

Effect of Security Education using KIPS and Gamification Theory at KOSEN

Keiichi Yonemura

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

Ryotaro Komura

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

Jun Sato, Takeshi Hoga, Yoshihiro Takeichi

Dept. of Electrical and Electronic Engineering
National Institute of Technology, Tsuruoka College
Tsuruoka-City, Yamagata, Japan

Eikoh Chida

Dept. of Electrical and Computer Engineering
National Institute of Technology, Ichinoseki College
Ichinoseki-City, Iwate, Japan

Masato Matsuoka

Kaspersky Labs Japan
Chiyoda-Ku, Tokyo, Japan

Abstract— 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. We examined the educational effect and issues on multiple practicing of KIPS (Kaspersky Industrial Protection Simulation) which is based on gamification. Practicing experimental results showed that multiple playing simple contribute to the positive educational effect and we find the possibility of positive skill transfer, however we obtained a great future work which we need the educational contents that can fill the gap of multiple practicing effectively. KOSEN has the big mission that updates the practice-based curriculum constantly.

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

I. INTRODUCTION

Cyber-attacks on industrial equipment are really heating up in the industry. KOSEN, which is the National Institute of Technology in Japan (we call it KOSEN), produces a lot of quality industrial engineers to the industry. And KOSEN started cyber security educational project last year and is develop educational system that faces the threat of cyber-attacks in the world. What KOSEN students have the security skill and knowledge is conducive to the enhancement of cyber security on OT (Operational Technology) fields, making that our students can contribute to the industry. Although we advanced ICT security education using original educational contents for cyber security we developed ourselves, we think it is not easy to learn the OT security at that time. Because OT security has a lot of things which we can learn in actual

operation, so it has the aspect which is difficult for us to obtain an expected educational effect if we don't have actual industrial equipment and environment.

KIPS (Kaspersky Industrial Protection Simulation), which has developed by Kaspersky Lab, is the board game using gamification 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, 2].

In that issue, we examined security educational effect while we practiced the corporation version of KIPS which is comparatively close to ICT security and the Water Plant version of KIPS which is comparatively close to OT security, and then confirmed the difference between to practice with ICT security skill and knowledge and to practice with OT security skill and knowledge. This fact is really useful for us, that is KOSEN, which produce a lot of quality human resources to the industry, because we can examine the educational concept in the future.

In this investigation, we attempt to practice multiple playing the KIPS for KOSEN students who can be active in the industry because they master the basic skill and knowledge of engineer as a result of previous report. If we confirm the effect of what we practice multiple plays of KIPS, we can enhance our framework which produces stronger human resources effectively by applying the effect to our educational concept. In the multiple plays, we examine the relationship between OT security skill and ICT security skill. The examination of

relationship will be able to find the possibility that can be transfer the skill between OT security and ICT security each other effectively and that also makes contributions to the progress on future educational practice.

II. GAMIFICATION AND KIPS

We describe two topics that support the fundamental direction of practice of education using the contents applying the gamification, and they are essentials of our investigation [2].

A. Gamification

Gamification has been defined as "the use of game-play mechanics for non-game applications" by Deterding et.al. [3], which is used in many areas on education. One of the important features on learning by using gamification is that students actively learn and take solutions facing problems. Problem solving with gamification has also noted to be important benefits of using games in education [4, 5]. A problem-solving mechanism built with a game-based strategy enables not only they obtain knowledge and skills, but also its application throughout the learning process.

B. KIPS (Kaspersky Industrial Protection Simulation)

KIPS (Kaspersky Interactive Protection Simulation) is the cyber security practice, which has designed to enhance

analytical skill about both problems on the cyber security and the risk of latest computer system in operation [6, 7].

Players have to prevent the profit maximally and preserve the trust during exposure to a series of unexpected cyber threats. Furthermore players have to aim developing and running about the cyber defense tactics by selecting best suited cyber security countermeasure (see Fig. 1).

Players analyze a situation considering priorities of damage by cyber-attack, business and security, making a tactical decision based on uncertain information, a limited budget and feasible measure. Each scenario has changed by the situation each players 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.

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 corporation version again after seven days of first playing the corporation version.

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



Fig. 1. KIPS, the Cyber Security Board Game from Kaspersky



Fig. 2. Water plant version of KIPS which seems to be like OT security domain

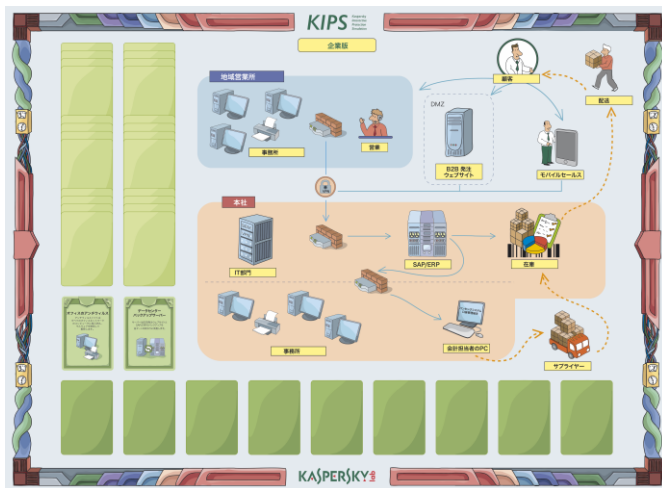


Fig. 3. Corporation version of KIPS which seems to be like ICT security domain

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 (two-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).

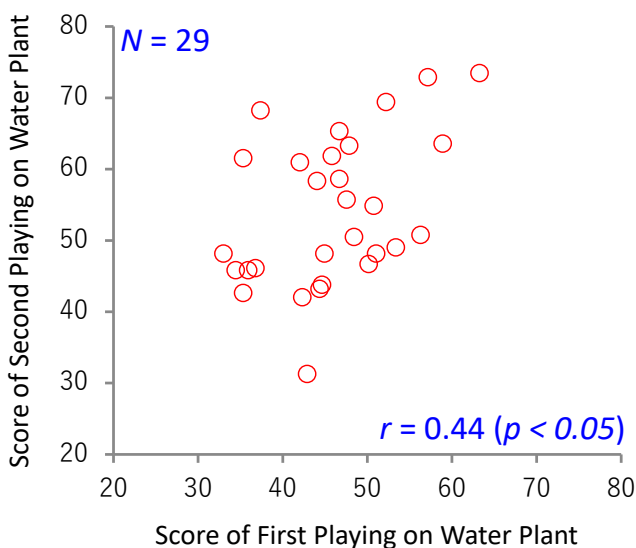


Fig. 4. Scatter diagram of the scores about first and second playing the water plant version

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 whether 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.

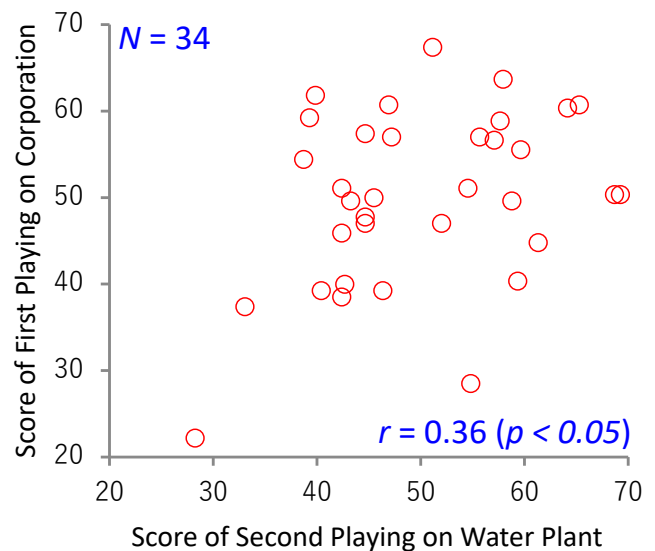


Fig. 5. Scatter diagram of the scores about second playing the water plant version and first playing the corporate version

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.

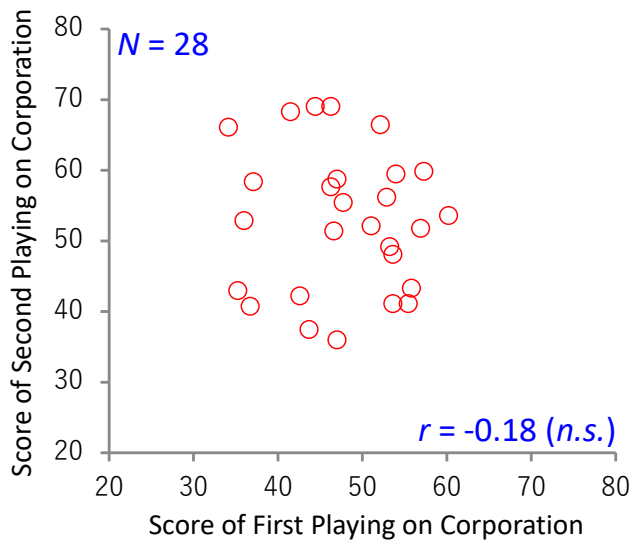


Fig. 6. Scatter diagram of the scores about first and second playing the corporation version

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 an 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.

ACKNOWLEDGMENT

This research can progress as part of the K-SEC (KOSEN Security Educational Community) project which fosters the cyber security talents on National Institute of Technology.

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] K. Yonemura, R. Komura, J. Sato, M. Matsuoka, "Practical Security Education on Combination of OT and ICT using Gamification Method at KOSEN," 15th International Conference on Remote Engineering and Virtual Instrumentation (REV2018), Duesseldorf, 21st-23th Mar. 2018, Germany, pp484-493.
- [3] 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.
- [4] 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.
- [5] 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.
- [6] Kaspersky Lab., "Kaspersky Interactive Protection Simulation -An effective way of building cybersecurity awareness among top managers and decision makers-," pp.1-3, 2017.
- [7] Kaspersky Lab., "Kaspersky Security Awareness -Gamified training programs for all organizational levels-," p.2, 2017.