

Living in a Digital World: Improving Skills to Meet the Challenges of Digital Transformation Through Authentic and Game-Based Learning

Margit SCHOLL

Technical University of Applied Sciences Wildau
Wildau, 15745, Germany

and

Frauke FUHRMANN

Technical University of Applied Sciences Wildau
Wildau, 15745, Germany

ABSTRACT

The constant proliferation of digitization is increasingly penetrating all areas of life and requires greater awareness and improved skills to handle processes based on information and communication technologies. Digital technologies and infrastructures form the basis for new digital applications, new exploitation potentials, and digital business models as well as communication in digital value-added networks. This has changed people's communication behavior, and new knowledge is needed to deal with digital technologies, coupled with soft skills to cope with the changes triggered by digitization. It is also necessary to foster a new awareness of the various challenges and threat scenarios facing organizational and social values. Due to shorter and shorter technology cycles, lifelong learning is taking on a new meaning. This brings into play cooperative learning exercises in cross-disciplinary teams drawing on authentic and game-based learning approaches. The results of three pilot courses on information security sensitization that used an integrated learning 3.0 approach combining authentic and game-based learning are presented and discussed.

Keywords: digitization, software code, transformation skills, lifelong learning, cooperative learning, information security awareness

1. INTRODUCTION

Almost all business processes and specialized tasks depend nowadays on the secure and smooth operation of information technology (IT). The constant proliferation of digitization is increasingly penetrating all areas of life and requires greater awareness and improved skills to handle processes based on information and communication technologies (ICT). Digital transformation (DT) is an ongoing process of change that not only affects individual enterprises, modern administrations, and other organizations but it is also having an increasing impact on the entire (knowledge) society and all human beings. Digital technologies and infrastructures form the basis for new digital applications, new exploitation potentials, and digital business models as well as communication in digital value-added networks. DT has changed people's communication behavior, and new knowledge is needed to deal with digital technologies, coupled with soft skills to cope with the changes triggered by digitization. It is also necessary to foster a

new awareness of the various challenges and threat scenarios facing organizational and social values (e.g., physical injury; negative internal and external effects; the violation of laws, regulations, or contracts; a diminished right to informational self-determination; an impaired ability to perform tasks; financial effects).

But what is really new? Why do we need to think about digitization and its impact on business processes, skills, and human behavior? Modernization in our society, in businesses, public administrations, and other organizations is inconceivable without the use of modern information technology systems (ITS) based on software, and this involves code development. So, on the one hand, the security of IT is determined primarily by the security of the software used on the ITS [8]. On the other, a more systemic viewpoint on software is needed to assess the impact of digitization and code development on society and social life. In the sense of this latter approach, in July 2017, the German newspaper *Süddeutsche Zeitung* included the headline "Software is eating the world" taken from a 2011 article in the *Wall Street Journal* by venture capitalist Marc Andreessen [21]. The *Süddeutsche Zeitung* shows in the article that our lives are increasingly determined by programming codes and asks whether democracies can leave this development in the hands of private companies [21].

Regardless of the more politically oriented issue of the newspaper, the article points to a discussion that was conducted back in the 1970s/1980s and has not lost any of its explosive potential today. In 1977 the Massachusetts Institute of Technology (MIT) computer pioneer Joseph Weizenbaum wrote, "The programmer is the creator of universes whose sole legislator is himself" [32]. This is because a program structures processes and gives the (working) world laws. This tie-in was underpinned by US lawyer Lawrence Lessig with his 1999 thesis "Code is law" [20]. Also in Lessig's opinion the code is used as a regulatory instance and lays down behavioral guidelines, comparable to the law for the market or social norms. Technical measures thus become an instrument of deliberate and targeted social intervention. It may be inferred from this that the code is also a proper and effective regulatory instrument for dealing with knowledge and structures [25]. This ultimately means that there are also norms in cyberspace and that the program code, and thus digitization itself, structures and changes *social* worlds. This is the actual challenge people have to be trained to cope with.

The program codes of technical systems structure human action in the digital world. Technical systems and the program code give

people the freedom to design their social lives or to restrict them. Technical systems and program codes are not error-free and are thus susceptible to successful cyberattacks. However, DT and information security are about more than technology [18], because information systems involve human beings, and users do not always act the way they are supposed to [1]. In the next section, we summarize the relevant skills needed in a digital world. Section three examines the main aspects of authentic and game-based learning. In section four we explain our methodological approach of integrated learning 3.0, and afterwards we show its evaluation results. Our conclusions and future work are presented in section six.

2. SKILLS NEEDED IN A DIGITAL WORLD

Human action is changing through comprehensive digitization and virtualization. Software code, value decisions, and the type of programming structure that determines processes in work and everyday life are delegated to algorithms. You may be thinking of

- searching for information with only one search engine or using social networks naïvely or taking fake news as true facts,
- developing autonomous vehicles or the Internet of Things (IoT) and ignoring possible cybercrime threats, or
- introducing digitization and virtualization in smart companies or smart cities with smart technologies and automated administrative acts.

Nevertheless, the structured processes in software code include a more dynamic way of working in companies and public administrations and require employees to be prepared for this DT. There is a lack of digital skills and competencies, not only for the digital culture and work in organizations but also from the perspective of social development:

- Digitization of the working world puts new demands on employees' competencies.
- Digitization of the democratic social and private world puts new demands on citizens.

From the point of view of employers in the German-speaking world, there is an urgent need for action regarding the following hard skills [12]:

- media competence (chosen by 74 % of the 591 managers surveyed),
- basic IT-competence (56 %), and
- technical knowledge (40 %).

However, in the digital working world a number of soft skills are also highly relevant (see fig. 1 and [12]).

Due to shorter and shorter technology cycles, lifelong learning is taking on a new meaning. Recent research suggests that for new sensitization vis-à-vis information security to occur, a change must be made to include learner-centered, realistic, and participatory learning environments with real-world contexts. Innovative teaching and learning methods that integrate reflection, self-assessment, and performance review are needed. This brings into play cooperative learning exercises in cross-disciplinary teams drawing on authentic and game-based learning approaches.

3. AUTHENTIC AND GAME-BASED LEARNING

Authentic learning describes learning through the application of

knowledge in real-life contexts and situations. The four characteristics are [23]:

- 1) An activity that involves real-world problems encountered by professionals and the presentation of findings to audiences beyond the classroom
- 2) The use of open-ended inquiry, thinking skills, and metacognition
- 3) Learner engagement in discourse and social learning in a community of learners
- 4) Learners directing their own learning in project work

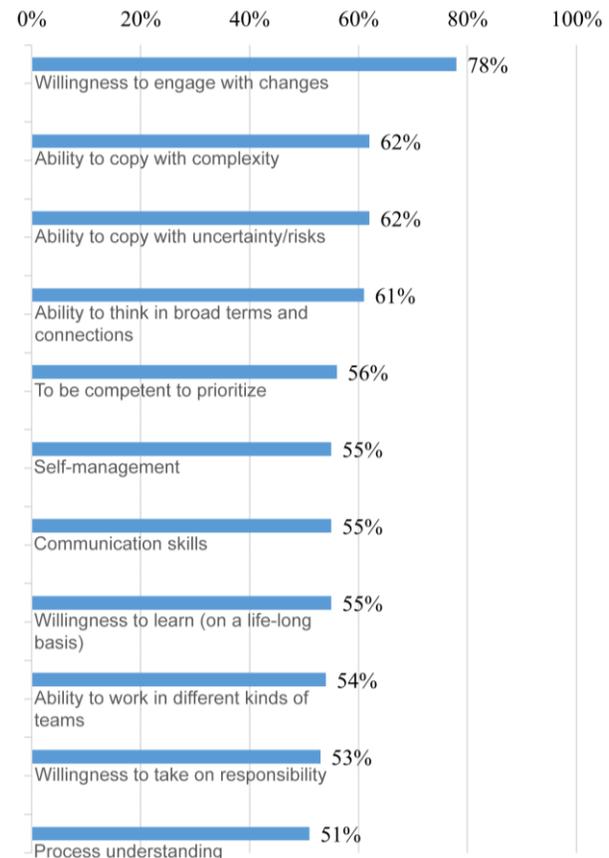


Fig. 1 Soft Skills where there is a very high need for action from the point of view of employers (591 managers surveyed)

From research and practice we know that 21st-century competencies include collaboration, real-world problem solving and knowledge-construction skills, skilled communication, and global awareness [30]. We need to engage people, especially digital natives, through *social learning* [24]. We need new educational options for managing digital transformation with feedback systems helping managers to develop and communicate business models [31]. And we need interdisciplinary communication [3].

Traditionally, game-based learning (GBL) is used as an educational method to motivate learners and inspire them to engage in learning processes [15]. There exist four main learning elements in GBL: Motivation, Feedback, Practice, and Reinforcement [5]. Motivation is developed because games often have different levels and provide rewards to enable one to move forward [5]. Feedback in games is given immediately and helps learners to know their status and move further toward reaching their goals [5]. In this way, feedback should trigger deep cognitive processing and improve the memory of learners, which contributes to better

learning [6]. To achieve or to solve goals, games enable active and experienced-oriented learning by trial and error, repetition, and by providing the opportunity to learn from failures [9]. Reinforcement of the learning process comes from repetition, which strengthens the learners' memory and can replicate the real-world risk in the context [5]. Games enable learner-centered learning that takes into account the user's level of knowledge and his/her individual needs [9].

Digital game-based learning (DGBL) is the modern way to introduce learners to new experiences via high-tech (mobile) devices and software [9, 15]. Consideration of the international research shows that no consistent classification of GBL (= analogue) and DGBL (= digital) is made. Thus, current international research mainly refers to digital serious games, while under the term GBL one also finds research results that include the content of digital play scenarios. According to Le, Weber, and Ebner, high-quality digital games exert a great power of fascination on gamers, and virtual exploration rooms are well suited to the instigation of learning processes [19]. Serious video games really work. Test game use proves its *effectiveness* in that students using the game scored significantly higher than classes that did not [2]. There are thus three (more) reasons to use games [16]:

- they can make people behave better;
- learners perform better; and
- players work harder of their own volition.

However, further study results suggest that the motivation, commitment, and development of problem solving competencies are strongly influenced by the nature and design of the games [7].

Regardless of the exact assignment, GBL/DGBL has been internationally established as a recognized teaching and learning method in the educational sector [11, 14, 17, 29] as well as in continuing education and training [13, 33]. However, there is still a need for research on how to really obtain a sustainable learning performance [4, 7] and an attractive design of realistic learning arrangements [10].

4. METHODOLOGICAL APPROACH OF INTEGRATED LEARNING 3.0

In our research project “SecAware4job,” sponsored by the Horst Görtz Foundation, we developed and tested a curriculum aimed at strengthening the soft skills required for the digital world, raising awareness about information security, and providing students with the latest security knowledge. The methodological approach applied in the corresponding module “Sensitization for Information Security” is based on the integrated learning 3.0 approach, which combines authentic and game-based learning (see fig. 2). In order to test their acquired competencies, the students are invited to pass different certificates—for example, the exams on IT security and data privacy offered by the European Computer Driving Licence (ECDL) or the challenging exam to obtain certification as an IT security officer, which is valid for five years.

Although serious analogue games are not so popular, especially in the USA, where 97 % of teachers use digital games created for educational use [22], they can be also used in different ways and in diverse disciplines. They might be a very useful way to practice the soft skills needed for teamwork, discussions, and a collaborative decision-making process. *Social* learning is necessary in a digital world. According to Hsu et al., both GBL and DGBL

strategies have their own advantages and the difficulty is to combine these two types of learning strategies and to find a balanced relationship between them [15].

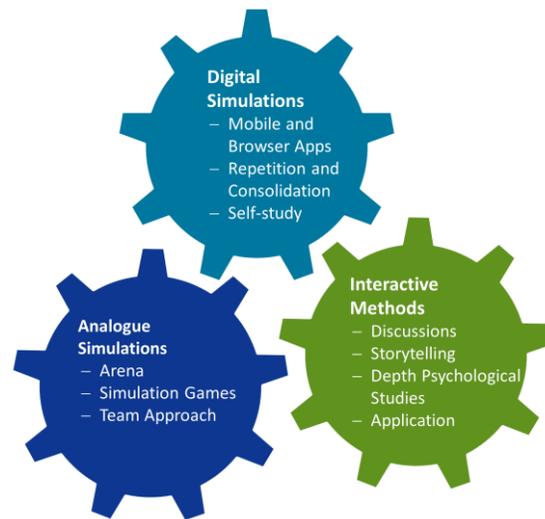


Fig. 2 Integrated learning 3.0 approach in “SecAware4job”

In our own research project “SecAware4job,” a clear distinction is made between GBL and DGBL, and both learning strategies are explored with students, both separately and in combination [26]. This is unique in the international research context. The combined use of analogue and digital game-based learning scenarios exploits the advantages of each learning strategy (see below) and should result in greater learning success.

We built up analogue game-based learning scenarios—the so-called “IT-Security Arena”—as circuit training with short games lasting a maximum of fifteen minutes and developed correspondingly short digital simulations for the purposes of repetition, consolidation, and supplementation [9]. The advantages of analogue learning scenarios consist in finding a joint solution in a team, in the resulting social exchange of experience and knowledge, and in the strengthening of team and communication skills. Digital learning scenarios promote the individual deepening of the learning content. This can be done independently of location and time, at an individual pace, and as often as desired. Thus, they are oriented to the life situation as well as to the needs and knowledge of the learners. Interactive methods like storytelling, discussions, and depth psychological studies complement the common learning strategy for information security sensitization. We called this learning methodology “integrated learning 3.0” [27], because it combines (theoretical) knowledge transfer with interactive emotional-based elements and team action as well as communication and decision making.

5. EVALUATION OF THE INTEGRATED LEARNING 3.0 APPROACH

In “SecAware4job” the methodological approach was tested and evaluated in three pilot courses. In the summer semester (SuSe) 2016 five students (2 female, 3 male) on the accompanying Business Administration program took part in the compulsory elective module “Sensitization for Information Security.” These students were very motivated and interested in the topic information security and actively participated in the course. Their high level of motivation crystallized in the ambition of all the students to

obtain the highest and most challenging certification as an IT security officer. Four of them completed the exam successfully.

In the winter semester (WS) 2016/17 the content of the module “Sensitization for Information Security” was integrated as a compulsory course in the Municipal Administration Management and Law program. Eleven students (9 female, 2 male) took part in that course. These students were less interested in the topic information security and, at the beginning, some of them were also skeptical about the methodological approach applied. However, three of the participants successfully passed the IT security and data privacy exams of the ECDL. Furthermore, one student who was initially highly skeptical of the applied methodological approach developed an analogue game-based learning scenario with her partner as part of their project thesis at the end.

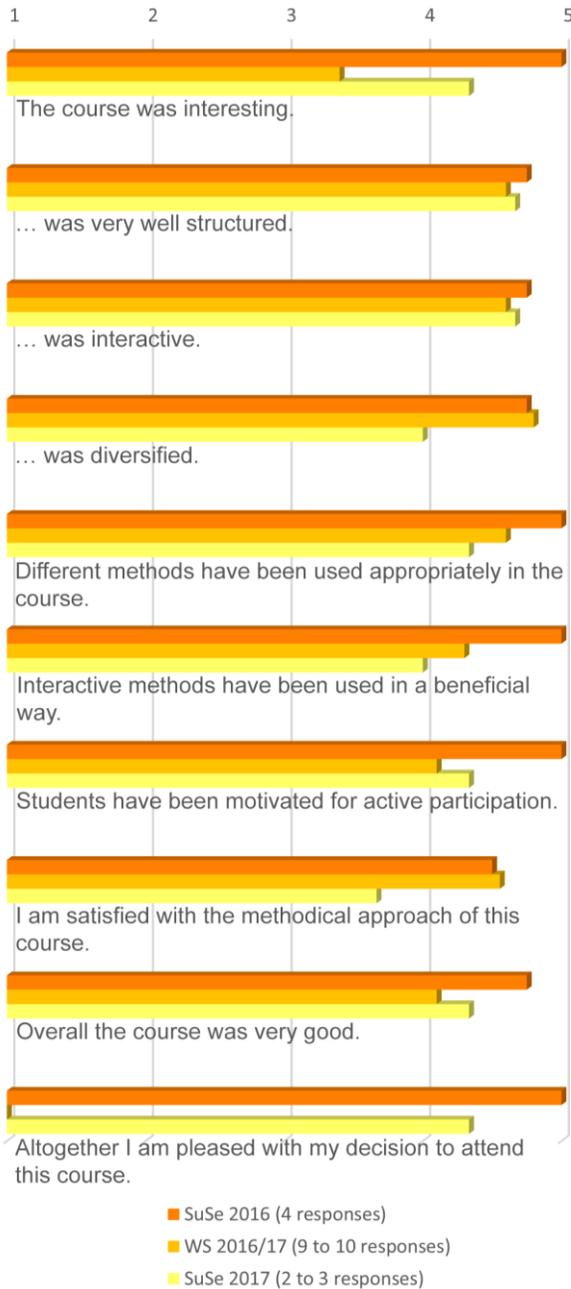


Fig. 3 Evaluation of the pilot courses (1=disagree, 5=agree)



Fig. 4 Measures to protect sensitive information. Self-assessment of the learning success (1=disagree, 5=agree)

In SuSe 2017 six students (1 female, 5 male) on the accompanying Business Administration program chose the compulsory elective subject “Sensitization for Information Security.” These students were also very interested in the topic and five of them worked hard to attain the IT security officer certificate. Three of them completed the exam successfully.

The final student evaluations (see fig. 3) of these three pilot courses show a high level of satisfaction with the course and the applied methodological approach of integrated learning 3.0, which consisted of a combination of lecture, analogue, and digital game-based learning scenarios, as well as interactive exercises.

However, it is striking that the participants in WS 2016/17 who attended the compulsory course found it less interesting than the students on the compulsory elective courses. Because it was a compulsory course, these students were not asked the final question.

The aims of the project “SecAware4job,” which set out to raise awareness about information security, enhance knowledge in this area, and ideally trigger behavioral changes, were reached—in particular for the students of the compulsory elective courses—and could be implemented in their working lives. The results of the self-assessment questionnaire can be seen in fig. 4.

The successful participation of the students in the complex certification exams for the ECDL or to qualify as an IT security officer, which are independent of the Technical University of Applied Sciences (TUAS), is another proof of the practical and successful application of the developed methodological approach of integrated learning 3.0 in the field of information security.

However, the differing evaluation results and levels of interest in the certification exams between the students of the summer semesters and the winter semester show that the course should be offered as a compulsory elective course in the future. There are plans to integrate the module “Sensitization for Information Security” as a compulsory elective course in all TUAS programs in the near future.

6. CONCLUSION

To understand the impact of comprehensive digitization on the life of our society, a systemic view of ICT is needed. Software code and algorithms structure processes and people’s actions. Software (code) structures and processes act therefore like laws in giving the social world perspective [20, 32]. People need new competencies and skills in the digital world, in order not to leave decisions entirely up to machines. Technical measures become an instrument of deliberate and targeted social intervention [25] and change people’s communication behavior. New knowledge is needed to deal with digital technologies. Soft skills are a central element in coping with the changes triggered by digitization [12]. It is also necessary to foster a new awareness of the various challenges and threat scenarios facing organizational and social values.

On the one hand, a new information security culture needs to be established in all organizations [26]. While the number of organizations that apply information security measures is increasing, surveys of corporations show that it is unusual for these measures to be accompanied by specific in-depth evaluations of their effectiveness [28]. Since these awareness-raising measures demand resources such as time, money, and the willingness of employees, every organization should have an interest in assessing their effectiveness.

On the other hand, sustainable learning needs to be developed. Due to shorter and shorter technology cycles, lifelong learning is taking on a new meaning. The combined application of analogue and digital game-based learning scenarios and interactions in the “SecAware4job” project [9, 26, 27] takes advantage of both game-based learning strategies combined with authentic learning, with the goal of achieving greater learning success.

The advantages of analogue learning scenarios consist in joint team solutions, in the resulting exchange of experience and knowledge, and in the strengthening of team and communication skills and lead to sensitization with regard to information security, which is needed to establish an information security culture in organizations.

Authentic learning scenarios make learners aware of the relevance of digitization for each employee and organization—this enhances the ability to think contextually and increases understanding of the processes involved.

With digital learning scenarios, digital competencies can be strengthened and practiced independently of location and time.

In addition, the digital variants can take more account of individual knowledge—for example, different degrees of difficulty can be offered.

Game-based learning combined with an authentic learning approach is being reviewed and has been tested in “SecAware4job” as an effective teaching and learning method, especially as a means to stimulate motivation and change behavior (relating to information security).

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