The Learning Curve of Reality Batchelor's Thesis 2019 Meri Elise Miettinen

Meri Elise Miettinen

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Aalto ARTS, Department of Design
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Feeding our senses a stimuli that is so similar to what we see in reality, that we interpret it as reality. In all other mediums your consciousness is interpreting a medium. But in VR there is no gap. You aren't internalizing it. You are internal in it. It's a quantum leap in mediums because the medium is disappearing.

-Chris Milk, Founder of VRSE

ABSTRACT

Augmented reality, (AR) Virtual reality (VR) and Mixed reality (MR) are revolutionizing our industries. In this study, we focus on how this technological leap will revolutionize the education industry. The main focus is on virtual reality.

Learning is not revolutionizing just because new tools are available. Learning is revolutionizing because it must. All work requires more and more rapid learning. Old learning methods and ways to provide information alone are no longer enough.

Virtual reality, augmented reality and mixed reality must be seen as enablers in different aspects of life. It is essential to understand how and where these ever-evolving technologies can be applied. The purpose of this thesis is to explore and discuss the benefits, challenges, opportunities, problems and places of these virtual enrichments in the learning environment.

The information is compiled from a variety of sources from the various fields that deal with virtual learning. The material of the thesis is collected through interviews, literature and work experience in developing and testing immersive educational products in Lyfta OY.

This study discusses the current role, disadvantages and benefits of the virtual learning environments, but also reflects the future of the ever increasing and prominent role of these virtual enablers in the learning environment.

So far, the new methods have been proven to be useful and effective in both learning and teaching. In virtual learning, experiential learning embodies the topic to be taught making it more meaningful. The individual learning curve can, therefore, be steeper, and learning is more profound and longer lasting.

There is much potential and as always with revolutionizing technological inventions, also challenges. Virtual possibilities do not serve all learners from various reasons and thus are not equal. However, that does not make them any different from other learning methods. By offering versatile ways to learn we take more and more learning styles into account, and this is the way to make education more equal and accessible in the classroom.

Student using an AR app by Lyfta Oy. Photo by: Serdar Ferit.

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INTERWEAVING TRADITIONAL & DIGITAL APPROACHES IN EDUCATION

Educative technologies, such as VR, AR and MR are still relatively new to the education field. Some students, teachers, schools and organizations have already adopted them in their daily use. These early adopters have shown both the pros and cons of the new learning technologies. All of the learning tools we currently use have both advantages and disadvantages, but we still decide to use them because the advantages are considered greater than the disadvantages.

The disadvantages of these new educative technologies are partly different from the more traditional ones, and that is one reason why they can be considered hard or scary. For teachers with none or very little technical training and experience, facing new technological problems can be scary. Something called 'virtual reality' even sounds harder than the word 'textbook.'

We must overcome this barrier together. If we are not willing to learn new, we will go backwards. Education cannot afford to do so. When we look at the advantages of these new technologies used in education, we can see how they offer us new, earlier impossible opportunities in classrooms. Just like with other learning tools, the advantages can and should be considered greater than the disadvantages. These technologies open up possibilities that are impossible to achieve only by using the more traditional tools. (The advantages and disadvantages of VR in the classroom are discussed in more detail in the 'Virtual Reality - Situation now'- section.)

Using these technologies in education might sound difficult especially for the teachers, but there are also easy ways to add VR in daily teaching. For example, filming a 360-degree video of a class has significant potential to transform the way in which we support the student-teacher pedagogical practice. When we set up a situation where students and teachers are able to re-experience their teaching, it supports students to produce reflections that show a much better understanding of both teachers and their pupils' behaviors. (Walshe et al., 2019) This kind of situation is a great place to start interweaving the new technologies into teaching.

A teacher might think, why does it need to be a 360° video. Why is a 2D video not enough to deliver the information given in the class? The immersive, embodied nature of 360-degree experiences support students' understanding of pedagogical practice in a number of ways.

Spatial situatedness, what students feel as though they are physically in the classroom when engaging with the 360° experiences: the embodied feeling of 'being there.' (Heidegger, 1962) A class is a lot more than just shared information: it is also a shared experience that supports the learning.

Filming a 360-degree video can also be the key to deal with absences. It is not always easy or even possible to facilitate students' access to classroom environments. Instead of students doing extra tasks to replace their absence, repeating a course or even failing it, students could participate through VR. Used like this, VR would reduce the absences and student and teacher workload. Besides, students participating though VR can engage with lesson without disturbing the children or the teacher. The result can be an experience of a more 'realistic' classroom dynamic.

Another advantage of the immersive, embodied nature of 360° experiences is that they also support students' understanding of the wider narrative of scene-setting within a lesson. As students experience the classroom, they are better able to understand the significance of this narrative as a pedagogical decision. This affects the students' trust in education positively. The use of the 360° experiences also allows students to better understand the decision-making process of the teacher, both in their planning and in their in situ responses to the fluid happenings of the classroom. 360° video can support students to understand the nuances of classroom relationships, for example, effective use of a teaching assistant. (Walshe et al., 2019)

However, there is still space for the more traditional educational tools: we can not rely on just technology when it comes to education. There are still valid places for more traditional learning ways in education. For example, studies suggest that physical cues in a book (spatio-temporal aspects, such as touch and page turning) better support readers in navigating texts in an intuitive way. (Jabr, 2013). Longhand note taking on paper is more effective than on a laptop (Mueller and Oppenheimer, 2014). With all this in mind, it is time for us to develop a more modern, equal and effective approach to education. We must take the best out of the learning and teaching tools we have. Often this means mixing and using them together.

Blended learning is described as "the thoughtful integration of classroom face-to-face learning experiences with online learning experiences" by Garrison and Kanuka (2004, pp.96-7). This approach is useful in building learning communities, and there is a reasonable body of supporting evidence for the benefits of digital learning technologies. (Higgins et al., 2012) For example, blended learning happens in a situation where the classroom and virtual learning environment blend in together to be a whole. In situations like this, teaching can also use different kind of pedagogy and didactic.

Information systems blend in to be a part of everyday functions, and networked environments stabilize to be a part of everyday life. Therefore, learning cannot anymore be restricted in one place. Learning happens in different environments and times throughout life. The different environments of learning blend into each other.

Blended learning approach benefits students in many ways. For example, students using paper tend to adopt a more concrete mindset (i.e., thinking about how things are done), while those on computers are more likely to adopt an abstract mindset (i.e., thinking about why things are done) (Oppenheimer, 2019). Why not develop our education system so that students can own both mindsets since they are both needed in everyday life and work?

Students taking part in conversation after a VR/AR part of a lesson. Photo by: Serdar Ferit.

2

VR AS AN ASSISTIVE TECHNOLOGY IN EDUCATION

Technology for learners with literacy difficulties is used widely in higher education, but schools have not yet harnessed it as well. For young people with literacy difficulties, the three most common assistive technologies (AT) are:

- Text to speech (TTS)
  - this will help a student that can't decode
- Speech to text or predictive text
  - this will allow talk to be typed or type to be predicted once a student has typed the first few letters. A student who struggles with writing and spelling could use this technology.
- Concept Mapping
  - this can help sequencing and planning for those students who struggle with organising and getting their thoughts into a coherent, linear style or writing. (Daulby, 2019)

Assistive technology products and services can provide useful support for children and young people who have literacy difficulties, helping them to develop independence. It bridges gaps and, more importantly, takes advantage of learner's strengths without making it unfair to others. (Daulby, 2019)

Every major operating system now has inclusive technology built in, such as Read Aloud in Microsoft Word or Windows speech recognition. Assistive technology, then, is becoming just 'technology', which is accessible to all. (Daulby, 2019)

Virtual reality is also one of the assistive technologies that can be used in education. Virtual Reality (VR) is increasingly being recognized as an effective tool for the rehabilitation of cognitive processes and functional abilities. A combination of traditional cognitive treatment and virtual reality-based methods can offer an effective, safe and interactive approach to the treatment of individuals with disabilities. (da Cunha, 2017)

The VR-DAD (Virtual Reality-Based Daily Activities Development) is a good example of using the immersive virtual reality to provide an environment for teaching people with intellectual and multiple disabilities. It can offer the possibility for these individuals to improve their skills and to be more autonomous, and this way bridge the gaps and take advantage of the learner's strengths

without making it unfair to the other learners. VR also offers the possibility to better track individual students' progress for both the student and the teacher (and why not parents and medical staff), which comes particularly useful when educating children with special educational needs.

Various studies have shown that VR is a capable tool in the rehabilitation of children with ADHD. It is flexible according to the requirements with the students. VR can remove distractions and create an effective and safe environment away from real-life dangers. It can increase students' incentives based on their interests. It provides suitable tools to perform different behavioural tests and increase ecological validity. VR can also facilitate a better understanding of individuals' cognitive deficits and improve them; assessment, rehabilitation; improving working memory, executive function, and cognitive processes such as attention. (Azadeh Bashiri et al.)

VR can also be an extremely helpful and useful tool when educating children with autism — building reciprocal communication and social skills, like expressing appropriate responses, facial and body cues, which are especially challenging for individuals with autism. In a small study, the researchers found that a social awareness program in VR taught participants new skills by role-playing situations like going on a job interview, how to interact with new people and other helpful skills like dating with positive results. (Leatham, 2018)

Student using a VR app by Lyfta Oy. Photo by: Serdar Ferit.

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ABOUT LEARNING STYLES

Learning style is the general, unconscious tendency of an individual to use certain types of learning strategies or learning methods to adopt new knowledge or skills. Learning styles are personal and individual ways to receive, process and recall information. Learning styles may also mix: the majority of us learn in a variety of ways.

Self-directed learners are aware of their own learning styles and may even be able to change their learning style (un)consciously depending on the learning situation. Individuals personal style of learning can be further explored by a psychological test, but the learners also try to identify it themselves. Identifying the personal learning style is useful in becoming a better learner.

People can be divided into groups of different ways according to learning style models. Learning style means the way an individual works best when learning new information. Learning styles have been shown to evolve in biological origin, but others say that learning style is a changing and evolving feature over time. The style of learning can equally well be generated by the interaction between the environment and genetics.

When we can not shape the learner's personality or cognitive learning, learning environments that support different learning styles must be designed to achieve better learning results in the classroom. All kinds of learners should be taken into account as far as possible in teaching so that all learners in a group would have as equal starting point as possible.

There are many different definitions of learning styles. The most popular and universally accepted learning style division is the Sense-Based Learning Structure. In this section, we consider this from a learner-based approach of virtual learning.

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SENSE-BASED LEARNING STRUCTURE IN VIRTUAL LEARNING

We gain information and remember things through our senses. Often one of the senses is more dominant than others. Others learn more effectively when they hear new knowledge, and others have to see to learn. Some people learn best by doing. It is essential for educators to understand the differences in their students' learning styles so that they can implement best practice strategies into their daily activities, curriculum and assessments. This also applies to virtual learning.

Sense-based learning styles are auditive learning style, visual learning style and kinesthetic & tactile learning style. If the individual has more than one strong sense channel, he or she may be able to learn with multiple senses. In this case, learning success is more likely because the individual does not have to rely on one single sense. Most of us use more than one channel to learn, so each way to learn is a unique mixture.

In this chapter, we discuss each learning style and consider whether and what benefit can VR bring to that specifically. The aim is to see the value that VR can bring into education from this point of view.

Students using an immersive learning (and teaching) platform by Lyfta Oy. Photo by: Serdar Ferit.

4.3 AUDITIVE VIRTUAL LEARNING

A learner who represents auditive learning style learns the easiest by listening. The hearing is the strongest sense in the learner's data processing. An auditory learner may benefit from processing the information out loud. It may help the person to speak out the information when learning to learn it better. From traditional teaching methods, auditive learners will probably benefit from small group activities, class discussions, and listening to recordings and videos.

Auditive learners are therefore best placed to receive oral information. They are often at their best in conversation situations. Some of them are excellent multipliers or imitators. Audience-like learners may also like to listen to the radio or music. However, all people have their strengths and weaknesses. Audience learners may have weaker visualization capability. Virtual learning methods can be a significant benefit for the auditive learner to develop visualization capability.

A virtual learning environment can also use audio to support learning. It is possible and recommendable to connect headphones to the virtual system. With all learners, headphones improve the immersivity of the virtual learning experience. Auditive learners often find learning to be more comfortable and natural when they can focus on listening. They may be more prone to get interrupted by background noise. When studying in virtual environments, the external, non-relevant sounds are easier to minimize or block through headphones. This allows the student to concentrate on the actual information. It is best to choose background noise attenuating headphones to connect with the virtual system, especially when used in education. They will help all students reach the most immersive virtual experience, which further deepens their learning.

Experiences in virtual environments can also be shared, meaning that more students or teachers can take part. Thus, the possibility of discussion in virtual reality remains unchanged. If more people attend a learning event, they can interact verbally through microphones that are built in most of the headsets available.

In this way, the description of the lesson can be utilized while the conversation between the participants remains open. For now, it is not possible for the whole class to participate. However, as technology develops, the virtual environments and experiences can be shared with more and more people simultaneously.

Sound can be utilized in virtual teaching even without headphones. An open discussion can be held between the class, even if some of the students are in virtual reality. Real-world students can, through the screens, see everything the students in virtual reality see. It is, therefore, possible to discuss together with the other students and the teacher. The discussion is not limited to the virtual reality learning experience. This is important because auditorial learners also learn by talking by themselves. It is important to remember that the usage of sound should always be used in a way that serves well the content being used.

Sometimes things experienced in the virtual reality can be challenging to discuss in the real world. We still do not have a complete description of all the phenomena and events of virtual experiences. So it may be challenging to rethink things that are virtually learned when trying to retrace them later. For more on this topic, see the section 'Challenges.'

Student using immersive learning (and teaching) platform by Lyfta Oy. Photo by: Serdar Ferit.

4.3 VISUAL VIRTUAL LEARNING

Visual learners may have a tendency to speak quickly but unclearly. Their thoughts are often visualized more quickly than they are able to express in words. Visual learners might find it difficult to find the right words even if they know what they want to say. They often enjoy drawing, acting and movies.

Visual learners often prefer reading in silence rather than listening. Some of the visual learners do not learn easily from written material. They need more material that is based on visual expression. Presenting an object with visual aid helps the visual learner to receive, perceive and print new information in memory. Examples of more traditional tools for this purpose include images, tables, and graphs.

Virtual environments are an excellent tool for visual learners. In virtual reality, it is possible to see how lungs are formed in 3D. The learner can also draw in three dimensions, with a variety of brushes and different environments. It is also possible to gain a cinematic experience. The student is present in this experience and can actively influence the environment. Many visual learners have more motivation to be actively present in a virtual learning event. In this way, they will probably also be able to get better learning outcomes.

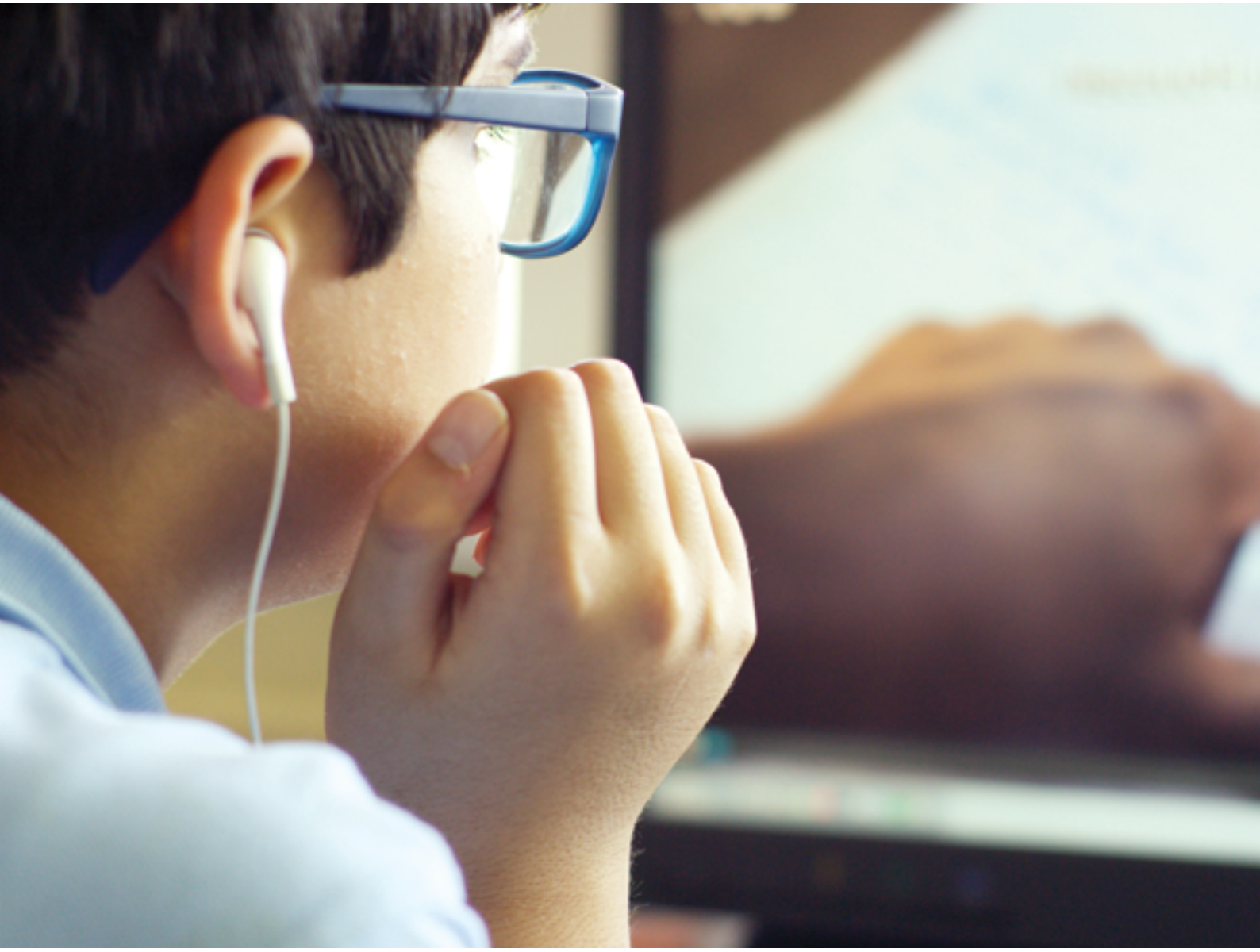
Visual learners often create images in memory to remember. In virtual reality, there is no need to focus on creating images, even if it is also possible to draw and create objects. The learner can safely use his/her entire focus to explore the 360-degree environment. Learners can absorb the information provided by the environment as such or interact freely with it just like in the real world.

Visual learners often need a general understanding of the matter in order to work effectively on it. Virtual experiences in simulated environments give the learner a quick overview of the topic being dealt with. One of the unique possibilities of virtual enrichments in education is to describe large entities quickly and accurately. This is discussed in more detail in the section called 'Opportunities.'

A virtual environment can be a more comprehensive experience of traditional visual learning tools. Most of the traditional tools, such as image or video, are two-dimensional. However, they often describe three-dimensional issues, entities or processes.

It is logical to explain three-dimensional, moving or changing phenomena or issues with a method that is capable to describe these dimensions, changes and movements more truly. For example, if you read an article about photosynthesis and see an attached picture of a birch leaf, the understanding of the physical phenomenon may stay weak. In virtual reality, it is possible to pick up the leaf from the birch, hold it and turn it around, then dive inside it and see all the plant cells and actual chlorophyll molecules taking part in the photosynthesis. In addition, the learner can also modify the molecular structure and see the consequences. This kind of opportunity can be help the learners significantly, especially those who tend to learn visually.

For visual (and also kinesthic & tactile learners) this kind of tool and approach is highly useful and increases the efficiency of the learning process.



Student using immersive learning (and teaching) platform by Lyfta Oy. Photo by: Serdar Ferit.

4.3 KINETIC & TACTILE VIRTUAL LEARNING

The terms tactile and kinetic are often used as almost synonyms, although there are differences between them. Learning to a tactile learner is more effective by doing. For example, writing, drawing and building three-dimensional models help the tactile in the learning process.

The kinetic learner learns by moving his entire body. Thus, receiving, processing and restoring a kinetic learner is effective. For example, study trips, pantomime, and dramatization of knowledge are an effective way to learn a kinetic learner.

Kinesthetic and tactile learners learn by doing and acting. Learning through virtual experiences emphasizes concrete actions, movement and self-reflection. For example, when learning about space, planets can be arranged in the right order and place rather than just looking at their placement and proportions from a two-dimensional image. In a virtual environment, the learner can walk between the planets and explore them by moving them from all dimensions.

Sometimes, it can feel unintuitive for the user to use controllers or gaze to navigate in virtual environments. There are solutions for this. For example, Leap Motion's software and hardware platform bring the users bare hands directly into virtual and augmented reality. They can be used in applications instead of controllers. This is a more intuitive way for humans to interact with their environment.

Kinetic and tactile learners often also look for tangible rewarding. Virtual environments can offer more concrete results in a game-like way. Progress and development can be addressed to the learners in concrete terms, such as level or awards. This not only rewards but gives the user a better opportunity to follow their own learning progress. For example, when the planets are positioned in the right places and order, the user can get a medal and move to the next level. Leve

In virtual learning experiences, the application can also more easily gather information about the individual's development over a long period of time. This allows the student and the teacher to monitor individual learning development and get real-time feedback and progress data. This feature in virtual learning may prove to be very important for especially kinetic and tactile learners.

Some of the kinetic and tactile learners may be inclined to restlessness. In virtual environments, the risk is reduced when more senses are needed in the learning session and the whole body participates. Possible negative effects of the real world disturbances are minimized when the

virtual learning environment fills the learner's senses with information.

All kinds of learners, maybe especially kinesthetic, will benefit from training new situations in advance. Virtual learning offers simulation opportunities in situations where a student needs (recurring) training. For example, presenting in front of a class can be hard. This can be practised in a safe virtual environment with the users own pace. When the moment to present comes, the learner already knows what the event feels like and what is expected from him/her.

Student using Lyfta OY's AR app. Photo by: Serdar Ferit.

5

MEANINGFUL VIRTUAL LEARNING

Learning is the modification and creation of internal models or schemas, and should always be meaningful.

From the viewpoint of cognitive learning psychology (Ausubel), understanding of meaningful learning focuses on understanding and building knowledge. The key to learning is the formation of meaningful connections in the pupil's mind. Importance always builds on the background of the learner's previously acquired knowledge.

According to the concept of socio-cultural learning psychology (Galperin), meaningful learning emphasizes social and cultural interaction. According to the concept of social learning psychology, the meaning is the result of social interaction.

From the perspective of humanistic learning psychology (Rogers), the interpretation of meaningful learning is emphasized by the individual and his personal experience. The key factors are values, internal and external motivation, feelings and atmosphere. The student's past experiences and values serve as a platform for building meaning. Personal meanings and values are emphasized, and also their relation to new knowledge. The significance of knowledge builds on the student's past experience and values.

Today's learning focuses on both the context of learning and the interaction between learners and teachers. Researchers have worked on the meaningful learning criteria (Jonassen 1995; Ruokamo & Pohjolainen 1999; Nevgi & Tirri 2001; 2003). In this chapter, the nine criteria of meaningful learning are addressed one by one from the perspective of virtual learning.

5.1 ACTIVITY

Students are actively involved in the production of learning knowledge; students themselves are responsible for their own learning.

Working in a virtual environment forces students to be active and make choices. Learning in this way offers the learner an excellent opportunity to break away from the traditional, more passive role of a student. Through virtual learning platforms, students play a more active role in the learning event than in most traditional teaching methods. This allows students to become the main character of the entire learning process.

The learner creates, through his/her own actions, a bridge between his own thinking and external reality. In most virtual learning platforms, students can also produce and modify the content. Activity and criticality are all prerequisites for professional development and can be practised through virtual learning.

5.2 CONSTRUCTIVENESS

The student is an active knowledge and skill builder; the student builds new knowledge based on previous knowledge; creating a common understanding of new things by discussing and thus builds new knowledge.

Virtual learning environments not only deliver new things and list existing information. Now it is possible to present information in its (simulated) correct context, or even from the learner's personal perception.

In teaching, it is essential to utilize existing media elements. Previously picture, animation and video have been the essential, basic elements to communicate something too hard to describe verbally. Voice, interactive presentations and exercises have also been there to support learning.

In addition to these tools, we can now take full advantage of the whole environment, another reality. The students can have a more active role in the learning event when it is possible to create, edit or interact with the environment. The virtual learning experiences should also be actively discussed and continued together after the virtual learning part. This helps the student to build information and actively connect the virtually received data to the whole.

5.3 COOPERATION

Students work together and build new information in cooperation with each other, utilizing each other's knowledge and skills; constitute a learning community with a central interaction and joint action; exploiting common debates and tasks. The goal is the quality of being dialogical.

There are several things that we will simply learn to remember and understand. Memorization and the importance of remembering things are still important, but pondering together and mirroring different perspectives will promote learning. However, they can not be the starting point.

The importance of social interaction is emphasized in learning situations that truly create a common vision, question matters, share information, or produce new knowledge and innovation. There are things that necessarily do not need to be discussed at all (e.g. how a device works). In most situations, we need to know enough about the subject to be able to cope in the collaborative section. However, besides self-study, there should be an interactive learning possibility to deepen the learning and the engram.

With virtual learning, we can either self-study or learn together. The social learning group is important for learning and motivation. Virtual experiences can be shared. So far it still needs a powerful computer and processor that every classroom do not have, but technology is developing rapidly. We are not far from the ideal situation, where schools can afford the technology that is capable enough to support learning and teaching.

Virtual reality can also be collaborative. For example, a problem-solving task can be implemented as a team, or a student can continue the work where another student left it. This way the whole class can work on the problem together as a shared, common process. In this case, the information of the previous student is transferred to the next student. The output and the total process can later be viewed, edited and corrected together. This way every student gains the same knowledge.

5.4 INTENTIONALITY ERGO GOAL ORIENTATION

The student determines and sets his/her own goals; responsibility for achieving goals by the student him/herself; students are actively and willingly trying to achieve their goals

Learning is not just about memorizing existing facts. The learner's own active role in building meaningful entities is essential. The student's own activity in the learning situation is emphasized when it is compulsory to act and take part in the task.

The big picture and the achievable goals in virtual learning are often clearer than in traditional teaching methods due to its concreteness. For example, inserting the digestive tract into numerical order may not be as objective as placing them in a cross-section human body. In this way, the subject becomes more concrete, and the learner's point of view may widen. Besides, development and progress are often easier to see and internalize thanks to real-time, visual, game-like representations.

5.5 CONTEXTUALITY & SITUATION-BOUNDINESS

Learning tasks relate to the real life of a student or are simulations of real life; things studied are linked to other areas of life, whereby the learned things can be transferred to other areas of life, such as work and leisure.

One problem with education has been that the teaching is too theoretical and out of the practical situation to which it relates. Knowledge should always have meaning in practice. Virtual learning connects information to authentic situations and experiences through simulation.

Knowledge always gets meaning in the mind. With virtual learning tasks, the context is explained and joined with the visuals, audio, physical feelings and of course the environment. The learning event is more realistic for the person as it is explained and experienced as a simulation in its "real" environment. The lesson learned is more related to the learner's real, personal life. In this way, the learner does not question the importance of the matter as easily or strongly in the real world. With virtual methods, there are fewer mistakes done in joining the information to its actual place and context.

5.6 REFLECTIVITY AND SELF-DIRECTION

Students express what they have learned and examine the thinking processes and decisions required by the learning process; students analyze their own learning and take more and more responsibility of it; with the help of different self-assessment methods, such as learning diaries or self-assessment tasks.

The virtual teaching material activates learners to reflect on and question their own or working community practices. Some of the tasks are so-called open problem-solving tasks that do not have one correct answer. In virtual teaching, there should be debating events (either) before, during or after the virtual part of the lesson. These events should include analyzing, discussing and questioning the learned issues. The virtual experience alone is not enough to achieve full understanding unless it is reflected and analyzed. Blended learning is the key.

Often, such tasks requiring reflection are tasks of open problem solving, that do not have one correct answer. For this reason, communication becomes very relevant. It is essential to question the lesson learned, to study it from different perspectives, and to link the learning material to the learner's everyday situations. Sometimes, depending on the case, it may be difficult to talk about virtual things and happenings the real world. In these cases, it might be better to do tasks or (group) projects outside VR.

These discussions, tasks or (group) projects help the students to express what they have learned and examine the thinking processes and decisions they did. These self-assessment tasks are may be more convenient to implement outside VR, but some virtual learning tools, such as Lyfta 2.0, also include inbuilt self-assessment tools.

5.7 INDIVIDUALITY

...among other things, taking into account the differences of the student's past knowledge, skills, competence and motivation in the implementation.

In virtual learning and teaching, individuality can be taken into account at least at the same level as with the more traditional teaching methods. Individual outputs can be compared to previous ones and monitored. Some virtual learning platforms automatically modify the next steps according to individual students' former results. The system gathers the data and guides the students according to that.

Basically, this means that virtual lessons can be slightly different between students in the same class. Some students may need to repeat some tasks during the lesson, or next lesson, according to the gathered data. Others can use this time to do an extra task or discover the virtual environment freely. The generated homework can also be slightly different between students. This is a possibility that VR brings to the classroom, and it can be used or not used.

Some students may have problems with their vision. In virtual environments, text and other essential learning elements can be easily changed to give each student a more equal learning opportunity. Also, possible hearing problems can be minimized with more suitable headphones and setting for example volume levels to fit the individual needs as well as possible. The experience is personal, so students with issues like these never need to be embarrassed or try to hide them.

In virtual reality, the system can be set up to accept different kinds of actions. It is possible to use controllers, own hands or even gaze to interact with the virtual environment. So students with physical disabilities are somewhat secured with virtual reality learning environments.

What comes to motivation, virtual learning platforms should be kept open to students to allow further self-study or rehearse. Other learning tools should be used to support the learning or/and give the learner a chance to choose the way they feel most comfortable to take in the information.

5.8 TRANSFER OF LEARNING

Applying knowledge to formerly learned things or entities; using the learned material in new contexts.

One of the educational challenges is to apply the learned knowledge into practice. When succeed, this should be reflected as improved behaviors and actions. However, often teaching in classroom involves so much matter in a relatively short period of time that it may not be enough to fully internalize or understand it. Learning often transfers from one situation to another rather poorly.

There are two types of learning transfer:

1. Easier transfer effect happens in a situation where the learned case is applied in a similar situation.

2. The more demanding transfer of learning happens in a situation where the learned method or principle is used in a totally different situation.

The use of virtual reality in teaching emphasizes the role of the easier transfer effect. It moves some of the things that have traditionally been more difficult to the area of the easier transfer effect. This is mainly due to the fact that in virtual learning it is possible to practice through simulation. This way the learned case is applied in a very similar situation in real life.The application possibilities of the subject can also be simulated in the virtual reality, and thus the virtual methods allows us to take a step even further.

Virtual learning methods brings an important and meaningful addition to teaching when it comes to transfer of learning. The student should understand the using situation and entity of the learned issue. Otherwise, there is a risk that the student will learn scattered knowledge or memorization.

VIRTUAL LEARNING - SITUATION NOW

This section discusses the situation of virtual reality in education right now and provides an overview of its near future. After this we take a look at its possibilities and challenges.

Everyone has heard about VR. It seems that augmented reality and virtual reality are developing rapidly and will be a massive part of our lives in the near future. This has been said for years, but everyone is still waiting for that long forecasted revolution.

Both AR and VR have been slowly coming for decades. The journey has seemed endless. Everyone has been waiting for the moment of the breakthrough. However, it has not yet happened properly. Technology is still too expensive for individual consumers and schools. There is still a long way to go with development. Also, more quality content must be produced continuously.

VR's field is constantly gathering more players; Startup companies and medium-sized businesses, but also huge organizations have their hands in the game. Google, YouTube, Samsung, HTC, Pinterest and numerous other big companies are involved in creating and developing VR technology and content. Right now, the trend is rapid and continues to accelerate, as there is a lot of competition in the industry. This makes VR more and more accessible every day.

VR is rapidly taking more space and is spreading to all sectors. Just as many industries, education and training are already in the VR field. In the global level, companies actively create content and applications which helps the integration process of VR as a tool at all levels of education. As usual, most of the companies are chasing economic benefits.

VR spreading to the education sector opens up a massive amount of new opportunities. For example, schools can now get to places that have previously been impossible to reach. There have been obstacles such as budget, time, or physically unavailable access. VR also brings in additional ways to help children in need of special education.

Schools and higher education organizations have also started to work with VR and AR to market themselves and attract people to apply for study. Thus, these schools have gained more competition in the application process. As a result of this, the average student in these schools is now better.

Augmented reality and virtual reality both have incredible potential. There are opportunities in all areas and fields. As always with the development of new technology, there are still challenges. The level of exploitation will be set by us. It will certainly also vary by field and sector. Only time will show the level and manner of how it will change the world.

Students using a VR app in classroom. The teacher is combining more traditional ways to learn in this lesson. Photo by: Serdar Ferit.

6.1 ABOUT POSSIBILITIES

LEARNING STYLES

VR takes different learners into account. Studies have shown that students who are typically less successful developed more academically with virtual methods compared to additional methods. These students learn virtually even more efficiently and faster than the best-performing students in the same class. (Winn et al., 1997) This is mainly due to taking the different learning styles of the students better into account. Virtual teaching methods help some of the students that are not served by more traditional teaching methods.

In education, it is important to remember that different learning and teaching methods always tend to favor and suit best to support a certain learning style. This is why it is important to offer multiple, versatile ways to learn.

DISABLED STUDENTS

Virtual reality can also minimize or mend the effects of some disabilities. VR can provide an alternative way for an individual to perform a particular task. For example, when an individual is prevented from using his hands, virtual reality can act intuitively through gaze and head movements. Disabled students can now explore or create new environments for them in a way that is possible for them. VR allows them to experience something that is usually difficult or even impossible for them in real life.

Sometimes VR can also give us more information about the disabilities or their severeness. SEN practitioner and researcher Ceri Williams whom I met in SEND Conference 2019, told me about a 13-year-old boy who was severely disabled. He could not talk or use his limbs. The doctors were not sure if he could understand his physical surroundings or be able to interact with it. When the boy was using VR for the first time, the doctors, researchers and relatives were looking at a screen where his experience was screencasted in real time.

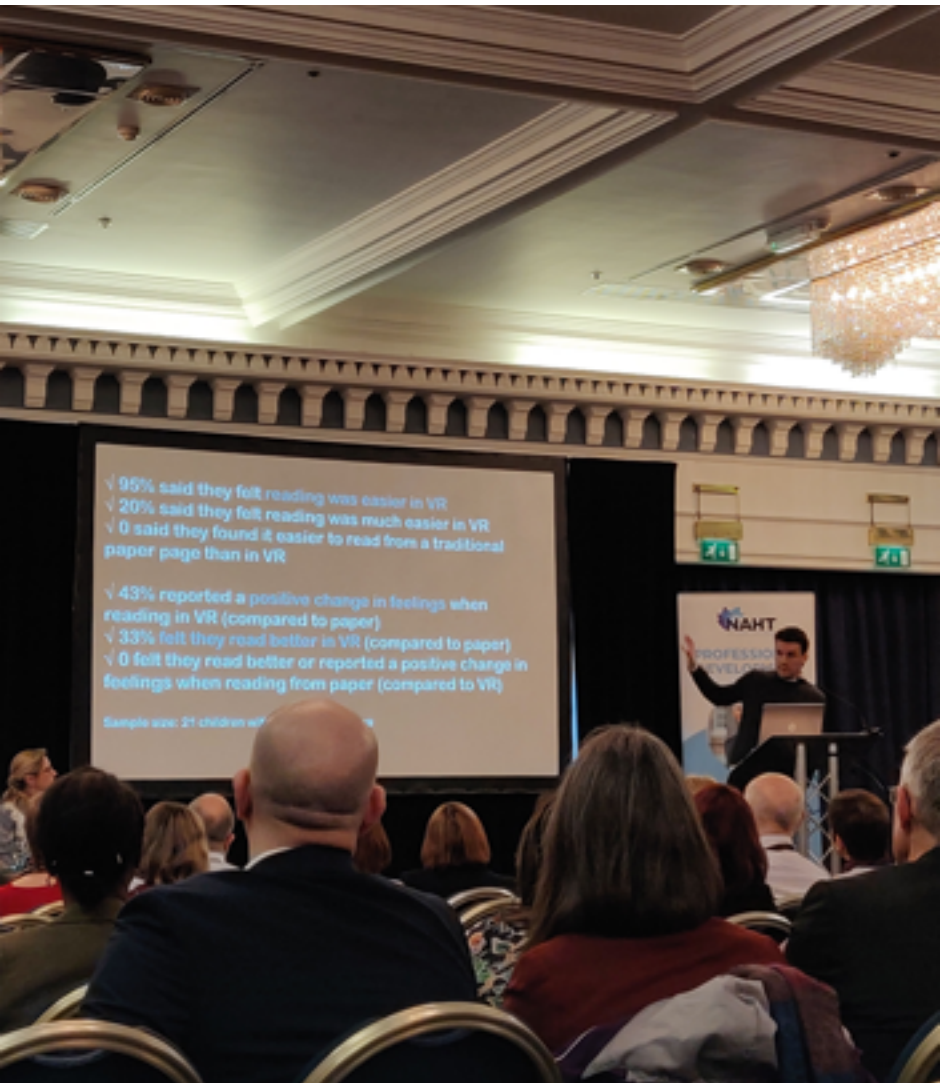
They could see him moving blocks with his eyes. After following his actions in virtual reality for a while, they all agreed that they were intentional, and the boy understood what he was doing. This is an excellent example of how VR can sometimes offer us crucial information of the (disabled) people we are educating. This kind of personal data can be further used to personalize the learning environment.

SPECIAL NEEDS

VR also helps to take into account pupils with special needs. This includes learning difficulties, such as different types of dyslexia. The reading can, for example, be slow or text seems to be jumping around which makes it difficult to read. Sometimes reading goes technically just fine, but the content is not understood. Virtual reality can be used as a safe space for training and even overcoming learning difficulties.

The fact that the learner can be alone in VR can help decrease the 'stage fright' of, for example, reading, which alone can make it easier. Also, the learner's enthusiasm and interest towards VR may help the reading. When a dyslexic student who is self-aware of the problem reads out loud, it might help that the VR factor takes the thoughts away from (social) pressure. This scenario does not help or treat dyslexia as such, but it decreases the factors that can make the reading more challenging.

VR also helps with other special educational needs and disabilities. Virtual learning can be helpful in e.g autism, spatial perception difficulties, or in attention deficit hyperactivity disorder, as Jukka Sormunen's interview later shows.



UP: Me and Ceri Williams discussing a VR app for dyslexic students I designed and developed for Lyfta OY. Photo by: Serdar Ferit (London, UK , 2019)

LEFT: Serdar Ferit, Lyfta's CO-CEO & CO-Founder, revealing the first results of a small study of the benefits VR can offer to dyslexia. The study was made by Lyfta OY. Photo by: Meri Miettinen (London, UK , 2019)

EQUALITY

VR makes education more equal, just like all the other learning methods used in education. When VR is taken into one teaching method among others, all kind learners are taken better into account. For example, kinesthetic students have been taken less into account with just traditional teaching methods. Each time a new method is added, the education becomes richer and thus serves better different kind of learners.

ACTIVE APPROACH

The virtual learning environment emphasizes learning-by-doing and interaction with the environment. For example, in a case study (Barnett et al., 2005), the students built three-dimensional solar systems and other astronomical phenomena in virtual reality. This supported students' wider understanding of space. Without the self-built three-dimensional spatial objects and their entities, the perception of space remained remote and conceptual.

The research focused especially on 3D modeling, which can be more intuitive in VR instead of a computer. Such VR access gives students the ability to build and experience visual and manipulatable objects and environments. VR thus helps dramatically illustrate the issue through active doing and experiencing. Traditional learning methods are in this sense somewhat insufficient compared to VR.

EXPERIENCING

VR offers the opportunity for constructivist learning, as it allows the learner to form his/her own knowledge of meaningful experiences. The physics-based building game Fantastic Contraption is a good example of constructivist learning theory in practice. It concretizes and materializes the principles of physics. In Fantastic Contraption, the student builds a machine. If it does not reach a specific target set on the machine, the user must solve the problem by manipulating the machine structure. The development will continue until the machine works correctly. In this example, the constructivist learning theory principles are easily visible within VR.

Whether it is about learning a new language, experimenting with chemistry or building new worlds, virtual reality offers a whole new level of immersive and experimental learning. Educational opportunities and potential will grow. As this technology develops, the number of content material increases and the whole industry grows, we have more and more experiences that exploit its constructivist character.

IMPOSSIBLE ENVIRONMENTS

VR is an excellent tool for learning in environments that are naturally dangerous. This allows students to explore such things as bioterrorism, risky chemistry experiments or how to act when a fire alarm rings. In virtual environments, pupils control their learning in an incomparable, hands-on way through which they become more involved and more committed. (Crosier et al., 2000). Experimental Comparison of Virtual Reality with Traditional Teaching Methods for Teaching Radioactivity. Education and Information Technologies) VR also allows deeper learning and understanding in things and situations that have not previously been possible to illustrate (at this level). In addition to dangerous places, also physically impossible environments such as Space can be accessed via VR.

FAILURE & REPETITION

VR provides a safe space for failure. For example, Learn Languages VR (by Mondly's) and Public Speaking VR (by VirtualSpeech) give students the possibility to practice their speech without the fear of 'serious' consequences or social shame. Errors can be made privately, in students' own peace and pace. This safe space provided by VR can also provide support for e.g. posttraumatic stress disorder or social anxiety. VR may also be particularly useful for specific groups such as students with dyslexia, ADHD, concentration difficulties, autism or disabilities. In the real world, similar rehearsal conditions are harder and more expensive to offer.

SUMMARY

VR has the potential to promote and widen the learning environment by creating immersive learning environments that are customizable. Customizability makes these environments even more activating and inclusive. Virtual learning thus may well concretize and accelerate the whole learning process. It can be an inspiring and motivating training method, naturally depending on the student preferences and characteristics. Studies have found that 80% of those who studied in virtual reality remembered what they had learned after a year. In comparison, a group that was taught only with traditional teaching methods remembered only 20% after a week. (Lahti, 2015)

VR offers simulation opportunities in situations where repetitive exercises occur. In a simulated virtual environment, the training can be done faster than in the real world. Exercises can be carried out in a completely unchanged environment, but it is also possible to modify the environment to make it more difficult or complex. For example, psychology's terminology and all the parts, structure and functions of the brain can not be learned through one exercise. Students can

improve their ‘retrieval strength’ by regularly recalling previously learnt knowledge.

With VR, it is possible to monitor the progress of training in the long or short term. The learning application can store student advancement and results in the system at each training session. This enables the teacher and the student to evaluate individual performance and progress. Privacy is retained when the student logs in to your system or application with a personal username and password.

The results can be presented in any way, for example through visual graphs or numbers. Possible problems in learning are easier and quicker to spot and observe when learning is monitored and measured in a clear way. Some students may want to improve their assignments and therefore practice more. Improved learning outcomes and tangible progress can also contribute to additional motivation.

VR can also be affordable. Today, almost all high school students have a smartphone that can be used to have virtual experiences. You can get a case for it from six euros from Google, or even cheaper by crafting it yourself from a cereal package. Even the lower school children survive from this task.

The smartphone and the case is already a door in the virtual world. The resolution of the content, as well as the level of interaction and immersion, are naturally not at the same maximum level as when using an efficient the latest and most effective computer and a virtual system.

However, it is possible to do much with cheaper VR tools in the classroom. We should also remember, that technology is developing rapidly and prices are going down. The VR industry is constantly developing standalone headsets that better fit the school budget. They can do high-quality graphics without wires, a computer, or even a smartphone. The content can be downloaded directly into the glasses from for example Google Play Store. With such solutions coming to market, VR is more available to everyone when there is no need to buy several, often expensive tools.

6.2 ABOUT CHALLENGES

PHYSICAL DATA

One of the challenges of virtual reality is nausea caused by it. Nausea and other unpleasant symptoms are created during the adaptation to the environment. Any adaptive environment can cause nausea symptoms. Weakness and dizziness can occur if there is movement in several directions, especially when the user feels and knows he/she is not moving with the environment; the user can see that the environment around moves without him/her moving. What the eyes see is contradicted by what the balance elements observe.

According to Jukka Häkkinen, a psychologist and researcher at the University of Helsinki, these symptoms can be avoided by making and consuming content with as few fast movements as possible. In the research, e.g. peaceful 360 ° videos caused less and easier symptoms. It is another question whether the virtual content should be designed and developed under the conditions and fear of the symptoms. (Häkkinen Jukka, 2017)

Some people get strong symptoms with milder content as well. Such people are often generally more vulnerable situations that cause nausea. There are people for whom virtual reality simply does not fit. (Häkkinen Jukka, 2017.) This can even be seen as an equality issue, especially when it comes to children and young people who use VR as a learning method.

PHYSICAL INCOMPATIBILITY

Physical space and virtual space are not congruent. Physical space barriers and space constraints are also constraints in the virtual space. Our body remains in the real world, even if we are sensing information from another environment. The same chair is on the way had the student virtual glasses on or not.

This problem has been attempted to solve, e.g. by utilizing teleportation. When in virtual space there is a need to move longer distances than real-world physically permits, the user can teleport from one place to another. This reduces the physical space needed around when using VR, but is not the most intuitive way for people to move. (Schmitz, Michael, 2017)

DISTRIBUTION OF EXPERIENCE

Simultaneous use may be challenging. In some cases, the wires are still attached to the headset. Also, physical space constraints make it difficult for users to experience together. As the number of physical space is limited, there is a chance of collision. By using synchronization software, it is possible to view for example multiple 360-degree videos at the same time. This allows everyone with a VR headset to see the same content at the same time. Shared experiences can significantly increase the price of the required system.

DEFECTIVE PHYSICALITY

Insufficient physicality in virtual space is also one of the challenges. (Schmitz Michael, 2017) All senses require stimuli from the physical world for the time being. We can see the virtual environment through glasses and hear the voices using headphones connected to the virtual system. It is not possible to touch and feel the surfaces of virtual environments, but when using controllers, the user can feel them vibrating. Our sense of smell does not get stimuli from the virtual world either. Virtual reality is not, a multi-sensory experience so far. For now, we can bring "artificial" sensory stimuli from the real world, e.g. by using a wind machine.

ETHICAL CONFLICTS

There are also ethical problems in the virtual worlds. They are mostly related to human behaviour and motives. Ethical problems in virtual reality are particularly relevant in the gaming industry. VR can in some ways desensitize users for criminal or violent actions. Especially in game content, there is a lot of violence and simulated fighting exercises. These scenarios may kill virtual people in a very realistic environment, from the first person perspective. When such experiences are repeating and frequent, it may be that the user is no longer moved by such extreme behaviour or violence at 'normal' level. They may begin to show signs of deteriorating empathy and compassion skills. In some cases, users are actively looking for events like this in order to get adrenaline spikes and the feeling of power from the real world as well. Such behaviours have been observed especially with players playing from the first person perspective in very immersive shooting or fighting games.

Another ethical problem in virtual reality is cyber-addiction. Some people are hooked to VR games. This may result in the weakening sense of the boundary between the real and the virtual world. They spend more and more time in virtual environments. This is likely to cause adverseimpacts on their lives in the real world. This kind of behaviour has already been described in

science-fictional books and movies, such as in Ready Player One, science fiction novel of American author Ernest Cline (2011).

OFFENCE CONSEQUENCES

What happens when an individual commits an offence or a criminal act in a virtual environment? This can be a disadvantage not only for the user itself but also for the others. Once the virtual experience is shared and one of the participants takes such action, one may physically be injured or mentally traumatized by another's actions. Is the penalty then similar to the penalties in the real world, or do we apply the current system to fit the virtual reality? Or do we need to write a virtual constitution law? So how do we condemn possible virtual crime? What if an underage person does it? Such things may seem irrelevant and insignificant at the moment, but for the future, it is important to consider them and be as prepared as possible.

TECHNICAL PROBLEMS

There are several problems with the virtual reality system. So far, the graphical quality displayed by the virtual glasses and lenses limits the realism of the experience. The resolution is not nearly the same as what we see in the real world through our own vision. In addition, the image may have a delay when turning the head. Delay can be minimized by a powerful computer, but system and experience quality is also sensitive to varying amount of light in physical space. (Schmitz Michael, 2017) This sense of sight already tells the user that the experience is not "real" but simulated. This affects immersion negatively. Systems are also not cheap. The price for a virtual system to be connected to a computer is about 500-800 euros. This still requires an efficient computer and a suitable platform and space. In addition, some of the programs and applications cost.

So far, virtual glasses can be heavy and uncomfortable. Navigation is still mostly supported by controllers. However, these problems will be solved when technology develops. Also with Leap Motion, you can use your own hands instead of controllers for a more intuitive and ergonomic virtual experience.

For now, mobile virtual glasses cannot identify the user's position or movement that well. They are not yet able to utilize proper motion controllers. However, technological progress is rapid; the first prototypes of proper motion-detecting mobile phones have already been introduced to the markets.

Even when the VR experiences through smartphones are graphically more modest, they are

much more affordable. Almost any smartphone can experience a sense of virtual reality, but for now, the applications and the experience remain far from the level of the apps used with a computer and advanced VR systems.

COMMUNICATION

Communicating between real-world and virtual environments may interrupt the user's virtual experience or be otherwise difficult. (Schmitz Michael, 2017) Voice recognition from the real world interrupts the virtual environment's perception, and user experience is disturbed. Also, for example, touch or other emotional sensation may interrupt the user's virtual experience. Because of the interruption, the possibility for flow effect also decreases. During learning experience, such interruption may interfere with learning and its depth.

When shifting back to the real world, communicating virtual reality matters can be difficult afterwards. Such a problem may arise, even if all parties to the discussion have in turn witnessed the same things in virtual reality. (Schmitz Michael, 2017) This may prove to be a problem in the school environment when learning experiences are discussed or shared afterwards.

If the parties discussing did not all prove the same experience, it is even more difficult to communicate about it. For example, it is not always possible to just simply point, demonstrate or show when everything inside the experience is immaterial. Some of the things and experiences of the virtual world are still so different from what we are used to in the real world that we may not even have the right, fully describing words for them yet. The virtual revolution will create its own part of our vocabulary.

Students being introduced to an AR app. Photo by: Serdar Ferit.

LET THE USERS TALK
- INTERVIEWS IN KUOPION KLASSILLINEN LUKIO

I wanted to give a voice to real people. I found out about a high school in Kuopio, Finland, called Kuopion Klassillinen Lukio, more familiarly “Klassikka”, that had already used VR technology broadly for three years in their courses.

I scheduled a day to visit the school. I interviewed the principal (that was the driving force behind this), one of their teachers and 25 students. My goal was to find out how the teachers actually feel about using virtual learning and teaching tools, and how the students feel to learn with using them.

I had prepared some questions to the principal, teachers and students, but in the situation I let them speak freely and add anything they wanted to add. Especially with the students that I interviewed in five people groups, my questions provoked some conversation between them.

I voice recorded the interviews and also gathered some data on paper, but mainly, in this section, I let them speak for themselves.

To see all the questions asked, see the section ‘Attachments.’

7.1 PRINCIPALS PERSPECTIVE: JUKKA SORMUNEN

Jukka Sormunen is the principal of Kuopion Klassillinen Lukio (High School in Kuopio, Finland). He is a teacher of physical education and health education. Sormunen coordinates the Educational Board's projects FinEduVR and Global Virtual Reality in Everyday Life, i.e. GloVR. Sormunen is also an entrepreneur.

Sormunen has always been interested in teaching technology and developed lesson recording a decade ago. This allows students to keep track of the course when sick. The high school also has an iPad teaching project that has been going on for about three years now. Logically next step was to bring in virtual reality.

Some tools were already acquired in this high school before the project was submitted to the Finnish Board of Education. They were already equipped and ready to do something fast. It was the first educational VR project to be funded by the Finnish Board of Education.

Sormunen is interested in technology as a principal and teacher. This and pure motivation to try, pilot and test have encouraged him to do this and other projects. For several decades, the high school has been wading in Finland on many issues, and on the other hand making research. The principal thinks this is a good thing, so everyone wouldn't have to go to the same pitfalls.

> *Virtual reality per se, it could be artificial intelligence at the moment, but it happened now to be more approachable then, it is more concrete.*

According to the principal, VR has practically not changed this high school, but it has enabled students to experience virtual reality devices and environments. The experience of gaining virtual access to, for example, a human being is an educational enrichment. It has opened up opportunities, for example, to biology teachers to tell more about human anatomy.

> *Our biology teacher has kept exams in VR. It is this day: a good school is no longer a box, it has to work together with companies and other organizations.*

According to Sormunen, there are very different high school students coming from 'Klassikka.' They've been rushing into virtual reality for two years now, as long as they just endure. These students are different in the sense that they have such experiences and abilities. Sormunen hopes that these young people will lower the threshold for other young people to try VR. He also hopes that the project will change and lower the technology resistance of teachers, for example on the vocational school side. "When this has been tried here, why not try it at a vocational school. I hope all this is good will go through it. ", Sormunen describes.

> *We train people to go to associations and businesses to work at some point. The more and closer we work with working life, the better.*

VR has changed the high school so that young people have already experienced virtual reality for more than two years. Young people themselves have taken responsibility for all the devices. The devices have been in free use. Nothing has ever been broken or lost. Students have also kept their computers up to date: they have admin rights to them. Responsibility has risen enormously in maintaining the lobby when students have access to valuable tools.

> *Can you imagine that 600 kids walk by and hang out in the area daily, but nothing disappears or breaks.*

Visuality and experientiality differ in VR as a teaching method when compared to more traditional ways of teaching. An individual can truly experience feelings of joy and fear for example. For example, a class has measured heart rate in biology by playing a VR game. In the virtual reality, behind the back of the student, a zombie attacked and the class followed how it affected the user's pulse. In such a learning situation, the student genuinely experiences what he/she needs to measure. It is also possible to see the structure of the heart and the eye, for example.

The students have also been able to find good games in sports and music, ride a bike, drive a formula or a horse. Or, it is possible to draw in three dimensions. Brushes can be flickering, radiant, or even have noises. Students can draw anything from all dimensions and environments: for example in space and snow scenes. There is also useful material for physics, such as Moodbox. This application has gravity, motors and mechanical parts that can be used to build a moving car.

But still, there is a huge need to get more applications that suit the educational purposes.

In addition, more coding skills and collaboration should be obtained. Sormunen believes that more easy-to-use platforms would be needed for students to encode. Some young people themselves have learned to encode with Unity (a game engine), and have made environments for virtual reality through code.

There should also be more training skills. That is, teacher training should begin to develop in the direction that teachers have more knowledge of these issues. At the moment we are at the starting point of using virtual reality in teaching. However, there is much potential in it.

> *...that experientiality, the memory is deeper and longer lasting when you experience it, you see it, unpack it and pile it compared to when you read about it or watch a video.*

The principal feels that students learn more effectively with virtual reality than with more traditional teaching methods, if you find the right program. For example, in anatomy, the structure of the ear is illustrated to the student much better when parts can be removed and scanned from every direction. Of course, there are good animations on the computer today, but true experience is a huge addition in VR. The memory trace of learning is deeper and longer lasting when the student personally experiences the matter. This way, the student will also participate more in the teaching.

Some of the students are able to settle down on the subject and better focus on handling it when they put VR glasses on their heads. By getting them out of the environment full of distractions, they get immersed. Some people really dive into the subject with VR. A student with a sensitivity to disorder in the class gets much more in-depth knowledge of the subject to be learned. This is possible when the outside world is excluded. According to Sormunen, VR's ability to use visual, audible and emotional experiences at the same time helps. With emotions Sormunen means the physical feeling: for example when golfing in VR, it feels like the club really hits the ball when the controller vibrates.

> *Through game-likeness, virtual reality environments might start to hook in the future. We could have young individuals who would be hooked on learning instead of heroin.*

Sormunen hopes that VR programs will become more functional and playful. For example, a speed race in piling a knee can also make learning fun. Perhaps learning could thus become addictive, resulting in that the students would practice more and more thriving for better results.

> *I don't see virtual reality to be more special teaching tool than a chalk and a board.*

Students having a break and playing ping pong in Kuopion Klassillinen Lukio. The chair in the right is for VR purposes. Photo by: Meri Miettinen, 2018

7.1 TEACHERS PERSPECTIVE: RITVA TILAEUS

Ritva Tilaeus, a teacher of history and social science, has not previously carried out a course where she would have used VR as a teaching method. She, therefore, has no previous personal experience of VR teaching. Tilaeus had heard from his colleague that he had used the method in a native language course. Tilaeus got excited to test it and pondered that this course was suitable for many reasons. The course can be split well into teams, and there is so much material to share with people. The group itself is suitable for this, and the teacher has time to learn new things right now. Tilaeus assumes that the course might be a bit challenging, but at least it is something new. It is typical for her to go open-mindedly to everything where she sees potential.

> *Often as we see here, we have students who then teach us teachers. I have thought about it and I think it's okay. Teaching and learning become more reciprocal. And they enjoy the fact that they have something to give.*

She is motivated to try out virtual teaching, especially because of its versatility. She wants to offer a variety of ways to learn because there are many kinds of learners. Tilaeus also notes that the versatility in teaching prepares the students in the approaching working life. She emphasizes expectations, skills and abilities.

> *Because it's not working at all so that someone here speaks and writes others, not really. It is a matter of teamwork, acting and cooperation.*

According to Tilaeus, history is a subject that can be well illustrated. Therefore she suspects that VR suits the subject well. But she is also sceptical: she doubts if this is good for the students who struggle in putting things in the right context. According to Tilaeus this is a problem for many.

Tilaeus predicts that VR will certainly be useful when compared to more traditional teaching methods. She is a visual learner and is "always looking for maps and pictures". There are students in the class who learn the same way. Those for whom the text is not enough. There are also those in the class who are used to studying so that they have the text that they underline and otherwise analyze.

> *I can't think of any school subject that it doesn't fit. To illustrate, especially, to illustrate, for sure.*

The teacher compares VR to the situation when the principal came up with the class recordings. Tilaeus immediately went into it because she thought it could not be something she could not learn. The technique was easy according to the teacher. At first, much more work had to be done: the lesson planning took time. We had to think carefully in advance of what goes on in the films and what comes to the student through the sound. And whether the chalkboard writing is such that the recorder catches it. Tilaeus expects this to be the same kind of thing. She doesn't believe that it will in any way make it more difficult in the future.

> *I don't know if it's complicating things, but it changes my work in a way that I now need to learn and perceive things differently... but usually these experiences are such that it won't be making it harder after this.*

Tilaeus estimates that VR can even make it easier for the teacher to work. For now, she has searched all the video clips and images to illustrate different subjects. That takes a lot of time. Now the students can create at least some of the material. However, she estimates that the time spent teaching as a whole will remain the same.

Tilaeus has an idea for the last week of the teaching period when all the exams are held. Previously, it was planned to hold an exam rehearsal that traditionally prepares the students for high school graduation. Recently, however, Tilaeus has thought that on the final week the class will go through the student outputs. It would be a kind of VR exhibition about the subjects of this history course. The exam rehearsal would be adjourned.

> *I do not know why I am in this situation that I will do this, but generally everything has turned out the best.*

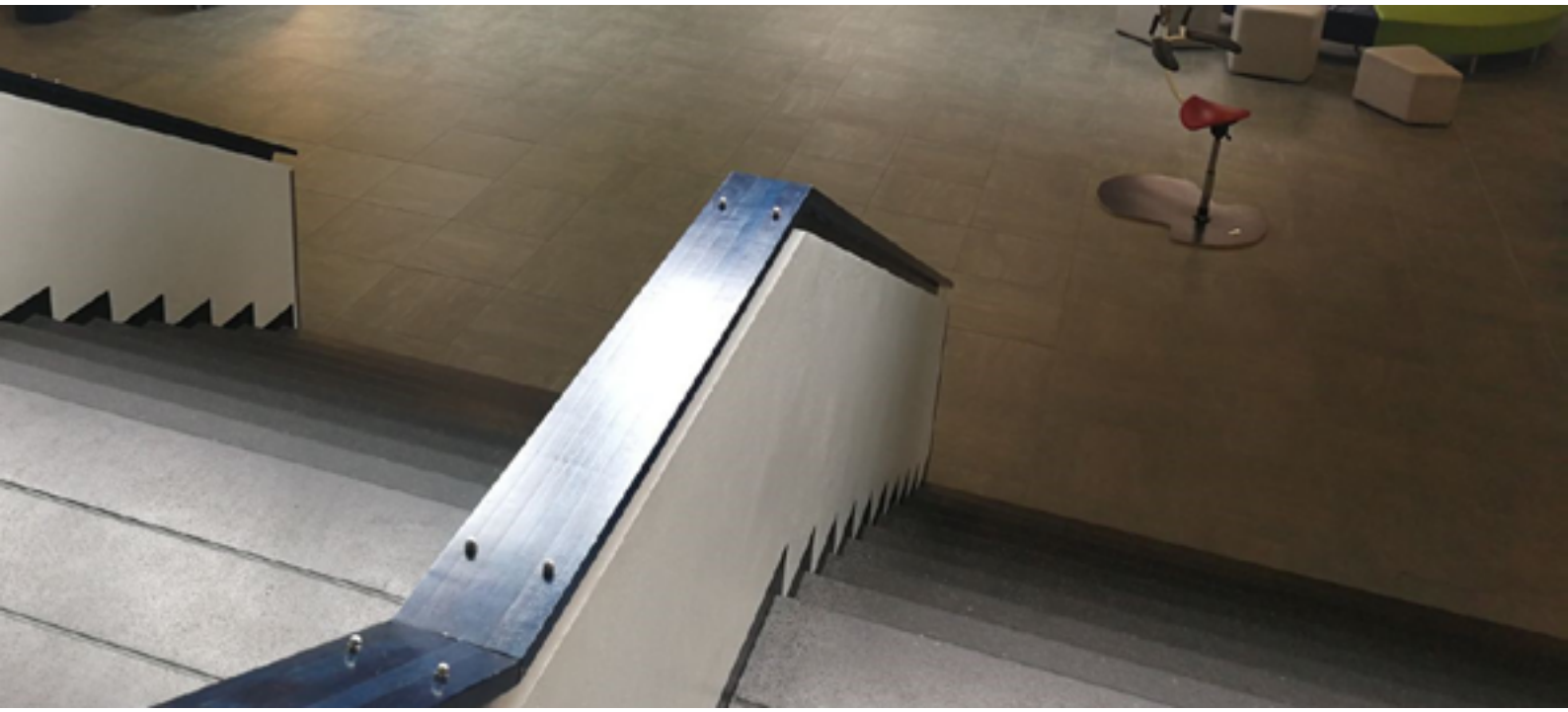
The evaluation of this course is another matter. Tilaeus plans to evaluate the group's performance by setting certain content criteria. He intends to give the group output a score, purely on its versatility and informativeness. The teacher does not intend to assess how the students have

expressed and presented the matter. It is not part of this history course.

Students also asked for an opportunity to write an essay during the course. Tilaeus will also evaluate that. The teacher thinks that some kind of exam might need to be organized, but is not sure yet. She thinks about organizing the exam for fairness and proper evaluation but says that in the final week the group will mainly focus on student outputs.

> *I was wondering how much I should have time and the capacity to get the most out of this. But I think their enthusiasm and investment also covers a lot, so that I don't need to have so much time.*

Tilaeus wanted to give the students the opportunity to try VR as a learning tool and see if they learned better. With their traditional ways of studying, they have missed out so much from this particular course, for example the majority of the culture section. Tilaeus emphasizes that it is not a good thing that although in any way the course has been studied, it seems to be more or less a scratch on the surface. There is so much material that the course only focuses on some of the most important things. They have missed for example India multiple times. Tilaeus has pondered, whether VR might have a solution to this. Through this, students will have the opportunity to get information on all areas of the course. The teacher believes that VR can teach or show some of the things that are usually impossible via traditional teaching methods.



Staircase leading to en immersive space Kuopion Klassillinen Lukio. Photo by: Meri Miettinen, 2018

7.1 STUDENTS' PERSPECTIVE

Especially the ones that identify themselves as visual learners, felt that they had gotten more out of VR, than from example reading a book or notes. This was explained by the students by the fact that in VR they see a much bigger part of the subject area. The images and the entire visual environment gave them more information, which was also easier to internalize and remember.

> *I have experienced that I have taken better account of and have got more out of it.*

Students believe that VR is suitable for all subjects. For some much better than others. Students thought that mathematics was one of the subjects VR suits the least. Except for example the graphs of geometry and the functions. To this history course, students thought that VR suits well because there is so much in history that can be illustrated through it. Students consider that VR's suitability for teaching also depends on the size of the project and the previous experience of the group. However, in certain areas and when used correctly, VR is suitable for all subjects.

> *In Finnish language it would have been good with the traditional way also, but in biology it was a much easier way for me to learn. I remember better.*

Students hoped to use a virtual learning platform in more and more courses. It would be nice if VR were used more in high school more than now. Everything should not be made virtual; teaching should also respect more traditional ways of learning. However, students think that variation and versatility are needed, and that is what VR brings to school. It also helps students to relax during the lesson, and relaxation is part of studying.

> *...I like it when there are versatile ways to learn.*

Some students felt they had more motivation to study with VR. They justified it so that when

Some students felt they had more motivation to study with VR. They justified it so that when the student is too tired or not feeling to read it, it is easier to see it. They read so much that they feel that they are numbing themselves with it. Students said that the learning outcomes they got through VR required less work compared to more traditional learning results.

Students were also delighted with VR's unlimited possibilities and the opportunity to use imagination. The possibility to carry out self-realization was also considered important.

> *...the interaction, that you can influence what it is and what it becomes.*

For most students, the first impression of VR was sceptical. Some also said that they were shocked when they were introduced several programs and platforms in the first hour. There was also talk of coding. However, as the course progressed and the students had learned the basics, their preconceptions vanished. Learning had become fun. The students say that they now want to dispel the preconception that VR really would be as difficult as it might sound at first. They want to encourage others to try it.

> *There was a feeling of despair, but it wasn't that difficult after all.*

> *At first it was a bit of a shock when you didn't know anything about how to do something like that, like what would become. But then in the end of the course I started to realize from the final course that it actually is a good thing in studying.*

However, the vast majority of students felt that they had genuinely benefited from VR teaching. This was caused, for example, by VR's interactivity and freedom to use their creativity. In particular, students emphasized that VR helped to learn by creativity. Learning through VR felt to be more coming from a student than an external factor. Most of them felt very motivated by this, but some had felt paralyzed at first. The reason for the feeling was that the learning situation was so different. At the end of the course, even the students who had felt paralyzed at the beginning recognized the benefits of VR.

Especially in biology, students had experienced VR to be useful. For example, when studying human anatomy, different organs could be taken out and examined separately. There was also information about the parts. The good thing in this virtual application was also that the multi-dimensional and anatomical structure became clear. VR helped the students to understand better things that were traditionally difficult to illustrate.

> *If you compare it to a textbook where you have a 2D pictures and you should see them and remember them. It is then compared to that you can correctly remove all parts of the body and and see whats underneath and at the same time you get information them.*

One of the students strongly felt that at the end of a Finnish language course that was done partly in VR, he did not know much more about the actual content than when she first came to the course. He focused too much on technology, and for this reason, the course was already a bit unimportant. The student felt that this was mainly due to his personal learning style. He saw, for example, that when taking a 360° picture, one had to think about what kind of outfits and scenery was chosen for it. According to the student, this kind of activity is related to the topic, develops thinking and is a creative activity. However, for some, it does not work.

> *For me the traditional learning ways suit better, taking notes and stuff. I've managaned this far with it.*

> *It may not serve my personal benefit but a fun addition to this. The potential is definitely there.*

Students have also noticed the fact that there are not many high-quality learning applications available. Some of them are only available in English. At the level of secondary education, one might first think that this is not a problem. However, for example, the vocabulary of chemistry might cause some difficulties to understand. Students hope that applications will soon be in Finnish because the exams are still kept in their native language. At present, applications are mostly self-made when there is not suitable content ready. This can be a kind of learning experience where students can also practice teamwork skills. However, focusing on VR's technical side

takes time from the subject itself, if it's not a technical lesson.

> *Then it is much more time efficient. No need to create something new.*

The perfect VR learning application should, in students opinion, be so easy to use that anyone could use it. The second most important feature of the application would be to learn as well as possible. The third criterion was diversity. The application should serve all kinds of learners. So at least there should be sound, image, text and interactivity. Students also hoped that there would be a more in-depth introduction available. They would like to have more information about VR and know how to use the applications. The outputs would improve, and there would be no need to use study time to learn the programs and applications.

Some of the previous VR courses have so far felt too laborious for this very reason. At the same time, however, students understood that the course time was limited and that the whole course could not be used for the introduction. Otherwise, they would study VR and its use. They started to think together that the high school could have a participatory course for this purpose. However, they would not make it mandatory.

> *It felt like nothing but a normal group work.*

It was clear to the students that at this point VR was still being tested as a teaching tool. Some of the students felt that in some subjects, virtual teaching is done in terms of VR. When there have been no applications suitable for teaching the subject, the students have done them themselves. This creation process has worked in a kind of course work. The end result has been a learning environment for that particular high school course. Probably one of the first, if not the first one.

> *I value being sent to try new ways and develop this way. Somehow it must.*
> *So we are now part of building it.*

> *Of course, we should focus on the subject and use VR as an instrument rather than as a purpose. That's how it should works, but at this point...*

Speaking of the future, the students think that VR should be a much larger and broader part of the high school world than it currently is. Students estimate that this scenario will come true in about ten years, depending on how much VR is being tested, researched and developed.

> *...It looks and feels cool. One can do awesome stuff with it.*

Students collaborating in classroom. Photo by: Serdar Ferit

CONCLUSION: DESIGNERS ROLE IN EDTECH

The use of virtual reality and augmented reality technologies in education is nothing new; the first recorded use was a flight simulator used to train US Air Force cadets in 1966 (Page, 2000)

However, it is fair to say that VR and AR technology has not yet brought about the revolution we all thought was coming a decade ago. This is due to technical issues, health and safety concerns, not having enough suitable high-quality content, financial issues and students' and teachers' (healthy) scepticism with the use of VR/AR in schools.

Technical issues are positive issues, they help us develop as humankind, and there is always a way to solve them. It only takes time and effort. Scepticism at a healthy level is also a good thing. Health and safety concerns are neutral: there is no educational tool that suits everyone. What comes to financial issues, we should never cut on education. Sometimes it takes a lot of money to open new opportunities to the children. Later on, this benefits the humankind. When the benefit is this exponential, there is not a good enough reason not to use VR in education.

There is an urgent need for tech companies to work with teachers and curriculum providers to create relevant content that can be used seamlessly in lessons. The extent to which these new technologies will be embraced by schools in the coming years rests on this critical issue.

Designers need to work together with teachers and students to be able to offer the best possible content, user experiences and user interfaces. Codesigning is the key here. Teachers must be introduced and briefed to these new teaching tools properly to make them feel confident to use them. Even teachers with a limited understanding of technology must be aware of how to best integrate these technologies into their teaching. Support must never be forgotten or limited.

It is crucial to develop material and content that suits the educational needs and truly covers (parts of) the national curriculum. This is where designers, developers, teachers and financiers need to work together as multidisciplinary teams. It is not children's job to make the books that they are reading, whether to develop the applications they are using. This is on our to-do list, not theirs.

However, we are slowly starting to see some of the first bits of the impact VR is making on education. The link between seeing things in 3D and understanding; immersive/interactive learning

environments; and the interplay between these ideas (visualisation, immersion, interactivity) and memory. Not forgetting the importance of being able to visualise concepts.

Virtual teaching methods also benefit students with special educational needs and disabilities (SEND). It can also work as assistive technology (AT). It may help students with for example dyslexia, disabilities, ADHD and autism. VR can help teachers track students' progress and point where the help might be needed. Also being able to see what the student is seeing and doing in VR affords far more opportunities for personalised learning and prevents the students from feeling too distant while they are wearing a headset.

VR & AR can be used as an 'agent of empathy' which can, in turn, be used to deepen learning. People who saw in VR what it would be like to lose their jobs and homes developed longer-lasting compassion toward the homeless compared to those who explored other media versions of the VR scenario, like text. (Herrera et al. 2018) Experiences are what defines us as humans, so it is logical that an intense experience in VR is impactful.

Most importantly, VR & AR can make education more equal by offering a versatile way to learn that supports sense based learning and helping children with special educational needs. We must remember that this requires the use of more traditional learning and teaching tools. Even when VR, AR & MR open up incredible opportunities and possibilities in both learning and teaching, they should be used together with other educational tools to offer blended learning experiences that support the best learning outcomes. These technologies can open many doors in education when used correctly, but they should still be considered just as another tool and enrichment in the classroom.

ATTACHMENTS

QUESTIONS TO THE STUDENTS OF KUOPION KLASSILLINEN LUKIO:

- Tell me about you: name, class?
- What three words would you use to describe VR learning?
- What was your first reaction when you heard you would be learning with VR?
- Were there any prejudices? If so, did they change?
- What have you learned with VR?
- What is the best thing about VR learning?
- What does VR learn to improve?
- Do you feel like you remember the things you've learned with VR?
- Do you feel like you are more motivated to learn with VR?
- Do you feel like you learned more quickly with VR as in traditional ways?
- What is the most interesting thing with VR?
- Do you feel like you have benefitted of VR in your studies? If you are, what?
- What has been the most useful learning platform or application in VR?
- What would be your dream learning platform in VR?
- Do you feel your know-how with VR will be useful?
- Should VR be used in every high school?
- Do you think VR is suitable for all the subjects? Where does it fit and where not?
- In which subjects have you VR been the most beneficial? Why?
- In which subjects have you VR been the least beneficial? Why?

QUESTIONS TO TEACHERS OF KUOPION KLASSILLINEN LUKIO:

- Tell me about you: name, what subjects do you teach?
- What three words would you use to describe VR teaching?
- What has been the best in teaching with VR?
- What should be improved, what doesn't work?
- Do you feel that the students remember better with VR compared to the more traditional tools?
- Do you feel that the students had more motivation to learn with VR?
- Do you experience VR as a user-friendly way? Why/Why not?
- What are the benefits of VR compared to the more traditional teaching methods?

- What are the disadvantages of VR compared to the more traditional teaching methods?
- Do you think VR is suitable for all the subjects? Where does it fit and where not?
- Should VR be used in every high school?
- Should VR teaching start already before high school? If yes, when?
- Does VR help some specific group of students in particular? If so, which and how?
- Have you had any troubles with a specific group of students? If so, which and what?
- Did you have a background in VR before you started to teach with it?
- How easy do you consider teaching with VR is?
- Has VR made your teaching easier? If yes, how?
- Has it somehow complicated it?

QUESTIONS TO THE PRINCIPAL OF KUOPION KLASSILLINEN LUKIO:

- Tell me about you: name, what subjects do you teach?
- How did you become interested in VR in education?
- How has VR changed this high school?
- What works with VR in education?
- What should be improved, what doesn't work?
- feel like the students can learn more with VR?
- Do you feel that the students remember better with VR compared to the more traditional tools?
- Do you feel that the students had more motivation to learn with VR?
- Should VR be used in every high school?
- Should VR teaching start already before high school? If yes, when?
- Does VR help some specific group of students in particular? If so, which and how?
- Have you had any troubles with a specific group of students? If so, which and what?

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