PEDAGOGICAL APPROACHES

RE:Source

Hanna Eggestrand
The Department of Sustainable Development, Environmental Science and Engineering (SEED), KTH Royal Institute of Technology, 100 44 Stockholm

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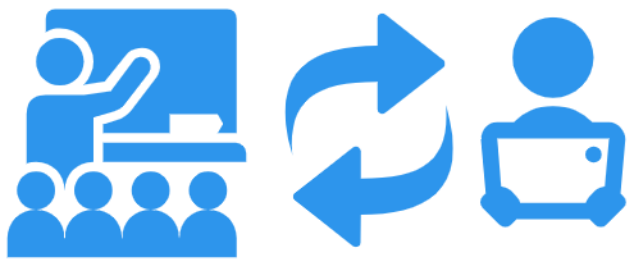
FLIPPED CLASSROOM

Instructional content is delivered outside of class ("homework"), re-purposing the time spent in class for inquiry, application and assessment.



The flipped classroom inverts the traditional "lecture first, homework second"-setup. The instructional content is delivered pre-class, often (partly) using online solutions, with teachers creating their own video lectures or utilising other's material. Delivery methods include:

- Pre-recorded videos
- Documentaries
- Radio shows/podcasts
- Readings
- Research assignments

The time spent in class can then be used in a more meaningful way by introducing collaborative and interactive activities. The approach can integrate other pedagogical practices, including case-based learning, board games, digital games and virtual reality. Key is that all content is well organised and easy to access, including clear and concise instructions.

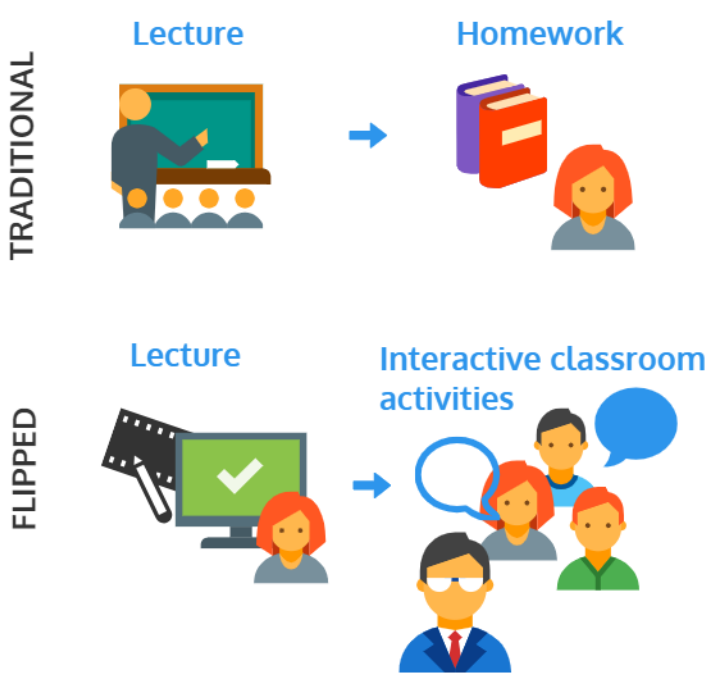
Some distinguish between the flipped classroom and the pedagogical approach of **flipped learning**, which encompasses and considers a flexible environment, learning content, intentional content and a professional educator.

Flipped learning then differs from **blended learning** in that the former has a clearer distinction between the online activities and face-to-face interaction whereas the latter, as the name suggests, truly blends computer mediated activities and in-person instructions.

Learn more: Teachers are sharing their experiences on YouTube. Additionally, many universities have an introduction to the flipped classroom approach available on their webpages, including:

- University of Washington
- University of Queensland
- The University of Texas
- KTH Royal Institute of Technology

The Flipped Classroom: A Survey of the Research (Bishop & Verleger, 2013).



- ✓ The flipped classroom is a way to facilitate learning and not a predefined way of teaching. The emphasis is on higher order thinking skills and application to complex problems.
- ✓ Students can review the course material at their own pace and several times.
- ✓ The teacher can be more directly involved and facilitate a deeper learning.
- ✓ The learning environment becomes more similar to a professional context, with students exploring the topic together with peers.
- ✓ Students can learn from each other, which is particularly useful in further training contexts and when the students have different backgrounds.
- ? Expect some initial push back from the students as they now have to be active in the classroom.
- ? Fundamentally, for the approach to work, it is essential that all students have access to computer and the Internet outside of classroom hours (unless they are only assigned printouts and published material).

WEB BASED EDUCATION

Traditional classroom teaching can be supplemented with web-based elements, or an entire course (or degree) can be taught online.

Online courses

Traditionally run by an academic institution and carries credit. Enrollment is limited and the teacher(s) is interacting with the students using online forums.

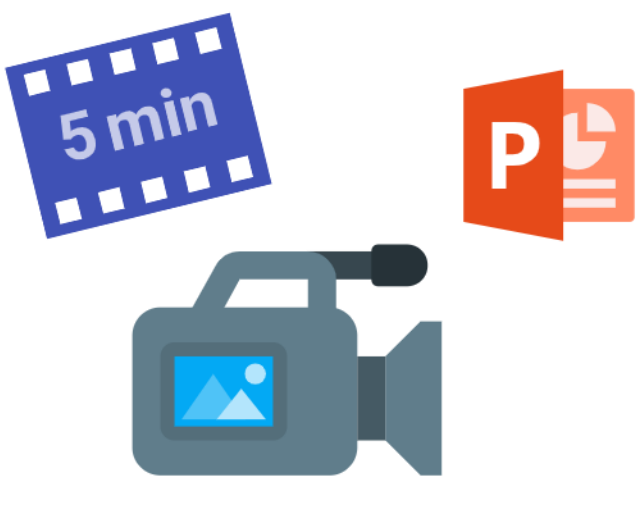
Delivering the course completely online means that neither students nor instructors need to be based near campus, but it limits the social interaction.

Online courses open up new possibilities to offer professionals the further training they need in response to a changing labour market. Professionals who have completed online courses testify to the courses' ability to transfer knowledge from academia to the industry, at least when carefully developed by both parties with such knowledge transfer in mind. Former course participants also experience that recruiters appreciate their expanded and deepened skillset.

Example: The PROMPT project (Professional Master's Education in Software Development) offers web-based distance-learning courses that promote software-related advanced skills for professional engineers. Several Swedish universities, industry associations and companies are involved and The Knowledge Foundation funds the initiative.

Other e-learning platforms

Khan Academy is a non-profit organisation producing short YouTube video lectures, along with some supplementary material. Subjects covered include math, science, computer programming, history, art history and economics. A person can choose to watch a specific video clip (mini lecture), or to go over a series of clips, without it being a part of a course structure.



MOOC (Massive Open Online Course)

MOOCs are open-access online courses with no limit to participation, hailed as a way to bring higher education to anyone with Internet access.

Typically, a MOOC integrates more traditional course material such as readings and filmed lectures with problem components (e.g. multiple choice questions, "drag and drop" tasks and peer-graded written assignments) and interactive user forums where course participants can discuss and help each other. The students complete the course without interacting with a teacher.

Generally, the MOOCs are free of charge, with the option to pay a minor fee for a certificate after finalising the course. However, it has been challenging for the MOOC providers to develop a framework for formal recognition of their courses. Most platforms offer their own credentials (certificate). Several now also offer college credits in the form of single course credit, credit for a sequence of courses or even online degrees.

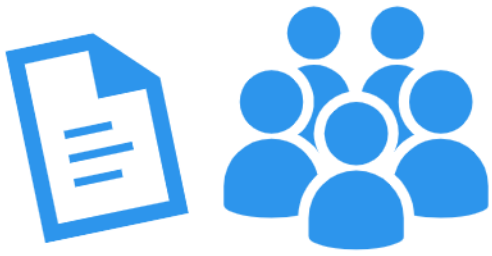
- Coursera: has some 150 partner universities (July 17). Example: Municipal Solid Waste Management in Developing Countries, created by École Polytechnique Fédérale de Lausanne.
- edX: A non-profit, open source MOOC provider founded by Harvard University and MIT in 2012. Example: Circular Economy: An Introduction, created by TU Delft.
- Udacity: A for-profit organisation, now focusing on vocational courses for professionals and "nanodegrees", with an emphasis on technology and IT.
- Alison: One of the biggest MOOC providers with over 800 courses covering a vast range of topics available (July 2017).

Swedish initatives: KTH offers some MOOCs through edX and Uppsala University trials three MOOCs via the FutureLearn platform.

- ✓ Active professionals generally need teaching to happen outside of working hours, preferably from a location of his/her own choice and either at part time speed or extremely concentrated ('boot camp style'). This has been challenging for the universities, whose budget structure is based on full-time students and the full academic year. Online courses can offer a way to overcome some of the issues.
- ✓ Main features of e-learning, including the option to seamlessly integrate real life footage and illustrative animations, the possibility to connect students and instructors who are physically in different places as well as to integrate content from different instructors (academic and others) are particularly useful when teaching within a field that is evolving rapidly.
- ✓ Although not without administrative challenges, universities can co-create online courses, drawing on each university's resources and area of expertise. This is perhaps especially important for subjects where the understanding and interpretation is rapidly evolving and relevant expertise can be found in different faculties (and/or outside of academia).
- ✓ Since an online course is created and set up in advance, it is possible to significantly limit the time required from the teacher(s) as the course is running. This could open up opportunities to involve people (from the academic world as well as the industry) with a busy schedules and/or limited possibility to be physically present on campus.
- ? It takes time and resources to develop an e-learning course and it can be difficult to estimate the time required beforehand. Courses need continuous updates to stay relevant, which can be particularly demanding if the field is evolving rapidly.

CASE-BASED LEARNING

A pedagogical approach in which the student takes on the role as a decision maker when faced with a real-world problem.



The case describes a situation with one (or multiple) problem(s) that needs to be resolved, often by a decision being made, and can be communicated through a shorter description or a collection of documents and other media. The story often ends openly, not with a leading question or similar prompt. Generally, the situation is seen from the perspective of a main actor, with more actors and stakeholders involved.

Importantly, a 'case' is firmly anchored in a real-world situation. Ideally, the entire case should mirror a real-life event ('field case'), although it is also possible to use a constructed but realistic storyline ('armchair cases'). Regardless, the situation should reflect what the students might face in their professional lives, staying as true as possible to the complexity inherently present in real-life situations.

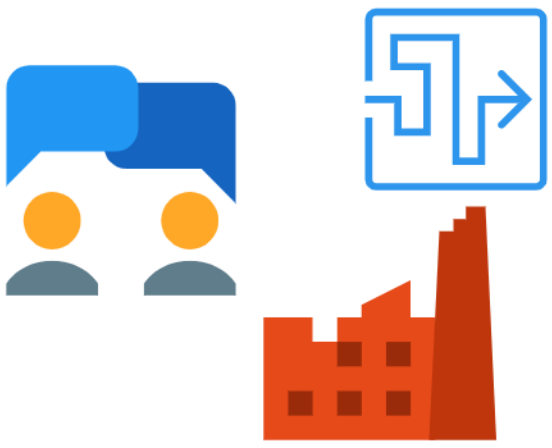
Consequently, there is no one correct answer or way of resolving the situation, although some solutions might be more realistic or compelling than others. To come up with the solutions, the students need to be present with the activity and critically reflect on the situation.

Cases can be constructed with different levels of difficulty:

Basic: The case introduces a problem but also a solution, and asks the students whether they find the solution appropriate or if they have any other suggestions.

Intermediate: The case only presents the problem and asks the students to create a viable solution.

Difficult: the students are presented with material that introduces a situation, but need to formulate both the problem and solution(s) themselves



Teachers can utilise already existing cases, made available for example via:

- The Sustainability Case Library, coordinated by CEMUS & CSD Uppsala. Contains sustainability-related cases available for others to use. Example: A Citizen's Movement for a Sustainable Future in Uppsala, inviting students to explore the option for local actors to establish energy and recycling parks in Uppsala.
- Harvard Kennedy School's Case Program provides a collection of cases within a wide range of topics. Teaching with cases offers additional resources for teachers interested in case-based learning.

The non-for-profit organisation Sustainergies let university students solve sustainability related cases created by the industry representatives.

Case-based learning is similar to some other teaching approaches, including (but not limited to):

→ **Inquiry-based learning**: An umbrella-term referring to pedagogies that encourage students to ask questions and solve problems.

→ **Problem-based learning**: Students work together to solve real-world problems in a self-directed, open and inquisitive process.

→ **Project-based learning**: Students are tasked with creating a defined end product.

→ **Experiential learning**: Goes as far as students applying their knowledge in a real-world context.

Challenge driven education

Another related approach is challenge driven education. The aim of this transdisciplinary method is for the student to understand complex societal issues, framed by companies or the public sector, and explore possible solutions when there is no inherently right or wrong answer.

KTH has compiled a Guide to challenge driven education, proposing 'rules of the game' and contributing towards a shared understanding of the approach.

Attract, a project funded by the Vinnova initiative on challenge driven education, gathered around 15 companies, 40 researchers at LTU and 2 municipalities to help build sustainable, attractive low-energy houses and outdoor environments in cold north Swedish climate.

✓ Case-based learning is especially relevant within education for sustainable development since it can contribute to a shift in focus from problems to solutions and strategies for sustainability, to make complex sustainability issues more concrete and to shed light on conflicts of interest.

✓ With the situational narrative of a case being conveyed from the viewpoint of a key actor, the case provides an excellent opportunity for the student to better understand the values and interests of this actor.

✓ The key characteristics of case-based learning, especially the focus on problem solving and bridging theory and practice, make the approach highly appealing for higher education and further education of professionals.

✓ Case-based learning can be a part of a flipped-classroom approach.

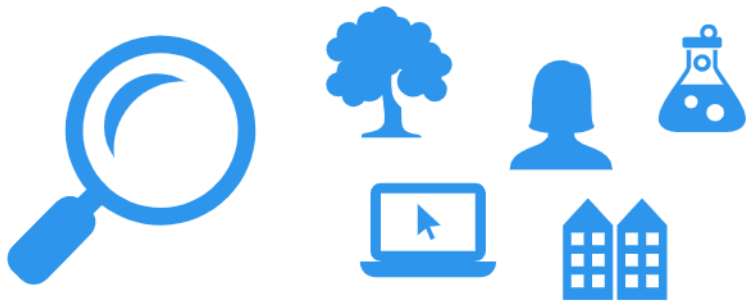
? Case-based learning can be challenging and quite demanding for the teachers, although also engaging and rewarding to work with. Extensive preparation is needed.

? It is essential to allocate sufficient time for the students' own knowledge acquisition. Some consider this to be a main limitation of case-based learning and argue that traditional approaches can cover more ground.

? Case-based learning formats present challenges in terms of examination as it can be difficult to, in a meaningful way, assess and measure what the students have learned.

LIVING LAB

Place-based, user-centered open innovation ecosystems, enabling collaborative learning among stakeholders in real-life environments.

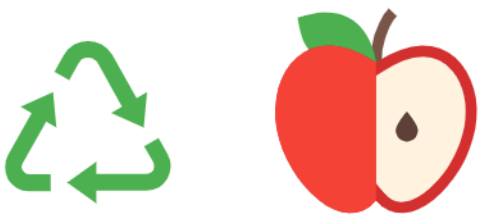


Living labs are public-private-people partnerships situated within real-life, everyday contexts (e.g. cities, city regions, rural areas, collaborative virtual networks).

A living lab arena can for instance be a new apartment building specifically designed for the purpose of research and development (e.g. HSB Living Lab). There is a multitude of projects looking to create living labs in connection to academic centres, including:

- Live-In Lab (KTH)
- HSB Living Lab (Chalmers)
- MIT Living Labs (MIT)

Other universities (e.g. Yale University) are in turn using the redesign and retrofitting of campuses to trial a living lab approach.



A living lab simultaneously stimulates and challenges research and development as stakeholders both participate in and contribute to the innovation process. It can:

1. Offer a way of trialing products, technologies, or processes.
2. Spatially create a niche environment to undertake innovation under protected conditions.
3. Function as a real-life demonstration hub.
4. Provide a platform to foster further innovation.

Learn more: Many larger living labs have webpages explaining their research approaches. The European Network of Living Labs (ENoLL) provides an introduction and overview of the living lab phenomena in their publication *Introducing ENoLL and its Living Lab community*. Additional information can also be found in:

- Innovation in Living Labs, *Technology Innovation Management Review*. January & February (2017).
- *The Emerging Landscape of Urban Living Labs Characteristics, Practices and Examples*, by McCormick and Hartmann (eds.) (2017)

- ✓ The urban living lab has attracted specific attention as an arena to test buildings, transport and energy systems innovations.
- ✓ Living labs can help advance collaboration between academia and industry.
- ✓ Bachelor and master students can be encouraged to undertake their theses in a living lab environment. Doctoral students can conduct (part of) their research in a living lab environment.
- ✓ Graduate students can get experience from a real-life setting and the industry whilst professionals can (re-)discover academia, furthering old or acquiring new skills.
- ? Designing a living lab takes time and effort, especially in the early stages. It can be challenging to identify and engage relevant partners, and the long-term and intensive collaboration that is a fundamental feature of a living lab can be both laborious and volatile. On a practical note, the upscaling of the model is often difficult.
- ✓ One option could be to conduct research (including thesis work) within an existing network rather than to start a new.

BOARD GAMES

The playful combination of strategy, skill and chance to achieve a pre-defined goal has made board games popular learning resources.

In addition to the social interaction and collaboration that comes with playing a board game, enthusiasts claim logic and reasoning, spatial reasoning and critical thinking are key features of the play. Moreover, board games can provide metaphors to link information and help players organise it into conceptual frameworks. Given this, board games have attracted attention as a pedagogical tool to use in the classroom.

However, although many attest to the general potential of board games to facilitate learning, their true potential is very much dependent on the context in which they are to be used. To what end is the board game introduced? Does it fit within the learning curriculum?

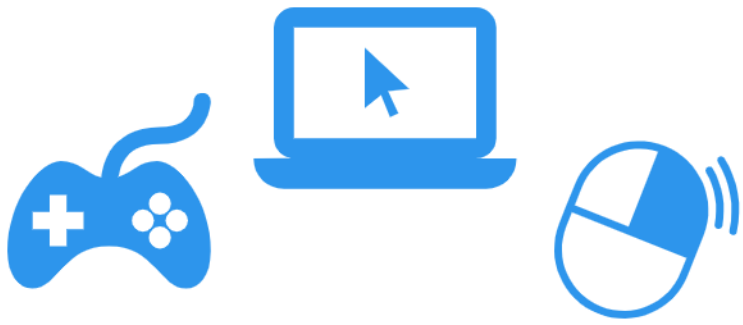
Selected examples:

- Power Grid: Bid to buy power plants, acquire the raw material needed and supply the most cities with power.
- Climate-Poker: Organise the biggest conference to address climate change.
- Nexus Game: The players act as policy makers in two different countries that have to cooperate to find the best way to manage the river they share and balance supply and demand for water, whilst also considering food production and energy generation.
- Games4sustainability: Board games.

- ✓ Board games can be a part of a flipped classroom approach, constituting the active classroom component.
- ? There seem to be few experiences with using board games within higher education.

DIGITAL GAMES

The inter-reactive elements mean that the player can change the game world and alter aspects of the game's space, narrative and outcome.



Video games: played on dedicated game consoles

Computer games: played on computers

There are several reasons why digital games can be used to create effective learning environments. Importantly, digital games offer a way for players to explore complex environments, with increasing difficulty. Players are encouraged to experiment and take risks, and can directly see how different decisions create different outcomes. Moreover, players can experience what it is like to be in someone else's shoes and to co-develop the character's identity.

Playing games seems to be intrinsically motivating and highly engaging, associated with the desirable state of flow.

Digital games for education and learning can either be specifically developed, often by independent studios or universities, or commercially developed. Many of the already existing ones are focused on primary and secondary level education rather than post graduate education.

Examples:

- Hush: Helping a Tutsi mother and her baby hide during the Rwandan genocide.
- Darfur is Dying: the player is a Sudanese villager in the middle of a humanitarian crisis.
- Climate challenge: The player is the president of the European nations and must address climate change whilst remaining in office.
- Plan it Green: Players help planning a city to make it more sustainable.
- Recycle City: Exploring how people reduce waste, use less energy, and save money by doing simple things at home, at work, and in their neighbourhoods.
- Garbage Dreams: The Zaballeen People in Cairo survives by collecting and recycling garbage. Can you do the same?

In 2008, the forecasting game Superstruct was played by several thousand people. The outcome was hundreds of possible solutions to (re-)invent the future in relation to five 'superthreats' (energy, food, health, security, social safety net).

Learn more: Platforms such as Games4Sustainability and Games for Change foster exchange of ideas and resources. MIT Scheller Teacher Education Program and Education Arcade has also published white papers on learning games and their potential.

Gamification...

...is about introducing game-based techniques, including interactivity, quantifiable outcomes (badges, point systems, time constraints) and engaging graphics to facilitate and enhance learning. Digital games offer one, but not the only, way to learn through gamification.

✓ Digital games accessed through the traditional desktop or video game set up (and hence viewed on a delimited, flat screen) fall into the category of non-immersive virtual environments. However, with the technology for more immersive virtual reality as well as for augmented reality evolving, the options for how to play and experience digital games are changing as well.

✓ One broad genre of digital games is 'serious games' that seek to address important issues, create awareness and catalyse positive social change. If used wisely, such games can encourage perspective-taking, provide a safe space to negotiate ethical and moral dilemmas and occasionally facilitate reflection upon one's own passive complicity.

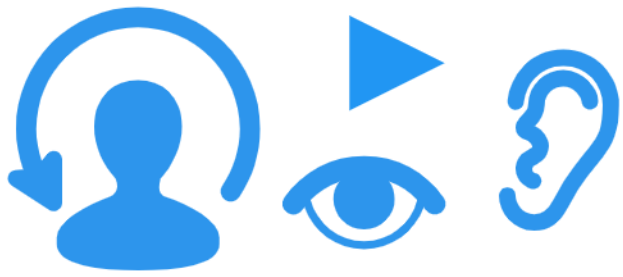
? Game developers and designers have to negotiate the fine line of creating games that are user friendly but that do not over-simplify complex subjects. Cultural appropriations, issues of representation and emotional manipulations are examples of issues that must be handled with caution.

? Developing a game requires substantial time, resources, and expertise. Professional game designers, software engineers, and learning experts are increasingly collaborating to develop meaningful learning experiences.

? Critical voices have been questioning the claim that progression in games indeed implies learning.

VIRTUAL REALITY (VR)

'Virtual reality' means 'near reality' and refers to a computer simulated "imaginary" environment that we can explore and interact with.



VR has self-evident applications where it is too dangerous, expensive or impractical to perform an act in real life (typically training fighter pilots or surgeons) but as technology is becoming both more advanced and cheaper, new possible applications are emerging.

There are two slightly different VR setups that could be used in a classroom. One option is to let students explore a virtual environment using a traditional desktop setup (computer, keyboard and mouse) or similar input device (e.g. the Wii TV game controller). The other option is to let the student wear a head mounted display (HMD), creating a far more immersive experience.

The HMD tracks the student's real movements and changes what the student sees in the VR world as he or she is moving. The student could also wear a data glove to interact with the VR world. When discussing VR, the immersive experience is often what is considered. Non-immersive virtual reality is regularly experienced by millions of users in the form of 'traditional' computer and video games.

Augmented reality (AR)

AR (or mixed reality) enhances the perception of reality by laying computer simulation atop of the existing reality. A traditional example of AR is the score in a game of football shown in the corner of the TV-broadcast, but more and more apps use AR technology in innovative ways (a popular example is the game Pokémon Go).

360 videos can now be recorded with relatively cheap cameras, but some universities have taken more comprehensive measurements to introduce VR technology. For example:

- Indiana University has created 'the Reality Lab', consisting of instructor stations able to host between 10 and 30 students, enabling immersive virtual simulations for the entire class. The VR technology has helped design students gain a richer understanding of their creations.
- Case Western Reserve University are using holograms created by Microsoft's HoloLens to teach anatomy.
- UC San Diego has a VR Lab where undergraduates can learn how to create VR content.

✓ VR defies spatial and temporal limitations, meaning students can "visit" places they would normally not be able to get to. This includes for instance historical events, the space, inside the human body or exotic locations. It is also possible to do more traditional field trips without leaving the classroom.

? Even if the software is becoming increasingly sophisticated, someone still needs to create the actual virtual reality that will be used in the classroom. Companies like Nearpod offer VR experiences with lesson plans, but these are aimed towards elementary school rather than university students.

? The cost of the equipment can be a prohibiting factor and there are concerns about what VR means in terms of quality, equitable education.

? In addition to cost, user friendliness and lack of standardisation still in early 2017 constituted major constraints, meaning there is still some way to go before VR will be genuinely useful in the classroom.

? Used clumsily or for its own sake, VR could distort rather than facilitate the learning, meaning it is important to carefully consider why and how it should be used before any implementation.

ICELAB

IceLab (Integrated Science Lab) at Umeå University is a creative laboratory taking on complex, transdisciplinary challenges. The core idea is to use mathematical models to evaluate hypotheses. They also organise IceLab Camp, training postgraduate students in defining and conducting a research project.

THESES WORK

Many companies and organisations working in the resource and waste management sector are welcoming students to work closely with them for their theses work. This includes, but is not limited to, Ragn-Sells, Sysav and SRV. Some companies also award scholarships to the most deserving student theses.

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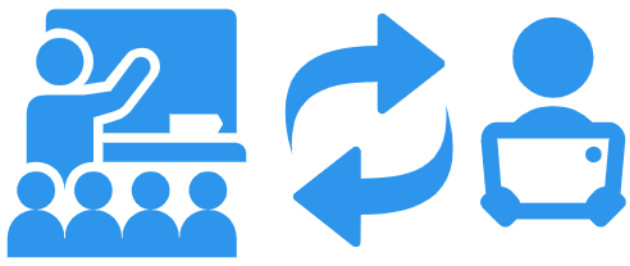

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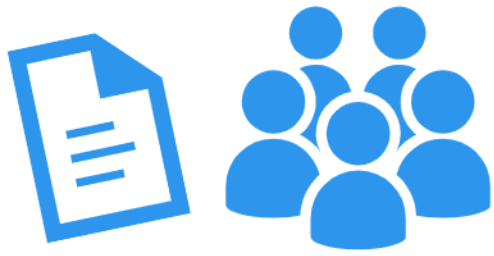

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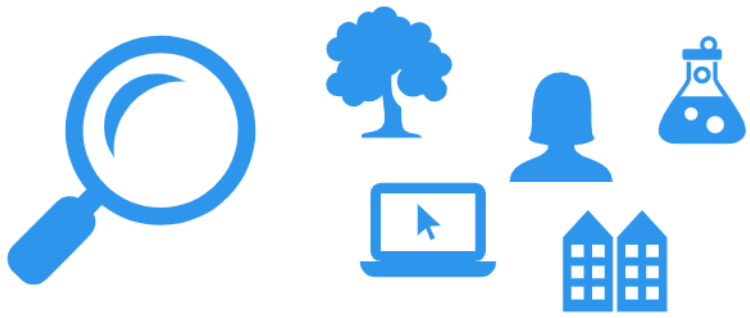

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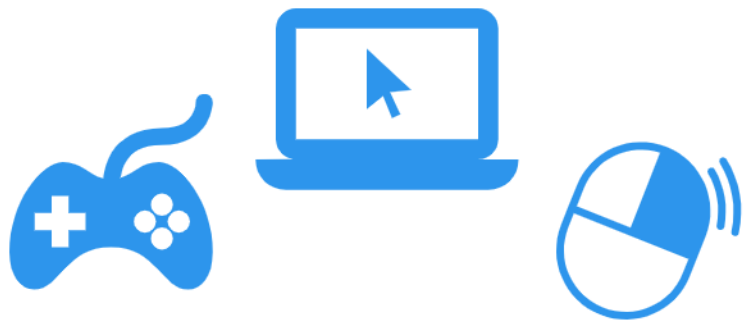

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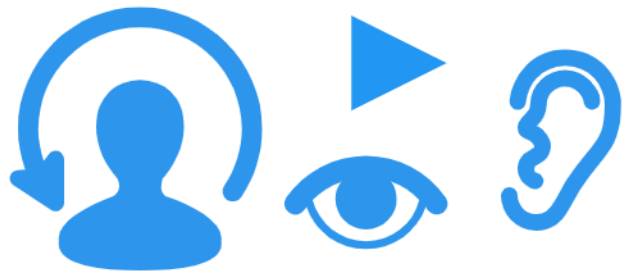
VIRTUAL REALITY (VR)



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