Learning Systems Thinking by Using a Commercial Game

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Abstract:
Systems thinking is one of Peter Senge's five diciplines (Senge, Kleiner et al., 2011, Senge, 1992) To see how incidents are tied together, can be valuable not only in organizations, but also in for example crisis training. Two commercial games are being tested in order to see if it is possible to get a better understanding of systems thinking within the scope of crisis training. The games are called Emergency 2016 developed by Sixteen Tons Entertainment, published by Deep Silver, and "911: First Responders"® or "Emergency 4: Global Fighters For Life First Response", also developed by Sixteen Tons Entertainment, and published by Atari. The paper will discuss the learning outcome regarding Systems Thinking from playing these games, and suggest how they may be integrated in education.

Keywords: Systems thinking, crisis training, gameplay, learning

1. Introduction

The goal for higher education is to educate and prepare the students for a future worklife. Organizations sending persons to higher education may recognize the potential the individual learner has for bringing back valuable knowledge to the organization.

1.1 The learning organization

The individual learner in the organization is important, and learning includes according to Knud Illeris (2007) both the individual and the social setting. Learning, he defines, is any process leading to a persistent change of capacity with any living organism, which is not only a result from amnesia, biological maturity or ageing (Illeris, 2007).

Learning organizations are according to Watkins and Marsick characterized by "total employee involvement in a process of collaboratively conducted, collectively accountable change directed towards shared values or principles" (Marsick and Watkins, 1999).

A key element in learning organizations is *learning.* Chris Argyris and Donald Schön developed the concept of *single and double loop learning* (Argyris and Schön, 1996). The double loop is where the organization modifies the "underlying norms, policies and objectives" (Argyris and Schön, 1996).

The individual in the organization also need to learn in order to understand how to move forward. Since we are discussing games as a learning arena, we argue that this has a strong relation to experiential learning and Kolb's experiential learning cycle(Kolb, 1984) describing how one can learn from experiences. From one experience, one reflects upon the actions and then conceptualize the learning. This can then be verbalized and turned into the basis for a new experience.

However, the learning organization need also to recognize the need for information processing, for knowledge generation and how to acquire knowledge and make use of it (Davenport, 1998). Pedler, Burgoyne and Boydell stated that "a learning company is an organization that facilitates the learning of all its members and continuously transforms itself" (Pedler, Burgoyne et al., 1991).

The learning and development are according to Peter Senge linked to what he has described as "The Five Disciplines (Senge, 1992). The five disciplines are: personal mastery, mental models, building shared visions, team learning and systems thinking, the latter being the most important of the disciplines as this brings the other disciplines together to form a coherent body of theory and practice. Systems thinking is thus important to learn about in order to contribute in an organization in order to support the learning process.

1.2 Learning by playing/Serious games

The term "serious games" was coined by Ben Sawyer (www.dmill.com) and the definition of a serious game is according to Bryan Bergeron: *"… an interactive computer application, with or without a significant hardware component that*
- *Has a challenging goal*
- *Is fun to play and/or engaging*
- *Incorporates some concept of scoring*
- *Imparts to the user skill, knowledge or attitude that can be applied to the real world"*
  (Bergeron, 2006)

Knowing that the average gamer in 2015 was 35 years old (ESA, 2015), it is possible to utilize games as a means for learning. In fact, games for learning purposes have been a focus for research for several years. James Paul Gee published in 2003 his research on games for learning (Gee, 2003). His work and the work of Mark Prensky (Prensky, 2001) have been significant in the development of "serious games", games made for learning purposes.

However, also games developed for a commercial purpose can be used for learning purposes (Gee, 2007). There are several examples of commercial of the shelf (COTS) games that are used for educational purposes.

1.3 Research Question

This paper discusses the utilization of two commercial games for learning about systems thinking. The course curriculum was crisis communication. The learning objective from the gaming was to learn about systems thinking regarding crisis management. To learn about the interdependency between the different parts, their connections and feedback loops that make up the system of crisis management, was the goal for the gameplay.

The games are called Emergency 2016 developed by Sixteen Tons Entertainment, published by Deep Silver, and "911: First Responders"® or "Emergency 4: Global Fighters For Life First Response", also developed by Sixteen Tons Entertainment, and published by Atari.

2. Systems Thinking

Systems thinking is a term coined by Barry Richmond in 1987, developing the STELLA software ("Structural Thinking, Experiential Learning Laboratory with Animation")(Richmond, 1994). He states: *"The purpose was to think more productively about how to improve the way a system worked. So, we had both key elements: System and thinking. The name felt more accurate."*
The definition he provides is systems thinking as: "…the art and science of making reliable inferences about behavior by developing an increasingly deep understanding of underlying structure"(Richmond, 1994).

In 1992 Peter Senge published his book "The Fifth Discipline: the art and practice of the learning organization" (Senge, 1992). Here he presents what he calls the five disciplines; personal mastery, mental models, building shared vision, team learning and then the "cornerstone" of the learning organization; systems thinking. This is due to a tendency of focusing on the parts rather than seeing the "whole", and that there is a need to see the organization as a "dynamic process".

In "The Fifth Discipline Fieldbook", a definition is offered: "Systems Thinking is a way of thinking about, and a language for describing and understanding, the forces and interrelationships that shape the behavior of systems. This discipline helps us to see how to change systems more effectively , and to act more in tune with the natural processes of the natural and economic world" (Senge, Kleiner et al., 2011)
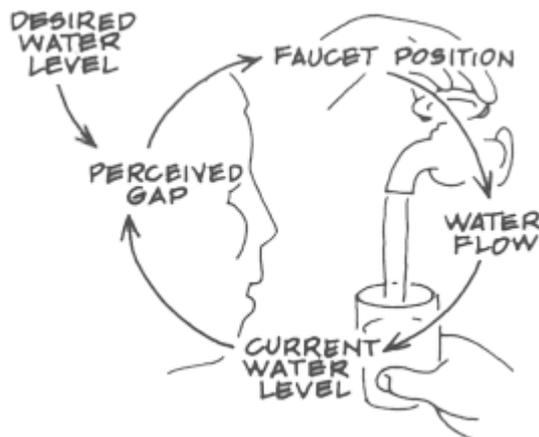

Figure 1 From Peter Senge's The Fifth Discipline (1992) - a simple system

Systems thinking require learning about some concepts that needs not only to be studied but also practiced. For instance; it is necessary to understand that the systems are made up by parts that inter-connect. That means that any changes made to any part or connection will affect the whole system. Also; the system structure will determine the behavior. The structure is how the system is organized. The parts are interconnected and the connections will determine how the parts work together. However, it does not just about understanding the parts and their connections, as the systems behavior is constantly in development. The system is complex, and there are feedback loops, different types of relationships, parts of the system may be adaptive and it is thus difficult to predict the behavior of the system.

Short term thinking and decisions, may for example have undesired effects long term, due to feedback loops. One example is the cut of expenses for advertising, and short term it will improve the budget and long term it may have serious damaging effects.
There is, however, no "quick fix" regarding understanding systems dynamics. Systems thinking in organizations require tools and deep understanding of the systems, their parts and connections, the feedback loops and their adaptiveness. In higher education it is still important to teach students

about systems interconnectedness. These students are to enter organizations with all their complex dynamics and the first step is to recognize that the systems exist and what they are made up by.

3. Games for learning/Serious Gaming

Games can be used for learning purposes (Gee, 2003, Gibson, Aldrich et al., 2007, Prensky, 2001), however, it is still difficult to merge good gameplay with good pedagogy (Ariffin, Oxley et al., 2014). Serious Games is a term coined by Ben Sawyer (Bergeron, 2006). A serious game is defined as *"…. an interactive computer application, with or without a significant hardware component that:*

- *Has a challenging goal*
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  (Bergeron, 2006)

Using games in higher education is something that students also seem to find useful. A study undertaken in Scotland and the Netherlands show that the majority of the respondents answer that they believe that gaming will contribute to their learning in Higher Education (Hainey, Westera et al., 2013). Their respondents are from approximately 22 years old to approximately 37 years old. Knowing that the average gamer is 35 (ESA, 2015), this may be an expected response.

The experiments carried out by S. Erhel and E. Jamet (2013) support the idea of learning from games. These games were, however, made for learning purposes. This is much like America's Army based on Epic's Unreal Tournament Engine (Michael and Chen, 2006). The games used for the investigations in this paper commercial off the shelf (COTS) games are used.

4. The games

The technical data on "Emergency 2016" are from http://store.steampowered.com/app/404920/ and show that their defined genre is "simulation" and "strategy". It is developed by Sixteen Tons Entertainment and published by Deep Silver on the 15th of October 2015. The engine is in-house developed based on the OGRE engine.

Emergency is a commercial series of games within the genre RTS (Real Time Strategy). The game is based on the different emergency response units, Police, medical and Fire department. The way we play is either as a single player experience, or a cooperative game mode, with each other. The goal of the game is to manage and direct your resources around the playable city and handle different scenarios. Throughout the game you will start with very few resources at your disposal, and gradually earn money to acquire more and better equipment. Emergency is based on micro managing every resource at your disposal. The game will gradually become more and more stressful since you have to move and give orders to every single firefighter or police officer.

You can play either alone and control every single unit for yourself, or you can play online and divide the different departments between the players. The multiplayer aspect of the game will require good communication and coordination between the players. Example: during a house fire the player in charge of the ambulances will have to wait until the player controlling the fire fighters have cleared out the fires that could have damaged or killed the ambulances personnel. If you choose to play on your own, the communication part of the game disappears, but you will have to know every location of every resource or accident by hearth. This gives a more stressful and a more rewarding experience on a personal level.

The other game is "911: First Responders" or "Emergency 4: Global Fighters For Life". The technical data for this is from : http://store.steampowered.com/app/323610/?l=norwegian . This is also classified as "simulation" and "strategy", and the developer is also here Sixteen Tons Entertainment. This is published by Atari and was released on 13th of April 2016. The game engine is the Vision-Engine. This is mainly playd with the modification "Los Angeles Mod" (http://www.losangelesmod.com) developed by the forum user "Hoppah". This is to make the game even more realistic regarding the access on gears/tools and tasks.

This is mainly played in the same way. It is about understanding the system regarding rescue operations.

The students involved in this project have also been involved in making gameplay and developing the game in the project that is within the Crisis Management (Skår, 2015). Comparing the in-house developed game and the two commercial games, they report on a higher stability for the commercial games. The Artificial Intelligence (AI) is more stable for the COTS games, but the potential is greater for the in-house developed as this can be used for a broader purpose.

5. Methodology

This study has mainly been of a qualitative character. The data have been collected using interviews, both individual interviews and group interviews(Creswell, 2003, Creswell and Clark, 2007, Dalen, 2011). The students were also to write down reflection notes after each time they played the game stating what they have done and what they had learned. The reflection notes (Bassot, 2013, Moon, 2006) were to describe the scenario, what they did through the gameplay and a sketch of the system they could detect.

The reflection notes were collected and then a group interview was undertaken (Brandth, 1996, Creswell and Clark, 2007, Dalen, 2011, Jacobsen, 2015).

The researchers field notes(Denzin and Lincoln, 2005) have also been a part of the total data material.

The students have also been a part of the writing process and have thus been able to secure the data similar to "member checking" (Guba and Lincoln, 1989)in order to validate and secure the data collected.

When analyzing the data we have sought to categorize into main categories and sub-categories in order to establish if there was any opportunity of learning systems thinking from the games and also if there were any potential of bringing the games into the ordinary education as a part of one of the courses.

6. Results and discussion

The students reported on having learned a lot from the games. They had learned how "the order of things" were regarding getting "people" in the games (avatars) rescued. The rules of the games were designed to allow actions to be carried out in a certain order (one action needs to be carried out before the next in order to get the best scores and to carry out the rescue operation). This depicts a *system* that has an order. This is possible to bring over to the real world as a system with elements that has interdependency. After having tested and understood the rules, they understand what is interdependent and the order of which to carry out the actions. Many of the "rules of play" are

applicable to the real world, and this understanding, the students find valuable. Just as in the "real world" the students can also play together. In order to win as a group, they need to share information and also make use of the information they have and receive in order to get the actions in the right order to make up the system. This is also similar to the real world; they need to communicate, but also make sense of the information they receive and make use of the knowledge.

The data from the interviews and the written reports show that the students understood the connection between systems thinking and what the game depicted. Also when playing as a group, they needed to have a shared vision of what to do, shared mental models, be able to learn in and as a team in order to beat the game and win points, which again gave each team player a personal mastery.

The games they played seemed to suit the curriculum well as they were about carrying out rescue operations. Their suggestions towards how to implement this in the education show that this can be be done in several ways; as a part of a course, as a part of a social game in the class (with larger classes one would need to make teams that may compete with each other), or something the students can be encouraged to play on their spare time.

If the game is to have an impact on the education, it would be useful to discuss the gaming sessions in class. In that way we would be able to reflect upon the learning and discuss the systems and compare them to the real world experiences. Also to connect the gaming sessions to systems thinking in order for them to understand the principles of interdependency between the different actions would be beneficial. This could either be done as a part of a course, e.g. in Crisis Communication.

7. Conclusion

The questions we presented in the introduction was if they could learn systems thinking from playing a commercial game, and to assess if this could be integrated in the education.

7.1 Learning from the commercial game

The COTS games seemed to work regarding learning about systems thinking in crisis management. The students report on an increased learning outcome using the games. It is important to see the how the different components of a rescue operation come together and form a system. This gives a richer picture of the different elements of the rescue operation and the chain of events leading up to the actual rescue.

Also it was possible to learn in a team, as multiple players could make up a team, communicating with each other and sharing knowledge. This knowledge needed to be made use of in order to come together to solve the tasks. Each of the team members experienced personal mastery, and they all shared the same vision and had the same mental models; to perform the actions in the correct way in order to win and score points.

7.2 How to introduce this in the education

Paired with writing the reflection note after the gameplay, the gaming supported the learning process. Writing reflection notes after *each* gameplay may be too much and reduce the fun of the

playing. The students suggest requiring two or three reflection notes, and discussing the reflection notes in class.

This would mean knowledge sharing not only within a smaller group, but also within the community that a class may be. The ideas and different outcomes from the groups can be discussed and experiences shared.

They may also reflect upon their experiences and test out new ways of playing and collect points, as well as learning about rescue operations. It is thus possible to facilitate for experiential learning (Kolb, 1984) using the games.

It is also possible to look at how to learn not only single loop; how to fix this, but also double loop(Argyris and Schön, 1996); what needs to be prepared and organized and done differently in order to gain the desired points.

7.3 Future research

The games should be tested on a wider scale. The threshold for learning the game is low, so most students should either on their own, or in groups manage to play them. The suggestion is that one of the assignments of the course is to provide a reflection on a part of the gameplay and relate it to the course curriculum. Interviews and a survey would provide data on how this affected the learning outcome with a larger number of students, and see if this is coherent with the result from this study.

Also to investigate what could be gained by bringing it in a class and share the different gaming sessions and to explore the learning potential from this way of using the games, would be interesting.

We are preparing a second cohort of this project in the spring and introduce one of the games as a part of the education. The students will be able to take part in workshops where they can be introduced to and play the game in groups. The number of students will decide on how many groups there will be and how many groups should share their experiences. What will be important, however, is that knowledge is not only shared and that they have fun playing the game, but also that they understand what can be transferred to the real life and how they can utilize this knowledge in their course, in their education and ultimately to understand the systems that make up crisis management in their own organization.

8. References

Argyris, C. and Schön, D. 1996. *Organizational Learning II. Theory, Method, and Practice* New York: Addison-Wesley Publishing Company, Inc.
Ariffin, M.M., Oxley, A. and Sulaiman, S. 2014. Evaluating Game-based Learning Effectiveness in Higher Education. *Procedia - Social and Behavioral Sciences* 123 20-27.
Bassot, B. 2013. *The Reflective Journal*. New York, USA: Palgrave Macmillan.
Bergeron, B. 2006. *Developing Serious Games*. Hingham: Charles River Media, Inc.
Brandth, B. 1996. Gruppeintervju: perspektiv, relasjoner og kontekst. *In* H. Holter and R. Kalleberg eds. *Kvalitative metoder i samfunnsforskning*. Oslo, Universitetsforlagets Metodebibliotek
Creswell, J.W. 2003. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 2nd ed. Thousand Oaks: Sage Publications, Inc.

Creswell, J.W. and Clark, V.L.P. 2007. *Designing and Conducting Mixed Methods Reseach*. Thousand Oaks, California.

Dalen, M. 2011. *Intervju som forskningsmetode*. Oslo: Universitetsforl.

Davenport, T., & Prusak, L. (1998). : 1998. *Working Knowledge: How organizations manage what they know*.

Denzin, N.K. and Lincoln, Y.S. 2005. *The Sage handbook of qualitative research*. Thousand Oaks, Calif.: Sage.

Erhel, S. and Jamet, E. 2013. Digital game-based learning: Impact of instructions and feedback on motivation and learning effectiveness. *Computers & Education* 67 156-167.

ESA 2015. The 2015 Essential Facts About the Computer and Video Game Industry. *In* T. E. S. Association ed.

Gee, J.P. 2003. *What Video Games Have To Teach Us About Learning And Literacy*. New York: Palgrave MacMillan.

Gee, J.P. 2007. *Good Video Games + Good Learning*. New York: Peter Lang Publishin, Inc.

Gibson, D., Aldrich, C. and Prensky, M., eds. 2007. Games and Simulations in Online Learning - Research and Development Framework Hershey, Information Science Publishing.

Guba, E.G. and Lincoln, Y.S. 1989. *Fourth generation evaluation*. Newbury Park, Calif.: Sage.

Hainey, T. et al. 2013. Students' attitudes toward playing games and using games in education: Comparing Scotland and the Netherlands. *Computers & Education* 69 474.

Illeris, K. 2007. *How we learn : learning and non-learning in school and beyond*. London: Routledge.

Jacobsen, D.I. 2015. *Hvordan gjennomføre undersøkelser? : innføring i samfunnsvitenskapelig metode*. 3. utg. ed. Oslo: Cappelen Damm akademisk.

Kolb, D.A. 1984. *Experiential learning: experience as the source of learning and development*. Englewood Cliffs, N.J.: Prentice-Hall.

Marsick, V.J. and Watkins, K.E. 1999. *Facilitating learning organizations: making learning count*. Aldershot: Gower.

Michael, D. and Chen, S. 2006. *Serious Games: Games That Educate, Train and Inform*. Boston, MA: Thomson Course Technology PTR.

Moon, J.A. 2006. *Learning journals: a handbook for reflective practice and professional development*. London: Routledge.

Pedler, M., Burgoyne, J. and Boydell, T. 1991. *The learning company : a strategy for sustainable development*. London: McGraw-Hill.

Prensky, M. 2001. *Digital Game-Based Learning*. 2007 ed. St.Paul, US: Paragon House.

Richmond, B. 1994. System Dynamics/Systems Thinking: Let's Just Get On With It. *1994 International Systems Dynamics Conference*. Sterling, Scotland.

Senge, P., Kleiner, A., Roberts, C. and Ross, R. 2011. The Fifth Discipline Fieldbook. London, Nicholas Brealey Publishing.

Senge, P.M. 1992. *The fifth discipline : the art and practice of the learning organization*. London: Century Business.

Skår, F. 2015. *INTERREG-midler til krisehåndteringsprosjekt* [*online*]: Hedmark University of Applied Sciences. Available at: http://hihm.no/om-hoegskolen/nyheter/interreg-midler-til-krisehaandteringsprosjekt [Accessed 31.03. 2016].