencies in circular wooden construction. The purpose was to find the best combination of teaching approaches to achieve these competencies and distinguish the topics of the e-learning course (the Intellectual Output O2).

The participating HEIs (VILNIUS TECH and HAMK) analyzed and reported the national and international situation in the education of timber construction. They examined closely how the circular economy principles materialized at three levels: university, national and international. They also analyzed which competencies and to what extent are developed at their universities. The reports served as data for identifying the cross-cutting knowledge gaps and required competencies.

The summary of the general information about education in timber construction is in the following chapter. Special attention is paid to the circular economy principles.

1.1.1. Education in wooden construction

FINLAND

Timber construction is taught in all the university-level Construction, Structural design, and Architecture programs in Finland. For example, Tampere University offers 5 ECTS courses called *Circular Economy and Building Construction*. Depending on the program, Universities of Applied Sciences also offer timber construction studies as a part of their master's studies. XAMK University of Applied Sciences has a 5 ECTS course *Utilization of renewable bio-based mate*rials. LAB University of Applied Sciences, on the other hand, provides a 5 ECTS course called *Technical and biological circles in the building process*.

The Circular economy is gradually becoming an essential part of timber construction studies in the Finnish degree programs. It has so far been integrated into the rest of the timber construction modules but will become an entity of its own.

LITHUANIA

Education in timber construction at the university level is very limited in Lithuania. Two universities, namely VILNIUS TECH and Kaunas University of Technology (KTU), focus their research and education on technological sciences and deliver BSc and MSc study programmes in Civil Engineering.

The education in the construction of timber buildings is limited at VILNIUS TECH. The 3 ECTS module *Steel and Timber Structures* is delivered in two BSc study programmes (Civil Engineering and Construction and Real Estate Management). Two BSc study modules were developed in frames of the previous Erasmus+ Strategic Partnerships projects and have been partly integrated into the aforementioned BSc study programmes: *Design, Construction, and Management of Wooden Public Buildings* (9 ECTS) and *Sustainable High-Rise Buildings Designed and Constructed in Timber* (9 ECTS). In the MSc studies, some timber construction-related modules are included in the Structural Engineering study programme, specialization *Advanced Light-Gauge Structures*: *Building Information Modeling (BIM) for Steel and Timber Structures* (9 ECTS), *Advanced Timber Structures* (6 ECTS), and *The Assessment of Timber Buildings, Experimental Investigations, and Strengthening* (6 ECTS). Education in timber construction is mainly limited to the design stage. The whole life cycle of timber construction is not covered, and circular economy principles are not sufficiently addressed in the education of bachelor and master students.

KTU delivers the BSc study programme Civil Engineering. It includes the study module *Steel and Timber Structures* (6 ECTS), which aims at delivering knowledge about steel and wood structural properties, the basis of calculation and construction of structural members and connections, mostly used steel and timber building structures. At the MSc level KTU delivers three study programmes in the field of civil engineering: *Construction Management*, *Structural and Building Products Engineering* and *Sustainable and Energy Efficient Buildings*. Study programmes Construction Management and Structural and Building Products Engineering are mainly focused on concrete and steel structures. None of the modules or subjects are dedicated to timber structures. The study programme Sustainable and Energy Efficient Buildings covers some themes on sustainability and waste management, but timber construction is not addressed at all.

Vytautas Magnus University Agriculture Academy delivers an MSc study programme Forestry, which deepens theoretical knowledge in the areas of applied genetics, productivity and dynamic sustainability of forest ecosystems, wetlands, ecological forest regeneration, and forest economics.

In conclusion, timber construction and circular economy principles are not sufficiently addressed in the MSc programmes by the universities in Lithuania.

SPAIN

Institute for Advanced Architecture of Catalonia delivers The Master in Mass Timber Design (MMTD). It is a 10-month online education program imparting the next generation of architects, designers, and engineers the skills to design, develop and build mass timber buildings. MMTD provides expertise in theories, cases, techniques, tools, and design projections of mass timber construction and the interrelated fields of architecture, structural design, assembly systems, material science, and thermodynamics. The program offers a unique online experience based on advanced design research methodologies, a philosophy of learning by doing, and a community of mass timber design experts that serve as faculty and lecturers. In contrast to the traditional online programs, the Master in Mass Timber Design is a 60 ECTS accredited Master's degree consisting of three 15 ECTS postgraduate programs, offers a real-class virtual environment based on a continuous, interactive, and collaborative learning process.

UK

In 2018 Edinburgh Napier University introduced an MSc in Timber Architectural Design and Technology - the first programme of its kind in the UK. The programme is designed for graduates in architecture, architectural technology, and other construction professions who want to become part of the growing international move towards innovative and high-performance timber building. The MSc equips students to work as design professionals within the timber sector. The programme includes modules on wood as a building material; offsite construction and design for manufacture, wood products and processing; building acoustics and sound insulation; energy performance; timber architectural form and technology, and timber building design. Students also undertake a large architectural design project or a technical dissertation.

AUSTRIA

The programme of Structural Design and Timber Engineering at Vienna University of Technology has formulated its overriding aim in research as the integration of the natural building material of wood into the building industry’s contemporary requirements. In the charged field between the polarities of architecture and civil engineering, the department with the two main study courses *Bearing Structure Theory for Architects* and *Timber Construction for Architects and Civil Engineers* acts as a bridge between the two faculties of building science at the TU Wien. The department provides its Master module on the themes *Structure Logics* and *Resource-efficient Materialisation.* At the same time, students of civil engineering are supervised in the compulsory subject of timber construction. The Master's architecture degree course in the department includes design and modules, also the construction-oriented course in the field of architecture in steel and timber construction, which is also on the curriculum of the civil engineering course. The engagement with these subjects is directed towards an academic examination of the usage potential of renewable raw materials in combination with optimized synthetic materials specifically for dense-packed urban buildings, and to implement this in pilot projects.

NETHERLANDS

The Delft University of Technology provides 4 ECTS course called *Biobased Structures and Materials*. The learning outcomes of the course are: 1) Students will be able to evaluate the consequences of the material properties of timber for the design of timber structures, structures for road and waterworks, and maintenance of monuments. 2) Students will be able to perform a literature search on a specific topic related to timber structures. The teaching methods are lectures, assignments, and presentations.

The Eindhoven University of Technology has a 5 ECTS course *Circularity in the Built Environment.* It explores the idea of a circular economy, highlighting the 21st-century attempts to (re)define boundaries, progress, and costs with the consideration of fair distribution. The course includes various circularity and sustainability assessments, the meaning of circularity for planetary and urban spatial planning and the design of circular buildings on a conceptual and technical level. Energy, materials, waste, and emissions are studied separately and in cohesion. The teaching methods are theoretical lectures, active assignments, and personalized follow-up research.

SWEDEN

Linnaeus University delivers 7,5 ECTS courses *in Energy and climate efficient construction*. It consists of building and construction-related sustainability issues, energy and environmental implications of materials for building products, and the effect of the choice of building structural system and material on the environmental impact of buildings from a life cycle perspective. The course also covers life cycle thinking, sustainability assessment, evaluation tools, and life cycle analysis methods commonly used within the building construction sector. The teaching methods include lectures, seminars, exercises, project work, and examinations.

Generally speaking, the analysis of international MSc studies revealed that only some programmes directly focus on sustainable timber construction. Although circular economy principles were not emphasized, they are gradually becoming essential in timber construction studies across various countries and MSc study programs.

1.1.2. Competencies

The future competencies of circular wooden construction group into seven competence areas, which are 1) resource extraction, 2) manufacturing, 3) onsite construction, 4) building occupancy and maintenance, 5) building disposal, reuse, and recycling, 6) generic competencies relevant to sustainability and circular economy, and 7) leadership, management, and collaboration. The first areas link directly to the construction of timber buildings, while the sixth and the seventh describe more general competencies needed in future working life. VILNIUS TECH (VT) and HAMK (H) analyzed which competencies and to what extent is being developed at their universities (Table 1).

Table 1. Competencies developed in VILNUS TECH (VT) and HAMK (H)

Competences	Very extensively	Extensively	Not extensively	Not at all
Resource extraction				
Knowledge of globally most common and local wood species			VT, H	
Knowledge of forestry			H	VT
Knowledge of local wood species			VT, H	
Knowledge of local climate and boundary conditions			H	VT
Use of secondary raw materials			H	VT
Sustainable resource extraction			H	VT
Knowledge of climatic variables that influence forests			H	VT
Timber extraction`s influence on current Ecosystem Services				VT, H
Environmental impacts from resource extraction				VT, H
Manufacturing				
Knowledge of material properties of wood		H	VT	
Knowledge of method to grade material to classes			VT	H
Knowledge of Type Approval of construction product			VT	H
Knowledge of preservative treatment of wood			VY	H
Knowledge of method to modificate wood (thermally and chemically)			VT	H
Knowledge of engineered wood product		H	VT	
Knowledge of different kind of wood-based construction product		H	VT	
Knowledge on carbon footprint and other environmental impacts on wooden material.			VT, H	
Understanding of the acoustic performance of timber buildings			VT	H
Understanding of the moisture performance of timber buildings		H	VT	
Knowledge of modern engineered timber products		H	VT	
Understanding of timber construction (using different materials)		H	VT	
Understanding of the fire safety requirements		H	VT	
Structural design skills		VT, H		
BIM application skills		VT, H		
Safety assurance in construction of timber buildings			VT	
Knowledge of thermophysical features of material construction			VT, H	
Understanding of comfort indoor		H	VT	
Understanding of circularity of materials				VT, H
Total or partial Integration with renewable energy sources			VT	
Knowledge of timber material costs		H		VT
Environmental impacts from manufacturing			VT, H	
Knowledge on determining the reuse potential			VT	H
nowledge on how to process secondary materials				VT, H
Onsite construction				

Competences	Very extensively	Extensively	Not extensively	Not at all
Understanding of construction techniques		VT, H		
Understanding of environmental impacts of onsite construction procedures			VT, H	
Evaluation of accessibility of the onsite construction area		VT	H	
Environmental impacts from onsite construction			VT, H	
Knowledge on construction processes		VT, H		
Building design	H	VT		
Knowledge on how to choose construction site/ properties of the plot	H	VT		
Building occupancy & maintenance				
Maintenance of timber buildings				VT, H
Understanding of comfort indoor			VT, H	
Assessment of the useful life cycle of timber buildings			H	VT
Understanding of the user's behaviour		VT		H
Understanding of performance of building (thermophysical, economic, social, and environmental)		H	VT	
Environmental impacts from building occupancy and maintenance				VT, H
Knowledge on how to minimise energy consumption and optimise energy demand in buildings			VT, H	
Mandatory and optional operations in timber building maintenance				VT, H
Building disposal, reuse and recycling				
Recycling and reuse of timber components			H	X
Design for disassembly			VT, H	
Identification of the potential second life of the materials				VT, H
Systemic understanding on circular construction processes and their connectedness			H	VT
Environmental impacts from building disposal, reuse and recycling			H	VT
Environmental benefits from reuse and recycling of building materials			VT, H	
Generic competencies relevant to sustainability & circular economy				
Ability to calculate, read and use drawings	VT, H			
Understanding written documents and writing clearly	VT	H		
ICT skills	VT		H	
Learn to learn skills		VT	H	
Disposal and waste			H	VT
Understanding of the environmental impacts		H	VT	
Knowledge of sustainable construction in timber			VT, H	
Assurance of circular economy principles in timber construction			H	VT
Ability to divulgate information about the circular economy and sustainability			VT	H
Circular construction			H	VT
Environmental benefits from circular economy implementation in wooden building sector			VT	H
Characteristic elements of circular economy				VT, H
Promotion and integration of renewable energy sources into timber buildings			H	VT
General knowledge about sustainability and knowledge on dimensions of Sustainable Development			VT, H	
Life cycle assessment			VT	H
Leadership, management & collaboration				
Negotiation skills		H	VT	
Acquiring, interpreting, and communicating information		VT	H	
Leadership skills		H	VT	

Competences	Very extensively	Extensively	Not extensively	Not at all
Team working skills	H		VT	
Organisational and planning skills of timber construction projects			VT, H	
Decision-making skills		VT	H	
Management skills in timber construction projects			VT, H	
Ability to communicate with society			VT, H	
Presentation skills	H	VT		
Networking skills		H	VT	
Interaction skills		VT, H		
Ability to build trust in work community			VT, H	
Ability to manage conflicts		H	VT	
Ability to acknowledge role of emotions in leadership			VT, H	
Ethical leadership skills		VT	H	
Time management skills		VT, H		
Cost management skills		VT, H		
Safety management skills	H	VT		
Quality management skills		VT, H		

The competence areas of resource extraction and building disposal, reuse, and recycling do not include competencies that universities develop very extensively or extensively. On the contrary, timber extraction`s influence on current ecosystem services and environmental impacts from resource extraction is not developed at all. The outcome in the identification of the potential second life of the materials (Building disposal, reuse, and recycling) is similar. One or both universities cover all the other competencies in these two areas, such as knowledge of local wood species, design for disassembly, and environmental benefits from the reuse and recycling of buildings, at least to some extent.

The most developed competencies belong to areas of generic competencies relevant to sustainability and circular economy, and leadership, management, and collaboration. They include the ability to calculate, read and use drawings, understand written documents and writing clearly, presentation skills, and safety management skills. According to the analysis, all the leadership, management, and collaboration competencies are developed in both universities. The generic competencies, on the other hand, include areas developed only in one university. Only characteristic elements of circular economy are not covered in either of the universities.

1.2. Analysis of innovative learning methods and pedagogical approaches

Each partner selected, analyzed, and reported an innovative and student-centered pedagogical approach (task O1/A2), which provokes students' thinking instead of traditional lecturing. The pedagogical methods were appointed to each HEI in the project application according to their experience. HAMK analyzed phenomenon-based learning, RTU and UNIPA research-based learning, VGTU blended learning, and LAUREA social leadership approach.

The partners performed and summarized a literature review of the pedagogical method. They evaluated it by identifying the method's advantages and disadvantages. They also suggested practical application strategies for timber construction education and the Wood in Circle project.

In this chapter, we present the main content of these chosen approaches to suggest an application for the pedagogical framework.

1.2.1. Phenomenon-Based Learning

Since its application in 2016 as part of Finland’s National Core curriculum for Basic Education, Phenomenon-based Learning (PBL) has attracted growing international attention. The curriculum states that all students aged between 7–16 should have at least one Phenomenon-based module per academic year (Opetushallitus, 2014). Because of its relatively recent application, experiences are still quite scarce, and research on the subject is limited.

The idea of breaking down subject-based compartmentalization of knowledge is not that new. The Phenomenon-based insights occurred in Finland as early as the 1930s, as a particular topic was proposed to be taught simultaneously with different subjects. The idea was further developed in the late 1940s when the plan was to combine various topics into natural phenomena-based themes (Hyyrö, 2010). In the 1980s, as a part of the Finnish core curriculum, phenomenon-based learning was re-introduced but did not experience large-scale application before 2016, when the use of Phenomenon-based Learning beside the traditional subject-based classes was made mandatory in Finnish comprehensive schools.

Currently, Finnish pedagogical knowledge on Phenomenon-based learning is exported internationally. There are several ventures to capitalize on the gathered experiences on the method. (Education Finland, 2021).

The problem-based learning is not a pedagogical theory, but a collection of pedagogical practices. It combines theories like constructivism, social constructivist theory, emergent learning, and the theory of situated cognition. PBL also applies problem-based, inquiry-based, and research-based learning methods.

PBL is a method of achieving wide-scale knowledge on a single topic (Helsingin kaupunki, 2016). It has a basis on five principles:

1) Phenomena are holistic.
   The research is conducted on real-life situations with researchable topics. Subject boundaries are crossed, and the phenomenon is studied as an entity. This can be approached with methods and the basis of different previously taught subjects. Phenomena and learning do not limit to a single theme.

2) Phenomena are authentic.

Research is conducted on current topics by using real-life sources. Authenticity is pursued, and practices from the field of science in question are used. Understanding different work- and learning environments is further developed, and research of phenomenon is linked to authenticity.

3) Phenomena are contextual.
   The objective is to obtain an overall understanding of the context. When conducting research, facts are ill-structured and cloud-like, not ready-defined. The process of learning is supported methodically according to set objectives and learning assignments.

4) Problem- and research-based.
   With the aid of research questions, the learners aim to understand the research phenomenon in question individually and as a part of a team and to build new knowledge on the phenomenon. Individual learners have individual goals and assignments inside the phenomenon. They also have a common goal of understanding the overall phenomenon.

5) Learning-process -based.
   Understanding and learning from a phenomenon form a process guided by learning assignments and feedback. The learner will document the learning process in a predefined manner. Learning assignments develop the learner's perception and facilitate learning of new topics.

Phenomenon-based teaching focuses more on learning than actual teaching (Ovaska, Rongas, Luostarinen, and Kekkonen, 2014). A student acts as an active operator inside the learning process rather than a passive receiver of teaching or a listener of lectures. The teacher should focus more on guiding, mentoring, coaching, and stimulating learners instead of traditionally lecturing and being a classroom authority. The teacher guides the learning process by asking specific questions and helps learners formulate their questions and study rather than give answers. The teacher is constantly assessing the process and giving out process-essential constructive feedback.

Workshop-like teaching situation is typical. It is informal, non-schedule-based, and may also occur outside school hours. The learner takes part in learning more actively than in traditional topic-based teaching. The learner makes critical analysis, asks questions, and brings doubts. She is creative in learning, manages, shares, and forms information with others, and assesses the knowledge obtained individually and as a part of the group.

In a PBL process, the emphasis is on the trip, not the destination. The learners study the topic in question also outside the actual teaching situation. This helps students function better as a part of the modern working environment, where the quantity of available information is enormous, and competence is connected to the ability to search for and process information. Learning is a cyclical process in which obtained information is constantly reverted to, reflected upon, and added by researching more.

There are relatively few reports on learning results using PBL. Lahtinen (2019) studied comprehensive-level 8th-grade students for their insights on Phenomenon-based learning modules. In the study, the participants of PBL modules stated that cooperation-, thinking- and problem-solving skills clearly developed, but the quantity of learning was less than in traditional teaching.

Leppiniemi (2017) studied teachers' views on Phenomenon-based learning. The results showed that successful PBL modules develop the working and thinking skills of the learners and enable more indepth knowledge of the subject in question. The success of the learning process requires all the parties in a learning environment to adopt a new role, which can sometimes be challenging.

Advantages of the method

According to Tissington (2019), phenomenon-based learning has the following advantages:

- Students learn how to apply their knowledge to real-world circumstances.
- Students can come to see connections between different domains of learning.
- It emphasizes skills that are required for 21st Century workplaces.
- It highlights the importance of linking theoretical knowledge to practical situations.
- Students get a holistic perspective on the phenomena under analysis.
- Engagement is enhanced because the focus is on solving problems rather than repetitively doing subject-based tasks.
- Students use group work, problem-solving, communication, and logical reasoning skills to reach conclusions.
- Students are encouraged to learn in independent cooperative groups to solve large problems.
- Educators across different disciplines can collaborate to create projects for their students.
- Educators can use flexible table layouts rather than traditional classroom layouts to encourage group problem-solving.

If not all, most of these advantages are relevant also for the future students of circular economy in wooden construction. One of the advantages of the PBL is that the phenomenon adjusts to local circumstances, and the tasks and learning assignments take into account the local conditions.

The circular economy is a broad topic. It allows the application of various approaches according to the interests of learners/students, which helps the commitment to learning. Also, when the definition of the phenomenon at hand is broad enough, different emphasis can be given to various topics according to timeliness.

As the circular economy is a new field of science, its teaching modules might be relatively demanding, at least time-demanding to construct. As scientific development and research are likely to occur rapidly soon, teaching modules might quickly become dated. With the Phenomenon-based learning method, an information base is created every time learning takes place in actual, real-world research with current, updated sources of information.

In Phenomenon-based learning previously obtained knowledge forms a basis of new learning. Previous collective competence is also used to build new knowledge in a PBL learning environment. As the participants of the planned module will be mostly master-level students, they are likely to possess prior knowledge and skills to thrive in a Phenomenon-based learning environment. If successful, the learners/students will become fluent in using new methods of information search and processing, which will benefit them in their future careers.

Disadvantages of the method

Tissington (2019) states the following disadvantages of phenomenon-based learning:

- All classes can't involve PBL. Sometimes there is a need for traditional direct or modelled instruction on a specific subject area. In the Finnish system, in which PBL is embraced, only one module per year of PBL is required, and the rest of the classes follow a silo approach.

- Students need to be trained in working in groups, identifying problems, and conducting research in successful PBL.
- The lack of structure in learning may be confusing to some students. The students need sufficient resources and support for their work.
- Some phenomena may not need all disciplinary knowledge to solve their problems, leaving gaps in learning and practice.
- The open-ended and student-led nature of PBL makes it hard for educators to present challenges in the sequence for optimal learning. For example, the nature of knowledge required to solve some problems may not be at the right developmental level for the students, causing roadblocks in learning. The students may identify that they need advanced mathematical skills to solve the problem under analysis, but they may not have the skills or knowledge to use that skill.

A clear disadvantage of Phenomenon-based learning is that most of the current experiences are from the Finnish comprehensive school curriculum, and the knowledge base on the subject is relatively thin.

From a teacher, an application of Phenomenon-based learning demands a new approach to teaching. Previous experience from Project-based- or Problem-based learning is helpful when planning a PBL environment. The planning of PBL modules differs from the planning of traditional teaching modules. The emphasis is on planning, the learning processes, and information-obtaining tactics instead of disseminating information. Using new ways to construct a learning environment can be laborious and overwhelming for some teachers.

Phenomenon-based learning demands active participation from the students, who form the learning problems by themselves. The research aims to find information concerning the task at hand. The method is more difficult for those students who are accustomed to the traditional way of teaching and learning. Phenomenon-based learning also demands more time to conduct than a traditional teaching method because gathering information and forming individual points of interest is more time-demanding than when all information to be used is ready-made and given to the students to use.

Phenomenon-based learning also sets requirements for the quality of student/learner groups participating in the module. There has to be a well-functioning group with openness, mutual respect, and confidentiality for the learning to have sought-after learning results. In some cases, such groups can be hard to form or need extra effort in the initial stages of grouping.

The scheduling of the Phenomenon-based module is also more challenging than traditional teaching methods. Wide-scope learning of various phenomena must be given sufficient time for students to gain a deeper understanding.

Proposed application strategies

Elements of Phenomenon-based learning are easy to integrate into the Wood in Circle module. Since the project aims to develop a new course for circular economy in wooden construction used in the future in various European countries, it is hardly desirable that the entire module has a basis only in Phenomenon-based learning. There must be guidelines that can be replicated when needed.

As learners, master-level students are most likely to possess the required skills and competencies for information gathering and processing. The more heterogenous the group is with various fields of expertise, the better the results are. In timber and wood construction, every student should know the basics of the construction industry.

For the teaching of the module, specialists from various fields of construction together with experts in pedagogy should be recruited. Some expertise in Phenomenon-based learning is recommendable.

A loose methodological framework that allows phenomenon-based elements should be developed. Single teaching topics would be built allowing local, group-based interests and current issues to become part of the module. In the module, teachers should provide students with general information and instructions for gathering data and conducting research. There with plenty of time and guidance for individual and group-based work.

Co-creating a circular economy in a wooden construction module will be a fruitful process if elements of different pedagogical approaches are combined into planning. At best, the process can produce something completely new. Hopefully, phenomenon-based learning is applied extensively in the process.

1.2.2. Research-Based Learning

Research-Based Learning (RBL) is the concept of integrating research results and activities into a learning strategy (Sucianto et al., 2019). Research-based learning is a learning method using contextual learning, authentic learning, problem-solving, cooperative learning, hands-on and minds-on learning, and inquiry discovery approach, in which the target of RBL is to encourage the high-level thinking skill of students (Monalisa et al., 2019). The students are not only given information and knowledge but also have to be directed to a higher level of thinking skills, namely creating or communicating (Sucianto et al., 2019).

It is a learning model which is associated with such activities as analyzing, synthesizing, and evaluating, and enables learners and lecturers to improve their assimilation and application of knowledge.

The growing importance of involving undergraduate students in professional research activities has been recognized in the university ecosystem since the end of the past century (Boyer, 1998).

Research-based learning (RBL) aims to promote and develop student competencies related to research practice and to benefit students through activities linked to research. This technique implies the application of learning and teaching strategies that link research with teaching.

Given that the reach and implementation of RBL for undergraduate students are very wide, it is necessary to define the learning objectives, the audience, the expected learning outcomes, and the desired competencies to be developed to determine the appropriate methodology and processes to be applied (Noguez & Neri, 2019).

RBL is related to Discovery-Based Learning, Inquiry-based Learning, Experiential Learning, Problem-Based Learning and Project-Based Learning. A common characteristic of these RBL techniques is that, in them, all activities are oriented to develop students' skills in research (Noguez & Neri, 2019).

In general, RBL consists of three stages 1) exposure stage, 2) experience stage, and 3) capstone stage. The exposure stage is gathering information based on inquiry and looking for the literature and research articles of specific research of interest. The experience stage is identifying and formulating problems based on literature and experimental experience. The capstone stage is explaining a certain plan or idea in giving a problem solution, measurement method or computation (Sota & Karl, 2017).

There are several implementations approaches to research-learning: research-oriented (RO), research-based (RB), research-tutored (RT), and research-led (RL). In table 2. there is a summary of characteristics from each approach.

Table 2. RBL implementation approaches according to University of South Carolina

Student Involvement	Emphasis on Research Content	Emphasis on Research Processes and Problems
Students as Participants	**Research-tutored**: Course content emphasizes students learning in small group discussions with a teacher about research findings.	**Research-based**: Course content emphasizes students learning through inquiry-based, problem-based, and project-based activities.
Students as Audience	**Research-led**: Course content is based on disseminating factual and conceptual knowledge about the research interest(s) of the faculty member.	**Research-oriented**: Course content emphasizes procedural knowledge about the research interest(s) of the faculty member or learning about the process by which knowledge is produced.

The tips for each RBL implementation approach are as follows:

1. Research-led teaching:
   - Explain the relevance of the course material to research you or others are conducting.
   - Present research findings on a topic discussed in the course.
   - Invite a guest researcher to present relevant research on a topic discussed in the course.
   - Bring research artefacts into the course.
   - Ask students to independently read specific research articles that you have selected.

2. Research-oriented teaching:
   - Invite students to spend time in a research lab or site and observe real-world research.
   - Make a presentation of research methods and approaches.
   - Demonstrate experimental techniques and real hands-on computational aspects in science disciplines.
   - Ask students to not only read and understand a research article, but also to search through the bibliography of that article. In addition, ask them to study not only the text but also the figures, diagrams, tables, and simulations presented in this article.
   - Introduce students to peer review which is often used in the research process (i.e., in grant applications and journal article submissions) by having them make small presentations in class that are evaluated by the other students in the course.

3. Research-based teaching:
   - Introduce students to inquiry-based learning using a Socratic "questioning style" of lecturing and lab assignments that require students to formulate and answer their research questions.
   - Ask students to make observations, formulate ten questions, and share one of these questions with a group of other students. The next step is to ask students to develop hypotheses as a group based on the question, think of ways of testing the hypotheses,

and write up individually their ten questions and one hypothesis as a 750-word mini-proposal for research project;
- Each year share with students a body of work produced by a previous group of students and ask them to make improvements and additions to it. Repeat this process until publishable materials are produced.
- Require students to undertake an independent or team research project.
- Require students to publish an article or produce a research outcome.
- Engage students directly as consultants with organizations. A small group of students clarify the issue with the internal personnel on organizational premises, collect information using a variety of research methods, and analyse this information from the perspective of both academic theory and the specific organizational context. They make recommendations for action both orally and in writing. As well as getting real-world experience in solving a problem, students also experience working with a team of diverse peers to produce credible outcomes.

4. Research-tutored teaching:
   - Divide students into groups that are facilitated by a tutor. The tutor acts as a task giver, as an information resource responding to student requests, and as a facilitator moving from sub-group to sub-group helping discussions to develop.
   - Assign graduate students as mentors to undergraduate students working on a research project.
   - Encourage research postgraduates to allow undergraduate students to shadow them for a short period.
   - Have undergraduate students do an assignment in their first semester in which they interview, as a group, faculty about their research. Each group is allocated a different faculty member.
   - The faculty member provides three representative pieces of writing (e.g., journal articles) along with a copy of their CV and arranges a date for the interview. Students read these materials and develop an interview agenda. Based on their reading and the interview, each student individually writes a 1,500-word report on 1) the objectives of the interviewee's research; 2) how that research relates to their earlier studies; 3) how the interviewee's research relates to his or her teaching, and other interests and the area of study (University of South Carolina).

In general, the RBL defines an approach in which teachers encourage students to be researchers, discoverers, and creators of their own and others' learning within a lesson or series of lessons that encapsulate a learning aim or objective.

It is also stressed that one of the important factors of RBL is involvement and collaboration among the research group members. Thus, the existence of the research group is very important (Healey et al., 2014).

Advantages of the method

Universities should develop research skills in their undergraduate students from the first year. One of the main advantages would be to awaken students' interest in knowledge and the problems that society faces so that students may broaden their perspectives and focus on their study areas (Noguez & Neri, 2019). It is emphasized that, nevertheless, there would be enormous value in involving students from the beginning of their careers to acquire basic research skills, such as the search for information from authoritative and reliable sources, the critical analysis of knowledge, and the development of oral and written communication skills to be able to present the results. All these competencies are important for future professionals and can be taught to undergraduate students. Furthermore, students would feel better oriented in their chosen university careers, and consequently, they could become more involved and motivated to carry out their studies (Boyer, 1998).

Some researchers found that research-based learning can improve academic achievement, promote learning style, and build new knowledge with oneself (Brew, 2010). Research-based learning has advantages for the students: to improve the learning motivation, encourage skills to perform a certain important task, to improve problem-solving skill especially on complex problems, to make the students more active and able to solve complex problems, to make comfortable learning process, to improve interactivity, and mutual collaboration (Suntusia et al., 2019). It also can develop and practice the communication skills, give students an experience of project organization, provide a learning experience that involves students in learning to gather data and information, to analyze the data according to the data types and at the end disseminating the research results (Sucianto et al., 2019).

This methodology facilitates the development of students' cognitive activities by stimulating creativity, critical analysis, logic, flexibility, risk management, research skills, problem solving, initiative, mental conflict, resolution, summation, and conclusion. Furthermore, this type of research learning is based on a shared interaction between the students themselves, stimulating communication and teamwork, as well as decision-making skills.

Furthermore, since the search for new and updated studies, as well as the knowledge of the state of the art, allows students to be critical of the state of the research, of what are the strengths and weaknesses and therefore to stimulate the student in the investigation of new and alternative solutions to the problem.

Disadvantages of the method

The main disadvantage could be represented by an incorrect guide for the student in following this methodology. A student who has never performed an RLB could conduct incorrect research, and not have the maturity and criticality to identify which research needs attention and with what degree of attention. For example, the student may not evaluate how old the research findings are compared to the current state of the art or what is the order in which to perform this study. In fact, the position of the teacher is essential, as he must illustrate procedures and tools to follow.

Proposed application strategies

Research-based learning is suitable for this course as this is a Master`s level course, and students should have gained some research skills in bachelor-level studies. It is also fundamental for the search for new and alternative solutions concerning the existing state of the art. Students could develop a research project about circular economy in wooden construction and use their research skills in developing a report according to requirements.

1.2.3. Blended-Learning Approach

Since the mid-1990s, larger student enrolments and more diverse student populations have resulted in a greater emphasis on enhancing students' learning experiences in higher education (Poon, 2013). In the late 1990s, Blended Learning (or mixed or hybrid learning) emerged as a new teaching method for distance learning through the application of technology and the internet to improve students' learning and encourage teachers to change their methods of education, and therefore to shift learning to a more student-centered model rather than a teacher-centered learning model (Taylor, 1995).

The simplest form of blended learning was considered as a mixture of physical classroom activities and learning activities supported by online technologies (Garrison & Kanuka, 2004) and was further developed into the integration of learning activities, students, and instructors (You, 2015).

Graham (2006) describes blended learning as "*the convergence of face-to-face settings, which are characterized by synchronous and human interaction, with Information and Communication Technology (ICT) based settings, which are asynchronous, text based, and involve humans operating independently*". Thus, Blended Learning can be defined as the integration of thoughtfully selected and complementary face -to-face and online approaches and technologies (Kaur, 2013). Kaur (2013) summarized Blended Learning definitions from various perspectives (see Table 3).

Table 3. Definitions of the Blended Learning approach (based on Kaur, 2013)

Perspective	Definition	Author
Holistic perspective	The delivery of instruction using multiple media. This includes the integration of instructional media into a traditional classroom, or into a distance learning environment. It also includes any combination of media that supports instruction, regardless of the mix of synchronous or asynchronous media	Holden and Westfall (2006)
Educational perspective	Blended learning means courses that integrate online with traditional face-to-face class activities in a planned pedagogically valuable manner; and where a portion of face-to-face time is replaced by online activity. It is primarily focused on integrating two separate paradigms, the classroom–synchronous, and online–asynchronous	Laster (2005)
Pragmatic perspective	Courses that are taught both in the classroom and at a distance, and that use a mix of different pedagogic strategies: - To combine various pedagogical approaches, such as constructivism, behaviourism, cognitive learning approaches to produce an optimal learning outcome with or without the use of instructional technology. - To combine any form of instructional technology such as CDs, films, web-based training with face-to-face instructor-led programming. - To mix or combine instructional technology with actual job tasks to create a harmonious effect in terms of learning and working.	Blended Learning (2009)
Corporate training perspective	The use of multiple instructional media to deliver one course or curriculum, such as a sales training course involving pre-reading, lectures, and role-play practices.	Wexler (2008)
CLO – Chief learning officer perspective	Executing a learning strategy that integrates multiple delivery modalities (both synchronous and asynchronous) and, in doing so, creates the best possible learning solution for the target audience.	Peters (2009)

The major characteristics of Blended Learning can be summarized as follows (Graham, 2006; Whitelock & Jelfs, 2003):

- Blended learning strategy combines different types of internet-based technology to achieve educational goals.
- The blended learning strategy is a hybrid of traditional methods of education with technology and the internet.
- Blended learning integrates different teaching methods based on multiple theories such as Constructivism and Behavioural theory.
- Blended learning is an education program that consists of in-person classroom time as well as individual study online through e-learning applied and the internet.

Khan et al. (2012) and Salakhova et al. (2020) conducted a comparative analysis of technologies of the traditional forms of learning and blended learning (see Table 4). According to the results of the comparative analysis, blended learning creates a new environment that makes it possible to focus on the students' styles and interests. The electronic environment has several specific capabilities and advantages compared to the traditional learning model.

Table 4. Comparative analysis of technologies of the traditional form of education and blended learning (Khan et al., 2012; Salakhova et al., 2020)

Education process	Technology of “Blended learning”	Traditional approach
Application location	Any place and flexible	Fixed classrooms and not flexible
Method of Learning	Online and Face-to-Face	Face-to-Face
Usage of Technology	Using the technology is necessary and mandatory	Using Technology not mandatory
Preparation for a class	Looking through the answers to the tests determining difficult questions among students, the selection of drills and developing exercises.	Writing a plan / text for a lecture (a seminar), preparation of training and developmental exercises.
Technology of conducting a class	The teacher guides students to solve difficult issues and hone skills.	The teacher explains the new material at the lecture, controls understanding, at a practical class student consolidate their skills.
Learning technology	Students independently watch a video lecture, prepare questions. The teacher guides students to solve difficult issues and hone skills.	The teacher explains the new material, controls the understanding of the material, students do exercises on their own at home.
Knowledge transfer	Knowledge is acquired independently with elements of interactive forms.	The teaching material is transferred from the teacher to the students in a passive form.
Methods/ technologies	Communication, cooperation, collaboration.	Interactive technologies.
Approaches	Personalized.	Differential.
ICT	Office 365, Google, Web-2, Moodle, etc.	Multimedia and web technology.
Activity of students	Active.	Passive

Student	Responsible for his/her training. Interacts with all participants in the educational process.	Studies according to the activity scheme "listen - remember - reproduce", plays the role of a mentor.
Teacher	Carries out the construction of educational activities, fulfils the role of mentor.	Carries out the transfer and control of knowledge, maintains discipline and order in the classroom.

The Blended Learning approach can be categorized in terms of the focus of learning by making three kinds of broad distinctions (Nair, 2019):

- Skill-driven learning:
  Combines self-paced learning with optimal support from the instructor or facilitator side to develop specialized skills.
- Attitude-driven learning:
  This approach to blended learning uses digital media solutions to bring about a behavioral or attitude change.
- Competency-driven learning:
  This type of learning is focussed on developing professional skills and competency to survive and thrive in a professional space. For this purpose, students are assisted with knowledge management applications and mentoring by teachers.

Kaur (2013) distinguished three essential components of Blended Learning approach, namely learning environment, media and instructions.

1. Learning environment component
   A learning environment can either be *synchronous* or *asynchronous*. Each learning environment has a distinct set of advantages and disadvantages. The goal of blended learning is to leverage the specific positive attributes of each environment to ensure the optimum use of resources to attain the instructional goal and learning objectives (Holden et al., 2015; Kaur, 2013).
2. Media component
   Media refers to vehicles that deliver content. Some instructional media, however, may be more appropriate than others in supporting either a synchronous or asynchronous learning environment, but no single medium is inherently better or worse than any other (Holden et al., 2015; Kaur, 2013). Different types of useful media for Blended Learning are provided in Table 5.
3. Instructional component
   This component is used to select the most appropriate instructional strategies that support the learning objectives. Such strategies are the products of learning objectives and serve to ensure the learning objectives and facilitate the transfer of learning. When developing Blended Learning, maintaining instructional quality is paramount (Kaur, 2013).

Table 5. Media used in Blended Learning (Rossett et al., 2013)

Live face-to-face (formal) 1. Instructor-led classroom 2. Workshops 3. Coaching/mentoring 4. On-the-job (OTJ) training	**Live face-to-face (informal)** - Collegial connections - Work teams - Role modelling
Virtual collaboration/synchronous - Live e-learning classes - E-mentoring	**Virtual collaboration/asynchronous** - E-mail - Online bulletin boards - Listservs - Online communities
Self-paced learning - Web learning modules - Online resource links - Simulations - Scenarios - Video and audio CDs/DVDs - Online self-assessment - Workbooks	**Performance support** - Help systems - Print job aids - Knowledge databases - Documentation - Performance/decision support tools

Synchronous instructional methods consist of traditional classrooms, virtual classrooms, live product practice labs, interactive chatrooms, and mentoring (Woodall, 2010; Kaur, 2013). *Traditional classrooms* allow instructors and learners to be face-to-face in the same place. The subjects usually consist of topics such as complex, broad, programmatic, or new content, that require face-to-face interaction, expert observation, culture building, team building, networking, business problem solving, or materials to be presented by an instructor or facilitator. The term Instructor-Led Training (ILT) is used synonymously with on-site training and classroom training. (Woodall, 2010.)

Virtual classrooms allow instructors and learners to be in different places at the same time and allow the instructor to archive the event for later viewing. These events are usually conducted using virtual meeting tools. The topics covered can be like those dealt with in a live classroom unless they are too complex or contentious. (Woodall, 2010.)

Asynchronous learning is based on the schedule. While the course of study, instructor, or program provides materials for reading, lectures for viewing, assignments for completing, and exams for evaluation, the student can access and satisfy these requirements on their own schedule but must meet the expected deadlines. Common methods of asynchronous online learning include self-guided lesson modules, pre-recorded video content, virtual libraries, lecture notes, and online discussion boards or social media platforms (TBS Staff, 2021).

Success Factors for Blended Learning

According to Poon (2013), some factors that affect the success of blended learning are distinguished. These factors fall into two major categories – the student and the institutional factors.

1. Student related factors:

Consideration of learners' needs, and management of their expectations and the level of understanding is central to the successful development and implementation of Blended Learning modules (Bliuc et al., 2007; Harris et al., 2009; Mitchell & Honore, 2007, cit. from Poon, 2013).

Evidence from the literature also suggests that it is essential to consider learners' motivation (Stewart, 2002) and ability to cope with independent learning (Tabor, 2007). The attitude and motivation of learners as particularly significant when virtual learning (e-learning) is involved, as those factors affect acceptance and participation (Mitchell & Honore, 2007). It is necessary to manage students' expectations, especially the idea that fewer face-to-face classes mean less work. In fact, students must be encouraged to take more responsibility for and autonomy over their learning (Tabor, 2007; Vaughan, 2007, cit. from Poon, 2013).

Furthermore, Blended Learning can only be successfully implemented if the learners have sufficient knowledge of, and are ready to use, the newly introduced technology. Learners must be trained and equipped to navigate the information and communication technology used in blended learning (Beadle & Santy, 2008; Harris et al., 2009, cit. from Poon, 2013).

2. Institutional factors:

The first suggestion for institutions that intend to implement Blended Learning is that they must be realistic about the investment of time, effort, and resources required for development and implementation (Poon, 2013). That includes spending resources on communication to encourage instructors and prospective end-users to become actively involved and fully aware of Blended Learning initiatives (Garrison & Kanuka, 2004; Harris et al., 2009).

Institutions must create the necessary policy, planning, resources, scheduling, and support systems to ensure that Blended Learning initiatives are successful. The resources required are not restricted solely to the acquisition of equipment and technology but also refer to the human resources used in developing and managing the implementation of Blended Learning. It is also important to provide technology training and support for the students and professional development for the academics who will use the Blended Learning approach. The development program should teach academics how to redesign their courses, the most effective way to deliver their courses online, and the effective use of technology (Beadle & Santy, 2008; Harris et al., 2009; Poon, 2013)

There are also technological requirements for Blended Learning to be successful. Stewart (2002) suggests that course content and learning approaches be evaluated for accessibility, with consideration of bandwidth, firewalls, and connection speed, while Childs et al. (2005) suggest that easy and regular access to technology for both facilitators and learners is a prerequisite for the successful delivery of e-learning.

Advantages of the method

Literature review revealed main advantages and benefits of the Blended Learning approach, which are summarized in Table 6.

Table 6. Benefits of Blended Learning approach (based on literature review)

Benefits	Description	Authors
Improved students' grades and pass rates	Blended Learning has a positive effect in reducing dropout rates and improving examination marks	Garrison and Kanuka (2004); López-Pérez et al. (2011); Kenney and Newcombe (2011); Almasaeid (2014); Akbarov et al. (2018); Bakeer (2018); Boyle et al. (2003); Khader (2016); Vernadakis et al. (2012)
Enhanced student learning outcomes	Blended Learning improves learning outcomes for students	Boyle et al. (2003); Dziuban et al. (2006); Lim and Morris (2009); O'Toole and Absalom (2003); Twigg (2003a); Poon (2013); Kaur (2013)
Student's satisfaction	Blended Learning enables the students to become more motivated and more involved in the learning process, thereby enhancing their commitment and perseverance.	Donnelly (2010); Sharpe et al. (2006); Wang et al. (2009); Woltering et al. (2009); Owston et al. (2008); Twigg (2003); Poon (2013)
Ability to foster a professional learning environment	Encourages students to learn in an interactive and collaborative environment, and at their own pace and in their own time	Graham (2006); Owston et al. (2008) (Poon, 2013)
Greater flexibility for students and teachers	Increased flexibility of access to learning that reinforces the student's autonomy, reflection, and powers of research. The online components benefit other learners by allowing them to work whenever and wherever they prefer, as they can access the Internet without making the journey to campus	Sharpe et al. (2006); Poon (2013); Kaur (2013)
Potential cost and resource savings	Costs for institutions are saved as developed materials can be placed online and re-used for an extended period of time. The use of blended learning can reduce the staff and student classroom contact time and consequently save on staffing costs.	Graham (2006); Vaughan (2007); Poon (2013)

All benefits are valid in the education of civil engineering and construction technology students. Face-to-face lectures and site visits are combined with e-learning approaches. It allows students to learn and access material in a variety of modes. Teachers on the other hand, can make the content of the course attractive to students. Blended Learning has the potential to enhance the personalization and relevance of studies.

Disadvantages of the method

Literature review revealed main challenges of the Blended Learning approach, which are summarized in Table 7

Table 7. Challenges of Blended Learning approach

Challenges	Description	Authors
Technological problems for students and institutions	Users can get into difficulties with technology use, failure of technological applications, bad internet connection, etc.	Hofmann (2014); Smyth et al. (2012); Welker and Berardino (2005–2006); Poon (2013); Kaur (2013)
Unrealistic student expectations	Some students may assume that fewer classes mean less work. Thus, they can experience problems with accepting responsibility for personal learning.	Vaughan (2007); Poon (2013); Park and Choi (2009)
Student-perceived isolation	Reduced opportunities for social interaction in a face-to-face classroom environment. The teacher may have difficulty attracting certain categories of students to the educational process.	Smyth et al. (2012); Poon (2013); Salakhova et al. (2020)
Large initial load on the preparation of the course	Planning and developing a blended learning course usually takes two to three times the amount of time required to develop a similar course in a traditional format.	Johnson (2002); Poon (2013); Salakhova et al. (2020)
Difficulty in acquiring new teaching and technology skills	Difficulty in acquiring new learning technology skills, such as how to foster online learning communities, facilitate online discussion forums, and manage students	Voos (2003); Poon (2013); Salakhova et al. (2020)

Again, all challenges are valid in the education of civil engineering and construction technology students. Preparing an interactive course for engineering students is time-consuming. Some students unrealistically expect that the Blended Learning course is "easier" and they can "multitask" during the lectures. Higher technological skills are required from both students and teachers. Technical problems, especially related to the internet connection, are unpredictable.

Proposed application strategies

This method is usable in organizing intensive learning courses for Master's students. An E-learning course fits nicely between the two intensive face-to-face courses. The project will develop an E-learning platform and, thus, implement the Blended Learning approach.

1.2.4. Social leadership approach

Social leadership is an approach, which allows leaders to increase social capital in their teams. Approach is also applicable for any team member, as it allows to examine own understanding of trust and interaction/ dialogue skills.

<u>Background for development of social leadership</u>

The need to develop social aspects of leadership have been discussed in engineering leadership literature over the past years in increasing amount compared to earlier years. Particularly literature concerning alliance contract model, a form of construction contract where financial benefits and risks are shared between different stakeholders, emphasises importance of "soft skills" as trust, co-operation and commitment as crucial leadership skills in construction. (Yli-viilamo et. al 2013).

Ristola (2016) writes of organizational culture and specifically meaning of building trust. Swift from old structures to new co-operative ways of working does not happen overnight. Bringing different parties to a same room does not create trust. Different trainings and rewarding policies may function as agents for change.

Love et. al (2006) write of total quality management and meaning of learning. Commitment is a key to learning. Change is needed in culture and behavior amongst professionals, teachers and professional institutions. They see that change can be achieved by bringing philosophical elements to leadership thinking. They see so called "mind set" to be more important than concretical actions.
"Social leadership" in this context is an developing approach, where the social connotation of leadership is collectively examined in the group in the field of construction. Phenomena attached to this concept are trust and interaction. The selection of these concepts are based on both literature and on interviews with construction managers (RRR- project 2019).

<u>How should leadership be taught in engineering</u>
Rottmann's (2015) research show clearly, that leadership position is seen in a negative light amongst engineering students. Leadership position is seen hierarchically challenging and to be in conflict with the core task; which is solving technical problems. "Social leadership" answers this problem as it connects these two identities, technical and human, in a way where student participants can themselves create their shared conception of trust and interaction, which is supported by/ integrated with.

Kumar & Hsiao (2007) write in their article "Engineers learn Soft skills in a hard way" that necessary leadership skills concerning challenging interaction are often learned in working life after graduation. They require changes in education system and have used a problem-based orientation to teach interaction skills at classroom. According to their experiences problem based learning and service learning (often used in social field) are good choices for these purposes. They underline importance of hands-on teaching to bring the results. This suits well to use of functional methods and allocation class time to interactive exercises.

Lean thinking is emphasized in contemporary construction management research (e.g. Dave, 2016; Gao, 2015; Aziz, 2013) and it has become a widely appreciated tool in construction management. Brioso (2015) has develop lean management training programme for master students. The training course provided an understanding of Lean Construction Principles and methods through lectures, workshops, simulations, and discussion periods. The resources utilized represented a low investment so they could be easily replicated by the attendees.

Rottman et al. (2015) have studied engineering leadership in context of identity. They claim that acceptance and implementation of engineering leadership education depends on widespread recognition of engineering as a leadership profession. They have found four barriers to this recognition. Reese (2003) (In Rottman) write that it takes 5-10 years for an engineer to become accustomed to managing technical processes. Swift to human leadership might feel both uncomfortable and "un-engineer" like. Secondly, traditional hierarchical leadership role may be in contradiction with egalitarian team based norms (Breaux, 2006, Graham, 2012a in Rottman). Thirdly, leadership as a term may resonate in a negative manner to people whose reputation hinge on technical precision. (Gopakumar, 2013 and McGrath 2001 in Rottmann). Fourth viewpoint deals with educational system; as long as leadership is offered as optional extracurricular involvement students see it as peripheral to core curriculum (Alajek et al, 2013, McGarth, 2010 in Rottman).

Rottman et al (2015) name three viewpoints that should be taken into account when planning leadership education in technical field. First, engineering students should be socialized to think of their discipline having two both technical and humanistic elements. (CEAB, 2008; EC, 2009; NAE 2004 in Rottman). Second advice is, that engineering students should be exposed to leadership education that forces to unpack traditional and hierarchical view of leadership. (Baranowski,, 2011; Foster & Sheridan, 2013; Grasso & Martinelli, 2007; Harris, 1989 in Rottman). Thirdly, engineering leadership should be defined more clearly on the basis of engineers' professional experiences (Andrews and Farris, 1967; Reeve, 2010; Reeve et al. 2013 in Rottman)

To further clarify the experienced need to develop human leadership in the field of construction empirical data has been utililised. This data consists of eight interviews conducted in Nordlund's doctoral thesis process. The content analysed data clearly confirms, that trust, interaction and co-operation are the most important themes in social leadership.

All these themes are included in the concept of social capital. Therefore it can be argued, that examining social capital and finding pedagogical design to promote social capital in a group is the essence of social leadership. This is the objective of the study module. These skills are developed alongside technical/ managerial skills to support the two different leadership identities.

From the information, we have gathered we need to draw conclusions on what kind of pedagogical design needs to be constructed in order to achieve the object of increased social capital. We pay attention to the following

As mentioned earlier, empirical data together with objectives of Wood in Circle project lock the content to social capital. This is in line with literature findings, though naturally id not covering all leadership development needs. Based on our prior experience we highlight the importance of integrating the technical and social content to resolve what Rottmann (2015) calls identity conflict.
The collection of recommended pedagogical solutions seems to favour non-behavioristic styles, as is outlined also in the Wood in Circle objectives. We see that the design to fit to these recommendations is a combination of Laurea's Learning by Developing. In this chapter we open up these concepts and in chapter four present a plan of execution.

Advantages of the method

Multiprofessional work and phenomenon based learning require students to see the substance as phenomena which cross traditional boundaries of disciplines. Social leadership (trust and interaction) raise social capital and therefore help to communicate more efficiently. Service design helps to gather together the project based approaches and promotes innovation. Services as results are also circular economy friendly.

Disadvantages of the method

As Rottman (2015) states, there is an identity conflict between soft leadership skills and technological expertise which is consider the primary engineering leadership task. Presenting soft skills in a wrong manner may cause resistance to participate due to this reason.

Proposed application strategies

The “social leadership”- module starts the e-learning course “Circular economy in wooden construction.”

First the students will conduct two social leadership exercises concerning trust and interaction. After this, in Hämeenlinna intensive week they will participate in the development project, social exercises

<u>Discussion and exercises concerning personal relationship towards the concept of trust</u>

The students will be provided a story where different aspects of trust are present. Exercises related to reflecting own conception of trust will be created.

<u>Discussion and exercises concerning dialogue as a tool for strengthening trust</u>

Principles of dialogue are presented in the next chapter of story. Students examine themselves as interactors by help of dialogical exercises.

<u>Different wooden construction related exercises construct technical knowledge</u>

Students conduct different activities concerning wood construction, communality and finances in the example case Mainiemi mill area. Further on story is written to describe these exercises and same familiar characters “hold” the earlier elements of trust and interaction alongside technical knowhow.

2. THE METHODOLOGICAL FRAMEWORK

As we have learned, the education of civil engineering and construction technology engineering needs to be renewed in a way that supports students' active learning. Recommendations for learning strategies favor hands-on methods that allow peer interaction and attachment of experience to the learning process.

It is generally acknowledged that conventional teaching methods do not enhance students' active learning, problem-solving, critical thinking, collaboration, and creativity needed in complex transdisciplinary situations. The teacher-centered approaches focus on the transmission of information from teachers to students through various teaching activities such as lectures and examinations. The student-centered philosophy emphasizes, on the other hand, the student's learning experience and permanent learning. The students are actively involved in their learning process. They create their knowledge through real-world experiences instead of being passive and gaining knowledge and information only from their teachers (Muganga & Ssenkusu, 2019; Brown, 2003; de Boer Garbin et al., 2020; Bhosale, 2020; Borda et al., 2020).

The challenge is, however, developing methodological frameworks that guide the design of the learning experience. In this chapter, we describe the development and content of a methodological framework.

2.1.1. Development of a methodological framework

According to McMeekin et al. (2020), there is no formal definition of what constitutes a methodological framework nor published guidance on to develop one either. The authors analyzed 30 studies to understand how such frameworks are developed and found seven different approaches. Most commonly, frameworks have the basis of existing methods and guidelines. The popular approaches are refined and validated through experience and expertise, literature review, data synthesis, and amalgamation, data extraction, iteratively developed, and lab work results.

However, there is an unspoken consensus that the framework should provide structured practical guidance or a tool that guides the user in the process through a step-by-step approach or using different stages (references 1-5). The framework should include specific structures: It is a “set of structured principles, an approach for structuring how a given task is performed” (IGI Global, 2019). It is also seen as a “sequence of methods,” a body of methods, rules, and postulates employed by a particular procedure or set of procedures” (Rivera et al., 2017).

McMeekin et al. (2020) identified three phases in developing methodological frameworks (Figure 1). The stages follow each other and start with identifying the evidence to inform a methodological framework. The second phase is developing the methodological framework, followed by evaluating and defining the framework. The Wood in Circle project applied the three-phase process (Figure 1.) by McMeekin et al. (2020).

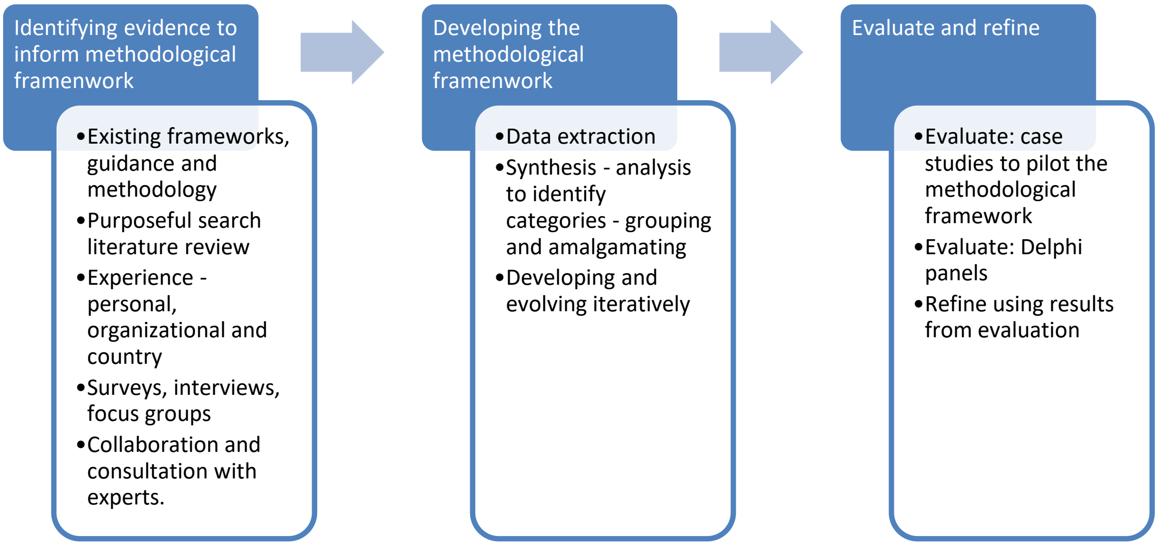

Figure 1. The process of developing a methodological framework by McMeekin et al. (2020)

Phase 1 – identifying evidence to inform the methodological framework

This phase includes two steps. The first is identifying previous frameworks or guidance used for the foundations of the new methodological framework. The second is identifying new data to help develop the methodological framework. There are several sources for the data, such as purposeful literature searches, qualitative research (focus groups, interviews, surveys), the collaboration between interested parties, and the experience and expertise of the developers. If qualitative research is included, it should be conducted with experts in the field of the methodological framework and not restricted to the author's experiences (McMeekin, 2020).

This stage started when the project applied for funding and continued during the first project year. Literature reviews and authors' experiences pointed to the need to increase student-centered pedagogies in the curriculum. Therefore, blended learning, research-based learning, phenomenon-based learning, and social leadership were natural choices as pedagogical approaches.

Social leadership as a newly developing approach differs from blended learning, research based-learning, and phenomenon-based learning. It is not a pedagogical approach per se but refers more to a philosophical mindset to set yourself into communication with others. Social leadership strongly connects to leadership but is a generic working skill. All team members should be aware of and develop it, yet it is the leader's main responsibility.

Phase 2 – developing the methodological framework

In this phase, the frameworks or guidance identified in the previous step are adapted, combined with other instructions, and built upon to create the foundations of the new methodological framework. The information is processed using appropriate methods, such as transcribing qualitative data, entering themes into predesigned tables, and entering quantitative information into piloted data extraction forms. Once the information is extracted, it should be analyzed, synthesized, and grouped or amalgamated into categories to inform the new framework. The process is iterative; after grouping the new data, it is brought back to the key experts and the study team for refinement. This iterative approach continues until consensus is reached on the proposed methodological framework (McMeekin, 2020).

The project partners analyzed research information on blended learning, research-based learning, phenomenon-based learning, and social leadership in the spring of 2021. Laurea UAS gathered the analysis reports from partners and carried out content analyses. The aims were to summarize the content into generalizations and to generate a synthesis of each approach to see which topics are most relevant to lift into the center of attention in the creation of the study unit. The main themes were decided in internal discussions based on experience and analysis findings.

The project partners wanted to look for a corresponding match to resonate with a bigger picture, the main idea of student-centeredness. Based on project discussions, constructivism became an umbrella concept of the methodological framework. Blended learning, phenomenon-based learning, and research-based learning are based on constructivist ideology. Therefore, they were situated under the umbrella of constructivism in the framework structure (Figure 2). Social leadership as a mindset was seen as a cross-cutting theme and an entity of its own.

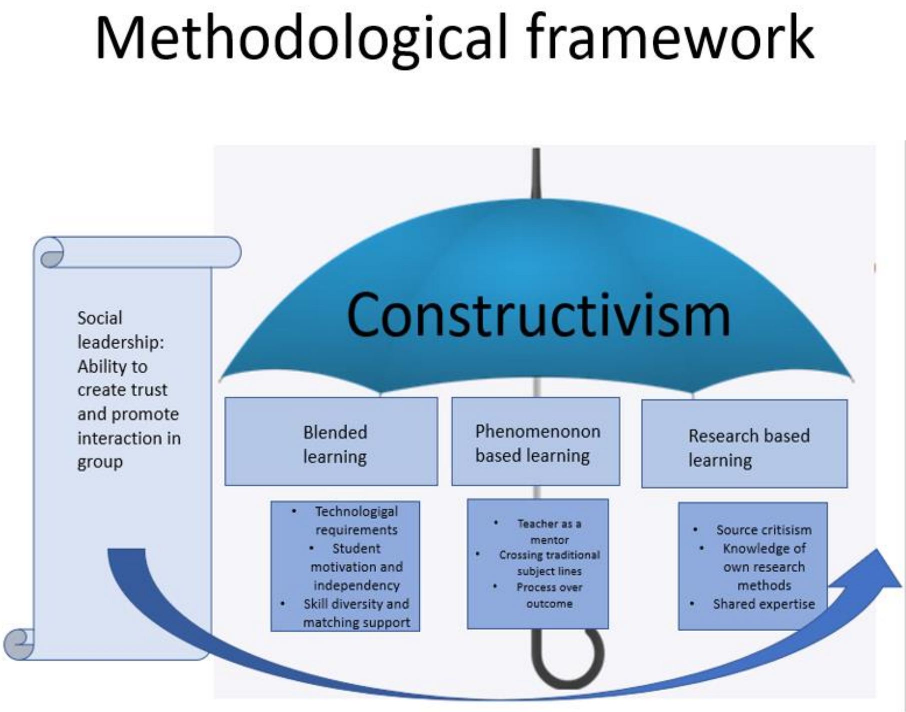

Figure 2. The structure of methodological framework

Phase 3 – evaluate and refine

In this final stage, the proposed methodological framework should be evaluated and refined. Evaluation techniques include using case studies to pilot the methodological framework and Delphi panels. The results from this evaluation are used to refine the methodological framework if appropriate. Refining will include updating the methodological framework with any changes identified from the evaluation stage and presenting these changes to key experts and the study team for verification.

These suggestions are not intended to be prescriptive, and the developer should adapt them to their specific situation. Finally, the developer should include the term ‘methodological framework’ at least in the title of the study, preferably in the body of the text too, and as a keyword if possible.

At the end of the project, the methodological framework was evaluated and refined by the project partners and students. Laurea UAS introduced the methodological framework for the project partners, who integrated it into the course curriculum and teaching.

2.1.2. Constructivism as an umbrella concept

De Boer Garbin et al. (2020) argue that the constructivist approach is a paradigm for student-centered approaches. Constructivism promotes essential skills for professional performance in engineering (Elander & Cronje, 2020). Christie & Graaf (2017) discuss the meaning of active learning in engineering education. They define active learning as an approach to instruction where the student participates in the learning process. Despite the growing awareness of student participation, passive ways of learning still dominate engineering education (Byers et al., 2018).

In constructivism, the world does not have absolute truths or pre-existing knowledge. Scientific knowledge and truths are built by scientists. People who are the subject of research also produce information in their actions. In constructivist research, phenomena and world meanings are socially and culturally produced structures. Constructivist research usually applies qualitative methods. Constructivism is conceptualized as the opposite trend of positivism (Jyväskylän yliopisto, 2021).

Five themes pervade the diversity of theories expressing constructivism: 1) active agency, 2) order, 3) self, 4) social-symbolic relatedness, and 5) lifespan development. With different language and terminological preferences, constructivists have proposed, first, that human experiencing involves continuous active agency. This distinguishes constructivism from forms of determinism that cast humans as passive pawns in the play of larger forces. Second, comes the contention that much human activity is devoted to ordering processes – the organizational patterning of experience using tacit, emotional meaning-making processes. In a third common contention, constructivists argue that the organization of personal activity is fundamentally self-referent or recursive. It makes the body a fulcrum of experiencing and honors a deep phenomenological sense of selfhood or personal identity. But the self is not an isolated island of Cartesian mentation. Persons exist and grow in living webs of relationships.

The fourth common theme of constructivism is that individuals cannot be understood apart from their organic embeddedness in social and symbolic systems. Finally, all active, meaningful, and socially embedded self-organizations reflect an ongoing developmental flow in which dynamic dialectical tensions are essential. Order and disorder co-exist in lifelong quests for a dynamic balance that is never quite achieved. The existential tone here is unmistakable. Together, these five themes convey a constructive view of human experience as one that emphasizes meaningful action by a developing self in complex and unfolding relationships. One can easily see the spectrum of contributions that have constructed constructivism (Mahoney, 2004).

SUMMARY: CONSTUCTIVISM

In constructivism, the world does not have absolute truths.

Phenomena and world meanings are socially and culturally produced structures.

Learning is seen as an active process of a learner instead of passively taking in knowledge and information.

Learners actively construct their knowledge and integrate new information into their pre-existing knowledge and experiences.

A paradigm for student-centered approaches: enhance students' active learning, problem-solving, critical thinking, collaboration, and creativity needed in complex transdisciplinary situations.

2.1.3. Pedagogical triangle

The methodological framework guides designing and facilitating a learning experience by informing how to implement the core values, theoretical assumptions, and preferences into a specific learning situation. It is essential that teachers understand learning theories and their impact on learning and teaching. In the project, constructivism was applied as a theory and concept of learning and teaching. Pedagogical models (methods) are blended learning, phenomenon-based learning, and research-based learning. The teaching methods in the course were selected based on the previous two layers shown in Figure 3.

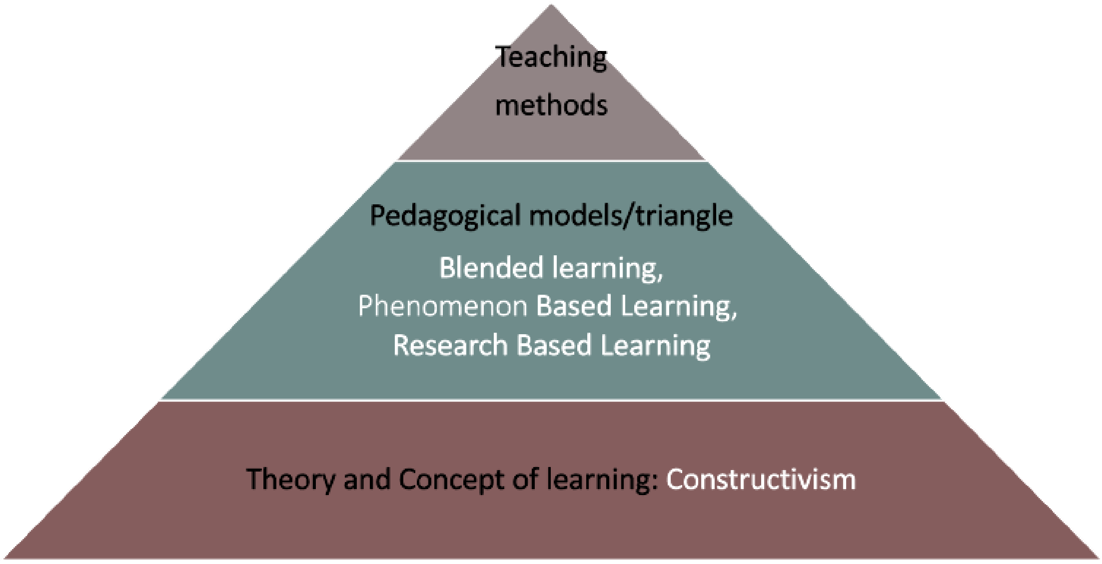

Figure 3. Relation of the theory of learning, pedagogical models, and teaching methods

Here a pedagogical triangle (Figure 4) is a tool to examine sensitive teaching and learning processes. As a form of a triangle, any pedagogical action can be defined as a space between the three points of a triangle: the teacher, the student, and the knowledge/content/subject to be learned.

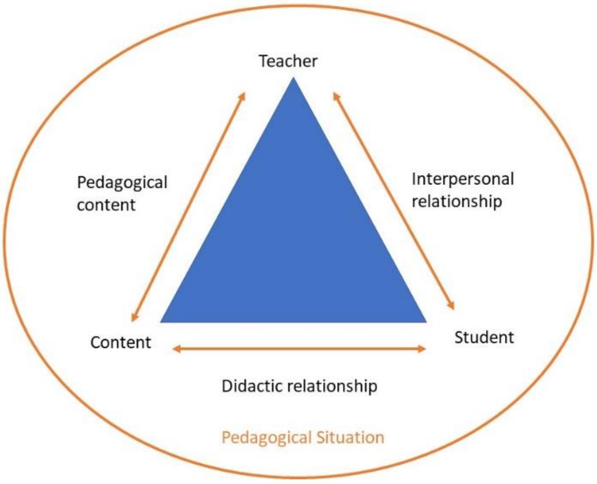

Figure 4. The pedagogical triangle by Friesen & Osguthorpe (2017)

The pedagogical triangle presented here consists of two overlapping forms. The circle form represents the pedagogical situation or context, and the triangle outlines the relationship between the teacher, student, and content (Friesen & Osguthorpe, 2017). The pedagogical triangle helps to define

- Who (student) should learn what and with whom (teacher, other students, and other kinds of participants)?
- Where and how does learning take place (pedagogical situation)?
- What is the purpose of learning?

The elements of the triangle refer to different pedagogical possibilities depending on whether only one of the triangle points is considered or whether the relationship between them is the priority.

The teacher constitutes the teacher's personal history, education, knowledge, competencies, and experience. The learner includes issues such as learning, growth, skills, and social interaction. The content consists of all the subjects of the curriculum. (Friesen & Osguthorpe, 2017).

2.1.4. Any place and flexible – Blended learning

As mentioned earlier the simplest form of blended learning is a mixture of physical classroom activities and learning activities supported by online technologies (Garrison & Kanuka, 2004). It has developed further into the integration of learning activities, students, and instructors (You, 2015). Figure 5 describes an example of a blended learning situation with the structure of the pedagogical triangle.

SUMMARY: BLENDED-LEARNING

Combines different types of internet-based technology to achieve educational goals.

A hybrid of traditional methods of education with technology and the internet.

Integrates different teaching methods based on multiple theories such as Constructivism.

Consists of in-person classroom time as well as individual study online through e-learning and the internet.

Creates a new environment that makes it possible to focus on the individual styles of students and their interests.

Integrates thoughtfully selected and complementary face -to-face and online approaches and technologies.

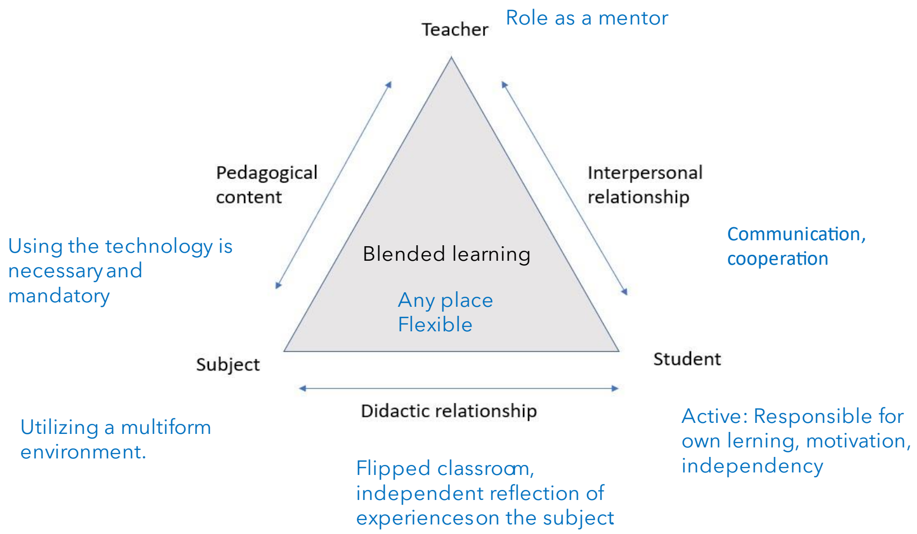

Figure 5. An example of a blended learning situation with the structure of the pedagogical triangle

2.1.5. Process over outcome – Phenomenon based learning

In a Phenomenon-based learning process, the emphasis is on the trip traveled, not the destination. Learning is a cyclical process in which obtained information is constantly reverted to, reflected upon, and added by researching more. Phenomenon-based learning entices learners to research the topic in question outside the teaching situation. It helps the learner function better in the modern working environment.

Teaching is embedded in a problem-solving environment in a phenomenon-based learning. The teacher starts by posing questions or problems, and the students build answers together to questions or problems posed concerning a phenomenon that interests them. Instructional goals are negotiated, not imposed, and evaluation serves as a self-analysis tool. Figure 6. shows an example of a phenomenon based learning situation with the structure of the pedagogical triangle.

SUMMARY OF PHENOMENON-BASED APPROACH

There is a responsive relation between teaching and learning

It crosses the traditional subject lines and stresses the learning process over the learning outcome.

Learning is a cumulative and guided process. It consists of five dimensions: holisticity, authenticity, contextuality, problem-based inquiry learning, and the learning process. Learning starts with the observation of a phenomenon from different points of view.

Theories to be learned by the students are connected to practical situations and phenomena.

Teacher acts as a mentor and don’t fully instruct the learning process.

Students have an active role and set their own goals and solve problems independently & collaboratively with others.

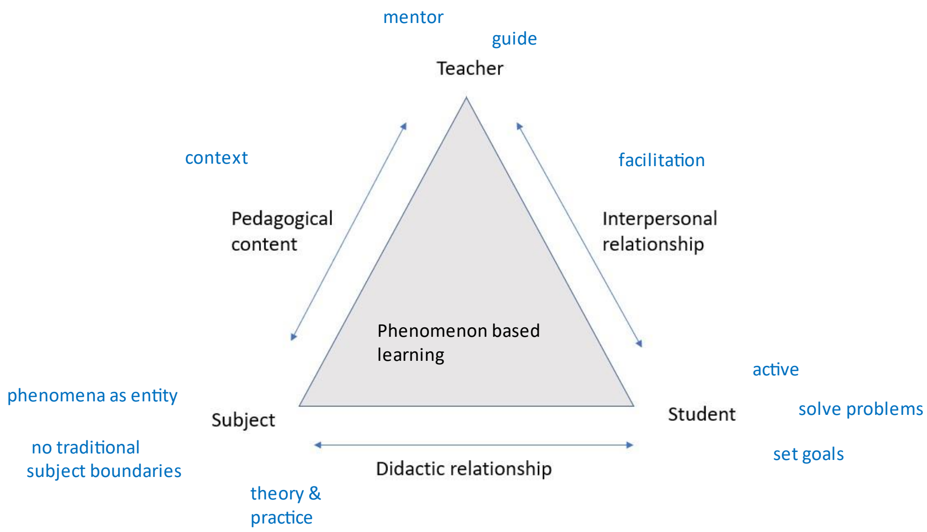

Figure 6. An example of a phenomenon-based learning situation with the structure of the pedagogical triangle

2.2.4. Analyzing, synthesizing, and evaluating – Research based learning

Research-based learning aims to promote and develop student competencies related to research practice and to benefit students through activities linked to research. The technique implies the application of learning and teaching strategies that link research with teaching.

Research-based learning is a learning method using contextual learning, authentic learning, problem-solving, cooperative learning, hands-on and minds-on learning, and inquiry discovery approach, in which the target of RBL is to encourage the high-level thinking skill of students. Source criticism, knowledge of own research methods, and shared expertise are essential. An illustration of a research-based learning situation with the structure of the pedagogical triangle is shown in Figure 7.

> SUMMARY OF RESEARCH-BASED LEARNING
>
> Students are directed to a higher level of thinking skills, namely creating or communicating.
>
> Teachers encourage students to be researchers, discoverers, and creators of their own and others' learning.
>
> Promotes and develops students' competencies related to research practice and benefits students through activities linked to research.

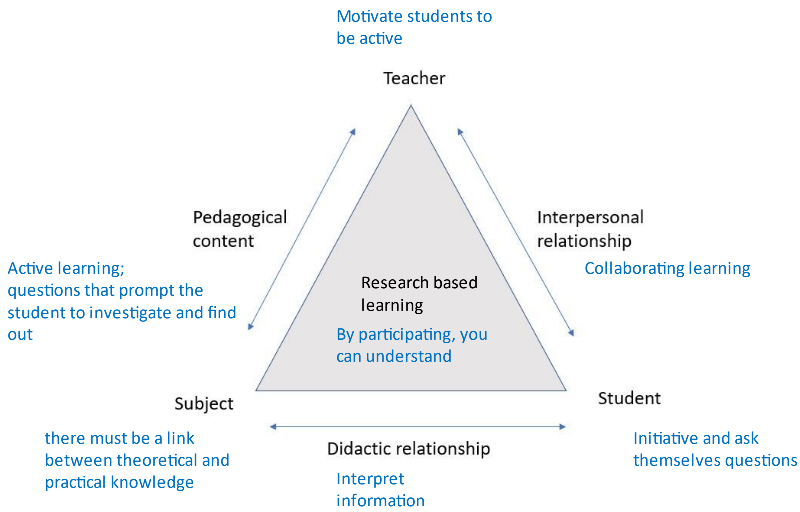

Figure 7. An example of a research-based learning situation with the structure of the pedagogical triangle

2.2.5. Social leadership/ Dialogue and trust

The role of social leadership in the context of this framework differs from the other approaches. Utilizing dialogue and trust in oneself relates to attitude and to the way of being with other people as co workers rather then a pedagogical approach, which could be chosen for temporary use. Adopting stronger dialogical skills together with ability to build trust is explained here in this report earlier and in more detail in the curriculum and training course on IO3 platform.

3. EVALUATING AND DEFINING THE FRAMEWORK

According to our experiences, developing a methodological framework follows the process described by McMeekin et al. (2020). The identification phase consisted of data collection, based on which project participants selected pedagogical approaches for the project. These were blended learning, research-based learning, phenomenon-based learning, and social leadership. At no point in the project, we needed to change the pedagogical approaches since they provided proper guidance for student-centered methodology.

The second phase was developing and structuring the methodological framework. As blended learning, phenomenon-based learning, and research-based learning are based on constructivist ideology, constructivism emerged as an umbrella concept. The methodological framework was structured with an umbrella form, and social leadership as a mindset was included as a cross-cutting theme.

The framework brought together all the theoretical parts but did not give practical guidance on pedagogical situations. Hence the pedagogical triangle was introduced. It is a structure for analyzing the specific interrelationships and interactions between the teacher, student, and content/subject. The pedagogical triangle helped analyze the interactions between teachers, students, and course contents (e.g., circular economy).

The methodological framework was finalized at the end of 2022. It consisted of constructivism as an umbrella concept, three pedagogical approaches (blended learning, research-based learning, phenomenon-based learning), and a cross-cutting theme of social leadership. The pedagogical triangle was integrated as a tool for applying a framework in practical student-centered learning and teaching situations.

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