Internet of Things: Opportunities for Vocational Education and Training
Presentation of the Pilot Project

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Abstract: In the Internet of Things (IoT), machines and devices are equipped with sensors and Internet connections that makes it possible to collect data and store this data to cloud services. In vocational education and training, the stored data can be used to improve decision-making processes. With the help of this data, a teacher can also get a more accurate picture of the current state of the education environment than before. IoT should be integrated into vocational education and training because IoT will help to achieve important educational objectives. IoT is able to promote students' preparation for working life, the safety of education environment, self-directed learning, and effective learning. It can also improve the efficient use of educational resources. In additional, IoT based solutions should be introduced so that students would have a vision of new types of IoT skill requirements before they enter the labour market. In this paper, we presents IoT related aspects that enable to meet the above-mentioned educational objectives. By implementing a pilot project, we aim to concretise IoT's possibilities in the education sector.

1 INTRODUCTION

The Internet of Things (IoT) (Whitmore et al. 2014) allows enhanced interaction between the physical world and computer-based systems. It makes possible for devices, machines, people and other types of physical objects to collect data and transmit this data to cloud services. This data can be utilized in decision-making processes to improve accuracy and efficiency. It also makes sense to integrate IoT more closely into vocational education and training because IoT will help to achieve the important objectives of vocational education. IoT is able to promote students' preparation for working life, the safety of education environment, self-directed learning, and effective learning. It can also improve the efficient use of educational resources.

Working life is going to be even more technical in the future when IoT connects physical machines and devices to the digital world. This means that machines and devices are equipped with sensors that send state information to the data warehouses of cloud services over the Internet. This will change working life and place new demands on employees' know-how. Education should prepare future employees for these changes. These changes should also be taken into account in curriculums. Above all, vocational education and training should introduce IoT based solutions so that students would have a vision of new types of IoT skill requirements before they enter the labour market.

A safe school environment is an important issue for students to make them feel safe (Young et al. 2016). However, there are some physical school environments, especially in vocational education, which set a number of challenges for a safe schoolwork. There are often machines and equipment whose correct and safe use can be challenging for novice users. Therefore, it is important to ensure that students can use these machines and equipment in a safe and skilled way so that any kinds of physical hazards can be avoided. New instruction and oversight methods are always welcome to better prepare new and young workers to occupational safety. The results of the studies show that the young participating in the labour market often have a higher incidence of accidents and other negative work effects then the workforce in general (Andersson et al. 2014; Laberge et al. 2014; Schulte et al. 2005).

In recent years, there has been a growing interest in self-directed learning (SDL). SDL promotes the

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role of the learner. The aim of SDL is that learning happens when the individual learner takes ownership for his own learning. It is important to cerate the learning environment where SDL can concretise in a proper way. For self-directed learning, there must be tools to keep students on the right learning path. Feedback is among the most important features of SDL (Embo 2010). Students need feedback on the development of their professional skills.

So, self-directed learning creates new challenging requirements for learning technologies. Teo et al. (2010) mentioned that technology may have direct impact on self-directed learning because it has greatly facilitated access both to information resources and to online expertises. Related to self-directed learning, being able to access a wide and unlimited range of information to serve learning needs and interests are important for students. This includes capturing, storing, manipulating and displaying information as well as making contact with fellow learners and experts around the world. Jossberger et al. (2010) noted that educational environments should be adaptive to the learners' needs to achieve individual learning. Furthermore, teachers should support learners to become competent in the domain but also guide them to become self-directed learners. The interaction between the student, teacher, and environment is important.

New technical solutions are always welcome to improve educational outcomes. Nowadays in vocational education, teachers can use a wide range of multi technical resources to enhance learning. For example, simulators and video-based approaches can be utilized. However, these technical resources must be able to combine to an integrated adaptable solution in order to promote effective learning. Lowman (1996) expended the scope of effective teaching by defining it as the process of selecting the materials, resources, teaching strategies, and assignments that have the greatest potential to contribute to student learning.

Theall (1999) viewed effective teaching as a complex, multidimensional, and dynamic process affected by the individuals who involved in the process as well as by the circumstances in the classroom. IoT is a tool that, in many cases, enables to integrate various technical tools to a workable educational entity. Mohd (2016) mentioned that students in vocational education viewed their instructor as an effective educator when they are accessible, fair in testing and grading, technology competent, and manage class time. IoT can promote education with respect to all these factors.

In Section 2, we bring out IoT related things that enable to meet the above-mentioned challenges. Section 3 introduces our pilot project related to the IoT opportunities in education. Section 4 concludes the paper.

2 IoT IN VOCATIONAL EDUCATION

Due to IoT the information and communication technology (ICT) penetrates deeper into vocational education and training. ICT spreads to places where it has not been utilized on a large scale in the past. Trough IoT, the physical and digital world are linked more closely to each other. Machines and things equipped with sensors represent the physical world. The digital world includes cloud services, data analytics, intelligent algorithms, and user terminals. The digital world also includes software-based intelligent services and user friendly interfaces built on top of the above-mentioned components.

IoT enables that data can flow from the physical world to the digital world through data networks. With the help of this data, a person can get a more accurate picture of the current state of machines and systems. As a result, control operations and decision-making processes will become more data-driven because the collected data enables fast and clever conclusions for control functions. In addition, the actions of control functions can be executed more quickly because data can also be transmitted from the digital world to the actuators of the physical world in the form of control commands. IoT will make the machines and services of vocational education more intelligent in the future. Of course, it can be said that IoT is already integrated into education on a small scale (Pruet et al. 2015; Selinger et al. 2013; Wang 2010).

2.1 Students' Preparation for Working Life

Many countries and companies have identified IoT as one of the key factors when trying to guarantee the future competitiveness of the industry. Vocational education institutions play a key role in these competitiveness strategies because these institutions educate future workers. Therefore, IoT must be integrated into vocational education more widely.

Relating to the machinery and equipment, ICT technology is becoming more and more a tool of general use. Younger generations even expect that ICT technology will facilitate working life (Jones et

al. 2010). In the future, the software will play the more important role everywhere compared to the physical iron. A machine or a thing equipped with the sophisticated software will observe its condition and its environment better than before. In addition, devices will send information to cloud services that allows the remote monitoring of devices, and even the remote use of devices. Remote monitoring has been commonplace at least the past twenty years. However, IoT is changing remote monitoring because cloud services and data analytics come into play (Mohammed et al. 2014). These changes set new requirements for future employees.

2.2 Safe Education Environment

ICT and IoT solutions often improve the safety of working environment (Carbonari et al. 2011). Related to vocational education and training, the collected data can be analysed to detect such wrong ways of using the machine, which may create a hazardous situation. After the findings, the student can be guided relating to the safe work procedures. Data analytics can be used to detect data anomalies compared to the data representing the normal operating machine (Wang et al. 2015). This allows predict machine failures that can be dangerous for students. The machine can be stopped before a hazardous situation.

The teacher can also define the students authorized to use a specific device based on the required skill level. The student must always log in the device, for example, using fingerprint authentication. Safety is also increased by the fact that the machines equipped with the right kind of sensors are able to recognize human limbs, and therefore, these machines do not pose a danger to humans. On the contrary, the intelligent machines are capable to prevent the dangerous situations that careless people cause themselves. For example, the machine can automatically stop the movement of the actuator when a dangerous situation arises.

If an accident occurs for some reason, the collected data can be used to analyse the accident. The course of events can be analysed afterwards, for example, by using the stored video. The stored data may indicate that, for example, the student has had sufficient capacity for independent use of the device.

2.3 Self-directed Learning

IoT is able to promote the independent work of students. Intelligent devices are able to guide the students and give feedback to students. IoT enables advanced remote monitoring which enables the teacher to monitor the work of several students at the same time. In real time, as well as afterwards, it is possible to find out who are using a certain device. With the help of collected data and advanced data analytics, it is possible to evaluate how well the students have performed with their exercise works independently. For the reason that this evaluation may be carried out automatically by an impartial system, IoT is able to promote the equal treatment of students. The collected data also enables the automatic documentation of students' progresses.

2.4 Efficient Use of Education Resources

With the help of IoT, the teacher is able to see the current state of the whole education environment better than before. Sensors will be the extra eyes and ears of the teacher that help to make the right decisions at the right time. Efficiency improves when information flows seamlessly from place to place. All the information can be displayed in a centralized user interface. Couple this with the results of real-time data analytics, teachers are capable of faster and better quality decision-making than without the help of IoT. So, it possible to improve the quality of teaching. IoT can offer autonomously working solutions for teaching. Teachers will benefit from this because they can manage better with their daily routines. Intelligent systems assist to direct the teaching to the right direction.

3 PILOT PROJECT

By implementing a pilot project, we aim to concretise the above-mentioned possibilities. Figure 1 presents the implementation solution of our pilot project. The solution consists of three parts, which are the training area, the cloud service, and the user interface components of the teacher. Data flows from one part to another over the Internet. Next, the logical operation of the system is described and technical implementation issues are mainly neglected.

3.1 Training Area

The training area consists of a machine, video camera and control unit. If IoT is considered, the control unit has an important role. In the pilot project, the control unit is implemented using the Raspberry PI board which is a credit card-sized single-board computer (Raspberry Pi Foundation 2017). It is widely used in IoT pilots.

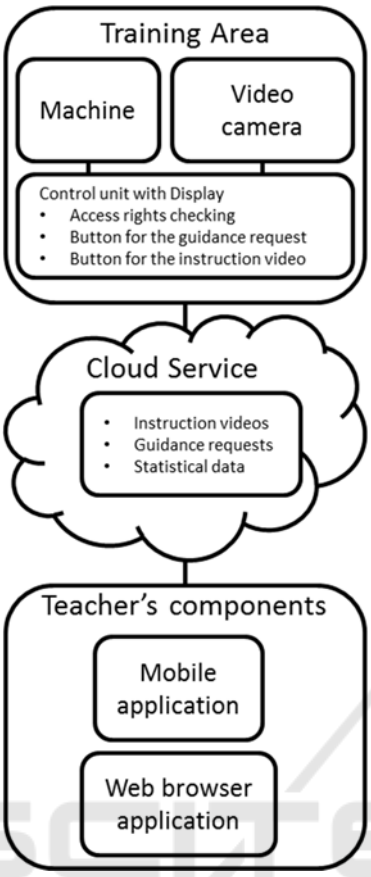

Figure 1: Three parts of the pilot project.

The control unit includes a user authentication unit so that the machine can be used only by the students having the required skills and knowledge. For example, the power supply of the machine is not switched on until the student's access right is authenticated. Such switching on can be done wirelessly, for example, by using the Z-wave technology (Gomez and Paradells, 2010). We use the NFC reader for user authentication so that each student has his own personal NFC tag. Another even more trustworthy technique for this use would be the fingerprint authentication. Immediately after permitting the use of the machine, the control unit switches on the video surveillance of the training area.

A control unit button allows the student to send an invitation to the teacher when the student needs guidance. Another control unit button allows the student to start the instruction and safety video of the machine. With the help of this video, the student can independently recall the issues related to the safe use of the machine. Xeroulis et al. (2007) mentioned that computer-based video instructions are able to serve as a useful pedagogic adjunct for basic skills training.

3.2 Cloud Service

The system-related information is stored into the cloud service. There are stored the instruction and safety video, access rights and guidance requests. In addition, all statistical data including the videos relating to the video surveillance is stored there. All this information not necessarily reside on the same physical server. For example, videos may be stored on different servers than other information.

3.3 Teacher's Components

The user interface components offer a view of the system data. With the help of the mobile application and the web browser, the teacher can monitor the training area in real-time. The guidance requests sent by the students can also be viewed through these components. They also offer a view of the statistical data. For example, based on the stored data, the teacher can examine how long each student has used the machine. The stored videos can also be viewed afterwards.

4 CONCLUSIONS

This paper has emphasized that IoT is capable of improving vocational education and training in many ways. There is also a need to integrate IoT into the learning process because young people are accustomed to find answers to open problems with the help of digital devices. This paper points out that IoT solutions are suitable for teaching the basic technical skills and safety issues. When IoT is incorporated into education in a reasonable way, it can serve as a useful pedagogic adjunct for skills training.

Companies have already taken the first steps of IoT. It is expected that education will follow the business with a slight delay after the IoT solutions will stabilize and prices will fall. The changes will not happen overnight. IoT's utilization can proceed in small steps. The solutions implemented in a hurry and their technical problems can be factors that can give students a bad impression about IoT solutions. Once the first steps have been taken, the workload of offering it to additional devices is relatively small. In many cases, it is possible that the manufacturer of some technical device produces the IoT components of that device. In addition, we have to remember that IoT is only one tool among other tools to improve educational activities. It cannot replace teachers but it

will certainly pose challenges to the teachers' professional skills.

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