

# Towards Immersive User-Friendly Future Learning Spaces in Education

Pasi MATTILA<sup>a1</sup>, Sanna BRAUER<sup>b</sup>, Leena ARHIPAINEN<sup>a</sup>, Anni RANTAKOKKO<sup>a</sup>  
<sup>a</sup>*Center for Internet Excellence,  
P.O.Box 1001, 90014 University of Oulu, Finland  
firstname.lastname@cie.fi*

<sup>b</sup>*Oulu University of Applied Sciences, School of Vocational Teacher Education  
Sepänkatu 20, FI-90100 Oulu, Finland  
firstname.lastname@oamk.fi*

**Abstract.** This paper discusses the changes required in the future physical and virtual learning environments. The paper briefly introduces the preliminary findings of the case study of changing physical spaces towards more immersive and user-friendly learning environments. This paper provides information for facilitating a development of teacher training, and how to change traditional physical learning environments towards future learning spaces taking into account immersive environments. It is important to develop learning environments for the 21st century learners by taking into account pedagogy, architecture and technology approaches and being able to change school working culture including changes in teaching, leadership, technologies and physical school infrastructure.

**Keywords.** immersive, collaboration, physical learning environment, virtual learning environment, virtual worlds, vocational education

## Introduction

Future physical and virtual learning environments are under a large investigation in the field of education. Learning environments can strongly influence students' learning experiences, for example, according to [5], there is an explicit relationship between the physical learning environments and educational outcomes. Weak conditions of learning environment can make teaching and learning more challenging. Also, 'play in education' has been seen as an important factor in learning. Different outdoor technology enhanced playful learning environments have been designed and implemented in Finnish schoolyards [19]. Learning should be regarded as a life-long process, which occurs in different learning contexts, for example, in formal schools and classrooms, but also in other innovative and informal places and spaces [22]. Different creative and participative learning activities, including games, with new technologies have regarded as an important aspect of learning in innovative learning environments [13][20][22]. This paper introduces the evolution of vocational education and learning environments. Then, three dimensional (3D) virtual learning and training environments are described from education point of view. Finally, the paper presents the case study

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<sup>1</sup> Corresponding Author.

of the changes in vocational school's physical learning spaces and the preliminary findings. The aim is to introduce ideas and needs for the development of an immersive physical learning environment. This information will help to develop teacher training and physical learning environments from a traditional physical school environment towards future learning spaces taking into account immersive environments and utilizing digital learning materials and ubiquitous computing solutions.

## **1. The evolution of vocational education and learning environments**

Multidisciplinary professional training requires different learning environments. Finnish education providers can be seen as pioneers in introducing new learning environments and developing those within the institutions. Various learning environments have been piloted with advanced technology such as Augmented Reality (AR) and virtual worlds. These new environments combine the personalized learning environment into collaborative new space of engaging learning and gaming as far as offering challenging learning experiences such as edupreneurship in virtual worlds.

Vocational education and training in Europe is evolving and converging. The aim of the European Credit system for Vocational Education and Training (ECVET) is to enhance a cooperation in vocational education training, international mobility and ensure recognition of learning outcomes based on credit transfer. Learning outcomes are not dependent on the learning process or the learning context in which they have been achieved. Thus, it is possible to use them to identify what the student has achieved in one learning setting or context compared to what the student could have been expected to achieve in another setting or context. ECVET outlines people's greater control over their individual learning experiences and offers flexible ways and learning paths to move between different countries and different learning environments. [29]

ECVET and European cooperation will challenge vocational education and training providers in various ways to explore new pedagogical models and learning solutions. Teaching of labor-intensive sectors is often demanding with expensive equipment and special expertise. New learning environments, such as 3D environments or simulations, allow for instance practice dangerous situations in authentic learning environments or similar circumstances. Teaching and learning safety at work is an important learning point when designing new learning environments for education providers. Education expenses can be cut by strengthening the cooperation between organizations and through exploitation of new technologies.

### *1.1. Challenges to change vocational education and training*

The aim of development programmes in vocational education is generally to improve students' performance and enhance completion of studies. The purpose is to provide opportunities to achieve the knowledge and skills to meet working life competences needed today, and especially in the future. Technology, of itself, cannot drive the educational change. Instead, in vocational education and training, pressure for change is particularly directed at the role of teachers, leadership and educational support services as well as updating training and learning environment solutions. Technology often encourages teachers to foster student-centred teaching methods. New advanced technologies enable personal learning environments to improve learning outcomes and student motivation by enhancing collaboration and just-in-time guidance.

Vocational teacher's role is essential in the renewal of vocational education. The demands of working and daily life skills are constantly changing. These changes are apparent in teaching and learning. Technology is advancing rapidly, and an individual vocational teacher often finds it demanding to keep up to date on both pedagogical methods and new learning environments not to mention their personal substance knowledge. Collaboration and networking among teachers enhance sharing best practices, pedagogical models, innovative learning environments and creative approaches when utilizing immersive technologies in education. However, there is still a great demand for simple action models for implementation. These action models should include both pedagogical and technological descriptions and instructions.

Learning in virtual worlds often supports constructivist learning. Connectivism is an alternative theory of a digital age for behaviourism, cognitivism, and constructivism. The learning theory by Siemens [33] states that learning is primarily a network-forming process and learning happens as a part of diverse, social network, which is augmented by the modern digital technology. The entity of personalized learning path is always a combination of a variety of different learning environments and pedagogical approaches. The blended solutions bring the pedagogical paradigm to connectivism and connective knowledge. Learning a profession is contextual by nature, and an important skill for a future's talent is to know how to combine different sources of information, estimate validity of information and apply all the information available. Pedagogical approach based on connectivism supports collaboration and makes exploring such learning environments challenging and rewarding. Pedagogical models combined with the added value from new solutions of virtuality are expected to promote students activity to acquire more knowledge and skills. This is believed to encourage shared experiences and expertise among both teachers and students. One of the objectives for development is often related to personal learning environment with the idea of lifelong learning combined to digital portfolio as a personal knowledge database of an individual to serve for a life.

### *1.2. InnoMill and LIPPO projects*

It is often thought that virtual environments are created to complement the physical space. The design process may also be reversed. The change of physical environment in the InnoMill project described in Section 4, began to form in an augmented reality project. LIPPO – augmented reality and open social networks in learning [27], is a national project piloting augmented reality and mobile solutions in vocational education and training. This project aims at large-scale development of the physical and virtual learning environments in vocational institutions. The main purpose of the project was to create the multidisciplinary pedagogical development model as well as to share and spread the experiences of augmented reality in labor-intensive training.

The pilot project aims to improve student performance and improved learning outcomes by enhancing student-centered learning methods and creating enriched learning environments. Augmented reality and mobile solutions bring added value in teaching and learning in order to provide opportunities to learn the knowledge and skills that meet the current and future demands of working life. The model promotes working life-cooperation and learning outside the classroom.

The project was preceded by the pedagogical development team report of different suitable virtual and mobile learning solutions for the institution. The main target was to define labor-intensive learning environments and teaching and learning methods as a

whole in order to provide directions towards the future of vocational education in different areas and different organizations with applicable solutions. The future of vocational education in Finland was launched and designed during the project with the results and ideas for a new kind of physical learning environment and learning spaces where different kinds of media solutions blend seamlessly into the various areas of teaching and learning, as well as teachers 'and students' everyday lives.

Vocational education focuses often on teaching different type of skills. Social media services and new technologies provide a platform of visualization on what students have learned, as well as it reflects on a variety of ways to work. The most important step in the learning process appears to be the ability to enhance the personal growth and professional identity. Students learn to combine theoretical knowledge and experience of the generated data into knowledge needed in working process. Professionals of the future find their identity consisting of growth towards goal-orientation, commitment, attitude and ethics of the profession. This process is based on a connective knowledge and shared expertise with both learning networks and professionals in the district.

ECVET enables lifelong learning for all, with transfer, recognition and accumulation of individuals learning outcomes achieved in formal, non-formal and informal contexts. In the future, it will be significant to identify how the employee includes oneself in relation to employment and occupation. The teacher's role is to encourage and guide the student to become aware of their professional identity and skills. Visualizing the puzzle of expertise into concrete skills helps students to understand their full professional potential, their own suitability of the industry and their own desires and interests. Visible work processes during the training will set a view to the nature of the work and to sustain progress towards professionalism. In working life the employee is required to identify personal skills, professional knowledge and to market their own skills and strengths. All these demands encourage students to develop a digital portfolio with blended media solutions. The LIPPO - project also tested extensively augmented reality brought into the teaching and learning methods :

- Augmented reality business cards
- Virtual guiding in premises of the institution
- Virtual information and communication technology education presentation
- Operating manuals for machinery implemented with augmented reality.

## **2. 3D Virtual learning and training environments**

In today's world, learning is no longer restricted to sitting quietly in the classroom, reading books and memorizing things [35]. Students can easily access information by themselves from the Internet and other sources. As the world and work life have changed drastically, the educational methods used in schools have still stayed similar for a long time. At the same time more and more students are stating that they do not enjoy school or feel that the information that is taught there is too theoretical and far from their daily life. This is one reason, why there is certainly a need to review the educational methods used in schools and introduce new types of learning to school. Educators must react to the obvious changes in the society and be prepared to review the learning methods being used in their teaching. It is also important to try out new

educational methods open-mindedly and see the potential in developing them. 3D virtual learning environments have great potential in bringing new, immersive learning to schools. Virtual learning environments can enhance online communication to a completely new scale. The first impressions of having students sit individually in front of their computers might seem unsocial, but in fact studying in virtual learning environments can be extremely social and interactive. Using avatars, it is possible to bring people from all over the world to the same virtual space to communicate and collaborate. Being in the same space can make interaction feel more real than if it is done using online chatting. In addition to that, the meeting spaces can be created culture-neutral if so wished, which is never entirely possible in real life [15].

### *2.1. From 2D towards 3D virtual learning environments*

The use of new information and communication technologies (ICTs) including 3D virtual learning environments has provided additional value to previous e-learning environments and learning processes. Tools for collaborative and phenomenon based learning are under development. Also, social interactions are important in virtual learning situations. For example, discussions and argumentations with others can lead into better learning results. Therefore, learning environments are needed to be developed for supporting learners to be more self-guided and -directed [21]. There is a need to move from traditional classroom type of learning environment towards game-like learning environments and simulations. Future virtual learning environments should be developed in a way that they can facilitate the learner in thinking and learning processes. [34]

Virtual learning environments (VLEs) have a long history and there has been various range of different kinds of virtual learning environments [31][30][7]. VLEs have turned the traditional 2D Internet based environments towards 3D learning spaces [14][30][10][11][16]. The interaction with the 3D environments can enhance a learning experience when compared to the real life learning situation, and thus, learning can be more motivating [4][36][37]. Even though, 3D virtual environments have been extensively investigated [16][12][23], there are still lacks in usability and user experience issues in new 3D virtual environments. Often new environments have been development from a technology point of view - not enough from a user point of view. Therefore, more studies are needed in order to improve the interaction with 3D virtual spaces and objects. Likewise, there is a need to develop physical learning environments towards more innovative, immersive and use-friendly spaces in order to meet future challenges in terms of collaborative, mobile and immersive learning. A challenge is to bring physical and virtual environments close to each other in order to provide smooth interaction for users to live and learn in both, physical and virtual environments utilizing the available material for learning.

### *2.2. Examples of 3D virtual learning environments and their use in education*

There are two types of virtual environment platforms: open source platforms and proprietary platforms. Open source platforms are developed by communities of experts, allow users to possess rights to the content they have created themselves and move it to other environments if they so wish, and are usually free of charge. Proprietary platforms (e.g. Second Life), however, are conducted by companies that own all the

rights to the content that is created by the users. Both types of platforms are commonly used and have their own strengths.

TOY (Tulevaisuuden OppimisYmpäristö) [24] is a virtual learning environment developed for comprehensive schools by realXtend [28] in cooperation with the School of the Future programme at Center for Internet Excellence and subcontractors. It has been built to enable users to produce content and functions. In the TOY environment there are three kinds of spaces: a communal lobby, a cooperative learning space and a private sandbox space. The environment has been studied with pupils and students from primary and secondary schools [3]. The realXtend platform has been used also in Vocational Education School at HAMK University of Applied Science, where the Virtual-Mustiala 3D learning environment was developed and studied [25]. Based on these previous experiences, in the SILC (School Innovation and Learning Center) project, 3D virtual learning and education environments will be developed for the upper secondary and vocational education, and then evaluated with authentic users, both teachers and students.

*EON reality* ([www.eonreality.com/education](http://www.eonreality.com/education)) is one example of a proprietary platform using advanced 3D technology. In education, EON reality has specialized in developing an interactive virtual 3D library, where there are various different 3D models dealing with different phenomena and school subjects. Educators can put different 3D models together to create their own 3D scenes with interactions. All the contents, for example a magnification of human's heart or a planet in space, can be seen in 3D with the according equipment. This kind of learning could be one example of how exciting visualizing and interacting can help to facilitate learning in all levels of education.

*AvayaLive Engage* is a virtual platform that can be used both in business and in education. Users can choose own environment from different already existing templates and then tailor them. [1][26] Many universities in USA have virtual campuses via Avaya. For example, Massachusetts Institute of Technology has used AvayaLive Engage to be able to bring together virtual and real life lectures so that some students have been attending the lecture physically and others virtually from around the world with AvayaLive Engage. [17]. *Open Wonderland* is an open source virtual toolkit for creating collaborative 3D virtual worlds (<http://openwonderland.org/>). Wonderbuilders Inc. builds special-purpose virtual learning environments for customers. VMed Learning Spaces is one example of their products; its purpose is to enhance communication and teamwork skills training for doctors, nurses and other health professionals (<http://www.wonderbuilders.com/portfolio/vmed>). Students can practice social skills and different procedures in a virtual hospital setting alone, with other students and instructors. *ShanghAI Lectures* is a global cooperation network that functions mostly as a lecture series via videoconferences. In 2009, 18 universities from all over the world participated in these lectures. [15][8] *iSocial* is a virtual learning environment developed "for teaching social competence to youth who have been diagnosed with Autism Spectrum Disorders (ASD)" (<http://isocial-temp.missouri.edu/iSocial/>). Its students can practice social interaction with each other and teachers.

*Second Life* is the largest and most used user-created virtual world with millions of users around the world. Joining Second Life is free, but if a user wants to build something there, he/she has to pay for it. Users create different spaces and can for example get to know people, shop or visit tourist attractions in there. Second Life can be used to learning; many schools have their own islands in Second Life and there are

also for example areas where it is possible to learn languages with native speakers. Examples of using Second Life in education:

- *East Carolina University* is one of the many universities worldwide that have created their own campus with different kinds of features in Second Life and used it in their courses in various ways. [18].
- *Korea National University of Education* has organized teaching practices in Second Life for pre-service teachers. The teacher students were first given demonstrative lectures by the course teachers and then placed in virtual traditional classrooms to practice teaching each other. [9]
- In *Konnevesi high school* there has been a project called Learning games and virtual environments supporting the renewal of teaching and learning (LEVI, OVI in Finnish) in which different possibilities of using virtual worlds in secondary education have been examined. (<http://www.peda.net/veraja/konnevesi/lukio/ophhanke2010/engl>)
- *EduFinland* is an archipelago in Second Life, where “Finnish educators can easily and safely experiment with the possibilities of Second Life in education”. Both, the educators and the students, can use the area to collaborate and share ideas. (<http://edufinland.fi/in-english/>)

### **3. Challenge to change physical learning environments and working culture**

The world has changed, learning has changed and even learners have changed, while the school as an institution and the classroom has stayed almost the same for the past hundred years. The narrowness of the definition of the learning environment, classroom- and book-orientated teaching, the central role of the teacher as well as a limited variety of teaching methods have hindered the school's progress, making it unable to keep up with the development of society at large. A comprehensive change in the school's operational culture is required. The role of teachers, management and support systems and learning environments need to be developed simultaneously so that they can meet today's and tomorrow's requirements.

The school can no longer claim the sole right to learning, the teacher no longer owns the knowledge and the book is no longer the only source of learning. In addition to formal circumstances, learning happens in informal situations, anytime and anywhere. Students utilize technologies and media mostly in order to create learning networks and to find information for them. Although digital natives adopt new technologies from an early age, their understanding of information in context is still to be guided to learn. Critical evaluation and judgment of information and its sources becomes a new skill to be developed by students.

Learning environments in the school of the future cover a new variety of different pedagogical opportunities without excluding traditional learning and teaching methods. They offer a wide range of flexible areas that can be used by the entire local population from morning until evening. Teachers' opinions must be taken into account, but equally students, parents, local companies and the entire community must have a say. The premises must be suitable for all user groups and all occasions, from everyday operations to school celebrations. In the school of the future the central areas will be in efficient and versatile use during evenings, weekends and school holidays.

#### 4. Case study of the changes in physical learning environment

This paper presents the changes in physical learning spaces towards innovative and user-friendly learning environments in InnoMill project. Our study approach is based on the Sawyer's [32] theoretical framework, where one key idea is to understand learners' active role in their own learning process. In this approach, learning is no longer seen as a knowledge transfer between a teacher and a student, but the teacher's role has turned from a transferor to an instructor. One of the teachers' tasks is to design learning environments in a way that they can facilitate students to learn deeper conceptual understanding. Learning environment is a place, a space, a community or a practice that supports learning. In this case, we see learning environments not just as spaces but as unities that include many dimensions: virtual, physical, social, pedagogical and psychological.

The aim of the study was to find out how physical space and furnishing influence learning activities in the learning area from the collaborative point of view. We studied a physical learning environment in a vocational education institute in Finland. One big learning area, old sport hall, (Figure 1A) was developed towards future learning environments by changing furniture and ways to use space. Our approach was to make changes in order to facilitate the use of space and technology. In start situation, the use of the old sport hall was very minimal. In this study, the environment was totally redesigned taking into account social communication and collaboration aspects. Finally, six spaces were designed into new learning environment (Figure 1-3):

1. **Space A: Living room** for 20-40 participants, acted also as a presentation area.
2. **Space B: Cradle of creativity** (a tent) for 10-20 participants, acted as an innovative collaborative space.
3. **Space C: Business Forum** (wooden barn) for 5-10 participants, acted as a teamwork place e.g. entrepreneurship studies.
4. **Space D: Warehouse** (an army tent) for small group 3-5 participants, acted as a regulation and personal practice spot.
5. **Space E: Camp fire** (fireplace space) was designed for (further) collaboration and brainstorming area.
6. **Space F: Virtual space**, a context of virtual space can be adjusted according to use and learning situation. Virtual space is projected on the wall and it will act as a bridge between physical and virtual spaces.



**A:** The start situation: The space was an old sport hall which was not in active daily use.



**B:** A plan of the future situation: three different sized tents, one barn and a virtual wall.

**Figure 1.** A) The start situation in the sport hall and B) the design pattern.



**Space A: Living room**  
For 20-40 participants.  
Acted also as a presentation area.



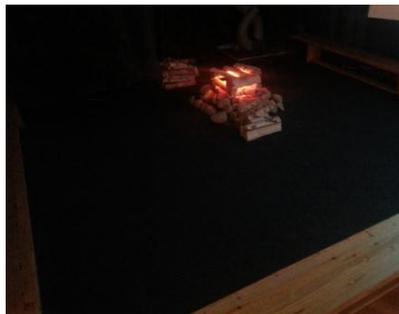
**Space B: Cradle of creativity**  
For 10-20 participants.  
Acted as an innovative collaborative space.



**Space C: Business forum**  
For 5-10 participants.  
Acted as a teamwork place e.g. entrepreneurship studies.



**Space D: Warehouse**  
For small groups 3-5 participants.  
Acted as a regulation and personal practice spot.



**E: Camp fire**  
For 3-5 participants.  
Acted as a more relaxed collaboration and brainstorming area. (benches around the fireplace)



**Space F: Virtual space**  
For present and remote participants.  
Acted also as a bridge between virtual and physical spaces.

**Figure 2.** New learning spaces A-F developed into the old sport hall.

## 5. Findings: From 'Three times a year' to 'Three times a day'

In this paper, we present our preliminary findings on how users, both teachers and students, experienced the new environments. These findings are gathered by

observation and small scale interview discussions. In general, all users experienced new learning areas (Spaces A-E) positively. They experienced that the new learning areas can support collaborative working methods and it is easier to work in groups. In addition to regular users, many visitors have tested this new learning space and found it motivating and interesting. This kind of space is one of the first trials in vocational and higher education, where there is a need to develop future learning environment and solutions for 21st century learning and training.

One main benefit of changing this learning environment (old sport hall) was the utilization rate of the environment. Before the change, the old learning environment was used three times a year. This space was not used for sport at all, because the vocational institution has new sport hall for that purpose. After the development of these new learning spaces, the environment is used three times a day. This is a remarkable change. In this project, an empty and almost unused space was transformed to a versatile and innovative learning spaces. Learning environments consisted of various kind of tents supporting different learning activities. The atmosphere was created by using solid paintings and a virtual stage like constantly changing speaker's corner.

The other new space, we designed for the environment, was a virtual space (Space F). At this design stage, we merged physical environment with virtual environment possibilities. This virtual space enables the further development of the learning space used with virtual learning environments.



**Figure 3.** Example view of the new learning and collaboration environment. Spaces E and F are located on the stage on the right side, after space A (Stage is snow in Figure 1A and Figure 2F).

## 6. Conclusion and future work

In this paper, we have discussed the needs for changes in future learning environments, both physical and virtual. One aim of this paper is to raise discussion about the state of traditional learning environments and their inability or weaknesses to meet future challenges of the 21st century learning and the use of physical and virtual spaces in education. We also examined how both physical and virtual vocational education spaces could be designed to reflect the changes in architecture, technology and pedagogy. In this paper, we presented how the changes in furniture and in the use of space can produce an innovative, immersive and user-friendly learning environment.

The preliminary findings of the users' experiences of new learning environment are also presented. In the future, we will conduct more extensive studies of how users (e.g. teachers, students, visitors) experience the learning spaces and what possible needs and wishes they have for the both physical and virtual teaching and learning spaces. Also, in the future, it is important to design spaces for one or two people in order to enable individual and more private work.

In addition, we have planned to use the already existing environment and develop it further in vocational education. The development work will include additional changes in physical infrastructure like acoustics and lighting. Moreover, we will concentrate on developing the use of virtual worlds in the learning environment. In vocational education this means development of virtual 3D training environments (e.g. hotel, bank, insurance company or virtual shop etc.) where different professional learning situations can be trained. Virtual environments will become a part of the physical space and enhance immersive experiences in both worlds.

In the future, it is important to develop innovative learning environments for the 21st century learners by taking into account pedagogy, architecture and technology approaches. The key issue is to change the school working culture, which includes changes in teaching, strategic leadership, in-service training, technologies and physical school infrastructure. At best, the change in working culture and the change of the physical environment go hand in hand and reflect the change in the use of virtual worlds. This comprehensive information is needed in all levels of education - from basic education to vocational and higher education.

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