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KoKemus

KoKemus –

Developing an Ecosystem of Education

Development of educational service ecosystem using physiological data and intelligent systems

PROJECT ACTORS

Contributors to the Kokemus project and this publication:

University of Jyväskylä (JYU)

Suvi Karjalainen

Anita Malinen

Tiina Parviainen

Mikko Vesisenaho

Eeva Harjula

Pyry Heikkinen

Jari Korpela

Tiina Kullberg

Juha Leukkunen

Mari Manu

Jarno Mikkonen

Eeva Rantala

Jyväskylä University of Applied Sciences (Jamk)

Minna Haapakoski

Katariina Korniloff

Kaisa Lällä

Minna Silvennoinen (Jamk/JYU)

Poke Vocational College

Pekka Janhonen

Pekka Ouli

Matti Puttonen

Tomi Rahkonen

Taneli Temonen

Project partners have included:

Valteri Centre for Learning and Consulting

Tiia Koskinen, Taina Kuittinen, Markus Linja, Katariina Minkkilä

Air Force Academy

Riitta Penttinen

Patria Aviation Oy

Jari-Matti Taskinen

Firstbeat Technologies Oy

Tero Myllymäki

Liikkeen Viisaus

Merja Soanjärvi

Project steering group:

Pasi Tyrväinen (University of Jyväskylä/Faculty of Information Technology), Jari-Matti Taskinen (Patria Aviation Oy, representative of companies), Päivi Häkkinen (University of Jyväskylä/Department of Education), Riitta Penttinen (Air Force Academy), Pekka Janhonen (Poke) and Sanna Sihvonen (Jamk), and Hilkka Laine (Regional Council of Central Finland, representative of funding provider)

The project activities also included a huge number of educators and students from the organisations participating in the project network and other individuals and companies interested in simulations.

Photographers

Poke forestry (Auli Dahlström)

Air Force Academy (Antti Siukola)

Valteri School (Suvi Karjalainen)

Layout and illustrations

Family Creatives Oy

Translation

Käännöspalvelu Elisa Wulff Ky

Press

Jyväskylän yliopistopaino

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BACKGROUND INFORMATION ON THE PROJECT

Project's steering group

- Main contributor: University of Jyväskylä (JYU, Department of Teacher Education, Department of Educational Sciences, Centre for Interdisciplinary Brain Research CIBR)
- Partial contributors: Jyväskylä University of Applied Sciences (Jamk), Poke Vocational College
- Partners: Air Force Academy, Patria Aviation Oy, Firstbeat Technologies Oy, Valteri Centre for Learning and Consulting, Liikkeen Viisaus Tmi

Funding scheme

- Main funding provider: Regional Council of Central Finland
- Funding scheme: European Regional Development Fund (ERDF; 2014–2023)
- Funding provider's register number: A75070
- Project implementation schedule: 1 August 2019–30 June 2022

Objectives and purpose of the project

- Creating a centre of excellence for simulation-based learning.
- Developing professional education, adult education and education services.
- Developing collaboration and sharing practices between education institutions and companies.
- Strengthening understanding of adults' learning and related factors in the context of simulation-based learning in vocational training and adult education.
- Using research evidence as a support for developing simulation-based education and simulation environments.
  - The project introduces a new, multi-method approach that brings together qualitative and empirical methods (brain research and physiological measurements) in an aim to form a more in-depth and comprehensive understanding of the factors related to learning.
  - As verbalised experiences do not always succeed in covering all dimensions of the learning experience, there is also a need for other indicators, such as neurophysiological measurements. Meanwhile, as interpreting brain signals or heart rate variability also requires paying attention to individuals' experiences and situation-specific factors, a multi-method approach is necessary for building a comprehensive understanding.

Living & experiencing & reflecting & doing

Experiential learning – A comprehensive theory of adult learning

The experiential learning theory is a comprehensive theory of adults' learning and growth. The experiential learning of adults involves overcoming one's prejudices, expanding and advancing one's knowing, and making re-interpretations. Learning involves the re-construction, re-organisation, re-defining, re-thinking and re-shaping of experiences. Learning experiences and practical activities are part of the learning process.

What is experience? "Experiential" refers to three different kind of qualities of experience:

A) Life experience (a holistic "lump" of experience)

B) Learning experience (immediate experience, element of surprise)

C) Doing things and engaging in activities

The "lump" of experiences a person has – the life he or she has lived so far – sets an individual tone and boundaries for learning.

Reflection binds these three different qualities of experiences into one single process.

"A fracture is a state caused by a person's insecurity related to his or her knowing and/or competence. It forces you to doubt yourself, your thoughts, your vision. A fracture is a comprehensive experience, which is what makes it difficult to pinpoint. The fracture will break the holistic entity of conscious and tacit - against your will. It is interesting to link this idea of a fracture to Polanyi's argument that what is once broken or destructed can never be brought back again."
– Anita Malinen

Fracture

- → Disrupts routines and familiar patterns of thinking and doing.
- → Experienced as an emotion – confusion, surprise, anxiety, annoyance etc.
- → "You need to die a little" (Guy Claxton), a need to retain something that is important for you.
- → May be a threat to the person's identity.
- → Implies that there is something hidden "behind a curtain.

Experiential learning is

- → retrospective (a gone-over perspective)
- → critical
- → analytical
- → personally meaningful
- → engaging in activities, doing

"Experience is the adult learner's living textbook."

- Eduard Lindeman 1926

Simulation-based learning-
A simulation replicates reality

→ Simulation-based learning is a widely used and studied experiential learning method that involves the utilisation of simulations representing real-life situations, particularly used in safety-critical fields and contexts that require a lot of repeated training.

→ While simulations do not fully replace practising in a genuine environment, they can help construct, strengthen and maintain the skills and working life competencies required in real-life situations.

→ Typically, simulation training comprises three stages:

- Providing instructions – Setting goals, discussing exercises and related instructions.
- Simulation exercises – Carrying out simulation exercises.
- Debriefing – Discussing and reflecting on the simulation exercises, examining goal achievement.

→ Simulation-based learning makes use of various kinds of simulators and the use of VR, AR and XR technology is also becoming increasingly prevalent. Drama and acting can also be utilised in the implementation of simulation-based learning.

→ The benefits of simulation training

- Cost-effectiveness, safety, repeatability, modifiability.
- An opportunity to model various situations and scenarios (e.g. extreme conditions or sudden situations).
- Simulations are a particularly effective teaching tool in the early stages of new skill acquisition.
- An opportunity to experiment and also make errors safely.
- Strengthening critical thinking, problem-solving and decision-making skills.

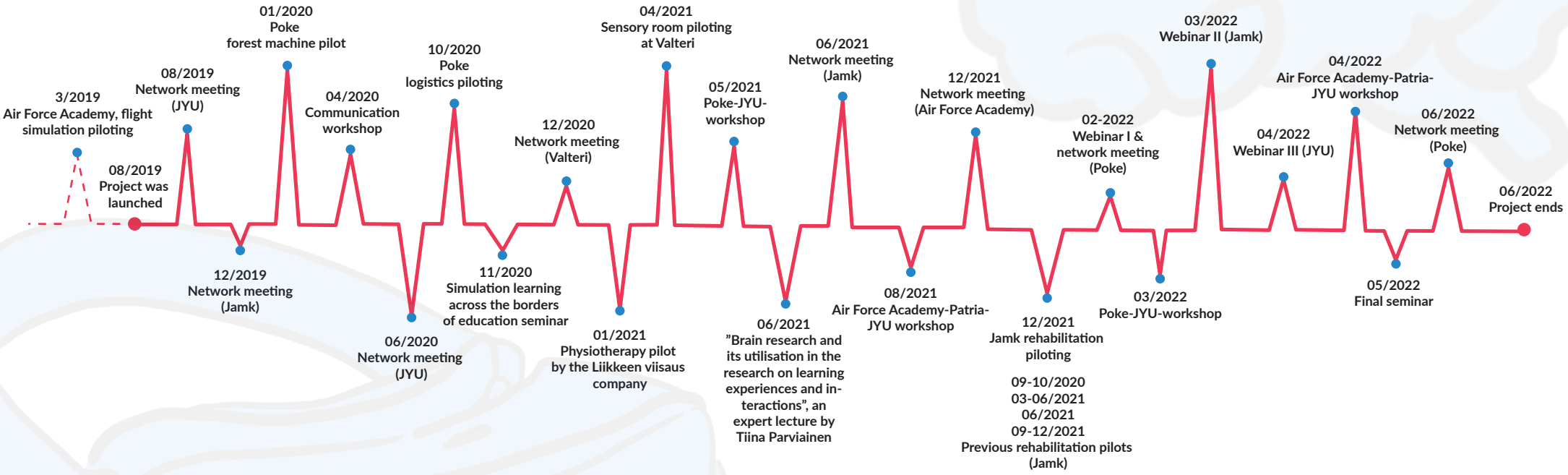
Measuring neural and bodily functions – Measurements in natural learning situations

- Neural and bodily functions can be examined using neurophysiological and physiological measurements. Electroencephalography (EEG) is used to measure the rhythmic activity of neural networks in the brain which have been found to be connected to aspects such as information processing, attention and alertness. Meanwhile, the heart rate, heart rate variability (HRV) and respiratory rate measured from the body may provide information about the person's alertness, stress and emotions, for instance.
  - Due to the lack of a single measure enabling us to examine learning from the perspective of bodily or neural functions, we must examine those characteristics of the measured signals that have been found to be connected to aspects such as attentiveness, alertness, commitment to tasks, stress, emotions and information processing, all of which are key background factors for learning.
- Key research questions related to neurophysiological and physiological measurements:
  - Can the state and reactions of the body and the brain be reliably measured in natural learning situations?
  - Can characteristics related to learning be identified and determined based on the measured signals?
  - How can this information be utilised in developing learning environments and practices?
- The measurements aim at examining the state and reactions of the brain and body during simulation learning.
  - Learning and experiences are built on the functions and reactions of the nervous system. As a result, the state of the body and the brain sets the tone for the learning situation. For example, the state of the brain and the body of a student who feels anxious or tired may not be optimal for learning, whereas the state of an eager and well-rested student may, at best, support his or her learning.
- Although neurophysiological and physiological measurements are typically conducted in controlled laboratory environments, those carried out in this study occurred during natural learning situations. This enabled the multi-method examination of simulation-based learning in genuine environments.
  - A challenge emerging in measurements carried out in natural learning environments is the lower quality of the measured signals compared to laboratory measurements. Neurophysiological and physiological measurements are also sensitive to various disturbances, which gain emphasis in natural situations. Movements, interactions and electronic devices can also interfere with the measurements.
  - It is also important to note that the neurophysiological and physiological signals do not directly lend themselves to interpretations of an individual's experiences or learning. For instance, anxiety and excitement may appear highly similar based on the measured bodily signals; by contrast, the individual's verbal descriptions of the experience will provide more detailed information about his or her actual emotional state.

PROJECT TIMELINE

Dozens of events

Timeline of the main measures carried out in the project



KEY PROJECT MEASURES

Piloting, workshops and meetings

Piloting

- Multi-method data collection carried out in a variety of learning environments.
- Pilots were carried out in diverse simulation environments, and they aimed at comprehensively examining simulation learning and related phenomena using multi-method data collection.
- After piloting i.e. the data collection, the work progressed to analyses (data-specific analyses, analyses combining various data sets) and finally to introducing the results in practice.
- The JYU project team planned and carried out the pilots in collaboration with the partial implementers and project partners. The JYU project team carried the main responsibility for performing the analyses and reporting the findings.
- Jamk designed and carried out its own pilots (in-person and remote simulations on rehabilitation), analyses and reports fairly independently, but in collaboration with JYU.

Workshop

- The goal of the workshops was to discuss the observations and results of the pilots with actors representing each simulation environment and to introduce the results into practice, i.e. co-development.
- The co-development process was carried out through means such as joint discussions involving discussing the current strengths of the implemented simulation-based education and its environment, how the results obtained from the piloting could be utilised in practice, and how simulation education could be developed based on the results.
- After the development workshops, various actors involved in the simulation environments launched or continued the development of simulation-based education and simulation environments within their organisation. This was done based on their resources and in collaboration with companies producing and developing simulations.

Network meeting

- A meeting within the project network in which each member of the project network presented its learning applications, learning environments and simulation-based education.
- The goal is to familiarise the project actors with one another, create opportunities for forming networks and engaging in cooperation, and share good practices and challenges.
- The meetings have also occasionally involved presenting the results of pilots by the organiser and insight gained from workshops that aim at co-creation, which also enables making use of the development measures in other simulation contexts.

Webinars and seminars

- Open events that provided information about the measures and results of the project for a wider audience.
- Making project activities visible and highlighting the expertise of the project network
  - Providing information about issues such as the project's objectives, completed pilots, multi-method research on simulation-based education, the results of the project, and insight gained.
  - Inspiring actors such as educational institutions and companies to build and develop new simulation environments for various sectors
- Also building new directions for collaboration between various actors at the national level.
  - E.g. educational institution–educational institution, educational institution–company, research institute–company, research institute–educational institution, research institute–research institute.
- Carried out online or as hybrid implementations

Example: Sensory room pilot and co-creation carried out at the Valteri School

- The sensory room pilot was designed in collaboration between Valteri and the JYU project team and was carried out in April 2021.
- The aim was to examine the impacts of the sensory room elements at the experiential and neurophysiological levels and to develop the use of the sensory room in the guidance and rehabilitation work carried out by Valteri.
- The piloting produced data on what kinds of experiences various sensory elements evoke on their own and when presented through multiple channels and how the body and brain respond to these sensations. A questionnaire was also used to ask about issues such as the participants' individual traits and previous experience in using the sensory room.
- The instructors who participated in the pilot found that the piloting had provided them with new perspectives on the potential use of the sensory room; however, at the same time, a need emerged for guided training on using the space and example exercises that could be used with different pupil groups in the space.
- In autumn 2021, efforts to co-develop the sensory room was launched. In addition to the Valteri staff and JYU project team, teacher students at JYU participated in the process. The co-development occurred as small workshops, among others.
- The Aistihuone opetuksessa guide (The sensory room in education; in Finnish, available at https://peda.net/jyu/okl/oppimateriaaleja-ja-valmiita-oppimiskokonaissuunnitelmia/aistihuoneprojekti) was produced as a result of the co-development, compiling research evidence on the senses, a multisensory approach and experiential learning, a presentation of the elements in the sensory room, tips for planning lessons utilising the sensory space and sense elements, and examples of possible exercises.
- The guide was introduced at the Valteri School Onerva in the spring of 2022 and will be used to support teaching, guidance and rehabilitation.
- The guide was presented and advertised to the project network at network meetings. Information about it was also provided to a wider audience through social media, as the guide can also be applied in contexts other than the sensory room at the Valteri School.

Versatile data and multidisciplinary

In the project, simulation-based learning has been examined using a multi-method approach that involved simultaneously utilising various data collection methods. The aim has been to examine the simulation-based learning situation and related factors comprehensively and profoundly.

Research questions

- → How does simulation-based learning appear to students and educators?
- → What happens in a person's body and brain during simulation-based learning?
- → How could experimental knowledge be combined with neurophysiological information?

Research methods

- → A multi-method approach
  - Qualitative/experiential methods: interview, observations, video-recording, questionnaires.
  - Neurophysiological and physiological methods: EEG, heart rate and heart rate variability (HRV), respiration.
- → A multidisciplinary approach
  - Adult education, education science, educational technology, cognitive science, psychology, brain research.

Analyses

- → The different types of data are examined as separate entities – in-depth understanding.
- → Combining various types of data – comprehensive understanding.

TYPICAL LEARNING SITUATION IN A SIMULATION ENVIRONMENT

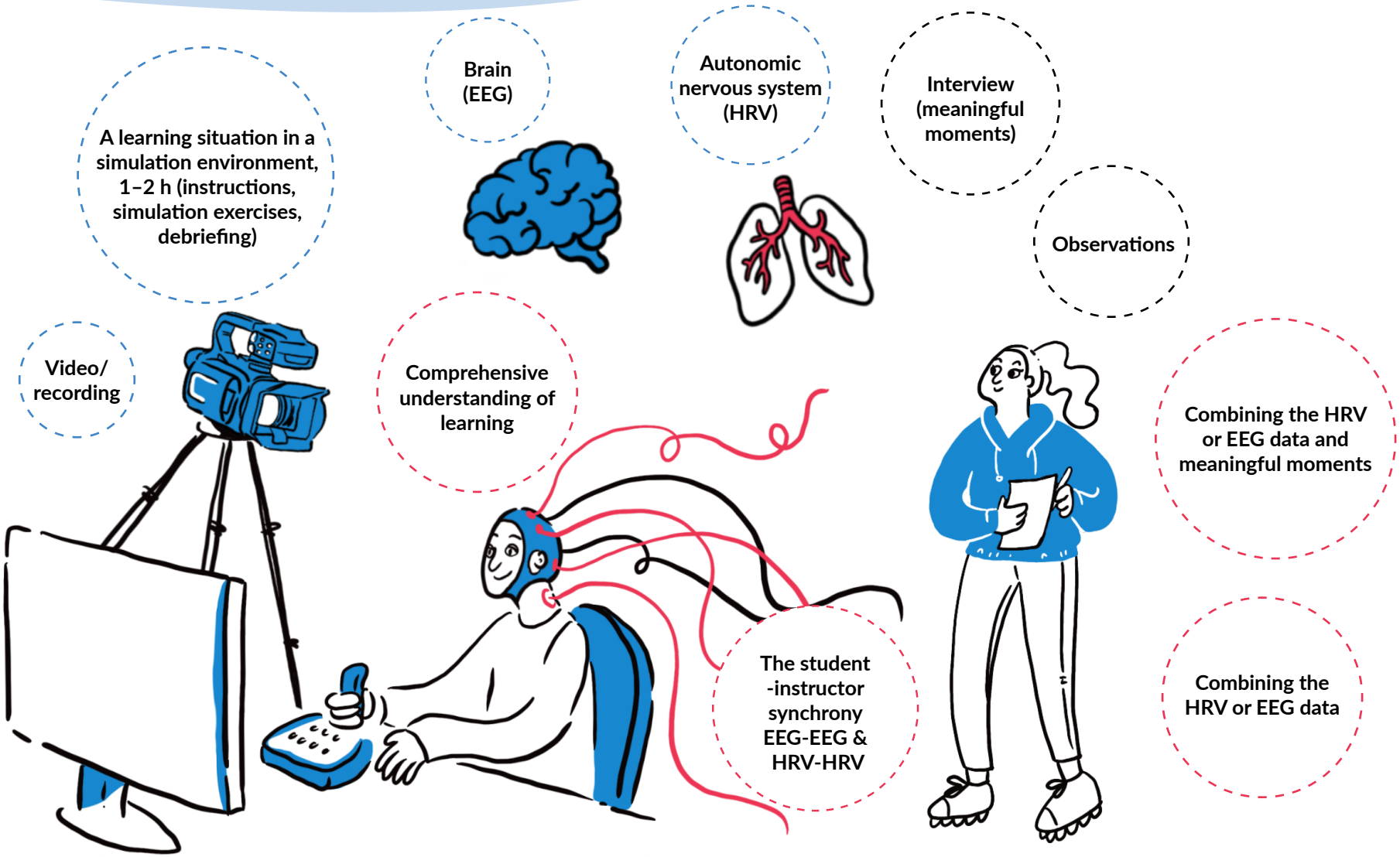


Illustration of data collected during the simulation-based learning situation and possible analysis paths.

(EEG = electroencephalography; HRV = heart rate variability)

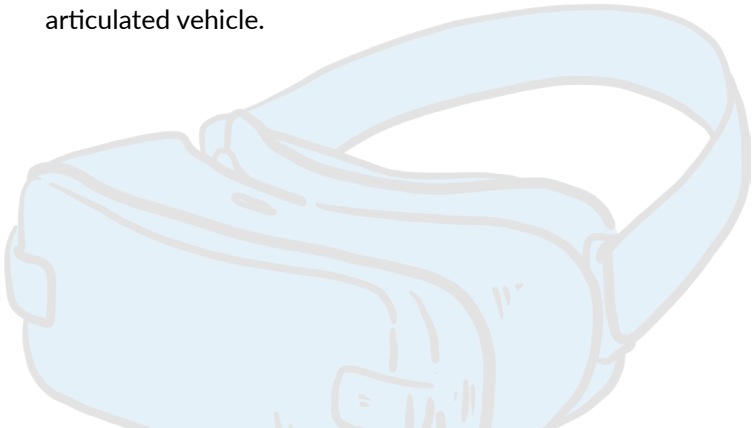
Forest machines, lorries and fighter jets

Poke, Saarijärvi, forest machine industry

Forest machine simulations are used in basic vocational education in the forest industry. The simulations allow students to practise the basics of the work technique, working models and logging processes. The forest machine simulations used at Poke correspond well with real-life work carried out with forest machines, as the simulation equipment is similar to the equipment used to control real forest machines and a VR headset brings new and more authentic dimensions to the simulated forest environments. The simulators make it possible to provide immediate feedback and later examine and assess one's performance based on a recording.

Poke, Viitasaari, logistics

In logistics, the same driving exercises can be carried out in a computer-based simulator and in real vehicle driving situations. The simulation training enables modelling e.g. extreme conditions and sudden situations. This would not be possible in exercises carried out with actual vehicles. The simulation training includes reversing exercises using a passenger car and a trailer, a lorry and an articulated vehicle.



Air Force Academy, Tikkakoski, aviation

At the Air Force Academy, simulation training plays a key role in pilot education, and the academy is making increasing use of simulation-based education. As a result of intense development efforts, the simulation environments used at the Air Force Academy enable joining together different simulators as well as simulators, artificial intelligence and real machines during the practices, which contributes to creating a more realistic and motivational setting for the training. The simulators are used for purposes such as practising basic aviation skills and air combat.

Physiotherapy, sensory room and rehabilitation

Liikkeen viisaus Tmi, Viitasaari, physiotherapy training

In physiotherapy training, simulation-based learning was utilised to simulate situations that involve examining and assessing the customer. The simulation exercises were carried out in pairs or groups, allowing all participants to take turns in playing both customers and the specialist. Simulation exercises enable the students to familiarise themselves with e.g. hip function and positions.

Valteri Centre for Learning and Consulting, Jyväskylä, sensory room

The sensory room at the Valteri School Onerva is a unique learning and rehabilitation environment that enables affecting the physiological state and experiences of an individual or a group by simulating different sensory environments. The sensory room is utilised to support pupils in practising abilities such as the regulation of alertness, attentiveness and linguistic skills. The sensory room enables producing different sensations individually or simultaneously. In the space, sensory experiences are produced using e.g. a fog maker, an aromatic diffuser and a wind machine, a vibrating floor, flashing lights, a light column and a smartboard with a touchscreen. Various sensory devices, fragrant spices and materials from nature that participants can touch and feel can also be used diversely in the room.

Jamk, Jyväskylä, rehabilitation

At Jamk, simulation-based learning is particularly used in rehabilitation, for instance, to support competence in mentoring and advice. Simulations can be used to practise encountering and guiding various client groups as well as skills necessary in working life, such as teamwork. Remote simulations developed and piloted at Jamk are a great match to the changing working life needs and facilitate the development of learning environments that are more diverse and independent of time and space.

Practice-oriented presentation of the insights gained

"Interaction and guidance are necessary for learning."

"Remote rehabilitation and simulations are part of the present and the future."

New ideas for how simulation training can be applied in different contexts.

Mutual peer support between educators, such as the importance of sharing experiences and practices with others

Simulations can be carried out in various ways, also remotely.

"Simulations are here to stay."

There is more awareness of other parties involved in simulations.

Instruction plays a key role: we talk about instructors and instruction even though students examine their own performance.

The significance of self-assessment and debriefing in learning and the assessment of one's activities

Taking students' individuality into consideration is important

E.g. the student's stress, strengths, personal interests, motivation, individual needs and working approaches, learning challenges.

We have identified the need to develop, strengthen and maintain the pedagogical capabilities required by teachers and educators in simulation-based education.

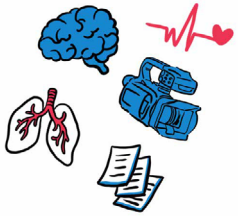
To make simulations more goal-oriented and interactive

How was simulation-based education developed during the project?

Utilise simulations in a more planned and systematic way in courses.

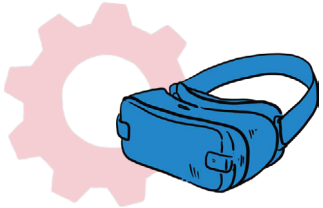
Increasingly goal-oriented; students must solve certain assignments on the simulator before they can move on to practise with real equipment.

The educator's position at the student's side during the simulation exercise enables making observations and interaction.



The utilisation of a simulation recording as a feedback and self-assessment tool

Engaging teaching staff in developing the education



Joint development with simulator manufacturers has been launched related to the exercises, instructions and giving feedback.

The development work is based on user experiences, pedagogics and the research findings of this project.

Behind the development of the simulations is a lot of work concerning softwares, -users and the evaluation as a background work.

The development of remote simulations and examination of related strengths and development needs.

Simulation-based learning

" A simulation replicates reality."

Simulation-based learning is a widely used and studied experiential learning method that utilises simulations, particularly in safety-critical fields and contexts that require a lot of repeated training.

Typically, simulation training comprises three stages:

- Providing instructions – Setting goals, discussing the exercises and related instructions
- Simulation exercises – Carrying out simulation exercises.
- Debriefing – Discussing and reflecting on the simulation exercises, examining goal achievement.

The benefits of simulation training:

- Cost-effectiveness, safety, repeatability, modifiability.
- An opportunity to model various situations and scenarios (e.g. extreme conditions and exceptional situations).
- Simulations are a particularly effective teaching tool in the early stages of learning new skills.
- An opportunity to make mistakes in a safe environment.
- Strengthening critical thinking, problem-solving and decision-making skills.

Issues to consider during simulation-based learning:

A safe and accepting atmosphere

- Confidentiality
- Mistakes and uncertainty are allowed
- Encouraging participants to ask for help

Feedback

- Support and encouragement
- Rewards for trying and persisting
- Reflecting on both successes and failures
- Helping learners to think
- Asking questions instead of giving advice

Interaction

- Calm presence
- Turning toward the learner and making eye contact
- Smiling and laughing together
- Positive verbal cues
- Listening

Implementation of simulation training

- Common ground rules
- Clear and achievable goals
- Reserving enough time for learning and not providing too much information at once
- Taking the learners' previous experiences (life experience, work and study experience) and personal characteristics into account
- Adapting the exercises to individuals (number and order of exercises, level of difficulty)

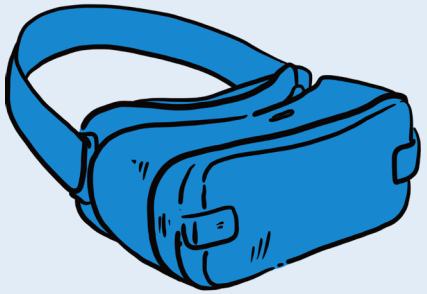
PROJECT IN NUMBERS

Impacts of the project

- → Simulation environments: aviation, forest industry, logistics, physiotherapy, rehabilitation, sensory room.
- → 6 research pilots were carried out and were participated by 70 students, 18 instructors and 8 educators.
- → Research methods: interview, observation, video-recordings, questionnaires, EEG, heart rate and HRV, breathing.
- → Organising a total of 5 workshops and 7 network meetings together.
- → 3 webinars were organised; 69 participants signed up for the webinars.
- → 152 participants signed up for the Simulation learning across the borders of education seminar. At best, 96 participants from Finland and abroad were present to listen to presentations by experts.
- → Alltogether 85 attendees around Finland registered for the final seminar (47 present, 38 online). 53% of the registered attendees had been involved earlier in the project's activities or events.
- → The project included 5 education institutions (JYU, Jamk, Poke, Air Force Academy, Valteri) and 3 companies (Patria, Firstbeat, Liikkeen viisaus).

Potential applications, opportunities and challenges

- Simulation pedagogics and exercises form a continuum along the education path.
  - Building education paths related to simulation training that enable students to make progress and keep motivated to learn new things.
- Simulation-based education should be linked more closely to curricula and implementation plans to ensure sufficient resources and making sure that the education is systematic.
  - Education providers' limited resources and sustainable development goals also make the use of simulations important in the future.
- Providing education for staff on simulation-based education.
  - There is a need for training on the basics of simulation-based education to introduce simulation training more diversely and extensively in different educational institutions.
- Supporting the development with research knowledge.
  - Stronger collaboration between education providers, companies and research institutions to ensure that research produces knowledge to support the development work of simulator manufacturers, and the work of teachers and other instructors. This will also enable paying attention to the research needs arising from educational institutions and companies.



- New forms of collaboration to develop simulation-based learning.
  - Teaching exchange/joint teaching, expert exchange, visits and visiting lectures.
- While developing simulators, paying attention to pedagogical viewpoints.
  - Simulator equipment and pedagogical development should be promoted side by side.
- It is becoming increasingly common to organise simulations in virtual environments (VR, AR, XR).
- Constructing and using simulation environments across sectoral boundaries.
- Building wider networks is important as sharing good practices benefits everyone and promotes the long-term development of simulation-based learning.
- Simulation-based education should anticipate and pay attention to changes occurring in working life.
  - Remote support from experts in virtual environments (e.g. installations and repair and maintenance measures in VR environments).
  - Remote control and management of equipment and machines.
  - In the context of rehabilitation, simulation enables remote appointments, and testing and assessing patients/clients remotely.
- The utilisation of neurophysiological and physiological measurements as a tool of students' self-reflection and self-assessment as well as feedback.
  - Requires developing neurophysiological and physiological indicators.
- It is important to obtain knowledge about the impact of simulation training and the transfer of competence to working life.

MORE INFORMATION

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Several magazine articles and blog texts have also been published and other media visibility has been achieved on the topic.

New publications will also be released later.

University of Jyväskylä, KoKemus project

Mikko Vesisenaho
Project Lead, KoKemus Project
mikko.vesisenaho@jyu.fi 0400247686

Suvi Karjalainen
Project Manager, Kokemus Project
suvi.k.karjalainen@jyu.fi 0504717182

www.jyu.fi/kokemus

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