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# Game-Based Learning for Facilitating Equity in ICT

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## ABSTRACT

Studies report a lower self-concept among female students, which is influenced by stereotypes rather than by objective achievement or individual aptitudes. This has consequences with regard to motivation for ICT studies and for later career choice. Therefore, the project Mit-Mut aimed at supporting female students' motivation and self-concept in ICT, particularly by enabling experiences of proficiency through a game-based learning approach. During the game, students worked in a social enterprise network role-play game for about six weeks. This paper provides insights into the processes and outcomes of the game. Qualitative research results show that, during the game, the female students developed their 'sense of mastery' as a prerequisite for a positive self-concept in using ICT and also a more differentiated perspective on females in ICT professions.

## KEYWORDS

gender, game-based learning, STEM, academic self-concept, motivation, information and communication technologies (ICT), stereotypes

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## BACKGROUND

Low-paid jobs, precarious contracts, bad job quality, and missing talent management are the reasons for about one half to two-thirds of European companies having problems with finding skilled workers. The remaining firms encounter genuine skill shortages, as stated in the latest Cedefop report (Cedefop. European Centre for the Development of Vocational Training, 2015). The inability to find job applicants with appropriate skills, despite the willingness to pay the price for these skills, is particularly a problem in growing, dynamic and international companies in the health, manufacturing, social care and ICT (Information and Communication Technologies) sectors. As well as recommendations at an organizational level (e. g. better and more stable jobs, strengthening the internal and external talent pipeline, or potential-oriented hiring) the Cedefop experts recommended a greater reliance on relatively unexplored talents - in the case of the ICT sector these would be female workers.

Though women's active participation in the ICT sector is essential for European growth, a major gender gap in the field is still evident. This seems surprising when considering the achievements made by women in education, as 59 % of the tertiary graduates in Europe are women. However, this high percentage is not reflected in ICT. Even if the achievement of girls, compared to boys, in science and mathematics, is the same or even higher in several countries(1), as found in the Trends in Mathematics and Science Study (TIMSS; Mullis,et al., 2012), this does not automatically mean, that "[…] *girls want to pursue all types of science-related careers. In fact, careers in 'engineering and computing' still attract relatively few girls*" (OECD, 2012 p. 2, see also Corbett & Hill, 2015).

This is reflected in the percentage of female students in ICT-related degrees(2) in Europe, which is 9.6 % of all female students, whereas the share of male students in ICT-related degrees is 30.6%. Just about one third of these students - male as well as female - in ICT obtain bachelor's degrees. This loss of talent, especially with regard to women, continues upon entering the workforce (European Commission, 2013). Most recent data shows a percentage of 82.3 male and 17.7 female ICT specialists within the 28 countries of the European Union (Eurostat, 2020). Regarding economic effects, estimates show that if women held digital jobs as frequently as men, the gain for the European GDP each year would be around 9 Billion Euro. Further, female workers in the ICT sector earn almost 9% more than women in similar positions in the non-ICT service sectors. The reasons for the figures and percentages described above are multifaceted and range from cultural factors, gender stereotypes (see also Ertl, Luttenberger, & Paechter, 2017), stereotypes about the sector, a lack of knowledge regarding jobs in the sector, socio-psychological barriers such as a lack of self-confidence, a male dominated environment, an "old-boys network" culture, or missing role models (European Commission, 2013).
Especially when considering the intense and consistently accelerating digitalization of society, it seems obvious that the empowerment of women in the sector is still of

high importance and that this leaking pipeline in ICT (see Blickenstaff, 2005) needs to be repaired. The marginalization of women in the ICT sector already starts in early years, resulting in a proportion of 1:3 young women and men respectively deciding for an ICT-related study as described above. The main reasons for this undesirable effect will be analyzed in the following section.

**INFLUENCES ON CAREER PATHS IN ICT**

Looking into possible influencing variables for a career path into ICT, we can distinguish a variety of theoretical or empirical models that explain different aspects, such as interests (Holland, 1997), motivation (Eccles et al., 1983), the socio-cultural environment (Dick & Rallis, 1991) or the socio-economic status that is attainable through a profession (Gottfredson, 1981). Motivational models, for instance, describe aptitudes and efforts and how far these provide options for reaching a particular goal (see Eccles et al., 1983). Socio-cultural models also focus on socialization factors and the cultural environment of a person (see Adya & Kaiser, 2005), while Gottfredson's theory (1981) of circumscription and compromise describes the impact of the prestige of a job on career decisions. All these models aim to explain decisions in an individual's career path by personal and environmental factors.

Dick and Rallis (1991) state that an individual's self-concept and their career values develop according to individual aptitudes (e.g. interests) that are mediated by the influence of socializers and past experiences (e.g. grades). Students interpret these past experiences in the context of socializers, e.g. they attribute their success and failure either to talent or to chance (see Dresel, Schober, & Ziegler, 2007) and build their self-concept based on these attributions. Furthermore, this interpretation of prior experiences provides either motivation for further achievement or not. A second path to the development of self-concept and career values comes from the perception of socializers that are connected to the cultural milieu of the student. These relations are essential when looking at gendered participation in STEM because socializers often have stereotypic perspectives about women in STEM (see Dresel et al., 2007).

In the following section we will refer to Dick and Rallis's model (1991) and focus on the variables of motivation as an indicator of a student's interpretation of experiences, interests as an aspect of the individual's aptitudes, and academic self-concept as a prerequisite for beneficial career values.

*Motivation*. The concept of motivation describes how eager a person is to make efforts to reach a particular goal, e.g. a good test score or a qualification. The self-determination theory (Deci & Ryan, 1992) describes differences in how far a person is motivated for their own sake, e.g. interest or pleasure in doing something (intrinsic motivation), or motivated by material or immaterial incentives from outside, e.g. money or prestige (extrinsic motivation). According to the Deci and Ryan framework (1992), intrinsic motivation can thereby describe an experience of *competency*, *autonomy*, and *social inclusion* that manifests in sustainable efforts over a longer time period, while extrinsic motivation is more goal-driven and therefore less sustainable. Consequently, intrinsic motivation can be seen as a

sustainable driver for raising interest and developing a career aspiration (Ihsen, 2009). Increasing motivation for pursuing a specific field therefore means providing individuals with experiences of competency, autonomy, and social inclusion in the respective field (see Deci and Ryan, 1992).

*Interests.* Interests can be described as personal aptitudes or affinities towards a subject or knowledge domain that are reflected in academic activities such as subject choice (see Korpershoek, Guntern & van der Werf, 2014), or indicate a specific school subject as a being favorite subject. However, interests within the context of ICT are subject to gender differences. Girls often find themselves less interested and less motivated in technical subjects and also show less participation in class than boys (see Jurik, Gröschner & Seidel, 2013). This also results from stereotyped images of such subjects that inhibit the development of interests (see also Kessels & Hannover, 2006). Children's interests develop quite early (Bleeker & Jacobs, 2004) and are often congruent with the interests of their parents, because parents often serve as role models which children like to follow (Kessels, 2015). Thus, if parents have reservations towards or stereotyped perspectives regarding a specific field, e.g. ICT as programmers working in solitude, it is plausible that children adopt these perspectives and lose interest. Raising interest in ICT would therefore mean showing children perspectives on ICT (especially female role models in ICT) that counteract these stereotypic views (see also Luttenberger et al., 2019) and encourage them to develop a positive perception of women and girls in ICT.

*Academic self-concept*. The term academic self-concept describes the personal estimation of one's own skills and competencies as compared to various other personal benchmarks – e.g. how much competency a person attributes to herself or himself generally in a subject, or specifically in comparison with classmates (Dickhäuser & Meyer, 2006). A high level of academic self-concept means that a person attributes to herself or himself a high amount of competency in a subject, yet it does not necessarily predict actual outcomes. This aspect is crucial in the context of gender, because boys tend to appraise their outcomes better (even overestimate them), while girls tend to regard their outcomes rather critically and tend to underestimate them (Jurik et al., 2013): with regard to most of the STEM subjects, girls tend to assess their achievements clearly lower even if they receive the same quality of outcomes as boys (OECD, 2015). These differences can be partially regarded as the results of socialization, because the development of a gender-specific self-concept starts to get significant after primary school (Senler & Sungur, 2009). The expectations of parents and teachers with respect to children's achievements and competencies are regarded as influential in these different self-evaluations of girls and boys (Ludwig, 2010; Dresel et al., 2007) and are communicated to children more or less consciously. Although a student's academic self-concept is relatively stable over time, it develops based on experiences (Marsh & Scalas, 2011) and the achievements of the student's peer group (Marsh, et al., 2014). Enhancing a student's academic self-concept for a certain field therefore means providing situations in which the student can experience mastery and competency, which is also one key aspect of intrinsic motivation (Deci & Ryan, 1992).

To sum up, motivation, interests, and an individual's academic self-concept are essential for his or her career choice in different ways. The earlier empowerment in these fields takes place, the better – especially when it means counteracting stereotypes in the student's environment. Computer games often provide a means of motivating children and providing them with experiences of mastery. The following section will therefore examine gaming as a method to develop these aspects and to serve as entry point for girls into ICT.

## GIRLS AND GAMING

In general, computer games are ascribed positive effects on learning and motivation (Chandel, Dutta, Tekta, Dutta, & Gupta, 2015), including feelings of competency that can support the development of a positive self-concept. Gaming approaches often refer to the previously mentioned framework of Deci and Ryan (1992) (see also Ryan, Rigby, & Przybylski, 2006), which identifies three basic needs for motivated and self-directed learning: autonomy, competency, and social inclusion. In particular the aspect of competency relates to establishing a sense of mastery and thereby to the development of a beneficial self-concept. Regarding the latter, Bandura's (1977) theoretical framework, which aims at explaining and predicting psychological changes, needs to be mentioned because it states that experiences of mastery can help achieve further enhancement of self-efficacy and corresponding reductions in defensive behavior.

The meta-analysis carried out by Connolly et al. (2012), for example, found that playing computer games is linked to a broad range of impacts, the most frequently mentioned in the studies analyzed being knowledge acquisition, content understanding, and affective and motivational outcomes. In a subsequent meta-analysis, Wouters, et al. (2013) found serious games in educational contexts to be more effective for learning than conventional methods. However, with regard to motivation no differences were found between gaming approaches and conventional learning methods. In line with Deci and Ryan (1992), the authors argue that serious games might lose their effects when conditions are given that limit the sense of control or freedom of action. The task of integrating instructional design and game design is therefore still considered to be most important when designing serious games. Similarly, Spangenberger et al. (2018), in their analysis of more than 150 studies, argue that fun in technology should be a major element in a game specifically attracting girls or young women.

The idea of engaging girls in gaming is mainly derived from the notion that gaming is regarded as an entry point to the culture of computing and ICT (Brunner, 2008). An increase in personal skills and ICT expertise can be derived from playing games which refrain from ascribed gender preferences. Personal achievements in playing games may range from a sense of mastery, when successfully solving complex tasks, the chance for building new relationships in multiplayer games, the possibility to take over or to experiment with other roles or identities, getting social recognition for skillful performance, or just having fun in exciting new worlds. Gaming is regarded as a "[…] gateway to mastery of a broader range of digital tools, to trajectories of IT expertise." (Hayes, 2008, p. 216). It is not only playing *per se* that is regarded as being promising in developing tech-savvy girl gamers,

but also games that include options for customization, editing tools or the development of game-related content (e.g. video-documentation), since these activities develop competences which may be transferred to technology related professions.

Research on this issue started twenty years ago, when Cassell and Jenkins (1998) put the issue onto the agenda, and continued one decade later, when Kafai, Heeter, Denner, and Sun (2008) put the emphasis on an understanding of gender biases in gaming and on possible ways for deconstruction (Butler, 2004; Gildemeister, 2010; West & Zimmermann, 1987). In the meantime, several studies have become available which show a more differentiated picture of women and girls in gaming. To mention but a few: the similarities in gaming behavior between men and women in MMORPGs (massive multiplayer online role-playing games), as observed by Yee (2008), the analysis of the relationship of gender and gaming as a function of context, or of different situations, or that the gaming preferences of neither girl nor of boy gamers are stable over time (Pelletier, 2008; see also Jenson & de Castell, 2011).

In line with this, Giammarco et al. (2015) found that women who play video games for their arousing, competitive, and distracting properties tend to be more interested in mathematics and the physical sciences than women who do not play these games. With respect to STEM (science, technology, engineering, and mathematics) careers, the authors argue in favor of including competitive and arousing elements in any intervention as a means of increasing both ability and interest in STEM fields. Also, Joiner et al. (2011), found that female undergraduate students benefited as much as male undergraduate students when playing *Racing Academy* to support their engineering studies. Furthermore, there were no differences in terms of participation rates (amount of time spent playing, participation in online forums) of male and female students.

Besides providing motivation and mastery experiences, computer games may also provide information and advice for students when choosing career paths that reflect their interests. Several approaches (e.g. Dunwell et al., 2013; Dunwell et al., 2015; Hummel, Boyle, Einarsdottir, Petursdottir, & Graur, 2018; Shi & Shih, 2012) report the beneficial effects of computer games in allowing students to discover their career aspirations and possible career paths. Dunwell et al. (2015) report students appreciating videos with role models talking about their jobs within computer games. Similarly, Shi and Shih (2012) discuss that the computer game provided an interesting environment for students informing themselves about career options, while Hummel et al. (2018) emphasize that their computer game facilitated students' development of competencies in connection with career-related emotions.

Regarding the question of how to design a compelling computer game, we learn from games focusing on the enhancement of girls' interest and motivation in STEM that one should avoid adopting stereotyped female and male roles when offering girls-only games, in order to enable peer collaboration, make use of compelling (role-play) narratives and offer tools for game design, thereby empowering girls to take over ownership of the game culture (e.g. Hughes, 2008; Kelleher, 2008;

Spangenberger et al., 2018). Approaches to serious gaming further deduct several game mechanisms, such as, for example, feedback, personal profiles, transparency of results, goals, competition, and collaboration. Günthner et al. (2015) discuss how far particular game elements, for example high scores, badges, achievements, avatars, and game stories, can contribute to these game mechanisms.

To sum up, we have very unbalanced gender proportions within employment in the ICT fields. Focusing on the pathways into ICT, one can distinguish motivation, interests, and the individual's self-concept as key variables for deciding on a career pathway. However, these are often, especially in the context of ICT, shaped by the stereotypic perspectives of the socializers. Therefore, specific facilitation is necessary. Computer games may provide the kind of facilitation that allows individuals to experience mastery in a specific field in order to develop a stronger self-concept within an area. They may also engage and increase a student's motivation for a specific area and make them eager to inform themselves about specific professions.

## RESEARCH QUESTION

This paper will focus on the implementation of a computer game for supporting female students in developing intrinsic motivation and interests in ICT.
Intrinsic motivation relates, to the experience of competency, autonomy, and social inclusion according to the Deci and Ryan framework (1992). Notably, the experiences of competency could also contribute to a growing self-concept in ICT of these students. The paper will first analyze how far the game was able to provide motivating experiences for the students and thereby look deeper into their perception of the gameplay process. The respective research question will be:

1. How far can a computer game for female students support intrinsic motivation by enabling the perception of competency, autonomy, and social inclusion in ICT?

Then, the paper will have a look into students' interest in ICT as an indicator for the outcome of the game. Besides considering ICT as a future profession for themselves, also a more positive (and less stereotyped) perspective on ICT and women within ICT might have an impact on students' interests. Thus, raising interests are a prerequisite for discovering ICT as a possible profession and unfold by a change in perspectives and attitudes towards this stereotyped domain, e.g. by recognizing girls as having talent at ICT, or by recognizing ICT in a less stereotyped way. This leads to the research question:

2. How far can the computer game raise students' interests with respect to ICT professions?

## CONCEPT AND IMPLEMENTATION

This paper will present the concept and implementation of a games challenge that was aimed at supporting motivation, self-concept, and interests of female students in lower secondary school. This level was chosen because research has shown this period to be especially critical for the formation of girls´ educational and career choices (Kafai et al., 2008). The game was designed to be embedded in a classroom context, which meant that teachers were able to include work on the game as a classroom project. The learning goal of this game is to experience key

competencies in the field of ICT (rather than specific content knowledge) and thereby to develop a positive self-concept as well as interests towards this field. The game comprises four pillars which are (1) a collaborative role-play game, (2) four mini-games that were played individually, (3) videos of and interaction with female role models in ICT and (4) teacher materials for classroom integration. In the context of this contribution, we will primarily focus on the collaborative role-play part of the games challenge, which was implemented according to an anchored instruction learning scenario (CGTV, 1992).

**Learning design and technology**

As a matter of course, the basic idea in the development of the game was to avoid any stereotypes focusing on (assumed) gaming preferences of girls. This means that the decisions were taken to include a challenge, to focus on ICT-related narratives, to offer an approach exclusively for girls, to enable collaboration in a social network, and to support the girls´ development in ICT by an app-prototyping task and the design of videos. The didactic design aimed at authentic learning situations that allowed the students to experience competency and self-efficacy in order to support the development of a positive self-concept in applying anchored instruction. As the latter is a key aspect of the game, it was designed to offer experiences of success as well as to give motivating and supportive feedback. Particularly the interaction with role models and continuous benevolent support and feedback by the game master Rachel Lovelace (see below) were regarded as being facilitators for the students to find appropriate attribution patterns with regard to their own skills and competencies in ICT. Actually, the game master Rachel was a fictitious character. She interacted with the players either in the form of video messages, e.g. informing them about weekly tasks, or by sending them text messages in the Social Enterprise Network. These textual messages were written by specially assigned persons of the game development team and provided either feedback to specific tasks, appraisal for different actions, or answers to students' questions.

The Social Enterprise Network (SEN) Yammer was the core technological element of the game (see fig. 1). In its functionality it is similar to Facebook but provides a closed/private network which was very relevant with regard to data-security for the young participants in the game challenge. The network served as an interaction and communication platform within the game, allowed for the creation of specific groups and data management (e.g. storage of students' work) and offered access to the mini games, videos and other project relevant information.

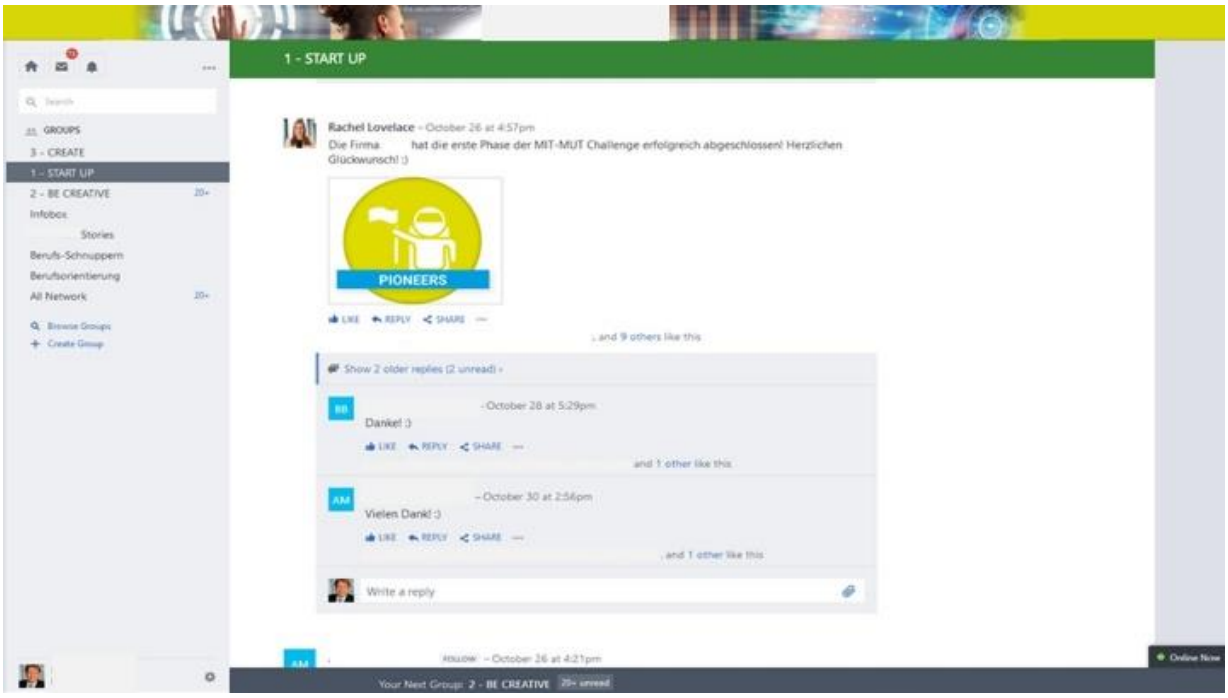


*Figure 1. The Social Network Platform (Yammer).*

**IT-related narrative and process**

The background story of the game challenge built upon a female Silicon Valley CEO - Rachel Lovelace - who during the course of the game also served as the game master. Rachel came to Austria to open a local branch of her company. She was looking for a team of motivated girls that would help her to enter the Austrian market. As a starting point of the game, she would send a video message to students asking them to build teams to develop an idea for a mobile phone app. After that, the five phases of the game began and lasted for six weeks. In the first start-up phase, students formed teams and developed a logo for their company. At the end of the week, they submitted this to Rachel and the other groups by posting it to the SEN. The second phase again started with a message from Rachel, who encouraged them to invent an idea and a concept for their app. The same procedure happened for the third phase, in which students were asked to develop a paper prototype of this app. During the fourth phase, students were preparing a video presentation of their idea and the paper prototype of their app. These videos were uploaded, and during the fifth phase a jury composed of the project team voted to decide the winners of the game challenge (see fig. 2). Depending on the specific rank the teams achieved, incentives, such as speakers or power banks for

mobile phones, or USB sticks, were awarded to the girls at the end. All the phases had a similar structure, starting with a video message from Rachel, then involving group work in the classroom, as well as some work to be done at home, and finally uploading the outcome and receiving textual feedback from Rachel. Additionally, students were encouraged to watch the role model videos and a new mini game was made available each week between the phases.

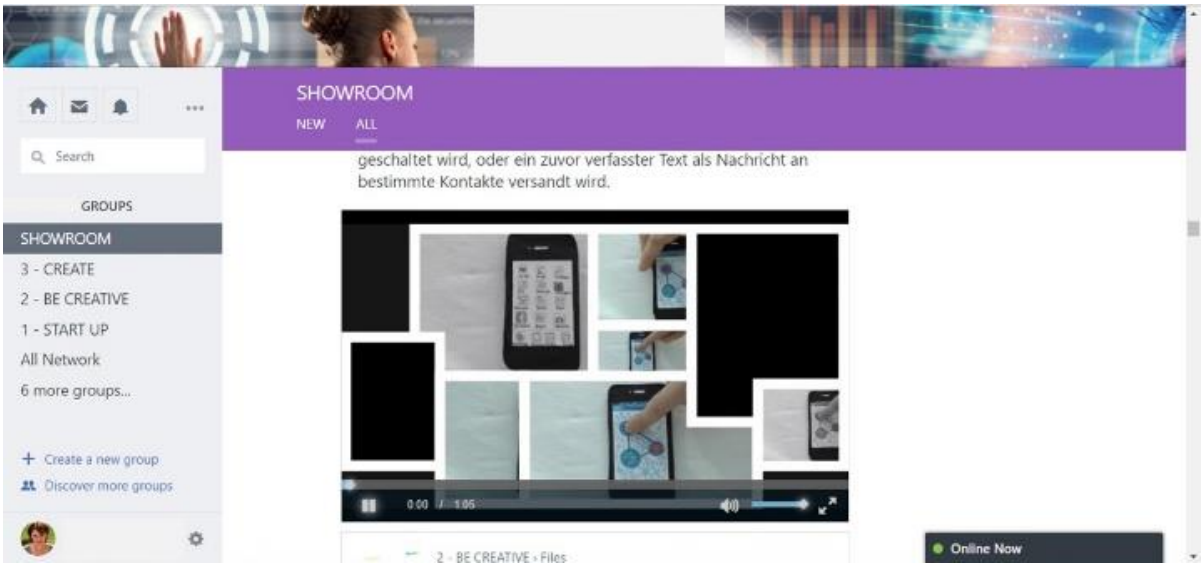


*Figure 2. One of the winning projects: "Timeflight" [Automatically informing preselected contacts when activating the flight modus].*

The mini games were additional to the game narrative, but players could receive a position in a high score list. These mini-games provided challenges for the players that were related to core competencies for working in the ICT sector. One, for instance, related to problem-solving, with the players being given the task to build a course using several tools that guided a ball into a bucket, another one was in the style of a tower-defense game, in which they had to defend their notebooks against virus attacks (see fig. 3). These mini-games were supported by teaching materials that allowed teachers to discuss related aspects (e.g. computer security) in classroom lessons and in this way support their groups.


*Figure 3. Bit-Buster. In this mini-game, students had to defend their notebooks against virus attacks.*

**METHOD**

Nine Austrian schools participated in the first run of the games, which lasted for six weeks, from September to November 2015. The participating students were from lower-secondary schools and aged between 13 and 14. 79 female students from these schools formed 20 teams that took part in the game and the related project work. The groups were formed in the classroom and participation in the game projects' activities was part of students' weekly coursework. There was a great variety in the number of contributions to the Social Network, ranging from 0 to 144 postings ($M$ = 13). Most of the groups stayed continuously in the game: 17 groups created logos for their companies (phase 1), 16 groups presented concepts for their apps (phase 2) and 15 groups provided paper prototypes (phase 3). Video presentations (phase 4) were only submitted by 10 groups, which indicates that this task was quite challenging. However, 16 groups took part in the final voting (phase 5). Thus, we can see that, in total, 80 per cent of the students stayed with the game during its runtime.

After the game, 60 students participated in 8 focus group discussions that took place in the schools from November 2015 till January 2016. A researcher came to

the school site, led the focus group discussions in accordance with an interview protocol and recorded the sessions. This interview protocol comprised 20 questions that investigated different aspects such as game implementation, the use of the different parts of the game, the evaluation of the game master Rachel, communication aspects, acceptance etc. Although the researchers followed this interview protocol, the length of the interviews varied from 19 to 49 minutes, which could be attributed to differences in group size, students' engagement and interactivity. After that, the recordings were transcribed, and pre-coded according to the questions by MAXQDA[3]. MAXQDA is a software package that allows amongst others the organization and coding of interview protocols and supports the analysis of these protocols by category summaries and frequency statistics. The first coding with respect to the questions of the interview protocol was followed by a more detailed thematic coding focusing on the concepts of the research questions. This followed a deductive approach according to Mayring (2014) with respect to the prerequisites for intrinsic motivation according to Deci and Ryan (1992), respectively autonomy, competency, and social inclusion, and the interest dimension that comprised of students interest in an ICT profession including the two prerequisites of changing the personal perspective of ICT professions and changing the view on women and girls in ICT. All (sub-)dimensions were distinguished whether students mentioned them positively e.g. "The game raised our interest in ICT" or negatively like "I found out that ICT is not for me". Each of the codes captured a short segment of the discourse (utterance) that related to the respective category. This coding combined elements from across the interview questions, because several aspects were mentioned at different points. The coding was performed by a trained assistant and validated by one of the authors.
Within the results section, we will first give a quantitative overview of the segments falling in each of these categories, followed by examples of statements made. These are referred to by the number of the focus group and the paragraph in the MAXQDA transcript.

## FINDINGS

The findings will be described in relation to the research question: first the motivational aspects of autonomy, competency and social inclusion, followed by effects on students' interests.

### Research Question 1: Motivation

Research question 1 referred to students' motivation. Regarding this, we will elaborate on how far students perceived autonomy, competency and social inclusion according to Deci and Ryan's framework (1992). Analyzing focus group discourses, students highly appreciated the aspect of social inclusion, followed by the aspect of competency (see table 1). For both aspects, focus group discourses comprised many more positive segments relating to this dimension than negative ones. This was different for the aspect of autonomy, for which discourses contained negative segments slightly more often than positive ones.

*Table 1. Number of positive and negative segments (focus groups in brackets) regarding the Deci & Ryan (1992) dimensions.*

| | **Positive segments** | **Negative segments** |
|---|---|---|
| *Autonomy* | 25 (5) | 26 (6) |
| *Competency* | 67 (7) | 7 (6) |
| *Social inclusion* | 95 (8) | 23 (8) |

*Autonomy*. Regarding autonomy, negative segments mainly related to the time-structure of the game, which resulted in deadlines that the students had to meet and the respective tight timing that went along with these deadlines. The positive segments related to autonomy associated with the chance to work independently and creatively on their own project.

> FG1, P 23: "I liked the collaborative work very much, as well as the fact that we were able to work independently and also the various kind of tasks"

Most groups appreciated that they had the possibility to work on their own ideas. Similarly, several other groups also mentioned the aspect of autonomy as a core part of the game. Focus Group 7 elaborated quite a lot about learning processes. They focused on the autonomy aspect in relation to the fun they had with their creative work and the fact that they did not care if they won or not, which could be attributed to experiencing some flow according to Csikszentmihalyi (1989).

> FG7, P 88: "And we didn't make it our goal to be winners of the game, but rather to do our work and have fun while doing it. It wasn't like: now we have to win, rather it was counting – wasn't it? To have fun and be able to design something creatively and so on."

Generally, most focus groups elaborated on the autonomy aspect as fun but sometimes with a different approach to winning the game. However, some groups also mentioned that their teacher used their game results for grading and these groups reported a lower level of perceived autonomy because of the need to perform well in the context of grades.

*Competency*. With respect to competency, several groups mentioned that they were enabled to have new experiences and that they succeeded and also enjoyed this experience, e.g. Focus Group 7:

> FG7, P 16: "That we were able to realize our ideas. We built our prototype and we recorded videos on our own and it was very interesting to do that the first time. [It was also interesting to see] how a company

> works, because we assigned Nadja to be the boss and she was a tremendous boss."

Many other groups also described how they were having new experiences. Focus Group 8 members particularly emphasized their feeling of mastery and competency.

> FG8, P 139: "Because one is proud if one succeeds, if one finally, for example, is able to download one's own app."

This feeling of competency was dependent on the students' skills and further support. Therefore, some groups encountered obstacles that they were able to overcome by themselves or with assistance of their teachers. Negative statements concerning competency were quite rare and related to the production of the video and to getting lost in the complexity of the SEN.

*Social inclusion*. With respect to the dimension of social inclusion, students elaborated on the power of their collaborative activities. Collaboration within the group rather than competition between the groups seemed to be Focus Group 7's motivation.

> FG7, P 74: "We really stuck together and discussed which app would be best and about our ideas, then we wrote down our ideas and everyone chose what she liked best and we thought about it further. And we thought about what someone could do with this app, if there is a need for this app or if something similar already existed and I think this was the aspect we liked most. Yet actually we all tended to have the same opinion."

A second aspect of social inclusion related to interaction with the game and the other groups within the game. Students interacted in the SEN, collected achievements, and checked what the other groups were doing, how they were performing and how their own results were perceived by the community. Most students appreciated Rachel, who was the face of the game for the students. Focus Group 8 described Rachel's efforts of structuring participation as follows:

> FG8, P 31: "Rachel [the character of the game] also worked very well, because if we were just hanging around, then she encouraged us to engage."

Negative statements regarding the social dimension related to group organization and processes, e.g. social loafing in some groups, sometimes competition-oriented activities and sometimes too much discussion-oriented behavior of colleagues in the group.

As the analyses show, the game, although it took place in the school context, was able to support the perception of autonomy, competency, and social inclusion. This means, that the Mit-Mut game succeeded in implementing key aspects of the Deci and Ryan (1992) framework, even though it was realized in a classroom context.

Thereby, one can assume that the reported experiences of competency contribute beneficially to students' self-concept in ICT.

**Research question 2: Interests**

Research question 2 focused on the outcome of the game in relation to effects on the students' interests. Here, we could distinguish several aspects that related to the image of ICT professions, women in ICT professions, and career aspirations. Besides the motivational aspects already mentioned during the process analysis, several focus groups also indicated a change of perspective towards motivating aspects of ICT professions in the concluding evaluation of the game. Most obviously, seven groups (31 segments) mentioned a more positive perspective on ICT, which went beyond the stereotype of sitting in front of a computer and coding, while only a few segments mentioned that they had not changed their perspective (see table 2). Furthermore, five groups (12 segments) noticed positive aspects of women in ICT. However, in only four groups could students imagine ICT as a future profession while other students in four (partially overlapping) groups excluded such career paths.

*Table 2. Number of positive and negative statements (focus groups in brackets) regarding a change of students' attitudes.*

| | **Positive segments** | **Negative segments** |
|---|---|---|
| *Perspective on ICT* | 31 (7) | 7 (3) |
| *Women in ICT* | 12 (5) | 0 (0) |
| *ICT as future profession* | 9 (4) | 11 (4) |

Looking at these results in more detail, students mentioned excitement about the creation of the app, e.g.:

> FG6, P 80: "For me, it was really a change, particularly the creation of the app that excited me."

or they also reflected some kind of conceptual change in their perspective on ICT as a profession, as was the case in Focus Group 1:

> FG1, P 150: "[For me, the image of ICT changed a little bit]. In earlier times I thought [the job requires] sitting the whole day in front of the computer, but in fact one has to, for example, collect information with paper and pencil and I rather think that was a cool thing but not only this one thing, it is the variety."

Students also elaborated that the game helped them to overcome their stereotypes about gender and ICT. This related to the reduced attribution of stereotypical proficiencies as well as to the perception of the workforce in ICT.

> FG8, P 129: "That I was … after all I thought that only boys are more proficient with computers but [I realized] there are also a lot of girls working in this field."

The participating students also related these general attributions of proficiencies to their personal work within the game and emphasized the game as a showcase for girls in ICT.

> FG2, P 13: "One can show that also girls are proficient with Computers."

These statements show that the participating students got deeper insights into ICT professions and the opportunities women have within them. These insights also enabled students to experience how far they would fit personally into an ICT profession. For some of the students, for example those in the last quote, one could conclude that the game strengthened their self-concept for ICT. Furthermore, the game also had a strengthening effect for students who did not see themselves in the field of ICT. By taking part in the Mit-Mut experience, these students clarified for themselves that ICT could be a career option.

> FG8, P 131: "I found out that I don't like working in this field."

One of the big impacts of Mit-Mut was that the project allowed students to make such decisions based on their own experiences rather than stereotypical attributions. Thus, some students mentioned their interest in gaining experiences in the field and also mentioned the variety of professions although their aspiration for a career in STEM didn't change.

> FG1, P 151: "For me, it was interesting, but it didn't change much, because I am not so interested in this field. However, it was interesting to see the variety of this field."

To sum up, Mit-Mut was able to show students the variety of ICT professions. Girls also were able to see that ICT careers offer interesting job profiles. This was appreciated by the girls and also acknowledged even if they were not personally interested in an ICT career path.

Generally, students of all groups appreciated being informed about ICT professions (64 segments) although some students in the groups (14 segments in five groups) did not appreciate this and characterized it as boring.

**Limitations**

Although Mit-Mut offered promising results, there are some limitations of this approach with respect to methodology, effects, and impact. The Mit-Mut game lasted for six weeks and was implemented as a field study in the classroom. Even if teachers undertook training and used the prepared teacher material, the particular implementations in the various classrooms may have differed according to local contexts. These contexts may also have affected student dropout for different

tasks, especially for the phase four of the video presentations. Furthermore, this project for students meant a deviation from normal teaching in school. Therefore, they may have appreciated this project more just because it was innovative as compared to regular teaching in class. However, in contrast to other initiatives to raise interest of girls in ICT, such as "Girl's Days", which usually focus on an interested audience, Mit-Mut addressed all female students in class. Considering that 50% of all Austrian girls at this age have career aspirations for just 3 very stereotypical professions (merchant, office clerk, stylist[4]), the innovation effect may have been balanced out by the participation of girls with stereotyped perspectives about ICT. Furthermore, the game design might not have been strong enough to also raise the interests of girls with very stereotyped perspectives about ICT and the six weeks of participating in the game might have been too short to change deep rooted perceptions.

Regarding the effects, the game targeted soft skills and attitudes, rather than a defined learning field and particular competencies. Therefore, no pre-post-test design measures for "hard" effects were made. However, considering the stereotypical perspectives about women in ICT as described above, the project-team decided to allow students to develop a sense of mastery and gain some experience of competency, facilitating their development of a stronger self-concept in ICT, rather than aim for testable knowledge.

The third limitation relates to the impact of the game. Considering that interests and stereotypes develop quite early, the game took place relatively late in the socialization process. Yet, at the age of 13-14 it is also too early for career decisions. Both aspects may have had an effect on the impact. However, within the Austrian educational system, students have to decide after lower secondary which school track they want to pursue and therefore Mit-Mut's approach was a step in the right direction at this age.

## CONCLUSIONS AND SIGNIFICANCE

Despite these limitations, Mit-Mut had powerful outcomes. First of all, Mit-Mut was *reaching* 13 to 14-year-old girls. Taking into account the fact that research literature often reports that girls are less interested and less engaged in STEM, and particularly in ICT (Ertl & Helling, 2011; Jurik et al., 2013), the quantitative results of Mit-Mut in particular could show that there is a way to increase interest and evoke a change of perspectives of the female students with respect to these fields. Furthermore, Mit-Mut could also encourage students to inform themselves about careers in ICT without getting bored (see also Shi and Shih, 2012). A second aspect relates to stereotypes which are often not available for reflection. Mit-Mut enabled female students to get a sense of mastery in a stereotyped area and to develop self-confidence and a positive self-concept within it. It further provided female role models in this field and therefore allowed students to rethink their own stereotypes about women and girls in ICT. These aspects support the particular significance of Mit-Mut: with regard to society, it is one step towards equal opportunities for women in the ICT sector. With respect to economy, it draws attention to an underrepresented group for professional development in ICT. In relation to the individuals, it allows them to realize the variety of professions in ICT, and in doing

so enlarges their background knowledge for making career decisions. Finally, for research and education, it shows that innovative concepts, when applied to teaching methods, are able to reach persons that usually are outside of the scope of their specific fields. Future research should further investigate the approach of longitudinal interventions for changing gender stereotyped perception of ICT. Introducing game-based learning environments into curricula could thereby be a promising perspective especially for ICT related subjects.

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**ENDNOTES**
1 Despite international findings that girls and boys receive increasingly equal scores in science and mathematics in most countries, Austria still has noticeable gender differences in PISA science and mathematics scores, as well as with respect to pupils' self-concept in this field.
2 ICT studies include: Physical Sciences (441 in Eurostat Codes), Mathematics and Statistics (46, 461 and 462 in Eurostat Codes), Computing (48, 481 and 482 in Eurostat Code), - Engineering and Engineering Trades (52, 521, 522, 523 and 524 in Eurostat Codes).
3 https://www.maxqda.com/
4 http://wko.at/statistik/wgraf/2020_04_Lehrlinge_M%C3%A4dchen_2019.pdf

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