In Search for the Right Measure: Assessing Types of Developed Knowledge while Using a Gamified Web Toolkit

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Abstract: Game-based learning has been used to teach topics in diverse domains, but it is still hard to determine when such approaches are an efficient learning technique. In this paper we focus on one open challenge – the limited understanding in the community of the types of knowledge these games help to develop. Using a taxonomy that distinguishes between declarative, procedural and conditional knowledge, we evaluate a game-based toolkit to analyse and solve an information security problem within a holistic crime prevention framework. Twenty-eight participants used the toolkit. We designed a portfolio of learning assessment measures to capture learning of different types of knowledge. The measures included two theoretical open-answer questions to explore participants' understanding, three problem-specific open-answer questions to test their ability to apply the framework, and 9 multiple-choice questions to test their ability to transfer what was learned to other contexts. The assessment measures were administered before and after use of the tookit. The application questions were analysed by classifying suggested ideas. The theoretical questions were qualitatively analysed using a set of analytical techniques. The transferability questions were statistically analysed using t-tests. Our results show that participants' answers to the application questions improved in quality after the use of the toolkit. In their answers to the theoretical questions most participants could explain the key features of the toolkit. Statistical analysis of the multiple-choice questions testing transferability however failed to demonstrate significant improvement. Whilst our participants understood the CCO framework and learned how to use the toolkit, participants didn't demonstrate transfer of knowledge to other situations in information security. We discuss our results, limitations of the study design and possible lessons to be learned from these.

Keywords: learning assessment, open questioning, information security, types of knowledge, SOLO taxonomy

1 Introduction

A number of serious games have been developed and used to support learning in a wide range of domains. However, there is still an ongoing debate to identify when game-based approaches are more efficient than traditional learning techniques. This discussion has been approached by both addressing the pedagogic principles that could be embedded in games to support learning, see e.g. (Kebritchi & Hirumi 2008; Hmelo-Silver et al. 2007), and by looking into the kinds of knowledge that are being developed and into the possible ways to assess it, e.g. (Gijbels et al. 2005; Anderson & Lawton 1992). The focus of this paper is the limited understanding in the community of the types of knowledge that game-based learning helps to develop.

Despite the presence of differing taxonomies there is a wide agreement that knowledge is not a simple construct and different types of knowledge exist. Here we review three different approaches to classifying knowledge and choose to use one that is simple, yet representative.

Probably the most widely used knowledge classification is Bloom's taxonomy (Bloom et al. 1956), used e.g. in (Anderson & Lawton 1992). Out of the three domains of this taxonomy, the most relevant to the type of learning considered here is the one on cognitive learning. It features six incremental levels. They start with *knowledge* – the ability to recall data or information. The second level is *comprehension* - understand the meaning of that data and the ability to state a problem in one's own words. Bloom's third level in the cognitive domain is *application* – the ability to use a concept in a new situation (also referred as *transferability* later in this text) or unprompted use of an abstraction (the meaning used later in this text). The fourth level is *analysis*, or the ability to separate material or concepts into component parts so that the structure of how they are organised may be understood. The final two levels are *synthesis* – building a structure or pattern from diverse elements and putting parts together to form a whole, with emphasis on creating a new meaning or structure; and *evaluation* – making judgements about the value of ideas or materials.

Another taxonomy that was developed by Biggs (1994) and that acknowledges that cognitive learning can hardly be ordered along a single hierarchy, considers seven types of knowledge. This classification considers the less tangible tacit and intuitive types of knowledge. According to Biggs *tacit* knowledge "is manifested by doing and is not verbally accessible". *Intuitive* knowledge is felt and might develop before being expressed symbolically. Similar to Bloom, Biggs argues that these two types of knowledge develop further in a hierarchy into declarative, theoretical and meta-theoretical. Here *declarative* is the widely understood formulation of facts, *theoretical* represents an abstraction from declarative, whereas *metatheoretical* is the level when scientific work around abstractions may lead to paradigm shifts, i.e. possibly introducing some sort of revision of previous knowledge. Finally Biggs considers the procedural and conditional types. *Procedural* is the knowledge of how things need to be done, formulating necessary event sequences or order of actions. *Conditional* knowledge involves making decisions, based on the circumstances. In the author's words "conditional knowledge provides the metacognitive support to procedural knowledge".

Although the taxonomy that Biggs suggests, provides extensive coverage of a wider idea of knowledge, it could be very difficult to work with. Intuitive and tacit by definition are very difficult to assess externally, and metatheoretical might be contradictory. That's why, for practical purposes, another simpler taxonomy is of interest. It was suggested by Sugrue (1995) and considers only three types of knowledge: declarative, procedural, conditional. Whereas the later two types could be considered to overlap with the ones suggested by Biggs, declarative knowledge could be seen as the combination of the explicit types within the hierarchical part of his taxonomy. The distinction that Sugrue's taxonomy captures, has been acknowledged as useful also in other studies, e.g. (Gijbels et al. 2005).

Different assessment techniques have been recommended to be used to capture different types of knowledge. Typically, closed questioning (i.e. possible answers are pre-suggested by the question) is widely used for declarative knowledge and the lower levels of Bloom's taxonomy, whereas open questioning is used where there is more ambiguity or there is interest in the reasoning process behind the answer (Atherton 2011). A typical closed assessment technique are multiple-choice questions (MCQ), and possible open assessment techniques are essay questions or concept maps, as used by Hay and Kinchin (2008). As written assessment is common in educational systems, and concept mapping might require some form of training, the former was preferred in this study. Naturally, there is a trade-off between the potential of a measure to capture depth of learning, and the difficulty to actually assess the provided answer. Whereas when using multiple-choice questions, correct answers only need to be checked and counted and after that could be statistically analysed with standartized procedures, open questioning requires careful consideration of each answer and analysis of its content. Such analysis is typically specific to the topic and sometimes does not result in an unique interpretation.

Nevertheless, different general-purpose techniques to analyse text exist. One common approach, used both in education and research is content analysis (Weber 1990). Content analysis can consider words, sentences or paragraphs as its unit of analysis and is meant to be independent of any implied context, thus trying to be as objective as possible. While widely used across a variety of domains, content analysis could not capture aspects of assessment, when questions are put in the context of a specific learning activity and, due to time pressure, relatively short responses are expected. Another technique, that allows for better consideration of the learning context, is thematic analysis (Aronson 1994). Thematic analysis allows to interpret a single construct in written responses as belonging to several different themes that it might relate to, thus making it possible to interpret references to content that has been learned. Finally, as represented by more complex forms of knowledge (e.g. synthesis in Bloom's taxonomy and both procedural and conditional in the other reviewed taxonomies), learning might not be represented by accumulating new factual knowledge, but rather better understanding the interdependencies between knowledge constructs that were already accessible to the learner. To address these, Biggs and Collis (1982) have developed a taxonomy meant to assess written answers and essays in depth – the structure of observed learning outcomes (SOLO in short). It represents a hierarchy used to classify written text according to its complexity and features levels from *prestructural* and *unistructural* through *multistructural* to *relational* and, finally, *extended abstract*. The first part of that hierarchy explores the ability of respondents to explain one or several themes within the domain, whereas the later levels correspond to their ability to explain their interrelatedness or draw more general conclusions, based on the considered themes.

The learning domain of the study was information security and its content adapted the Conjunction of Criminal Opportunity (CCO) framework from crime prevention and community safety (Ekblom 2010) to the purposes of information security.

2 Method

We report the evaluation of an early prototype of a game-based toolkit. The toolkit employs gamification techniques to analyse and solve an information security problem with the CCO framework. Twenty-eight participants took part in a study with an experimental aspect. Their age ranged from 20 to 65 with an average of 26.5 and median 23.5. There were 19 male and 9 female participants. Participants were randomly assigned in two groups of 14 participants each. The experimental part of the study was used to examine the effects of variation on learning with the toolkit. As part of the process guided by the toolkit and described below the experimental group was asked to assess a predetermined set of ideas, presented as if other study participants had written them, whereas the control group merely assessed their own ideas. This experimental component of the study was considered to be independent of the results reported in this paper.

CCO combines situational and offender-oriented approaches to crime prevention (Ekblom 2010). It comes at the price of greater, but necessary, complexity relative to other widely used frameworks. Paradoxically this equips practitioners to better handle the complex reality of crime.

The framework suggests 11 circumstances the conjunction of which leads to the criminal event and has been visualized on a diagram (refer to the background image of Figure 1a). The diagram features these circumstances as rays coming together to form the final conjunction. Considering each of the eleven generic causes in the CCO diagram, naturally leads to ideas for their intervention counterparts. These intervention ideas could block, weaken or divert the causes, such that the criminal event is less likely to be attempted, or to succeed.

The variety of possible intervention ideas and the exact details of their implementation lead to a classification of how specific, or general these ideas are. The CCO framework distinguishes between principles and methods. Methods represent the context-dependent practicalities of an intervention. These are often difficult to transfer to other situations – the success of interventions is very context-dependent. Principles, on the other hand, are the more general description of what is being done that is formulated in a way that could be re-applied, customised to context in other situations.

Six intended learning outcomes were sought when learning the CCO framework with the toolkit. These were listed and classified according to Sugrue's taxonomy as illustrated in Table 1.

Code	*Intended Learning Outcome (ILO)*	*Type of Knowledge*
ILO1	Understand what exactly CCO is, what it’s for, and the wider process in which it can be used.	Declarative
ILO2	Use CCO to interpret causes of criminal events within the worked examples.	Procedural
ILO3	Use CCO to identify preventive intervention principles that they could bring to bear against these causes.	Conditional
ILO4	Generate greater numbers of plausible intervention ideas – i.e. the first stages of innovation.	Conditional
ILO5	Grasp of the key threshold concepts, e.g. ecological level.	Declarative
ILO6	Use CCO terminology correctly.	Declarative

Table 1: The intended learning outcomes (ILO) that were considered to be important to achieve with the game-based toolkit and the corresponding type of knowledge according to Sugrue's taxonomy.

The toolkit guided participants through a process consisting of four consecutive parts: introduction to the scenario, idea generation, idea assessment and score review. The first screen of the toolkit introduced participants to an insider attack scenario. This included a textual description of the problem and a list of incidents that exemplify it.

Once participants were introduced to the scenario, they were taken to the subsequent idea generation part. It featured an interactive version of the CCO diagram. When a participant clicked on one of the 11 contributing rays of CCO, further information appeared and the participant was prompted to identify causes in a dedicated dialogue box (see dialogue box of Figure 1a). Once done with causes, participants were taken to a similar screen where they worked on interventions. Here they suggested their own methods and matched them to a customizable list of principles.

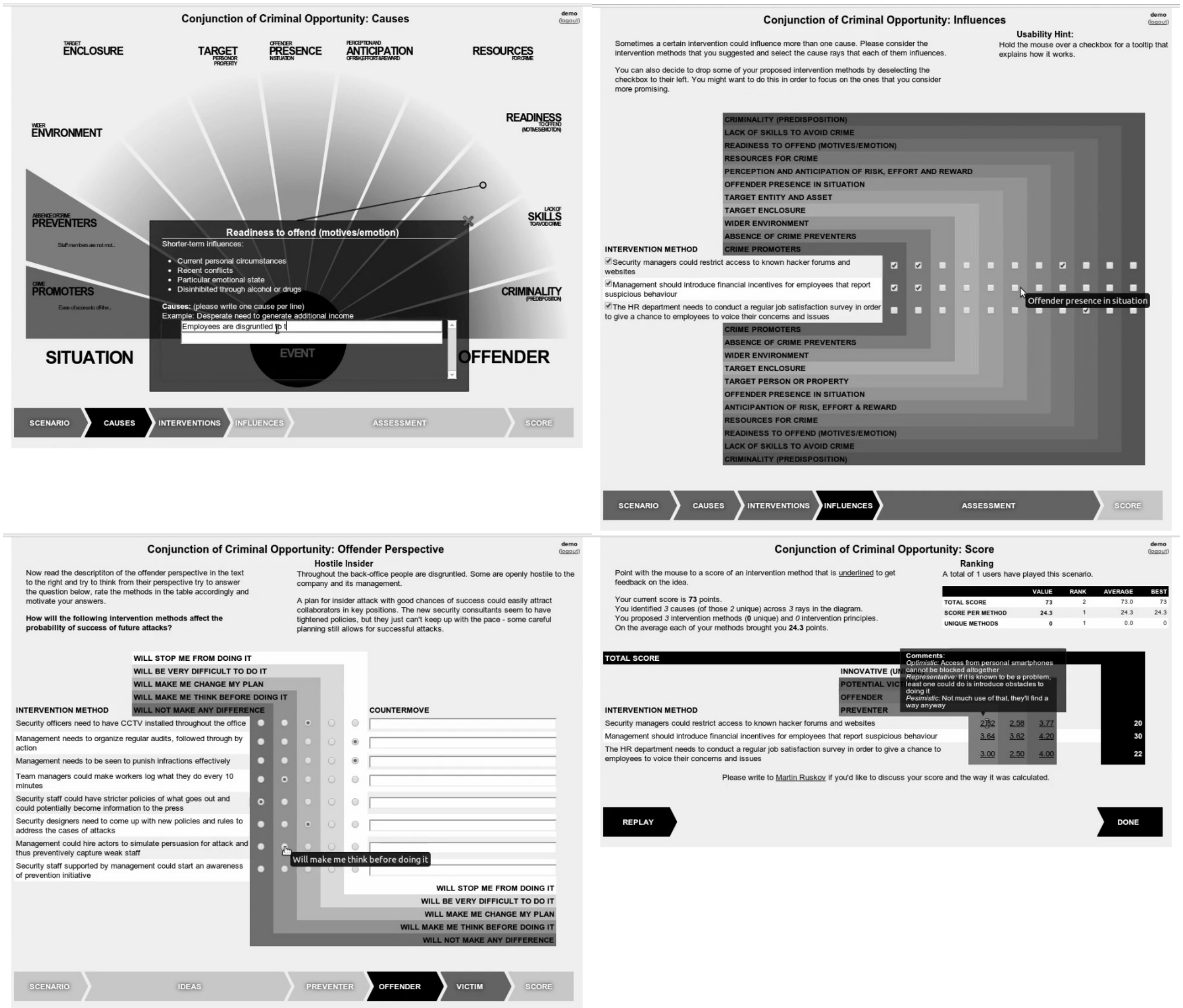

Figure 1: Screenshots illustrating key steps in the process, embedded in the CCO toolkit. From top to the right, then moving to lower row to the right: a) the screen prompting participants to generate ideas for causes, featuring the CCO diagram in the background and the interface to enter ideas; b) askinig participants to consider if their ideas relate to other generic causes; c) participants assessing and commenting on ideas of others; d) the final score screen with comments fed back to the idea originators. These are provided for illustration only and the textual page content is not relevant to this publication.

After these phases of generation participants were presented with an opportunity to identify possible matches between any of their suggested interventions and the 11 generic causes (see Figure 1b). This way they were given an opportunity to further explore the influence a suggested intervention could have on wider causes and subsequently how it is interconnected with other interventions.

The assessment part of the process prompted participants to evaluate ideas of interventions.

As already explained in the beginning of this section, the two groups got to review different sets of ideas in their assessments. Participants were asked to grade each idea along a 5-point Likert-scale and were provided with an empty text field if they wanted to provide further comments to clarify their assessment.

After that the toolkit engaged participants in a role-based assessment of the proposed interventions. In this assessment (Figure 1c) participants reviewed a predetermined set of ideas (as already described), both by rating them along a 5-point Likert scale and commenting whenever they found appropriate. Finally, the toolkit used a simple pattern matching mechanism to cluster intervention ideas. This entire process made it possible for the toolkit to provide feedback on ideas, suggested by participants, and to ultimately assign a score to participants in the study.

This happened within the final score and ranking screen (Figure 1d) that showed to participants their performance. This included a table with intervention ideas, suggested by the participant, and overall statistics and ranking of their performance. The table featured a breakdown of the three scores these ideas cumulatively received from other participants and feedback other participants provided via comments they gave while assessing previous similar ideas.

The game-based toolkit is described in further detail in other publications. The development and design decisions are reported in (Ruskov, Celdran, et al. 2013), and the learning and usability analysis is reported in (Ruskov, Ekblom, et al. 2013).

Code	*Question*	*Addressed ILO*
TQ1	How would you describe the CCO framework?	ILO1
TQ2	What is the CCO framework used for?	ILO1
PQ1	What are the key causes of the insider attacks in the above scenario?	ILO2
PQ2	What are possible interventions methods that would reduce or prevent further attacks of this sort?	ILO4
PQ3	For each of the methods, please suggest one reusable principle that generalizes the approach that has been used.	ILO3
MCQ1	Which of the following (if any) are causes working on an employee at a bank to help the commitment of financial fraud?	ILO5
MCQ2	Which of the following actors (if any) have interest in secretly planting a trojan onto a home computer?	ILO5
MCQ3	Which of the kinds of methods below apply to a “use secure password on your private computer” publicity campaign within a company?	ILO3
MCQ4	Which of the following (if any) could be parts of the enclosure around a file that is potential target?	ILO1, ILO5
MCQ5	At an open access internet café which of the following (if any) are potential non-professional crime preventers?	ILO5
MCQ6	Which of the following (if any) are well-formulated intervention principles?	ILO5
MCQ7	Which of the following (if any) are intervention methods rather than intervention principles?	ILO5
MCQ8	Which of the following (if any) are resources for a potential offender to commit an insurance fraud?	ILO5
MCQ9	An IT company has several cases of intellectual property leaks to competitors. For which of the following (if any) could they use the CCO framework?	ILO1

Table 2: Questions used in the assessment of this study and corresponding intended learning outcomes.

We designed a portfolio of learning assessment measures in order to capture progress corresponding to each of the intended learning outcomes, and resp. to Sugrue's knowledge taxonomy.

The measures included two theoretical open-answer questions to explore participants' understanding (see TQ1 and TQ2 in Table 2), three problem-specific open-answer questions to test their ability to apply the framework (PQ1, PQ2, PQ3, see Table 2), and nine multiple-choice questions to test their general understanding and their ability to transfer what was learned to other contexts (MCQ1-9). Each of the multiple choice questions included four possible answer options and participants were allowed to select any number of correct answers, or none. Participants were also given the opportunity to provide further comments or clarifications to each possible answer.

The study procedure engaged each participant for 90 minutes. The assessment measures were administered before and after the task of using the game-based tookit. Participants were allowed up to 20 minutes (whereas it typically took them around 15 minutes) to do each of the measurements and were asked to proceed further with the next step if they finished earlier, thus receiving more time to work with the toolkit.

The application questions were analysed by means of thematic analysis and by coding the suggested ideas into predetermined broad categories. Because PQ2 and PQ3 addressed two aspects of the same issue, respectively the methods and the principles of a small set of interventions, they were analysed together. The theoretical questions were analysed both with thematic analysis and with the SOLO taxonomy, the former used to explore the particular themes, and the latter – their interrelatedness. The transferability questions were statistically analysed using unpaired samples t-test with the assumption of equal variances.

3 Results

Our results indicate that participants were able to understand, engage with and use the toolkit. This is reported in another currently pending publication (Ruskov, Ekblom, et al. 2013). As Figure 2 demonstrates they showed some improvement in the way they identified problem causes and solutions (answers to the problem questions).

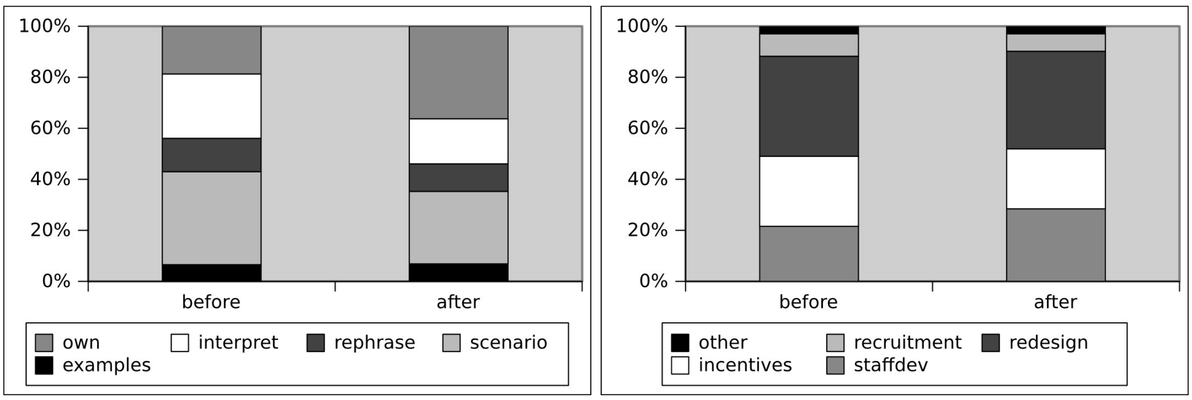

Figure 2: Distribution of answers to application questions: left - PQ1 and right - PQ2 and PQ3 (same distribution). The graphs compare answers before and after engaging with the game-based toolkit

For the identification of causes (PQ1) this meant that there was a stronger shift from causes implied by the scenario or variations of them to more indirect and complex causes that were original suggestions of participants. The average proportion of own ideas almost doubled from 19% to 36%.

The proportion of interventions (methods – PQ2 and principles – PQ3) that have to do with staff development increased from 22% to 28%. Such method ideas had to do with solutions such as training or showing better leadership, which are essential to security issues related to disgruntlement (Kirlappos et al. 2013).

Most participants showed some form of learning in their answers to the theoretical questions (TQ1 and TQ2) when comparing answers before and after using the game-based toolkit. These included rephrasing or relating to previous knowledge, explaining new themes within the subject, integrating different themes learned with the toolkit, or adopting the professional language of the toolkit. However, as can be seen in Table 3 these pieces of evidence were diverse.

Commonly, study participants expanded their answers after using the game-based toolkit, thus showing what new understanding they had developed. Typically in such situations they provided further necessary details in their responses after using the toolkit. In Table 3 E11/TQ1 is an example of a participant not giving anything specific in their answer before using the toolkit, but adding relevant concepts after that. This is an example of someone reaching the unistructural level in the SOLO taxonomy in their answer after using the toolkit. On the other hand C11/TQ1 exeplifies a second aspect (interventions) being added to the one already discussed (causes), thus exemplifying a newly developed multistructural answer.

In other cases the comparison of the two answers showed a change in the way that a given participant considered the topic and demonstrated their ability to better integrate what they had learned. Commonly they first wrote of the process that the toolkit took them through. After using it, they also wrote of its goal or implications, alongside the process (see C01/TQ2 in Table 3 for an example). This is typical for the relational level of the SOLO taxonomy. Among our participants there were no examples of participants moving to an extended abstract level in the SOLO taxonomy.

In two cases participants used their own terminology in their answers. For example. in C03/TQ1 the participant talks of "stakeholders" and "curbing the occurrence" of crime, but neither of these phrases was used in the toolkit or by the facilitator. This shows that they went through a process of relating what they experienced in the study to what they had previously known, describing the new knowledge in their own vocabulary.

Eight study participants demonstrated no form of learning in either of their answers to the theoretical questions. Instead they provided the same or even less information in their answers after using the toolkit. In two other cases, although participants showed that their understanding had developed in the answer to one of the questions, they only superficially answered the other. In these responses participants used the professional language of the toolkit, but didn't provide a response with substantial information in their answers (see C13/TQ2). These cases were considered as cases of mimicry, rather than learning.

participant /question	type of evidence	before	after
E11/TQ1	SOLO unistructural	*It tries to take a micro-approach in terms of identifying small problems in society that lead to a crime being committed (in terms of Information Security)*	*tries to reduce the risk and occurrence and severity of attacks by interrupting in the causes*
C11/TQ1	SOLO multistructural	*CCO framework is used to reduce crime related to leakage or attack of information by investigating their causes.*	*it is a framework to identify the cause of crime related to information system followed by intervention to eliminate the crime.*
C01/TQ2	SOLO relational	*CCO is used to identify current or potential breaches and to work through all the chains of effect, thus creating watertight solutions.*	*CCO is used to examine the many potential causes of incidents, and to explore what the implications of potential solutions would be, from all angles. Sometimes the implications are massive.*
C03/TQ1	own vocabulary	*a comprehensive method of curbing the occurrence of a particular crime with minimal effect to stakeholders.*	*a comprehensive method of identifying causes, possible solutions and assessing their impact to a particular criminal activity with little impact to stakeholders.*
C13/TQ2	mimicry	*it help people to reduce the chance of being cheated during online security.*	*protect vulnerable people from cyber crimes. give people an insight about increasing cyber crimes.*

Table 3: A selection from the assessment results, illustrating different types of evidence. The third and fourth colums contain unedited participant responses. None of the answers exemplified the extended abstract level of the SOLO taxonomy.

Statistical analysis running an unpaired t-test of the transferability multiple-choice questions (MCQ1-9) showed no significant improvement after using the toolkit (test result: m_{before} = 23.3, m_{after} = 23.9, df=54, t=1.674, p=0.226). However, on average the number of participant's correct responses improved by slightly more than a half, i.e. every other participant indicated one more correct option after using the prototype. Nine participants provided 21 comments for clarification of their responses to the multiple-choice test before engaging with the toolkit, with one responsible for eight of these comments. Only one of the participants provided clarifications to his answers in the final test, repeating one of his previous comments and providing two new ones.

4 Conclusion

The learning assessment showed mixed results. All measures showed some improvement, but this learning could not be quantified into statistical significance. Whilst there is evidence that our participants understood the framework and larned how to use the toolkit, there is insufficient evidence to conclude that participants were able to transfer their knowledge to other problems in information security. The answers to the theoretical questions showed indications to the various forms of learning and corresponding varying evidence. While there were indications for improvement by the majority of participants, it was difficult to generalize these into distinctive common patterns for the whole group.

We hypothesize that these inconclusive results are due to two reasons: shortness of the learning experience and imperfections of assessment. We develop an argument of the limited opportunity for engagement in the learning process that lab-based learning experiments allow for.

This paper presents results of a formative study of a prototype in a lab setting. While it is useful to evaluate serious games in a lab setting in order to improve their usability, progress in learning might be more difficult to capture in a typical one-hour lab experiment session. Whereas lab-based studies are still necessary as formative assessment during the development phase of game-based learning tools, we suggest that class studies or longitudinal web-based studies are more appropriate to assess learning happening with their help.

The different assessment techniques aiming at different types of knowledge allowed us to draw a comparison between the forms of knowledge that participants developed with our game-based toolkit. It seems that participants were better able to apply their knowledge in context, than to formulate, explain or generalize it. Two reasons for this come to mind. One could be that they actually needed more time and broader perspectives to get a deeper understanding. Another possible explanation is that our toolkit is more suitable for developing procedural and conditional knowledge, rather than declarative, similar to problem-based learning techniques, assessed by Gijbels and colleagues (2005).

The large number of cases when participants provided shorter answers after using the game-based toolkit, led us to consider several possible reasons for that behaviour. One obvious reason could be that they found that the essence of what has learned could be described with fewer words. However, another reasonable assumption is that they experienced assessment fatigue and were less motivated to put effort into their second answer. A third potential reason that we identified is that they might have considered it unnecessary to repeat something that they had written before using the game-based toolkit not that long ago. This problem could also be overcome by engaging with studies that would take participants through longer learning periods. Despite the fact that such studies require more effort to yield results, they might lead to more conclusive findings.

References

Anderson, P.H. & Lawton, L., 1992. A Survey of Methods Used for Evaluating Student Performance on Business Simulations. *Simulation Gaming*, 23(4), pp.490–498.

Aronson, J., 1994. A Pragmatic View of Thematic Analysis. *The Qualitative Report*, 2(1). Available at: http://www.nova.edu/ssss/QR/BackIssues/QR2-1/aronson.html/.

Atherton, J.S., 2011. Learning and Teaching: Forms of Assessment. Available at: http://www.learningandteaching.info/teaching/assess_form.htm [Accessed April 30, 2013].

Biggs, J.B., 1994. Modes of learning, forms of knowing, and ways of schooling. In M. S. Andreas Demetriou, ed. *Neo-Piagetian theories of cognitive development: implications and applications for education*. Routledge.

Biggs, J.B. & Collis, K.F., 1982. *Evaluating the Quality of Learning: The Solo Taxonomy : Structure of the Observed Learning Outcome (Educational Psychology Series)*, Academic Pr. Available at: http://mie.sagepub.com/cgi/pdf_extract/1/4/20.

Bloom, B.S. et al., 1956. *Taxonomy of Educational Objectives: The Classification of Educational Goals, Handbook I: The Cognitive Domain* B. S. Bloom, ed., Susan Fauer Company, Inc.

Ekblom, P., 2010. The conjunction of criminal opportunity theory. In B. S. Fisher & S. P. Lab, eds. *Encyclopedia of Victimology and Crime Prevention*. Sage.

Gijbels, D. et al., 2005. Effects of Problem-Based Learning: A Meta-Analysis From the Angle of Assessment. *Review of Educational Research*, 75(1), pp.27–61.

Hay, D. & Kinchin, I., 2008. Using concept mapping to measure learning quality. *Education + Training*, pp.167–182.

Hmelo-Silver, C.E., Duncan, R.G. & Chinn, C.A., 2007. Scaffolding and Achievement in Problem-Based and Inquiry Learning: A Response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist*, 42(2), pp.99–107.

Kebritchi, M. & Hirumi, A., 2008. Examining the pedagogical foundations of modern educational computer games. *Computers & Education*, 51(4), pp.1729–1743.

Kirlappos, I., Beautement, A. & Sasse, M.A., 2013. ‘Comply or Die’ is dead: Long live security-aware principal agents. In *Workshop on Usable Security*.

Ruskov, M., Celdran, J.M., et al., 2013. Unlocking the Next Level of Crime Prevention: Development of a Game Prototype to Teach the Conjunction of Criminal Opportunity. *Information Technologies and Control*, 8(1).

Ruskov, M., Ekblom, P. & Sasse, M.A., 2013. Getting Users Smart Quick: Results from 90 Minutes of Using a Persuasive Toolkit for Information Security Learning by Non-Professionals. In *SECRYPT 2013*.

Sugrue, B., 1995. A Theory-Based Framework for Assessing Domain-Specific Problem-Solving Ability. *Educational Measurement: Issues and Practice*, 14(3), pp.29–35.

Weber, R.P., 1990. *Basic Content Analysis (Quantitative Applications in the Social Sciences)* 2 Sub., Sage Publications, Inc. Available at: http://www.amazon.com/exe%bidos/redirect?tag=citeulike07-20&path=ASIN/0803938632.