7 Digital Technologies within the Supply Chain Management Curriculum:

An Experiential Learning Approach to Understanding Knowledge Co-Creation (An Essay)

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Abstract: This study explores how knowledge co-creation in the learning process is affected and facilitated by digital technologies, in particular 3D printing and RFID reading. A qualitative single-case study presents the learning process in class based on a model of intermodal transportation with RFID reading and 3D-printed objects. Data from five semi-structured interviews, questionnaires, situation observations in three experiential labs, and archival materials are interpreted through the experiential learning approach to emphasize the role of 3D printing in learning and knowledge creation. The study reveals how digital technologies transform the learning process to help students develop practical skills in the supply chain management (SCM) field. The active experimentation further shows that the use of 3D printing and RFID reading encourage meaningful communication between students and lecturers and increases students' active engagement in learning and knowledge creation. The findings reveal that the learning process in the digital era becomes transformed into increasingly new forms of integrative knowledge and competence, emphasizing practical and technical skills. It results in a shift from passive to active learning or from a teacher-centered to a student-centered approach to developing students' practical skills for companies' needs when adopting new technology in practice. The study shows the potential of digital technologies for further adoption in SCM and logistics curriculums beyond the so-called STEM disciplines.

More empirical studies applying experiential learning are suggested on how learning from formal education and so-called strategic learning from companies' experience can be integrated into the process of knowledge co-creation based on digital technology.

Introduction

The co-creation of knowledge has recently gained attention as an educational approach. In contrast to traditional institutionally-driven formal education, this approach can help understand the role of technology in providing educational facilitation (rather than teaching), students' self-efficacy, and practical skill development (García-Peñalvo et al., 2015). As new technology has developed and grown at a rapid pace in practice, the opportunity to shape a more effective education and learning process has also increased. Taking advantage of these advances, however, requires integrating insights between university education and practical experience. Several scholars have called to incorporate practical skills into higher-business education (Datar et al., 2010; Jæger et al., 2015). However, the integration of formal educational processes dominated by curriculum and expertise with companies' demands for new digitalization competencies still present significant organisational and educational challenges (García-Peñalvo et al., 2015).

The literature on education and learning process mostly concentrates on students' engagement (Zhao & Kuh, 2004), students' motivation (Stefanou & Salisbury-Glennon, 2002), students' success, and effectiveness of instruction (Vermeulen & Schmidt, 2008). So, research is still framed by a discourse on the social and experiential nature of learning in pedagogical theories. Several scholars have pointed out that university education has not adequately responded to the need for new competencies, especially regarding how to bridge the knowing-doing gap between theoretical knowledge and practical skills (Jæger et al., 2015).

At the same time, digitalization-related skills like three-dimensional (3D) printing and radio frequency identification (RFID) are not widely taught (Ford & Minshall, 2019), yet, many universities update their curriculums to adapt to the demand for interdisciplinary competencies (Jæger & Rudra, 2013). It is not surprising that the adoption of 3D printing and RFID reading is most mature in university engineering and computer graphics design courses within so-called STEM (science, technology, engineering, and mathematics) disciplines (Ford & Minshall, 2019). In non-STEM subjects like the social sciences, including supply chain management (SCM), logistics, and political science, however, there are only a few documented examples of 3D printing's adoption during in-class teaching (Kostakis et al., 2015; Ford & Minshall, 2019). Further, several scholars have emphasized the role of digital technology in education as a teaching and learning tool to develop students' competence and practical skills, as well as make teachers familiar with 3D printed products (Kostakis et al., 2015; Srivastava & Dey, 2018). However, it seems like there is a lack of understanding of how the learning process in the digital era becomes transformed to help students to develop practical skills, particularly in the SCM field. Moreover, how universities integrate these processes based on practical and technical skills are still underexplored. Thus, this chapter explores how knowledge co-creation in the learning process is affected and facilitated by digital technologies, in particular 3D printing and RFID reading.

Current knowledge of how the learning process changes due to the emergence of new technology is mostly incomplete in the literature, and the primary means of uncovering details of these effects is through laboratory experiments. This study is part of an ongoing research project. This project aims to tentatively examine the extent to which technological capabilities of 3D printing can serve as a means of learning and a way of meaningful communication among master students within the SCM discipline in a Norwegian university to help develop practical skills. Therefore, an active learning approach called experiential learning is applied (Itin, 1999; Kolb & Kolb, 2005).

The next section outlines the field of 3D-printing and knowledge co-creation in the learning process in more detail. The research method follows with a description of the educational scenario, research design, and experiential labs. The fourth section presents the case study. Then, the authors discuss experiential learning outcomes in the following section. The chapter concludes with implications for theory and practice, as well as giving an outline for future research opportunities.

Literature Review

3D Printing in the Learning Process

New digital technologies like 3D printing have a profoundly transformative effect on developing new business models, which increases their competitive advantage. The literature has largely addressed 3D printing as a form of additive manufacturing that builds 3D objects by adding layers of a particular material like plastic or metal to create the final product (Rayna & Striukova, 2016). This technology suggests an entirely different way of traditional subtractive manufacturing, which uses computer numerically controlled machines to identify a product as something that is created by machining operations (e.g., drilling, cutting, milling, boring, or sanding raw materials) into the desired shape (Watson & Taminger, 2018). In contrast, using the principles of additive manufacturing, 3D printers transform digital models of a product into a 3D object by laying down layers using appropriate materials (i.e., the printing process). Various manufacturers already apply 3D printing for prototype production because of its flexibility, cost, and time-saving advantages inherent in the technology.

The first stage of 3D printing involves creating a digital model of the object to be printed. This stage is usually done with 3D modeling software, using dedicated software provided by 3D printing services, or 3D scanners to create a model of an existing object automatically. The second stage includes the decomposition of the 3D model to add the layers that are printed one at a time (Rayna & Striukova, 2016).

The 3D printing platforms have primarily emerged to serve particular needs in business practice rendering low volume production economical and enabling mass-customization (Rayna & Striukova, 2016). While technical advances continue due to the predictive throughput and quality, educational disciplines still seem to inhibit the broader adoption of technology, including 3D printing, in the learning process (Simpson et al., 2017). This has been confirmed by recent literature reviews that have pointed to the increasing use of prototyping technology in curriculums only within engineering and design courses (Ford & Minshall, 2019). In social sciences like SCM and logistics, 3D printing in class has not been largely adopted. It can relate to an issue that it is not possible to let students experiment with real logistics and production systems because the complexity and stochastic nature of these systems are inherently difficult to grasp (Lundin & Marklund, 2008). Although 3D printing has been recognized as potentially transformative for SCM practices due to its ability to create products closer to customers around the world, it has the ability to customize those products in real-time and reduce inventory, shipping costs, and capital expenditures on factories and warehouses (Chen, 2016; Khajavi et al., 2014).

At the same time, several scholars have revealed 3D printing as a supportive technology during teaching to produce objects that aid learning, creating assistive technologies, and supporting outreach activities (Ford & Minshall, 2019; Kostakis et al., 2015). The use of 3D printing raises student engagement and motivation (Carpenter et al., 2016; Cook et al., 2015; Kostakis et al., 2015; Pantazis & Priavolou, 2017), as well as interest in the subject material (Letnikova & Xu, 2017). Further, 3D printing can facilitate the learning process (Berry et al., 2010; Schelly et al., 2015; Srivastava & Dey, 2018) from active student participation and through cross-curriculum student engagement that can help create a sense of empowerment (Schelly et al., 2015). Also, the adoption of 3D printing provides an opportunity to implement new ways of learning, like experiential learning (Blikstein, 2013; Jaksic, 2014; Kostakis et al., 2015; Pantazis & Priavolou, 2017). Adopting 3D printing has revealed the development of students' practical skills through active experimentation with 3D printing as an integrated part of the learning process (Kostakis et al., 2015; Trust & Maloy, 2017; Srivastava & Dey, 2018). The students developed competencies like 3D modeling, creativity, technology literacy, problem-solving, self-directed learning, critical thinking, and perseverance that are in line with practical skills reported as being essential for the companies' demands for new digitalization competencies (Trust & Maloy, 2017).

Knowledge Co-Creation in the Learning Process

Creating new knowledge is fundamental to the learning process. Knowledge is created when tacit knowledge transforms into explicit knowledge at the group and organisational level (Nonaka & Takeuchi, 1995). Tacit and explicit knowledge are two possible states of knowledge and should not be considered as two separate types. While tacit knowledge is a set of subjective perceptions and insights that are difficult to express in a semantic and visual way, explicit knowledge is objective, theoretical, rational, and structured to be expressed in a formal and systematic language (Ramirez et al., 2011).

Traditionally, knowledge has been viewed from two theoretical perspectives. The first perspective has focused on the resource-based view where knowledge is seen as a set of strategically essential entities that exist independently of their creators and are context-independent, so the role of individuals and organisations is to apply knowledge. The second perspective is based on social constructivism, which views knowledge as a set of shared beliefs constructed through social interactions and embedded within the social contexts in which knowledge is created, so the role of individuals and organisations is to create knowledge (Berger & Luckmann, 1966; Fong, 2005).

Paavola and Hakkarainen (2005) have identified three approaches to knowledge-creation. Learning can be a process of knowledge acquisition by individual learners (i.e., a monological approach). This acquisition view relies on the idea that knowledge is a property of an individual mind; an individual is a basic unit of knowing and learning (Paavola & Hakkarainen, 2005). According to an alternative dialogical approach, learning is an interactive process of participating in various cultural practices and shared learning activities that shape cognitive activity in many ways, rather than something that happens in individuals' minds. At the same time, a trialogical (i.e., knowledge creation approach) exists, which is when learning is a process of knowledge creation that concentrates on mediated processes where common objects of activity are developed collaboratively (Paavola et al., 2002). The third approach focuses on the way people collaboratively develop mediating artifacts (Paavola & Hakkarainen, 2005).

With the rapid advancement and application of new technologies, like 3D printing, in education, knowledge (co-)creation has increasingly become a new educational approach. Technology plays an essential role in providing a medium of communication, transparent engagement, empowering learner self-organisation, and integration of disparate fragments of experience to enable educational facilitation (rather than teaching), and learner self-efficacy (García-Peñalvo et al., 2015). The availability of specific tools like 3D-printed objects helps teachers and students advance and create knowledge (Paavola & Hakkarainen, 2005).

Kolb (1984) has defined learning in the context of the experiential learning process as "a process whereby knowledge is created through the transformation of experience" (p. 38). Experiential learning or active learning by doing is "a process of constructing knowledge that involves a creative tension among four learning abilities," or experiencing, reflecting, thinking, and acting (McCarthy, 2016, p. 92). Itin (1999) has viewed experiential learning as "the change in an individual that results from reflection on direct experience and results in new abstractions and applications" (p. 92).

In this study, the experiential learning approach was adopted to provide students direct experience using new emerging digital technologies in a business context and, thereby, encourage the process of jointly creating knowledge. Based on learning experience, the process of knowledge creation combines theoretical knowledge with practical skills (Itin, 1999; Kolb & Kolb, 2005). Specifically, it addresses active experimentation in Kolb's model (Kolb & Kolb, 2005). Experiential learning requires that students do not passively acquire knowledge; instead, they are actively involved in the learning process and knowledge creation (McCarthy, 2016). Brickner and Etter (2008) assert that it can promote greater interest in the subject material, increases understanding of course material, enhances intrinsic learning satisfaction, improves communication and critical thinking skills of the students, as well as interpersonal involvement.

In practice, knowledge is usually created through the transformation of experience (McCarthy, 2016). Companies that adopt new digital technologies, like additive manufacturing processes based on 3D printing, are pioneers in the market. They extend their existing practice beyond the scope of their experience (March, 1991). They need to process new experiences and learn from them to reduce the risk of uncertainty and costs, and thereby increase the feasibility of the implementation of new technologies. This is so-called strategic learning is when companies transform information from their past and novel experiences into knowledge (Gupta & Bose, 2019). Also, this knowledge needs to be supported by a fundamental theoretical basis and employee competencies to realize the intended business objectives. According to several researchers (Kuwada, 1998; Thomas et al., 2001), the process of strategic learning involves strategic knowledge acquisition, interpretation, and implementation. Strategic knowledge acquisition enables individuals to gather environmental information to extend their current knowledge through an exploratory process. New knowledge is synthesized in the process of interpretation, and finally, the process of implementation is institutionalizing the strategic knowledge developed earlier (Gupta & Bose, 2019).

The literature on knowledge creation is still quite limited (Fong, 2005). Recognition of this fact has encouraged this study to emphasize the knowledge-creation approach in extending the use of digital technology like 3D printing in education and addressing outcomes for the learning process.

Method

Educational Scenario

This study documents the first phase of the ongoing research project that started in January 2020. Specifically, this first phase tentatively examines the technological capabilities of 3D printing as an educational tool in a small sample of students at a Norwegian university to develop practical skills. The research project was inspired by the experience of an instructor at the Norwegian university who previously worked as an engineer designing small electrical appliances using 3D design tools, as well as making prototypes using 3D printing.

Therefore, the authors apply an action research approach based on the experiential learning literature (Itin, 1999; Kolb & Kolb, 2005). The experiential learning environment was achieved by using three labs: the Computer-aided design (CAD) lab for 3D designers, the Radio-frequency identification (RFID) lab for trace and track applications by students in logistics, and the 3D printer lab provided by the industry (usually used by manufacturing engineers). Each of these labs was used by specialists within separate academic and practical fields.

The knowledge co-creation environment was created by letting the students design their objects, attach an RFID tag to the objects to be tracked by tracking software at the lab, and use the 3D printing lab for printing both original objects drawn in the 3D design lab and spare parts upon failure of authentic parts.

Thirty-five students took part in the research project by attending several seminars within a particular course in supply chain visibility with RFID and Internet-of-things (IoT) technologies. The primary learning purpose was to teach students how new digital technologies can be applied to make existing life cycle management processes for a product more efficient and sustainable. To begin, the students studied the concept of 3D design using simplified software and the basics of 3D printing as part of the living experience. The authors took into account that students learn better if they are in charge of their learning processes (Freire, 2005), so they let them explore the project activities themselves within the framework of organized teaching. The students explored the process through trial-and-error to develop a creative way of thinking and create 3D objects.

The learning activities began with an introduction to the concepts of RFID tracking and 3D printing technology through lecture-based classes. Then, students were introduced to an industrial business context in which a new component of a product was needed. The students used 3D design software to design a new component. A model of the new component was stored as a standard stereolithographic file. Further, the students gave the component a unique ID stored in an RFID-tag and linked the ID with the STL-file with the 3D-model. The next learning activity had the students print the component using a 3D printer, fixed the RFID-tag with the unique ID to the component, taking into account the necessity of component's replacement when it is broken. Then, they scanned the RFID-tag to get the ID, used the ID to look up the 3D file with the STL-drawing, and finally printed a new component using the 3D printer. In the last learning activity, the students wrote reports on their artifacts and provided some information on 3D printing technology. Therefore, the learning outcomes were about the development of the students' practical skills using 3D CAD design, RFID, and additive manufacturing, applying 3D printing to support, repair, and remanufacture products.

To sum up, the process of learning and knowledge co-creation used to create and implement the educational scenario was rooted in the qualitative case study research approach. This approach allowed the authors to capture the contextual settings of the experiential learning process. It helped reveal how students developed their knowledge, practical skills, and perception of the way that 3D printing technologies affected communication between the lecturers and students.

Experiential Labs and Data Collection

The authors used multiple data sources, including five semi-structured face-to-face interviews, questionnaires to students, situation observations, as well as secondary data (i.e., literature review) and archival materials. The interviews were conducted with lecturers, students, and representatives of businesses that adopted 3D printing. The findings were supported by situation observations using three experiential labs that collected action-research data about the learning activities and knowledge co-creation. This allowed the authors to experience the complex relationships between the students, lecturers, and learning processes in class.

The CAD Design Lab in the High School

The CAD design lab was presented at the Norwegian university. The students used standard 3D-Design software from Tinkercad Online and Microsoft 3D Builder.

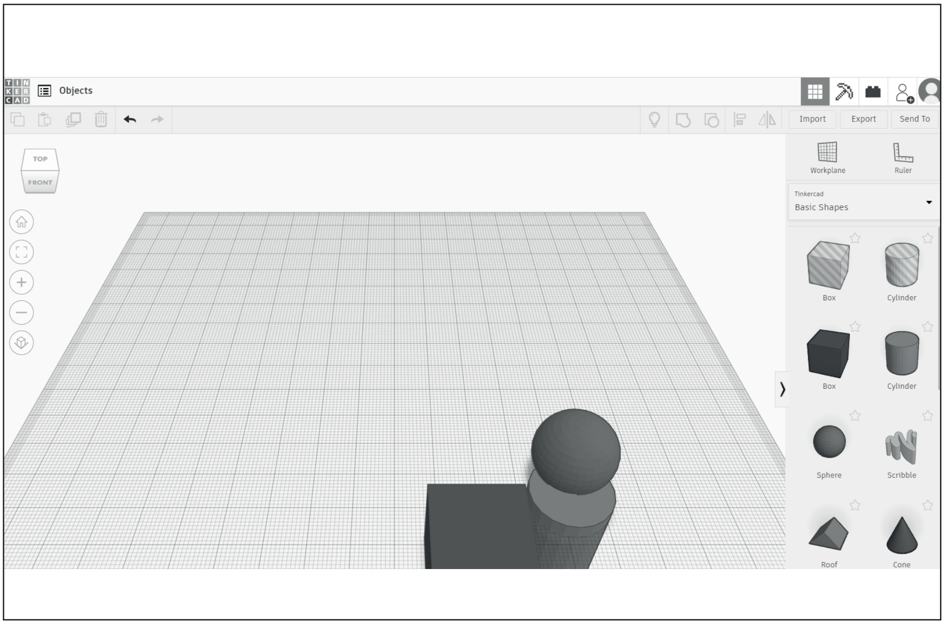

Fig. 1: TinkerCad 3D Design User Interface

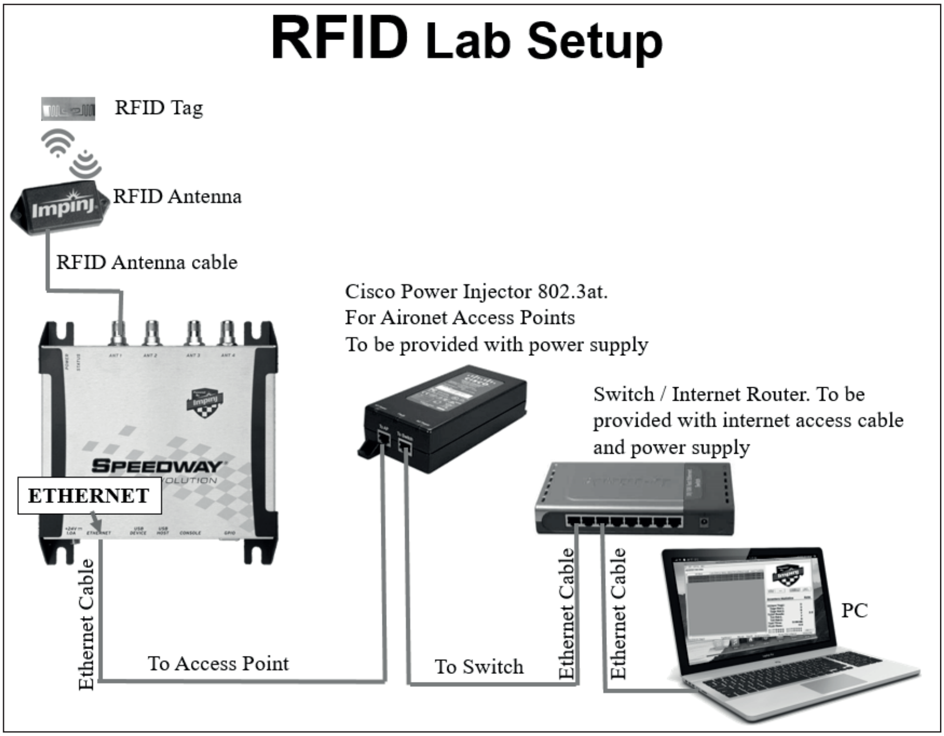

Fig. 2: The RFID Lab Setup

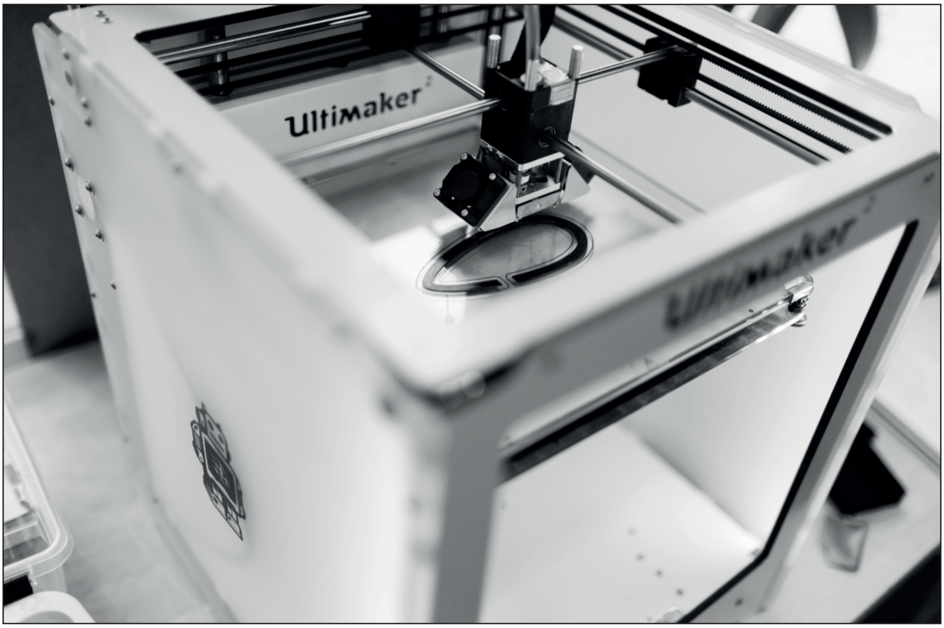

Fig. 3: The UltiMaker 3D Printer at iKuben

The RFID Lab in the High School

The RFID-lab consists of RFID tags (one per student), four RFID antennas, and an RFID reader with four antenna ports connected to the computer. The Power Injector is connected to a switch/internet router that is connected to the Internet and a computer with Impinj Multireader Software to display RFID events (see Figure 2).

The 3D Printing Lab in the High School

The 3D Printing Lab consists of a 3D printer, virtual reality hardware, software, and other innovation lab facilities. NCE iKuben is a cross-industrial cluster facilitated for fast and continuous business development, with a particular focus on digitalization, sustainability, and new business models for the Norwegian industry. The students used the 3D printer to print objects designed in the CAD design lab. RFID tags were attached to the 3D printed objects.

An action research approach was used. One lab provided by the industry (3D printing lab) was combined with a 3D industrial software design lab and an RFID lab at the university.

Data and 3D Printed Product Analysis

Upon completion of the Product Lifecycle Scenario using three labs, the students handed in their 3D-printed objects with a report. In the report, they presented their results and described how using 3D printed objects would affect the life cycle maintenance of products. The lecturers analyzed the reports, including the 3D models and physical objects created by the 3D printer, and provided feedback to the students.

Learning by Active Experimentation: Case Presentation

Container Tracking Using RFID-Reading

The first part of the active experimentation provides the students with competencies on how to track containers with RFID tags during intermodal transportation. The physical part of the lab simulates a simplified real-life distribution chain from a distribution center to a store and consists of small scale models of trucks, containers, and a railway.

The shipping containers are manufactured to customers' specifications, and there are subtle differences between them. They need to be stored and shipped in a way that they can be found quickly and easily to deliver to customers (e.g., the store in this case). So, the containers are equipped with RFID tags with a unique ID. RFID is an automatic identification technology in which information can be stored and remotely retrieved. RFID tags are like "little radio towers or transponders that send out information to a reader" (Robbins et al., 2014). The RFID system includes tags, tag readers, computer servers, and software (see Figure 4).

In the experiential case, four RFID reader antennas are located at different points within the distribution chain and connected to a computer server with RFID reader software. A feature of RFID tags is that they can be read at a distance, even through crates or other packing materials.

Figure 5 illustrates the distribution chain, including three shipments: 1) between the distribution center and the departing railway station by road, 2) between the departing railway station and the arriving railway station by railway, and 3) between the arriving railway station and the store by road. The location information of a sample container was transmitted in real-time to the computer server.

The scenario of the sample container shipment is organized as follows. Initially, the sample container is loaded onto the truck at the distribution center and leaves for its final destination, the store. When the truck crosses the gate, the RFID tag on the container is automatically read. The tag's ID is sent to the computer server of the logistics company, which adds a timestamp before registering the reading in the database. Second, when the truck arrives at the train station, the sample container is scanned again, and the database is updated. The sample container is then loaded onto the train carriage. Third, when the train arrives at the destination train station, the container is again scanned; the database is updated before the container is loaded onto a new truck to be shipped to the store. Finally, when the truck enters the loading ramp at the store, the container is scanned for the last time.

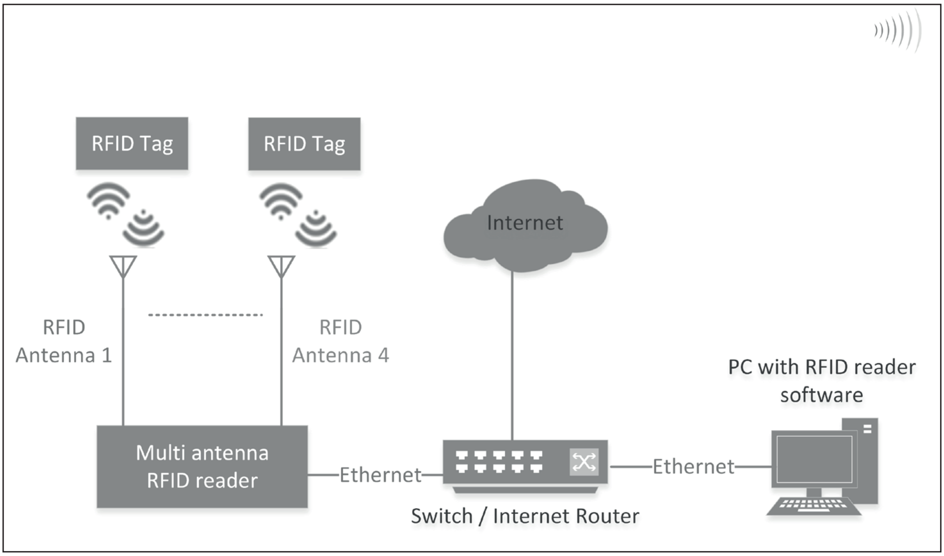

Fig. 4: The RFID System

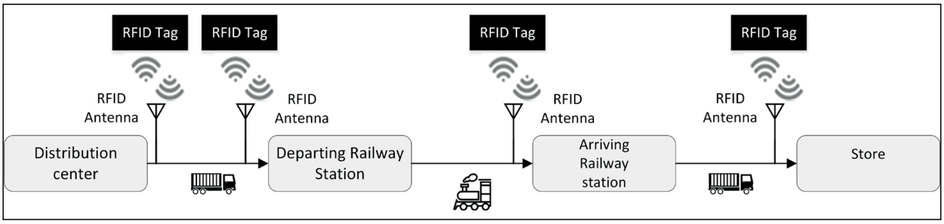

Fig. 5: Distribution Chain

Thus, the database contains four readings, including timestamps from four intermediate locations throughout the distribution chain. The collected information represents the status of the shipment of one specific container. This instance-level information is useful in tracking and monitoring the distribution process of a particular shipment. The RFID container tracking system eliminates the problem of lost containers, avoids delivery mix-ups, and reduces the cost of leasing extra forklifts at busy times (Robbins et al., 2014). As told one of the students involved in this experimentation stated:

> I feel more motivated during this active learning because I understand more how digital technologies like RFID work in real practice. I believe this wonderful experience will be useful for me to find a good job. Also, I think I perceive better how the adoption of new technology makes contemporary supply chains easier when tracking and collecting data during the container shipments and thereby facilitate their operational performance.

As told one of the lecturers involved in this experimentation said:

> Usually, the lecturers have significant theoretical knowledge and practical experience to endow students. However, I feel that our conceptual knowledge is not enough when a novel technology like 3d printing is adopted in the educational system. So, the lecturers act like a mentor rather than a leader during active experimentation in class. I can find a new collaboration between students and lecturers in creating knowledge on the spread of technology in curriculums.

Replacing a Tracking System's Component with 3D Printing

The second part of the active experimentation deals with a case when a simple component in the tracking system got damaged and has to be replaced. If the tracking system of the containers works wrong, the shipment of any container from the distribution center to the store faces many issues in performing operations. Operational issues include time wasted in finding the right containers, containers that cannot be found, or incorrect containers delivered to customers. Further, the logistics company and customers would have problems knowing whether the particular container has left the distribution center. Schedules for container movement would be broken, which results in supply chain delays and disruptions.

The logistics company had a discussion on how to, in the future, organize the supply of a specific tracking system component in case of its possible failure. The existing solution of sourcing from external suppliers is faced with several challenges. The logistics company had two alternatives: buy a new component from a supplier or create it using 3D printing technology. They decided to implement 3D printing due to cost and time-saving advantages instead of sourcing from the supplier for this specific component. The students in the active experimentation performed the role of maintenance personnel of the logistics company to realize this decision.

Initially, the students created a 3D model of the component as a 3D object by using 3D-design software. They stored the 3D-model as a standard STL-file. Then, they gave the component a unique ID stored in an RFID-tag and linked the ID with the STL-file with the 3D-model. An RFID tag with the unique ID was then fixed to the existing component, making it ready for replacement by 3D printing in case of component failure. After a few days, the original component in the tracking system experienced failure and had to be replaced.

Then the students scanned the RFID tag of the failed component to get the unique component's ID, which was used to look up the 3D file with the STL-drawing (see Figure 6). Then, the students printed a new component using the 3D printer and fixed an RFID-tag with the correct unique ID to the newly printed component. The 3D printed component was replaced in the tracking system instead of the previous one.

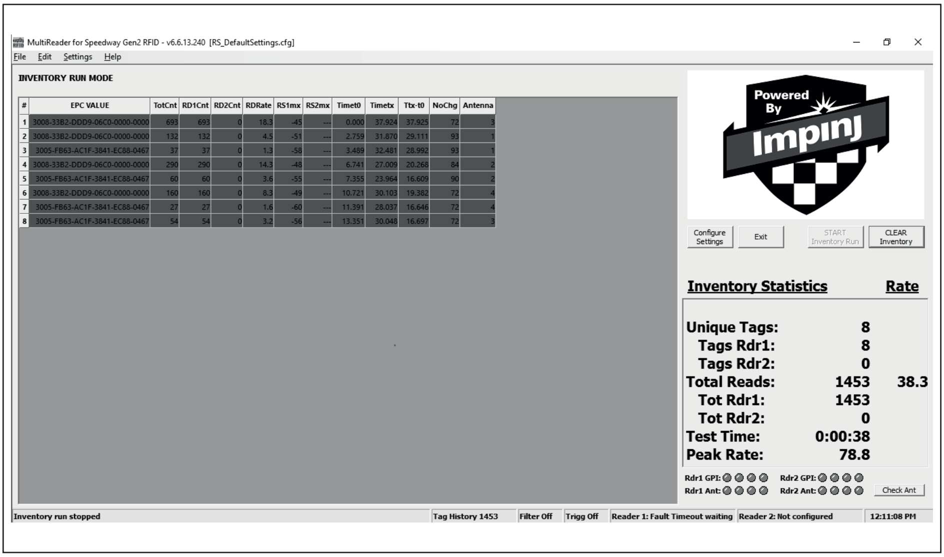

Fig. 6: Reading RFID Real-Time Events

As told by one of the lecturers:

> During this active experimentation, students could perceive how supply chain strategies are implemented in real practice and refer to a particular digital fabrication strategy. This active learning took students outside the class and into the global supply chain environment.

3D Printing Components and Results

In total, nine 3D components were designed, and six of them are presented in Figure 7. These components were relatively simple objects because the 3D printing time was a couple of hours per a simple object, and there was only one 3D printer assigned for the case. After a 3D printed object was made, an RFID tag containing the product identifier was attached to the object. All the objects were functional in practice.

As emphasized by one of the lecturers:

> The students successfully printed the components. At the same time, most important was to have them present during the process of 3D printing and discuss the issues of creating 3D objects and attaching an RFID tag with the product ID on the components. Also, it was nice to get the students' initiatives on how to make adjustments to the 3D printing components in real-time.

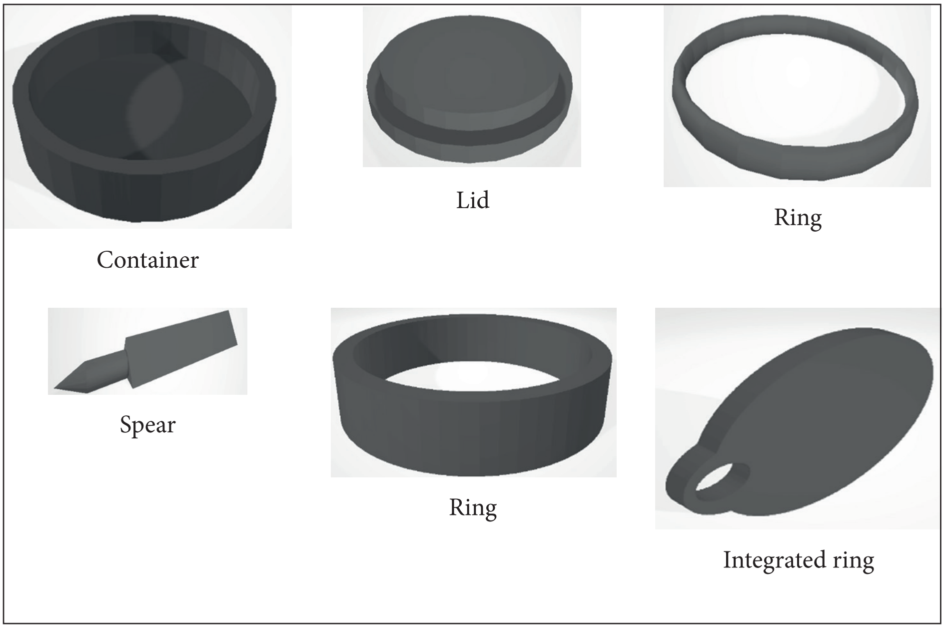

Fig. 7: Student Examples of 3D-Designed Objects

Conclusion and Implications for Theory and Practice

The active experimentation with digital technologies presented in this study has shown the transformative educational potential for students and lecturers within SCM curriculums. The experiential learning approach has shown that new technologies like 3D printing expand communication and knowledge co-creation in the learning process through the co-creation of 3D design, RFID tags, and 3D printing in a realistic industrial context.

The findings show that laboratory classes enable students to move from the concrete by observing phenomena to the abstract by understanding the theoretical foundations that are derived from the observation of phenomena. Pedagogically, this is important in laboratory classes for co-creating knowledge using digital technologies. At the same time, educational labs and workshops are limited in the range of equipment, experiments, and experiences that businesses need. So, the adoption of digital technology and experiential learning within SCM and logistics curriculums has not been widespread. The active experimentation has, however, identified that the knowledge-creation approach becomes practically relevant when there are available technical tools like RFID tags and 3D printing to achieve lifelong learning outcomes.

The use of digital technologies in the learning process encourages meaningful communication between students and lecturers and increases students' active engagement in learning and knowledge creation. Therefore, the findings revealed that experiential learning facilitates an increased understanding between students and lecturers of newly emerging technologies via workshop participation and active experimentation. This happens as they learn about their environmental, economic, and social effects (e.g., operational management of container shipping and avoiding storing large amounts of inventory that make SCM practices more effective). So, this educational experience shows the potential of digital technologies for further adoption in SCM and logistics curriculums beyond STEM disciplines.

The study reveals that the learning process in the digital era becomes transformed into increasingly new forms of integrative knowledge and competence, emphasizing practical and technical skills. This leads to a shift from passive to active learning or from a teacher-centered to a student-centered approach to developing students' practical skills for companies' needs when adopting new technology.

Further, as companies act as pioneers in the market when adopting new digital technology, the findings will be valuable for managers responsible for the realization of these technological projects. The active learning process through experimentation helps students deal with new digital technologies and helps them develop practical skills. Knowledge creation in active learning (i.e., by doing) processes become more valuable for businesses because it considers the complexity and stochastic nature of SCM practices and logistics operations that do not let students experiment with real supply and distribution chains.

Managers will gain new employees (former students) with special competencies who are able to realize the intended business goals when adopting new projects with digital technologies. This is particularly relevant when extending formal education to the use of companies' experiences in the learning processes in education and practice.

Limitations and Future Research

The findings are based on a single-case study of the instance-level information from the readings of the RFID tags about the status of one container shipment at a point in time. At the same time, if the same experimentation with data collection about several separate shipments within the same supply and distribution chain is continued, then data can be received at the process-level. The process-level data can be evaluated using statistical tools and quantitative methods to determine the minimum-maximum, average shipment time, and delays in predicting supply chain disruptions. The authors suggest that more investigations on experiential learning at the process-level should be conducted to provide insights into how to overcome complex and stochastic issues in real logistics and supply chains to help students develop practical skills in the SCM field (Lundin & Marklund, 2008).

Further, in this study, knowledge co-creation in the learning process is described in the formal education system. A better understanding is needed of how developing practical skills in 3D printing and RFID reading can occur beyond the formal educational system and how learning from formal education and strategic learning from companies' experiences can be integrated into the process of knowledge co-creation.

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