# Game Making as a Learning Strategy for Chemical Engineering

Sílvia Fornós
Center for Computer Games Research
IT University of Copenhagen
Copenhagen Denmark
sifo@itu.dk

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 812716.

## ABSTRACT

This document introduces the learning approach and projected outcomes of the author's ongoing PhD research, which aims to deliver guidelines for the use of game-based learning techniques, with game making at its core, in chemical engineering education. Since making games requires some technical knowledge that chemical engineering students do not usually possess, the author is developing a custom-made editor to make games intuitively without needing programming skills. Additionally, a game design workshop is included in the learning experience to ease the difficulties of beginners when creating games. All in all, the strategy facilitates hands on sessions that extend traditional education, during which chemical engineering content is approached differently than in a conventional class. Students work in teams, embrace a constructivist learning approach to create an educational game and participate in a hackathon-like event (game jam) to mention some of the features included in this learning experience.

## KEYWORDS

game-based learning; making games; game jams; constructivist education; chemical engineering; platform game; game editor

**ACM Reference format:**

Sílvia Fornós. 2020. Game Making as a Learning Strategy for Chemical Engineering. In *Proceedings of 2020 ACM Conference CHI PLAY 2020 (CHI PLAY'20), November 2-4, 2020, Virtual Event, Canada.* ACM, New York, NY, USA, XX pages. https://doi.org/10.1145/3383668.3419888


*CHI PLAY '20 EA,* November 2–4, 2020, Virtual Event, Canada

ACM ISBN 978-1-4503-7587-0/20/11…$15.00
https://doi.org/10.1145/3383668.3419888

## 1 Introduction

Our increasingly fast-changing society is introducing new technological opportunities every day which can significantly enrich our lives. However, the positive effects of accelerated socio-technical changes can only occur if versatile professionals, capable of thinking critically, can drive those changes and lead innovation. Hence, there is a common interest to educate students accordingly. New demands represent even so a challenge for old educational systems which are usually static and, therefore, do not tolerate change easily. This is the case of conventional engineering education based on a classroom with lessons about abstract concepts that lacks or has very little interaction with learners [1]. This sort of education has shown to fall short to effectively meet the new demands and requires to be addressed by educators and scholars. The activity of listening passively in class only covers a basic learning step focused on memorizing theoretical knowledge and needs to be extended with hands-on activities if we aim to educate the required professionals. In words of the professor in education **Jean Paul Gee**, "Traditional schooling is a vegetarian diet for carnivores" (2018). Through complementary practices, students can be challenged and face new situations where they take on an active role to put into practice content learnt in class. All in all, approaching learning from different angles than in a traditional class requires further attention, specially to ensure that learners are able to use their expertise in consonance with the demands of an unpredictable society. And precisely at this point is where this study sets out.

## 2 Learning Approach

During the first six months of my research, I considered different learning theories in literature that could facilitate and integrate the development of games in the learning process. My initial inspiration leans on **constructivist theorists** like **Jean Piaget**, who focus on experiences driven by learners' creativity where the teacher plays the role of a guide orienting learners rather than an instructor providing knowledge. These educational theories allow for a flexible learning experience produced out of a creation, like the ones experienced by children when playing with LEGO bricks and making creative creations. **Seymour Papert** led one of the first initiatives to use the same sort of approach with computers proposing the *LOGO* programming language in 1967 as an educational tool for children. Similarly, **Mitchel Resnick** developed *Scratch*, a graphical game maker also for children that allows them to program animations and small games intuitively by dragging and dropping the commands they want to use in the screen, with no need of programming language. The visual methodologies to teach programming to children offer an efficient learning experience [2] that can be reproduced for an audience with no programming knowledge like chemical engineering students. That is why digital tools used in primary and secondary schools to create games are a source of inspiration for the conceptualization of my game editor, through which chemical engineering students will make games representing chemical processes.

According to Gee, humans learn best when they are in an experience where they have an action to take or a problem to solve, they care emotionally (meaning something is 'at stake'), they can explore, try things and accomplish their goals. And video games can offer all that. In fact, game-based learning (GBL), i.e. using games in education, has become a relevant learning approach specially in Scandinavian countries in the last decade [2] and represents the foundations of my research. In general, one could distinguish four main resources in GBL:

1) *Gamification*: the use of game design elements in non-game contexts [3].
2) *Serious or educational games*: any form of interactive computer-based game software for one or multiple players to be used on any platform and that has been developed with the intention to be more than entertainment [4].
3) *Commercial games*: as opposed to serious games, commercial games refer to any form of game developed with the purpose of entertaining.
4) *Game making*: the process of making a game.

In the early 2000s, GBL emerged as a tool to increase motivation and improve the quality of the learning experience [5], mostly based on learners playing educational games. However, scholars have shown discrepancies with respect to the learning benefits of this type of games, according to a report by the National Research Council (2011). Advocates of GBL seem to be divided in two groups: those who tend to promote commercial games such as *World of Warcraft* or *Civilization* as powerful engaging tools and others that prefer to use educational games like *Word Island* or *CosmiClean* for its clear learning goals [6]. But, beyond commercial or educational games, a major topic for this study has been the center of academic debate, which is the discussion around **playing** or **making** games. In previous research, the action of learning by playing games has been identified as a limited and passive learning experience where knowledge is provided by the game, assuming that the game would act as a teacher in a typical **instructionist** learning approach [7]. On the other hand, if learners put themselves in the place of a game producer and create their games, the experience can reproduce a flexible **constructivist** learning approach [6] [7]. Nevertheless, playing video games offers a powerful **interactive** environment able to cause a broad array of experiences which, in my opinion, are very far from those lived in a conventional instructionist class. Quite the opposite, players, by just playing a game, can learn new skills, knowledge, insights, attitudes or behaviors that challenge them to think, explore, respond [8] and even create, depending on the game genre, like in the best constructivist learning environments. Thus, as far as learning approach is concerned, it does not make any difference if learners play or make games since games are usually educational per se and constructivism can occur during both playing and making. The focus should be put, though, on what to teach and how to **align learning content with game experience**. From this point of view, the technique of making games for learning or playing games that allow creating game items (*Minecraft*, *SimCity*, etc.) may have the advantage of counting on learners for the actual design of the game, which, in parallel, is part of the own learning experience.

Overall, I aim to provide an **unconventional learning approach** from a constructivist perspective which extends traditional teaching in order to, following with Gee's analogy, incorporate a balanced diet in educational institutions.

## 3 Projected Outcomes

I will deliver **guidelines** for the use of a **blend of GBL techniques** with **game making** at its core in an education context in science and technology. My proposal is that chemical engineering students create games to represent chemical processes. Thus, game creation becomes a creative process during which learning content acquired in a conventional class is needed to create **educational games**. Besides, a test is planned with an off-the-shelf game editor, ***Super Mario Maker 2*** (Figure 1), in view towards gathering data for the development of a custom-made editor. In this case, a commercial game is used for educational purposes. Finally, the learning activity is structured as a **game jam**, a hackathon-like event where participants create a game in a short period of time, i.e. from two to three days, in public institutions [9]. Game jam events enable participants to learn game development skills in a multidisciplinary and collaborative environment with potential for other pedagogical benefits, e. g. sociability, engagement, intellectual capacity, etc. [10]. From this perspective, the game jam is a game design technique moved out from its original context and, consequently, a gamification example.

**Figure 1: Representation of a distillation column in *Super Mario Maker 2*.**

## REFERENCES


[1] Kamal I Al Malah. A Perspective on Chemical Engineering Education. Glob J Eng Sci. 1(5): 2019. GJES.MS.ID.000523.

[2] Arnseth, H., Hanghøj, T., Henriksen, T., Misfeldt, M., Ramberg, R., and Selander, S. (eds) (2019). 'Games and Education: Designs in and for Learning', Leiden, The Netherlands: Brill | Sense. https://doi.org/10.1163/9789004388826.

[3] Deterding, S., Dixon, D., Khaled, R., and Nacke, L. (2011). 'From game design elements to gamefulness: defining "gamification"'. In Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments (MindTrek '11). Association for Computing Machinery, New York, NY, USA, 9–15. DOI: https://doi.org/10.1145/2181037.2181040

[4] Ritterfeld, U., Cody, M., and Vorderer, P. 'Serious Games: Mechanisms and Effects'. Routledge, London, 2009.

[5] Squire, K. (2005). 'Game-based learning: An X-learn perspective paper'. MASIE center: e-Learning consortium. Available at: http://www.masieweb.com/research-and-articles/research/game-based-learning.html

[6] Kafai, Y. B., & Burke, Q. (2015). 'Constructionist Gaming: Understanding the Benefits of Making Games for Learning'. Educational psychologist, 50(4), 313–334. https://doi.org/10.1080/00461520.2015.1124022

[7] Kafai, Y. B. (2006) 'Playing and Making Games for Learning: Instructionist and Constructionist Perspectives for Game Studies', Games and Culture, 1(1), pp. 36–40. doi: 10.1177/1555412005281767

[8] Lieberman, D. A. (2006). 'What Can We Learn From Playing Interactive Games?' In P. Vorderer & J. Bryant (Eds.), 'Playing video games: Motives, responses, and consequences' (p. 379–397). Lawrence Erlbaum Associates Publishers.

[9] Kultima, A. (2015, June). 'Defining Game Jam'. In FDG.

[10] Fowler, A., Pirker, J., Pollock, I., Campagnola de Paula, B., Echeveste, M. E., & Gómez, M. J. (2016). 'Understanding the benefits of game jams: Exploring the potential for engaging young learners in STEM'. In Proceedings of the 2016 ITiCSE Working Group Reports (ITiCSE '16). Association for Computing Machinery, New York, NY, USA, 119–135. DOI: https://doi.org/10.1145/3024906.3024913


.