

Security Education using Gamification Theory

Keiichi Yonemura

Dept. of Information and Computer Engineering
National Institute of Technology, Kisarazu College
Kisarazu-City, Chiba, Japan
yoramune@gmail.com

Jun Sato, Yoshihiro Takeichi

Dept. of Creative Engineering
National Institute of Technology, Tsuruoka College
Tsuruoka-City, Yamagata, Japan

Ryotaro Komura

Dept. of Electronics and Information Engineering
National Institute of Technology, Ishikawa College
Tsubata-City, Ishikawa, Japan

Kuniaki Yajima

Dept. of General Engineering
National Institute of Technology, Sendai College
Sendai-City, Miyagi, Japan

Abstract—Fostering talented people with excellent OT security is an important issue that is working closely with the industry where cyberattacks are increasing. We examined educational effects and issues in KIPS (Kaspersky Interactive Protection Simulation) multiple exercise based on Gamification theory. Experimental results showed that multiple performances contributed to a simple educational effect and there was a possibility of positive skill transfer, but KOSEN needed educational content that could fill in gaps in multiple exercises, I have a big mission to continually update the practice-based curriculum.

Keywords—security education; gamification theory; operational technology; ICT; KOSEN;

I. INTRODUCTION

The cyberattack of industrial equipment is getting really hot in the industry. Japan's National Institute of Technology (KOSEN) has produced many high-quality industrial engineers in the industry. Last year, we started a cyber security education project and developed an educational system faced with the threat of cyberattack. The fact that KOSEN's students have security skills and knowledge leads to strengthening of cyber security in the field of OT (Operational Technology), so that students can contribute to the industry. Although we have promoted ICT security education using our own educational content, we believe that it is not easy to learn OT security at that time, cybersecurity developed by ourselves. Since many OT security can be learned by actual operation, there is an aspect that it is difficult to obtain the expected educational effect without actual industrial equipment and environment.

KIPS (Kaspersky Interactive Protection Simulation), which has developed by Kaspersky Lab, is the board game using Gamification Theory that we can experience the cyber security practice and will be possible to carry out actual practice by simulating realistic scenarios. In our security educational project, we are advancing the education using KIPS, and examined the relationship between the educational effect using the security contents we developed and the effect using KIPS [1].

It was possible to confirm the difference between to consider the security educational effect which practiced the “Enterprise scenario (Corporate version)” which is KIPS where we are toward ICT security and the “Plant scenario (Water Plant version)” which is KIPS where we are toward OT security and practice a ICT security skill and to practice a OT security skill there. we got the very useful knowledge to consider future's educational policy for the technical college which produces human resources to the industrial world.

The industrial world tries to practice KIPS more than one times targeted for the technical college rawness which acquires a basis of the engineer who can play an active part in such flow this time. When the effect of practicing KIPS more than one times is admitted, the framework to take in during educational policy and excrete stronger human resources effectively can be strengthened. The relation between the skill of OT security and the ICT security skill is also considered in more than one times of implementation. Consideration on this relation will be something to grope after a possibility of the skill transfer with effective OT security and ICT security, and we contribute to improvement of future's educational practice as expected.

II. GAMIFICATION THEORY AND KIPS

We describe two topics that support the fundamental direction of practice of education using the contents applying the gamification theory which is essentials of our investigation.

A. Gamification Theory

The definition of Gamification has been used as "the use of game-play mechanics for non-game applications" [2] and it is used in many areas such as education, business and medicine. One of the important features of learning by using Gamification or Game-Based Learning is that students actively learn problems and take solutions by facing problems. Problem solving with gamification is also noted to be an important benefit of using games in education [3, 4]. A problem-solving mechanism built with a game-based strategy enables both knowledge acquisition and its application throughout the learning process.

B. KIPS (Kaspersky Industrial Protection Simulation)

KIPS is the cyber security practice by team battle which designed to enhance analytical skill about problems on the cyber security and the risk about latest computer system in operation [5, 6]. Educational targets are executive managers including business managers, departmental managers and information security administrators.

The purpose of KIPS is that to prevent the profit maximally and to preserve the trust during exposure to a series of unexpected cyber threats. The aiming is that to develop and run the cyber defense tactics by selecting best suited plan out of cyber security countermeasure prepared preliminarily (see Fig. 1).



Fig. 1. KIPS (Kaspersky Interactive Protection Simulation)

Subsequent deployment and final profit and expense of company change, in response to countermeasures against security events pouring in waves. Each team analyze a situation considering priorities of engineering against damage by cyber-attack, business and security, making a tactical decision based on uncertain information, a limited budget and feasible measure. Each scenario is decided based on security events changed by the situation each team is in, so it can not only simulate a situation occurred cyber incidents actually, but also verify the decision making based on appropriate tactics and effectivity of selected measures in real time.

KIPS is the cyber security practice based on gamification which has the following characteristics:

- Completing in a short time (two hours) while concentrating and having fun in the form of a game
- Building up cooperativeness crossover the organization by teamwork
- Train upping the autonomy and analytic skill by re-experiencing realistic security events

III. PRACTICAL PROCEDURE AND RESULT

KOSEN students who belong Dept. of Electrical and Electronic Engineering practiced KIPS. They played it total four times. First they played the Water Plant version (see Fig. 2) of KIPS twice and then played the Corporation version (see Fig. 3) of KIPS twice. Concretely, they played the Water Plant version again after three days of first playing the Water Plant version. And they played the Corporate version of KIPS after four days of second playing of the Water Plant version and then they played the Corporate version again after seven days of first playing the Corporate version.

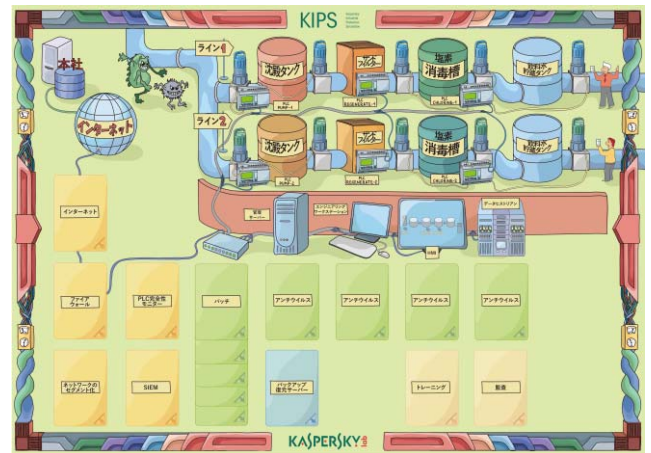


Fig. 2. Water Plant version of KIPS

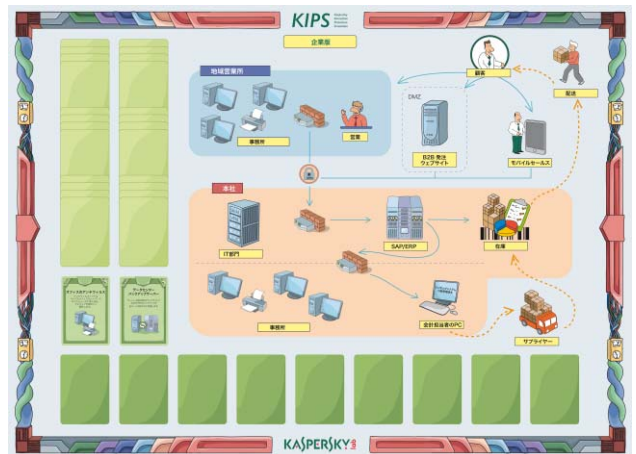


Fig. 3. Corporation version of KIPS

We can confirm the effect of embeddedness of OT security skill and knowledge on multiple playing by examining the score of first playing the Water Plant version of KIPS twice. And we can examine the possibility of skill transfer between OT security and ICT security which have different fundamental by examining to compare the score of second play of the Water Plant version with the score of first play of the Corporation version (that is third playing as a whole). Finally, we can also confirm the effect of embeddedness of ICT security (this is the point which is not OT security, that is the ICT security) skill and knowledge on multiple playing by comparing the score of first playing the Corporation version of KIPS twice (the third and fourth playing as a whole) as is the case with examining on twice playing of the Water Plant version.

A. The results of first and second playings of the Water Plant version of KIPS

Fig. 4 shows both score of first playing of the Water Plant version and second playing of the one on the scatter diagram. These scores have already standardized, and we said here that subsequent scores were standardized, too. As this result, we can confirm that second score is higher than first one significantly (tow-tailed t-test, $p < 0.05$) and multiple playing makes the effect of certainly embeddedness of skill which they learned (a result of decorrelation test shows that coefficient of correlation had comparatively strong correlation with significant).

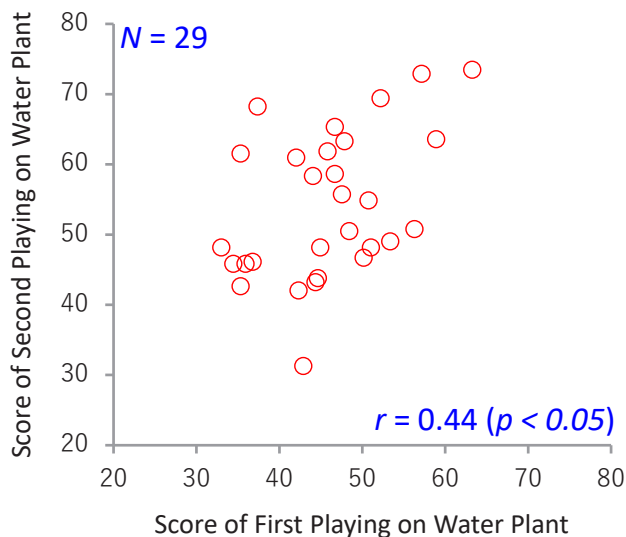


Fig. 4. Scatter diagram of the scores about first and second playing the Water Plant version

B. The result of second playing of the Water Plant version of KIPS and first playing of the Corporation version of KIPS

Fig. 5 shows the scatter diagram between the score of second playing of the Water Plant version of KIPS and the score of first playing of the Corporation version of KIPS (which was third playing of KIPS as a whole). We didn't compare the magnitude relationship between both scores here because they are different version so we can't compare simply. The point of view is that weather the skill and knowledge which they learned from playing the Water Plant version can transfer to playing the Corporation version, and then we confirmed the possibility that

the result has the effect (a result of decorrelation test shows that coefficient of correlation had weak correlation with significant). However the factor resulting from this transfer is wide-ranging, so we can only say that that possibility was suggested.

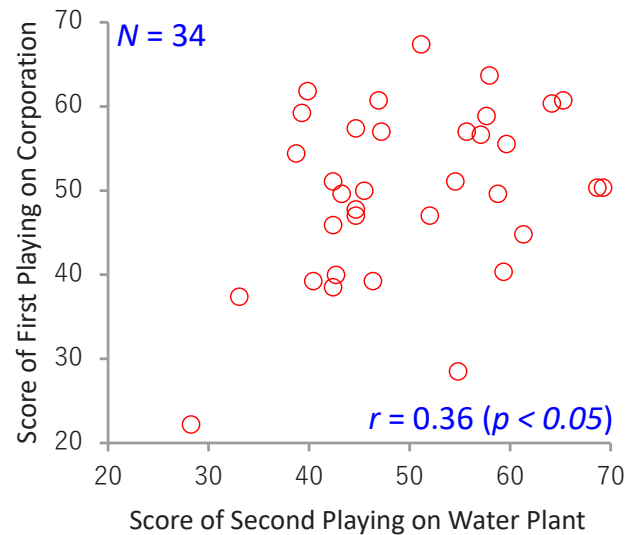


Fig. 5. Scatter diagram of the scores about second playing the Water Plant version and first playing the Corporate version

C. The result of third and fourth playing of the Corporation version of KIPS

Fig. 6 shows both score of first playing (third playing as a whole) of the Corporation version and second playing (fourth playing as a whole) of the one on the scatter diagram. It is peculiar to which we can't recognize the positive correlation and we can find negative correlation with no significant although the score of second playing is higher than first playing in totality differ from the comparison of Water Plant versions (a result of decorrelation test shows that coefficient of correlation had on significant). This result showed that a lot of reversal case on which the score of second playing is simply higher than the first playing occurred, and that result makes we can't simply confirm the effect of multiple playing.

These results show that the possibility of the difference of difficulty between the versions on KIPS and the possibility that is different from simple effect that playing number of times influenced the score on the educational effect concerning operational skill and the skill based on knowledge about OT security and ICT security. This result was the important findings while we examine the educational effect and concept in the future. That is, we can suggest the possibility that we need the educational contents which can complement effectively between the multiple playing.

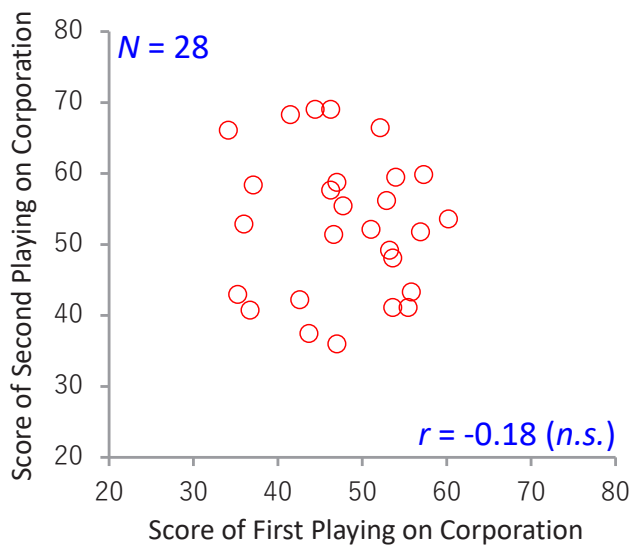


Fig. 6. Scatter diagram of the scores about first and second playing the Corporation version

IV. SUMMARY

To produce human resources who are good at OT security is important task for KOSEN which is closely cooperation with the industry on which faces increasing cyber-attacks. To incorporate the educational effect using Gamification theory which KIPS has can contribute to accomplishment of original goal on which we have operated our (KOSEN) original security education. In this time, we examined the effect and issues on multiple practicing of KIPS while we advance a series of research to examine the security educational effect using KIPS. Multiple playing made that we can confirm simple positive effect on our practicing the version which has domain of OT security skill mainly. Moreover, we can find that the possibility which OT

security skill can transfer to ICT security skill. However, we can't confirm simple embeddedness of security skill and knowledge by multiple playing while we practiced the version which has domain of ICT security skill mainly. This result showed the needs of educational contents which can complement effectively the gap of multiple playing, and we obtain a great future works to develop such some effective educational contents and to measure that effect at the same time.

For the purpose of training up the human resources who can contribute to the industry and practicing of effective security education, KOSEN has a big mission that we update the practice-based curriculum constantly.

a.

REFERENCES

- [1] K. Yonemura, K. Yajima, R. Komura, J. Sato, Y. Takeichi, "Practical security education on operational technology using gamification method," IEEE 7th International conference on control, system, computing & engineering, Penang, 24th-26th Nov. 2017, Malaysia, p.15.
- [2] S. Deterding, D. Dixon, L. Khaled, L. E. Nacke, "From Game Design Elements to Gamefulness: Defining "Gamification"," Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments (MindTrek 2011), Tampere, 28-30 Sep. 2011, Finland, pp9-15.
- [3] C. T. Sun, Y. Dai, H. L. Chan, "How digital scaffolds in games direct problem-solving behaviors-," Computers & Education, 57(3), pp.2118-2125, 2011.
- [4] Erik D. van der Spek, Herre van Oostendor and John-Jules Ch. Meyer, "Introducing surprising events can stimulate deep learning in a serious game-," British Journal of Educational Technology, 44(1), pp.156-169, 2013.
- [5] Kaspersky Lab., "Kaspersky Interactive Protection Simulation -An effective way of building cybersecurity awareness among top managers and decision makers-," pp.1-3, 2017.
- [6] Kaspersky Lab., "Kaspersky Security Awareness -Gamified training programs for all organizational levels-," p.2, 2017.