

Gamification of Information Security Awareness and Training

Eyvind Garder B. Gjertsen¹, Erlend Andreas Gjære², Maria Bartnes^{1,2} and Waldo Rocha Flores³

¹*Dept. of Telematics, Norwegian University of Science and Technology, N-7491 Trondheim, Norway*

²*SINTEF, P.O.Box 4760, Sluppen, N-7465 Trondheim, Norway*

³*EY, P.O.Box 20, Oslo Atrium, N-0051 Oslo, Norway*

eyvindbg@gmail.com, {erlendandreas.gjare, maria.bartnes}@sintef.no, waldo.rocha.flores@no.ey.com

Keywords: Information Security, Security Awareness, Gamification.

Abstract: Security Awareness and Training (SAT) programs are commonly put in place to reduce risk related to insecure behaviour among employees. There are however studies questioning how effective SAT programs are in terms of improving end-user behaviours. In this context, we have explored the potential of applying the concept of *gamification* – i.e. using game mechanics – to increase motivation and learning outcomes. An interactive SAT prototype application was developed, based on interviews with security experts and a workshop with regular employees at two companies. The prototype was tested by employees in a second workshop. Our results indicate that gamification has potential for use in SAT programs, in terms of potential strengths in areas where current SAT efforts are believed to fail. There are however significant pitfalls one must avoid when designing such applications, and more research is needed on long-term effects of a gamified SAT application.

1 INTRODUCTION

An employee receives an e-mail from someone claiming to be from the IT department, asking for their login information related to some important system management event. What does the employee do?

This scenario is only one of numerous situations where the employee is in a key position to either cause or prevent a security breach. Even if the company's technical security is cutting edge, a simple user error can sidestep almost any security barrier.

Security breaches frequently involve employees with low motivation to follow guidelines and policies, and/or lack of awareness, knowledge, and ability to recognize and intercept threats and attacks. Efforts made to tackle these issues include the implementation of Security Awareness and Training (SAT) programs. The purpose of an SAT program is to increase awareness regarding information security, explain rules and proper behaviour for use of IT systems, and produce the skills and competence the employees need to work securely (NIST, 2003). Still, trend reports show high numbers of security breaches linked to human error (Verizon, 2016), and studies indicate that current SAT programs largely fail to accomplish their goal of improving end user behaviour (Bada et al., 2015). Recent research suggests that personalising security training content can make training personally more relevant and understandable,

and combining this with practical exercises will more likely lead to improved security behaviour (Rocha Flores and Ekstedt, 2016).

The purpose of this study has been to consider if, and possibly how, the use of *gamification* – i.e. applying game concepts and mechanisms to engage and motivate people – can make a better learning environment for SAT programs. In this paper we present an evaluation of a prototype which applies gamification to security awareness training. We have conducted an empirical study with data collected through interviews and group workshops. The focus has been to identify how employees are best motivated to engage in security training—with a basis in gamification.

This paper is structured as follows. Section 2 presents background on SAT and gamification. Section 3 describes our method, before section 4 introduces our concept and prototype. Section 5 reports our results, followed by a discussion in section 6. Finally, section 7 concludes our paper.

2 BACKGROUND

This section presents existing literature on security awareness and training, and gamification. Potential ties between challenges, proposed solutions, and good practices for security training are identified, as well as

problems that gamification is known to solve.

NIST (2003) accentuates the importance of taking a step-by-step approach to the construction of security competence in order to change behaviour or reinforce good security practices. Shaw et al. (2009) outline three distinct states of awareness, or competence, that need to be considered when developing an SAT program: perception, comprehension, and projection. First, it is important to make sure that recipients have an elementary conception of what security is, such that they are able to perceive the importance and relevance of having a focus on information security. Then, one must ensure that learners are able to comprehend the actual purpose of the content — that the potential risks give meaning and are inherent to the learners. Finally, the goal of an SAT program is ultimately to affect employee behaviour towards security policy compliance. Will the learner acknowledge the policies and adjust their behaviour to follow them, after completing the training?

Behaviour change is a precarious subject and is actually more a case of psychology than of security itself (Tsohou et al., 2015; Bada et al., 2015). The first thing to acknowledge is that people are different and somewhat unpredictable. This affects both how people regard security in general, as well as how they will respond to security training (Beris et al., 2015). Tsohou et al. (2015) provide an aggregated list of factors that have been mentioned in extant literature to affect security policy compliance. Seemingly, there are several factors to consider other than just awareness. For example, people may have different opinions as to “how big a risk actually is” when it comes to security breaches or attacks. If the *perceived risk of a security breach* is low, one might not be as mindful to enact according to the security policies (Siponen et al., 2014). Other factors, such as *benefit versus cost of compliance* and *work impediment*, may lead people to diverge from compliance because the efforts of acting securely are considered too much of an inconvenience. Moreover, some people may in fact doubt their *self-efficacy* in that they are unequipped to handle security related issues. Tsohou et al. (2015) claim that these factors come as a result of “cognitive and cultural biases” that people may have, based on their personal beliefs and experiences.

While security practices apparently rely on several factors, one of them is how well people are aware and able to assess risk and apply knowledge to mitigate threats. In order to increase this knowledge, the question is how to maximise the effects of security training. In this, we seek to motivate people in developing their skills and embedding new knowledge in their daily routines.

Motivation is at the core of gamification. Deterding et al. (2011) define gamification as “the use of game design elements in non-game contexts”. Another definition by Huotari and Hamari (2011) focuses more on the *goal* of gamification, namely “a process of enhancing a service with affordances for gameful experiences in order to support user’s overall value creation”.

The idea of using gamification in SAT programs is not entirely novel. Thornton and Francia (2014) present a study on a “tower defence game” aimed at teaching students about password strengths. It is however not clear which aspects of gamification were used in the game.

Baxter et al. (2015) present a study which utilises elements such as a story, goals for the employee, feedback and progress. The authors acknowledge that their solution lacks “other gamification techniques such as competition based on points and leaderboards, achievement badges or levels, or virtual currencies”. The game follows a fictional investigation of a breach of security which may have compromised an international bank’s customer data. The study evaluated the effectiveness of the solution in two different experiments. First, it was assessed how the solution rated against (1) no training, to determine if gamification would be able to educate at all, and (2) training without gamification, to see if it was better than traditional training. Results showed that the gamified training is better than no training, but actually less effective than traditional training. In the second experiment, a much larger population was used to assess the difference between gamified training and no training. The results showed that the gamified training did *not* improve knowledge acquisition. In both experiments, the users of the gamified solution did however rate the training as more enjoyable, more fun, and less boring than the ones using the traditional training. The authors identify two main limitations for the study. Firstly, as already mentioned, the gamified solution was missing some of the core elements of gamification, which could have been decisive for the overall results. Secondly, the training was short in duration, and only a one-time effort—and thus not able to assess the long-term effects.

Several other studies have tried to assess the effects of gamification. Hamari et al. (2014) conducted a review of 24 empirical studies to investigate if gamification actually works. The conclusion was that gamification has in fact shown positive effects in improving learning outcomes on multiple occasions. However, it was emphasised that the effects depend on the users and the context in which the technique has been applied. It was also noted that there are currently few

high quality studies on the actual effects of gamification.

It is worth noting that several studies seem to employ a different definition and practice of gamification than the one we use. For example, gamification is not the same as serious games, such as actual games (virtual worlds) or computer simulations of real world scenarios, created for educational purposes. Consequently, studies that merely consider the use of actual video games in SAT programs (e.g. CyberCIEGE by Cone et al. (2007)) are not considered as very relevant input for the scope of our work.

3 RESEARCH METHOD

A flexible qualitative research design was chosen for our study. To support the exploring nature of experimenting with a new artefact in an already familiar context, our approach resembles a single iteration instance of the Design Science Research Process (DSRP) (Peppers et al., 2006). Using an interactive gamified learning software prototype as the design artefact, we wanted to explore if, and possibly how, gamification can provide a more engaging learning environment for security and thus give added motivation for practising good security behaviour. Our explorative approach is supported by Lebek et al. (2013), which has reviewed literature on security awareness and behaviour. Since the field is dominated by quantitative research, they conclude that qualitative studies could add value – noting also the infrequent application of experimental studies.

The main data collection was done through workshops with a total of 10 employees from two large Scandinavian companies in the knowledge-based industry. Additionally, prior to the workshops, a series of interviews were conducted with five security stakeholders from the same companies. The interviews were used as a means of quality assurance of the idea of using gamification in SAT from a company's perspective, and as such, as a foundation for arranging the employee workshops.

The workshop participants were mainly employees who do not work directly with information security, but all had encountered previous security awareness and training efforts in their workplace. At company A, the group consisted of two representatives from the human resources department, a quality and security leader, and two knowledge workers. Coincidentally, one of these has information security as a main area of expertise. At company B, all the participants were from the human resources department.

Research data were gathered through the follow-

ing combination of interviews and workshops as data collection methods:

Interviews: A total of five one-hour long interviews were conducted to gather information on the companies' experiences with SAT programs. The topics addressed were "general challenges with security awareness", and "gamification—and common training goals for employees and the company". The interviews were conducted in a semi-structured manner with open-ended questions, and the interviewees were encouraged to elaborate and use examples to illustrate their answers.

Workshop 1: The main focus in the first workshop was to identify overlaps between the desired business outcomes and the users' motivations for good security behaviour, i.e. why is it important to learn about security? Concurrently, there was a discussion to identify which motivational factors that users consider the most important for security training. The discussions were guided using a graphic slide-set with images and video related to the subjects. The participants were asked to choose five motivational factors that they would consider to be the most important in a gamified SAT solution, based on the 24 game economy factors listed in Burke (2014). Their results were submitted to a web form, and then discussed in plenary.

Workshop 2: Building on the results of the first workshop, an interactive prototype game with some sample content was created. This prototype is described in Section 4 below. The purpose of the second workshop was to let the participants test the prototype in order to get a hands-on impression of what a gamified security training application might look like. Based on this, the participants were asked to give their impressions on the use of gamification in SAT, and if this approach seemed more engaging, and furthermore; its potential of improving learning outcomes. After playing through the sample content that was developed for the prototype, the workshop participants answered an anonymous questionnaire where they recorded their opinions on the experience.

4 A GAMIFIED PROTOTYPE

Our idea of a gamified learning application should make people positively engaged with good security practices. An interactive prototype was designed and developed to investigate this hypothesis further. The prototype application contains security awareness material and training exercises wrapped in a gamified experience, using several familiar game-mechanisms such as points, progress, badges and

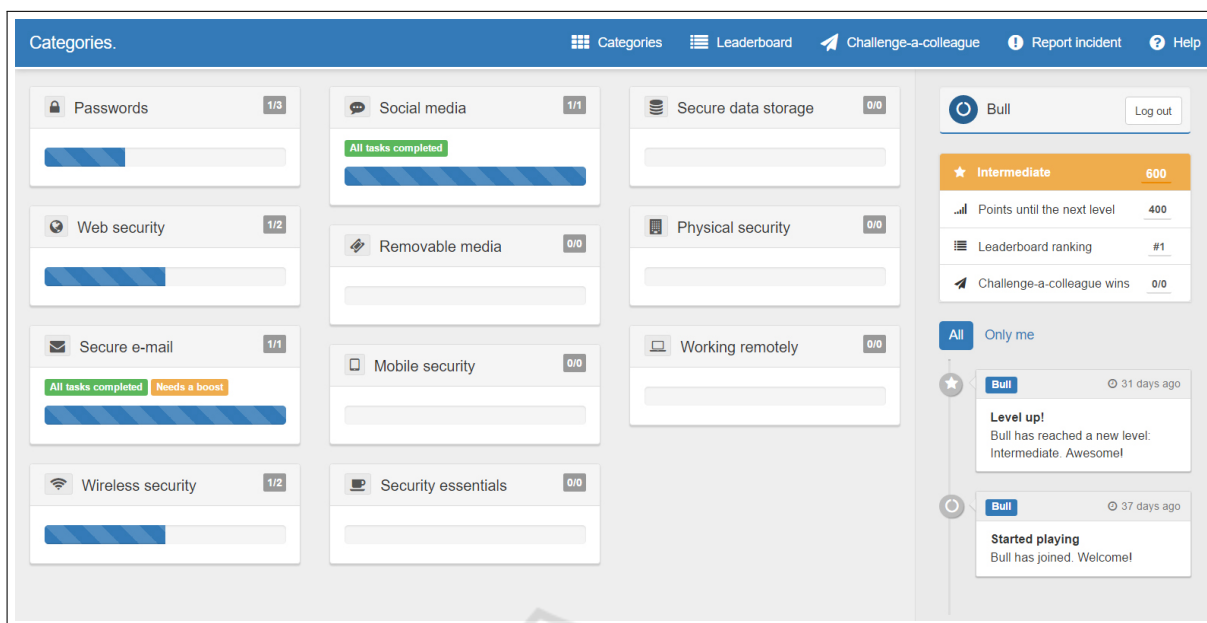


Figure 1: An overview of the prototype application interface.

leaderboards. A screenshot of the application is shown in Figure 1. The general circumstances around the application are the following:

- The employee controls when and where the training takes place by accessing the learning application through a web browser or an associated mobile application.
- There would be a large selection of tasks and exercises divided into different security categories. Multimedia content types include videos, quizzes, and links to external resources. There would also be different types of tasks to attain diversity in the learning environment. The content should also be regularly updated and extended.
- The exercises would be concise and compact. Each task or exercise should take only about five minutes to complete.
- The employee is free to complete any exercise they want, in whichever order they want. This gives the player a certain amount of autonomy and thus a more emergent engagement model in that employees do not have to follow a strict path. However, some restrictions must apply to ensure that the employees receive the required type and amount of training.

The prototype that was used in the second workshop constitutes a limited representation of the concept explained above. There is only a selection of gamification elements present, but it serves as an example of what a gamified solution might contain. SAT

material is presented in different exercise formats and grouped into different categories. The user holds a separate progression in each category, along with an overall score. By completing exercises, the user gets points that will eventually lead to increased skill level. A social timeline shows interactions from each player. Users are further able to track their own, as well as other users' progress through a leaderboard (as seen in the main menu). Although not implemented, another menu item labelled "Challenge-a-colleague" represents an idea of letting colleagues challenge each other on security related topics, through one-on-one quiz battles. Additionally, users should be able to report real life security incidents through the application, which in turn will award points.

5 RESULTS

This section presents the results from the interviews and workshops. The interviews report reflections on how SAT could be improved in general and what goals would be important for a gamified SAT effort, from the perspective of the two companies. These beliefs are given below, indicated by security experts of theirs. From the workshops, the results are presented per workshop, as they were chronologically dependent. The first workshop laid the ground for the development of the prototype, which in turn was the foundation for the second workshop.

5.1 Interviews

The interviews form a shared perception that security behaviour is challenging to improve, mainly since employees do not always understand the real risks connected with security breaches. Main reasons for this were outlined as a fundamental lack of competence on the subject, and that security breaches do not directly affect people themselves. An example given here was that for other fields where employees are required to have awareness and competence, such as Health and Safety Environment (HSE), people are more motivated to engage in the training, because failure to comply with those policies can result in personal injury.

A point made by interviewees at both companies concerned a common misconception among many employees; security behaviour is “something special” apart from what they are usually concerned with. This can be because security periodically receives high attention and falls in the background typically until “the next campaign”. Instead, the participants expressed a desire to make security more embedded in the overall company culture.

In terms of training content, the security experts expressed that they would like to incorporate material which is as relevant and personalised as possible for the target audience. Examples mentioned here were: (1) use of analogies to make the material easier to relate to for learners, (2) use of real stories (e.g., news stories) that describe security events and/or consequences of security breaches, and (3) make the information *tangible*, i.e. describe it in a way that people understand and can visualise. Training also has a tendency to be too lengthy, resulting in that people will try to avoid it or put it off until the last minute.

Social norms and persistent behavioural expectations are also believed to be a powerful way of embedding good security practices, especially towards new employees. Over time, this will help to create good habits among the employees to practice favourable security behaviour. Furthermore, interviewees from one company held forward that one could establish an internal company “brand” for good end-user security; a brand that employees will associate with something positive, and that can create a “talk of the office”. It was also considered important to continuously receive feedback from the employees in order to efficiently adapt the training to their needs and capabilities. Finally, current training methods tend to lack a proper way of measuring the effects of various activities on the actual security behaviour.

The business objectives related to security training were similar for both companies in ensuring that employees handle sensitive information in a way that

does not lay the ground for loss or disclosure of that information—as a result of a security breach. It is therefore said to be important that the management communicate and highlight the advantages of security, and to show that it is a vital part of the company’s culture and values. It is assumed that it is in everyone’s best interest to work in line with those values. A serious security breach can have consequences for the employees as much as for the business itself, especially when it comes to financial losses. Contrarily, a common objective is to retain an enjoyable atmosphere at work. Thus, if gamification can help to make security awareness and training entertaining and pleasurable, it was seen as a positive contribution towards that objective. Moreover, as added by one interviewee: good security behaviour is usually something that employees will need in order to interact securely with IT systems outside of work as well. By incorporating good practices at work, one will also be more aware of security risks at home and on travels.

5.2 Workshop 1

In assessing motivational factors of a gamified application for SAT, the answers from group A prominently feature factors related to *self-esteem* and *social capital*. *Mastery* was the single factor mentioned by most, which was explained with the need to feel that the training has a purpose, and that completing it has a challenge to it that leads to a sense of achievement. It was however also proposed by two participants that some would maybe prefer physical rewards more than virtual goods—at least that the final prize is something tangible.

The answers from group B show a clear indication that the users value *progression* as a motivational factor. This was justified by the wish of getting feedback from the training; some form of confirmation that you have completed something, or that you are in fact moving towards some goal. Another highly rated factor was *discovery*. This was explained by the desire to discover new knowledge and learn new things. Concurrently, as with group A, it was mentioned by two of the participants that there should be a reward for the “winner”, with an emphasis on extrinsic prizes.

The workshop participants also came up with some SAT related goals that they could expect all employees have in common with their employer:

- **Business Prosperity:** Training is important to secure the business, in the sense that all parties generally wants the business to go well. Moreover, it was mentioned that the work they have done and data they have produced has personal value, in the

sense that many hours of work and dedication has been put into it.

- **Work Gratification:** A common goal for both employees and the company is to have contentment in the workplace. A gamification-based SAT could give employees a positive experience with the training and thus feel more satisfied.
- **Competence Growth:** Employees are generally eager to learn new things and increase their competence. If security would appear as an important part of their work, they would be motivated to learn about it. Additionally, security awareness and competence is something one would apply outside of work, e.g. while browsing the web at home.
- **Clear Reasons:** It is very important to explain why some practices and processes are regulated by security. Clear reasons may have significant impact in employees towards compliance with regulations, and may also affect the perceived risks of security breaches.

Additionally, both groups declared that there is a significant value in the use of social media components. Interaction with other colleagues, e.g., shared accomplishments, comparison of ratings and engagement in collaborative challenges are strong motivational triggers. Moreover, the participants said it would be more encouraging to engage in something that others also do and care about.

5.3 Workshop 2

After playing with the gamified prototype and the included learning material, participants submitted answers to the following three questions:

1. Was your impression that the use of gamification can lead to *more motivation* towards completion of the training?
2. Do you think that the use of gamification can lead to *improved learning outcomes* from the training?
3. Do you think that the use of an application like this would make you *think more about security* when at work?

All participants answered *yes* to the first and third question. Nearly all answered *yes* to the second question as well, however two participants at company A said that they were not sure whether the actual learning outcomes would be improved. Rather, they emphasised that they would probably pay more attention during the training as it would be less tedious, and that the use of gamification could help reduce the battle of repeating the training. Beyond that, the participants

justified their answers by identifying the following attributes:

- **Progression:** Continuous track of progress in terms of levels, points and leaderboard ranking would create a sense of individual progression—and that “you are in fact increasing your knowledge/intellect”.
- **Competition:** Elements such as the leaderboard could spark competition between co-workers. It was however pointed out by some participants that competition may not resolve as an engaging feature for all types of people.
- **Interactiveness:** High level of interactiveness was said to potentially defeat some tediousness of e-learning (with more motivation) and also lead to more concentration—as in improved learning outcomes.
- **Conciseness:** Short and compact exercises that do not require any particular allocation of time in order to complete. Learning outcomes could be improved in the way that you would get served “small portions of information” at a time.
- **Accessibility:** Related to the conciseness, the ability to commence the training “when you feel like it” was mentioned as a sense of freedom that would lead to a more positive attitude towards the training as a whole. Also, the fact that the training is more likely to be “spread out” can result in a higher awareness and longer-lived mindset towards always-on-security.

The participants were also asked to consider whether they would use the application voluntarily. Interestingly, the answers at company A and B were quite dissimilar. The majority of participants at company A said that they would consider using the application voluntarily some minutes per day (though this was indicated to be of competitive reasons). At company B, the participants were quite clear in that they probably would not use the application voluntarily without any requirement from the management. One participant pointed out that even though it is interesting, it would still feel like work. However, they emphasised that the gamified training was more engaging, and that a minimum requirement of completion (e.g., by points) would not negatively affect that.

Lastly, the participants were asked to consider the most/least engaging type of exercise, and the opinions were rather diverse. There were however multiple participants at company A who pointed out that the most engaging thing about the exercises was the variety itself; that different types of exercises as a whole made the application more interesting. It was

also mentioned that it was liberating to be able to individually choose training topics, and that one could mix them freely.

6 DISCUSSION

This section leads a discussion on the use of gamification in security awareness and training programs. It is attempted to infer if and how gamification could be used in SAT. We also outline some directions for further research.

6.1 The Factors of Motivation

In essence, the purpose of gamification is to increase motivation (Burke, 2014). At the same time, motivation is arguably one of the main challenges in security awareness and training; motivation to learn and motivation to act. Rigby (2015) proposes that more effective gamification should build on a triad of psychological needs that consistently represent universal sources for motivation. These needs amount to what is known as Self-Determination Theory (SDT) (Ryan and Deci, 2000), comprising *competence*, *autonomy* and *relatedness*.

Competence is in many ways the same as mastery, and in the first workshop, this was the factor that was mentioned by most participants in group A to drive motivation. It was argued that the presented material should represent some form of challenge, some impression of interference that must be overcome. Mastery can be constructed with both internal and external forces. The solution needs to correctly assess the user's skill level in order to create a reasonable degree of challenge. Concurrently, mastery can be achieved with the use of points, levels and achievements, in that the player has "mastered" a level, or unlocked an achievement that few others have. Moreover, mastery can be enforced by the use of positive feedback, such as "excellent", "awesome", or "good job". In the prototype, this was used when a player had completed an exercise, or reached a new level. This contributes to let the player know that the efforts had meaning and that they indeed were accomplishments. Furthermore, Deci (1971) found that external rewards like positive reinforcements can increase the intrinsic motivation in the activity. One should however be very careful not to offer external rewards in a way that makes players expect to be rewarded for playing. In this case, rewards quickly turns into a negative motivational force, e.g. because someone feels that they can never win, or that they simply become spoilt with being rewarded for something they should

not need to be rewarded for. As a consequence, they will turn into not engaging with activities that does not result in rewards (Rigby, 2015). In the same way, it will not matter over time if you award people virtual points or badges if there is no deeper meaning to them than simply being points and badges. They should instead encourage and reward exploration, risk-taking (in the game), and extra practice, which indeed *feel* like achievements to the player (Ramirez and Squire, 2015).

The second factor in SDT, autonomy, means that people should have independence and freedom to make their own choices. For gamification, this typically means that the players are able to act freely in the play space (at least to some degree). In the prototype, the workshop participants (WPs) were able to for example choose whether they wanted to take all the exercises in the "password" category in one go, or if they wanted to mix tasks from several categories. Additionally, as opposed to regular security awareness and training (e.g., traditional e-learning), our gamified concept further promotes autonomy by letting employees control their training in terms of time, location and duration. Short and compact exercises means that training can be divided up in five minute intervals that can be freely distributed.

Relatedness, which is the third factor of intrinsic motivation (self-determination), conveys the fact that security training is important for business prosperity and development of personal intellect, and that the effort of a single individual matters. This should probably be considered in particular when creating learning material (regardless of gamification approach), in terms of emphasising the way an individual could represent the entire difference between causing or preventing a security breach — as described in the introduction. Further, relatedness is also affected by social aspects, such as feeling supportive of each other in our training. In the prototype this was also emphasised through the social functionality which enables players to keep an eye on the others. For example, the answers to the questionnaire in workshop 2 featured comments like: "It was fun to track people on the leaderboard", and "It was nice to follow the other players' progressions on the activity timeline".

Progression. In the first workshop, the participants tabulated a series of factors that they had experienced as pros and cons in previous training solutions. They also defined what they considered to be the most important motivators to be used in a security awareness and training solution. One of the recurring factors was *progression*. It was said that a sense of advancement and accomplishment is usually something

that is missing in current solutions. Completed training is often just recognised by a status change (e.g., from “incomplete” to “complete”). The feeling of progression would naturally be something that people perceive differently, however in a general sense, one might argue that it could be triggered by two things: (1; internal) a feeling that you have “used your brain” to process information or to solve exercises that you had not encountered before, and (2; external) getting feedback from some source that acknowledges your efforts and tells you that you have successfully completed something—that you are moving closer to your goal.

Supporting the first claim, Puhakainen and Siponen (2010) discovered that successful training solutions should in fact account for the learners previous knowledge; and present the material in ways that will trigger cognitive processes with the learner. However, this requires careful design of the actual content; the material that is presented. Thus, training programs should incorporate methods for assessing what the learner already knows, including processes for efficiently handling the repetitiveness of the content. This may however turn out to be a taxing process that could require a good deal of resources.

As for the feedback, this is where the gamification steps in. First of all, the basics: points, levels, and achievements represent a trivial way of recognising someone’s endeavours. However it does not—and should not—stop there to avoid a shallow focus on the “points/badges/leaderboards triad”. Progression can be relative—i.e. relative to others; other players. Social capital was presented by Burke (2014) as one strong motivational factor; the ability to share and compare your achievements with your peers. Maslow (1943) said that one of the basic needs for human motivation (as part of Maslow’s hierarchy of needs) is the *esteem*; self-esteem and esteem of others. Social esteem, receiving feedback in the form of recognition, attention, and appreciation from other people are strong motivational drivers. Seen also in line with SDT, the use of social interaction is important in a gamified application. The prototype used such social triggers in elements like the leaderboard, where people could compare their scores, and the activity timeline, where players could view their own and other players’ achievements.

Competition. For many people, comparison—as with the prototyped timeline and leaderboard—will almost instinctively evolve into *competition*. And competition can be a source of great engagement. However, as Burke (2014) points out: “In gamification, we most often want everyone to win”. This

is certainly true for security awareness and training; the objective is to educate everyone. Consequently, introducing competition into gamified solutions, especially as the one considered in this study, can be risky. When using competition based elements, it is important to balance them, and also let people opt out. One feature in the prototype that was honoured by the WPs, was the ability to filter the leaderboard, such that you could choose with whom you are competing. This way, if a player ranks low on the global leaderboard, they may still be competitive in their department or among their friends. Other players may choose not to follow the leaderboard at all. The activity timeline had a similar filtering mechanism. One participant emphasised that they would receive sufficient motivation from simply tracking their own progress. Still, comments from the second workshop included: “Competitions would probably make me use the application more frequently”, and “Challenge-a-colleague needs to be implemented!”

It is not easy to anticipate exactly how people will react to different competitive elements within an application. Some might find it engaging, some might find it demotivating. An important aspect will however be that players can choose which competitive level they wish to be on. Burke (2014) suggests that an alternative way of creating competition is by using a “collaborative-competitive” approach, where people are competing as teams rather than as individuals. Building on the team spirit, it could create a more healthy form of competition, where people would fight for their team, and potentially lose as a team, which is a softer way of losing than if you are alone.

6.2 Shared Goals for Security

In line with gamification definitions from section 2, Burke (2014) states that *goals* should be used to construct a path that will lead employees to reach their goals. Building on this approach, both the interviewed security stakeholders and the WPs were asked to identify what the goals with security awareness and training are, i.e. why should employees care. We have reason to believe that it is indeed possible to find a common ground where both employer and employees are in full agreement that security is something good, and something we should all strive for—which is at its core a good starting point for security awareness and training.

Related to this are some noteworthy factors which ultimately affect the employees’ compliance with security policies and regulations. Among them were *normative beliefs*, *social pressure*, and *habits* (Tso-

hou et al., 2015). During the interviews it was put forward that “security is often viewed by employees as a *separate* concern from all else that comprises the company *culture*”. The company culture typically consists of a manifold of behavioural expectations and normative beliefs that employees in the respective company possess and follow (Ruighaver et al., 2007); much like “the way things are done around here”. Secure practices need to be a part of the culture and the norms. One example that is featured repeatedly in the gamification literature is a marketing concept by Oracle (2016), which uses the social aspects of gamification to reduce people’s power consumption. In short, Opower lets people compare their electricity usage with the one of their neighbours; with statistical overviews and feedbacks upon low consumption etc. If you use more electricity than your neighbours, you would possibly feel like you are deviating from an expected group behaviour (Burke, 2014). Opower utilises the fact that people often want to align their behaviours with a group’s social norms—which in this case would be to save energy. As result, it has helped save over 9,6 billion kWh of electricity in the U.S. (as of May 2016, Oracle, 2016). However, it is not to be ignored that introducing new social norms and behavioural expectations can be a tricky affair. The use of a gamified training application could possibly help to attain the recognition that security needs, and, as suggested by a WP, for example create a topic for the occasional small talk around the coffee machine or in the elevator, e.g. topics like “How far have you come?”. If this could be achieved, it would also reinforce the effects of the social esteem.

6.3 Persisting Learning Outcomes

One of the main ideas considered in this study is that of having a long-term and continuous training program, with small exercises that are short in content and duration. This would allow the employees to distribute the training according to their own preferences, and complete the training on their own terms.

As with any educational program, the purpose of an SAT program is to facilitate meaningful and memorable learning outcomes for the employees. Shaw et al. (2009) concluded that hypermedia, or online applications, with the use of elements such as interactivity, adaptability, social learning, convenience, and instant feedback, have positive correlations with improvement of security awareness. The results from this study, particularly from the second workshop, indicate the same—i.e. that gamification can be a useful tool in creating improved learning outcomes for SAT programs. This can be explained by (1) reduced

tediousness of the training, such that one might pay more attention during the training, (2) more motivation towards completing the training, that is, people are not so reluctant to actually doing it, and (3) conciseness and availability of the exercises, such that employees are free to do the training when they want and also spread it out over a longer time period. Although already mentioned as a motivational factor, the latter argument also conforms to what is known as the spacing effect; that learning is greater when the training is spread out over time (Bahrick and Hall, 2005). This particular principle is applied in several products under a common idea of “microlearning”.

Another aspect of endurance is that people must not get tired of our SAT efforts. There is little long-term value in a system that creates huge immediate engagement, but falls short in maintaining this engagement. An example would be adding game elements to learning material with low quality. It would not matter how good the gamification design is, if people discover that they are completely wasting their time. Zichermann (2011) says that in order to create an engaging and meaningful system, it is important to determine how the system can “move the users along a path of mastery in their lives”. This implies that we shall not seek gameful experiences in themselves, neither only the motivational affordances. Gamification should rather be used to engage and inspire people in achieving their goals (Burke, 2014), hence reaching psychological and behavioural outcomes (Hamari et al., 2014). Considering this in an even bigger perspective, framed by the Aristotelian idea of a good life, involves thinking that our gamified application can be used for people to exercise and develop a good life (Sicart, 2015). In this case, keeping oneself (and your employer, family, friends) safe from security threats is potentially one such aspect of a good life, and one which a gamified application should strive to support on a personal level.

6.4 Personalisation and Freedom

Official guidelines (e.g., NIST, 2003; PCISSC, 2014) are unambiguous: an SAT program needs to be designed with the target audience in mind. This is a major challenge that applies to any SAT program. It was pointed out in the first workshop that content which did not appear relevant to the work of the individual employee only had a demotivating effect. Based on the conclusions of Puhakainen and Siponen (2010), and recommendations from NIST (2003), together with opinions collected from the interviews, a successful SAT application needs both to take into account are previous knowledge, and to adapt the con-

tent to fit job roles and responsibilities. The intuition is that gamification in itself cannot explicitly simplify the process of delivering the right content to the right people. However, small and concise exercises allows for more easily segregation of the content into different blocks or components of exercises that can be served to people with different job roles. In order to handle previous knowledge, there could be an introductory assessment that establishes an understanding of the current competence level of every new user. The user could then be assigned blocks of exercises accustomed to their current level of knowledge.

Another challenge that is fundamental to all SAT programs, is the process of reiteration. A company will typically have periodical (e.g., annual) security campaigns, where the material is quite similar every time. From the security perspective, that is in general alright, as the employees typically need to be aware of the same things from one year to another (perhaps with some minor alterations). However, as mentioned by the WPs, the repetitiveness can be quite tiresome.

The purpose of using gamification is for the most part to make the training less tedious, and help defeat the negative view that people may have on security (at least on the training) itself. Beris et al. (2015) suggest that the e-learning component of SAT programs only have a positive effect on those who have *positive* emotions towards security. There is however a possibility that gamification can create positive emotions towards learning, hopefully making people learn more over time, and contribute to positively affecting their behaviour. An interesting question here for further research is whether gamified learning would appeal to people who wouldn't otherwise be open to learning with traditional means.

Burke (2014) says that gamified solutions function best if they are opt-in, i.e. voluntary. If users engage with something mandatory—even if it is called a “game”—there is always a risk that it will turn into feeling like work (Rigby, 2015). Mollick and Rothbard (2013) found that consent correlates with how the use of gamification is perceived in the workplace. Although they could not conclude that consent directly influences the actual performance, their results showed that if there was consent from the employees to engage in the program, then it would improve their positive affect. Similarly, without consent, it would decrease. A suggestion made by the WPs was to have periodical campaigns, where a minimum amount of activity is in fact mandatory. This will result in a decrease of autonomy, however people will still be able to control and distribute their own training within the limits of the decided training period. In some cases, employees might also do more training than what is

expected or mandatory. But again, this relies on content which is found relevant and meaningful. A topic in the second workshop was to evaluate whether using the training application could be voluntary—implying that people would actually use the application and individually prescribe to the right amount of training. The opinions were slightly divided between the two groups (answers were both yes and no), and actual usage data would need to be collected over time to say something more precise about this.

6.5 Further Work

The results and our discussion must be considered in line with the context in which the study was conducted. As described in section 3, our data are based on professional opinions and personal opinions from employees in two Scandinavian companies, based on a single iteration of a gamified prototype for SAT. Our work serves to complement the overall research in the areas of security awareness and training, and gamification, and especially the combination of these. Essential in both design science and gamification is the iterative approach of (re-)design and testing to find out how well a particular mechanism performs, and naturally more work needs to be done to find a gamification design which performs well in practice.

Considering that the WPs are from two different companies, there may be cultural factors involved in their attitudes towards the gamified prototype. Ruighaver et al. (2007) have analysed a framework from organisational culture which contains eight dimensions to consider related with security practices of end users. Examples of dimensions include how employees are motivated, how open the organisation is to innovation and personal growth, and how employees are allowed to consider work as also a social activity. It should be investigated further if these factors have particular impacts on how to design a gamified SAT program.

Studying companies over time could be used to find out what security improvements can be attributed to a gamified SAT program they use. In contrast to Baxter et al. (2015), who only measured gamification impact from a one-time effort, the long-term effects of a durable program would be of much greater interest. From our work we derive a hypothesis that although short-term learning outcomes may be reduced with gamification, there is a potential to keep people open to learning about security at more occasions, than without gamification. Hence, the overall knowledge acquisition adds up to a greater sum, in addition to whatever additional positive effects gamification may have, such as making security less boring, and instead more meaningful.

A more advanced study would involve deploying a gamified training application with a company for a longer period of time. To investigate the knowledge acquisition results, one could allocate one group of users who only use normal training as a control group. To find out if training should be mandatory or not, another group could be assigned mandatory use of the application, while others have complete autonomy in their learning efforts. An interesting output from this kind of study would be to see how often the users would use the application, and if it is more than strictly required. And eventually; see if use of the application leads to changes in security behaviour, norms and practices within the company.

7 CONCLUSION

This study has considered the use of gamification in security awareness and training programs. Based on indications that current SAT programs are unsuccessful in providing employees with the needed knowledge – or at least behaviour change – an alternative concept has been drafted, and a prototype has been developed. In order to explore the appropriateness of this prototype, qualitative data have been collected through interviews with security experts, and workshops with user groups.

Through the study, it has been found that many of the problems that SAT is currently facing, are problems that gamification is intended to solve. The gamification design process has the end user in focus: why should the employee be interested in SAT? The study discovered four reasons for this, through the goals that were agreed as common between employer and employees. It is necessary that SAT programs are constructed to fulfil those goals. Another important question is: what drives the employees' engagement? We found that mastery and progression were the two most important motivational factors for our WPs. Additionally, the more self-determined the training is, the more motivating it will be. It is also clear that competition can be engaging for many, and potentially demotivating for others. When the purpose of the solution is to educate everyone on an equal level, it is important to use competition as well as external rewards with high caution. Gamification has further potential to deliver personalised content to users based on their skills and role in the company.

A general opinion among the WPs was that current training courses are too long. An important aspect that was considered is the use of small, concise exercises, as opposed to hour-long e-learning courses. It was discovered that this feature can give two important outcomes: (1) provide the users with a sense of

autonomy about the training, and (2) improved learning outcomes due to the spacing effect, and that the threshold for commencing the training is lower, when it does not require planning—it can be done on the go, when there is time, given that this is supported by the learning platform.

Ultimately, the whole purpose of an SAT program is to create good security behaviour among employees. There are certain things that employees do because they are following social norms, the behavioural expectations of the organisation, and good security behaviour should be among those things. However, infiltrating the corporate culture and creating new social norms is not a trivial task. As was pointed out by one of the interviewed security experts: “it takes time”. Behaviour change is tough, however, the results from the workshop proposed that, if SAT is something the employees are exposed to frequently, it can at least make users think—and talk—about security on a more regular basis.

Studying the effectiveness of security awareness programs is still rather immature as a research field, and the specific use of gamification in SAT programs is relatively unexplored. We argue that new approaches capturing this topic is of high importance, and this study contributes with exploratory results. These results are based purely on qualitative data collection methods; most of the data are views, opinions, and impressions. Thus, there are no concrete evidence that can actually show if gamification will improve the security awareness and training process. As such, our results could be used as input for other researchers when designing studies to capture the effectiveness of different approaches in SAT programs. It is necessary to study larger populations over time to determine whether gamified training is more effective than regular training.

ACKNOWLEDGEMENTS

The authors would like to thank the two organizations that contributed to our study, and the employees who participated in our workshops and interviews in particular. This work has received funding in a minor part from the SESAR Joint Undertaking under grant agreement No 699306 under European Union's Horizon 2020 research and innovation programme.

REFERENCES

- Bada, M., Sasse, A., and Nurse, J. (2015). Cyber Security Awareness Campaigns: Why do they fail to change

- behaviour? *International Conference on Cyber Security for Sustainable Society*, pages 118–131.
- Barrick, H. P. and Hall, L. K. (2005). The importance of retrieval failures to long-term retention: A metacognitive explanation of the spacing effect. *Journal of Memory and Language*, 52(4):566–577.
- Baxter, R. J., Holderness, D. K., and Wood, D. A. (2015). Applying Basic Gamification Techniques to IT Compliance Training: Evidence from the Lab and Field. *Journal of Information Systems*. American Accounting Association.
- Beris, O., Beautement, A., and Sasse, M. A. (2015). Employee rule breakers, excuse makers and security champions: Mapping the risk perceptions and emotions that drive security behaviors. In *Proc. of the 2015 New Security Paradigms Workshop*, pages 73–84. ACM.
- Burke, B. (2014). *Gamify: How Gamification Motivates People to Do Extraordinary Things*. Bibliomotion.
- Cone, B. D., Irvine, C. E., Thompson, M. F., and Nguyen, T. D. (2007). A Video Game for Cyber Security Training and Awareness. *Computers & Security*, 26(1):63–72. Elsevier Ltd.
- Deci, E. L. (1971). Effects of Externally Mediated Rewards on Intrinsic Motivation. *Journal of personality and Social Psychology*, 18(1):105–115. American Psychological Association.
- Detering, S., Dixon, D., Khaled, R., and Nacke, L. (2011). From game design elements to gamefulness: defining gamification. *Proc. of the 15th international academic MindTrek conference: Envisioning future media environments*, pages 9–15.
- Hamari, J., Koivisto, J., and Sarsa, H. (2014). Does Gamification Work?—A Literature Review of Empirical Studies on Gamification. *Proc. of the 47th Hawaii International Conference on System Sciences*. IEEE.
- Huotari, K. and Hamari, J. (2011). Gamification from the perspective of service marketing. In *Proc. CHI 2011 Workshop Gamification*.
- Lebek, B., Uffen, J., Breitner, M. H., Neumann, M., and Hohler, B. (2013). Employees' information security awareness and behavior: A literature review. *Proc. of the Annual Hawaii International Conference on System Sciences*, pages 2978–2987.
- Maslow, A. H. (1943). A Theory of Human Motivation. *Psychological Review*, 50:370–396. American Psychological Association.
- Mollick, E. R. and Rothbard, N. (2013). Mandatory Fun: Gamification and the Impact of Games at Work. *SSRN Electronic Journal*, pages 1–68.
- NIST (2003). Special Publication 800-50: Building an Information Technology Security Awareness and Training Program. National Institute of Standards and Technology (NIST).
- Oracle (2016). Customer engagement platform. <https://opower.com>. Opower Inc. Accessed on 15 Dec 2016.
- PCISSC (2014). Best Practices for Implementing a Security Awareness Program. Payment Card Industry (PCI) Security Standards Council. Available at https://www.pcisecuritystandards.org/document_library.
- Peppers, K., Tuunanen, T., Gengler, C. E., Rossi, M., Hui, W., Virtanen, V., and Bragge, J. (2006). The Design Science Research Process: A Model for Producing and Presenting Information Systems Research. *Proc. of the first international conference on design science research in information systems and technology (DESRIST 2006)*, pages 83–106.
- Puhakainen, P. P. and Siponen, M. (2010). Improving Employee' Compliance Through Information Systems Security Training: An Action Research Study. *MIS Quarterly*, 34:757–778.
- Ramirez, D. and Squire, K. (2015). Gamification and learning. *The gameful world: approaches, issues, applications*, pages 629–652.
- Rigby, C. S. (2015). Gamification and motivation. *The gameful world: Approaches, issues, applications*, pages 113–137.
- Rocha Flores, W. and Ekstedt, M. (2016). Shaping intention to resist social engineering through transformational leadership, information security culture and awareness. *Computers and Security*, 59:26–44.
- Ruighaver, A. B., Maynard, S. B., and Chang, S. (2007). Organisational security culture: Extending the end-user perspective. *Computers & Security*, 26(1):56–62.
- Ryan, R. M. and Deci, E. L. (2000). Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being. *American Psychologist*, 55(1):68–78. American Psychological Association, Inc.
- Shaw, R. S., Chen, C. C., Harris, A. L., and Huang, H.-J. (2009). The impact of information richness on information security awareness training effectiveness. *Computers & Education*, 52:92–100. Elsevier Ltd.
- Sicart, M. (2015). Playing the good life: Gamification and ethics. *The gameful world: Approaches, issues, applications*, pages 225–244.
- Siponen, M., Adam Mahmood, M., and Pahlila, S. (2014). Employees' adherence to information security policies: An exploratory field study. *Information and Management*, 51(2):217–224.
- Thornton, D. and Francia, G. (2014). Gamification of Information Systems and Security Training: Issues and Case Studies. *Information Security Education Journal*, 1:16–29. DLINE.
- Tsohou, A., Karyda, M., and Kokolakis, S. (2015). Analyzing the Role of Cognitive and Cultural Biases in the Internalization of Information Security Policies: Recommendations for Information Security Awareness Programs. *Computers & Security*, 52:128–141. Elsevier Ltd.
- Verizon (2016). 2016 Data Breach Investigations Report. Technical Report 1.
- Zichermann, G. (2011). The Six Rules of Gamification. <http://www.gamification.co/2011/11/29/the-six-rules-of-gamification>. Gamification Co. Accessed on 28 May 2016.