Creating the Foundation for a Virtual Game-Based Learning Lab to Stimulate Distance Education

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Abstract: Game-based learning has established itself as a student-centred supplementary learning activity in most higher education subjects. Many university campuses are today providing collections of board games available at no cost for self-directing student activities. For universities with a high degree of distance education there is little comparable material available for online courses. There is of course a plethora of digital games available online, but rarely with any alignment to academic subjects and specific courses. For STEM subjects there are several research studies that report on successful initiatives for virtual labs with a mix of tailored simulations and educational games. The aim of this paper is to describe and discuss the requirements for a virtual lab that could provide user-friendly access to simulations and educational games in a wide range of university subjects. In the first phase of this educational development project, the focus is on games for the subjects of History, Pedagogy, and Computer science. The long-term goal is to create a virtual learning lab for all university subjects. Beside the work on finding the appropriate learning games and applications, a large part of this project will be creating a structure for the virtual lab and providing access to different types of games. The research strategy utilizes the Design science framework, with a focus for this paper on the initial phases of 1) Explicating the problem and 2) defining the requirements for the artefact. Data were gathered partly through a literature review, partly through a study of earlier development projects at the university, and partly from discussions with other researchers in the field of game-based learning. Regarding phase 1) To explicate and elaborate on the problem, the findings indicate that the issues of user-friendly access and licenses for commercial games are of primary importance. This leads over to phase 2), which indicates requirements for high usability and user-friendliness in a virtual gaming lab. This means hosting a mix of commercial quality games and educational games developed and tested in earlier development projects at the university. There are also discussions on collaborations with other game developing teachers from outside our university.

Keywords: Game-Based learning, Virtual learning lab, Game-Based learning lab, Educational games, Distance education

1. Introduction

The practice of learning by playing games has a history originating many centuries before it was explicitly discussed as a didactic method in ancient Greece. In Africa and Asia logic and mathematics were trained by playing games such as Mancala or Chess, Checkers and their many precursors. Still practiced today, and according to a recent study by Rimban (2023), chess also has the potential to develop softer and more general skills such as critical thinking, problem-solving, decision-making, patience, and constructivist thinking. In ancient Greece, Plato considered play to be a necessity for education as a first step on a ladder towards what he called true knowledge (Hellerstedt and Mozelius, 2019).

Virtual learning labs for distance education and self-learning is a much more recent concept, devised in the 21st century, with roots reaching into the 1990s. The majority of applications implemented have been simulations in the field of STEM (Forbus, and Whalley, 1998; Qiu, 2007). As found in the study by Heradio et al. (2016), virtual learning labs have certain unique affordances, such as: (a) modifying or simplifying real-world models to make phenomena more visible to learners and adapted to different cognitive levels, (b) performing a wide variety of virtual experiments faster and easier with fast feedback to the students, (c) helping students in the visualisation of objects and processes that normally are hard to perceive, and finally (d) to orchestrate experiments that are too expensive or difficult to carry out with real-world applications In the 21st century, game-based learning (GBL) has established itself as a mainstream student-centred supplementary learning activity in most educational contexts. Collections of board games are available at no cost for self-directing student activities in many universities. For universities with a high degree of distance education there is no digital counterpart, such as a collection of digital games for online courses. Only a small fraction of the wide variety of digital games available online, are aligned to academic subjects, curricula and specific course topics.

In the contemporary digital era, a digital toolbox for distance education should also involve educational games. As highlighted in the study by Celestini (2020), GBL with games that support learning, should be seen as an innovative instructional strategy in higher distance education. The application and use of educational games in higher distance education could, depending on the game design, be aligned to different learning theories such as behaviourism, cognitivism, constructionism, and connectivism. Behaviourism is a part of many games in the sense of rewards such as badges or points to encourage certain behaviour, or to discourage behaviour with a

corrective approach. Cognitivism could be implemented in games through activities such as decision making and problem solving. Constructivism in the sense of knowledge is created by interaction and activities could be stimulated by increasing levels of challenge that require learners to seek new information and test ideas in the gameplay. Connectivism involves the idea that knowledge is formed by the learner as a result of connections between nodes of information in a constantly changing and chaotic game world. (Celestini, 2020) Two other learning theories that are closely aligned to game-based learning are the Flow Theory (Csikszentmihalyi, 2013), and Constructionism (Papert & Harel, 1991).

The aim of this paper is to describe and discuss the requirements for a virtual lab that could provide user-friendly access to simulations and educational games in a wide range of university subjects. In the first phase of the educational development project described in this paper, the focus is on games for the subjects of History, Pedagogy, and Computer science. In the following phases of the project ViSpel, the long-term goal is to create a virtual learning lab for all university subjects where the subject matter experts want to involve GBL. Beside the work with finding the suitable learning games and their applications, this project should also comprise the creation of a structure for deploying and storing games in the virtual lab.

2. Post-Pandemic Distance Education

Virtual learning labs have been around for decades in distance education (Farana et al., 2004), but the COVID-19 pandemic certainly highlighted their value more than ever before. Besides the more expected use in computer science (Ahfaaf, 2023; Czekansky et al., 2023), the concept was also tested in areas such as language learning (Dai et al., 2025), healthcare (Leclerc, 2022), and banking (Knihová, 2021). The barriers for implementing virtual learning labs in new areas during the pandemic were probably not related to specific disciplines, but rather to the ICT skills of teachers and instructional designers.

As highlighted and discussed by Mozelius (2022) and Haywood et al. (2023), many online artifacts created during the pandemic are worth preserving and developing further. The pandemic brought many obstacles for traditional education, but at the same time helped foster open and inclusive course design. The pandemic provided an opportunity to enhance the existing educational architecture and reinforcing the course design by reimagining how, where, and through which mediums teaching and learning occur (Haywood et al., 2023). Moreover, the shortcomings that were revealed during the pandemic could act as a catalyst for further development of pedagogy and technology in distance education (Mozelius, 2022).

3. Method

This study is the first part of a Design science research project aligned with the fivefold process outlined by Johannesson and Perjons (2014). As further discussed in Humble and Mozelius (2023), small scale studies in academia could be carried out with some selected parts of the full five-fold process. The present study mainly involves the two first phases of the process depicted below (Figure 1). In the first phase, the problem was identified and formulated after brainstorming and discussions among the authors. Moreover, the results from the earlier projects HistoTree and SPEDAT were analysed and discussed. Both those projects are described in the next section. In the next phase, requirements were gathered using a combination of a literature review, discussions with colleagues in the HEaD initiative, and previous experiences from other GBL projects.

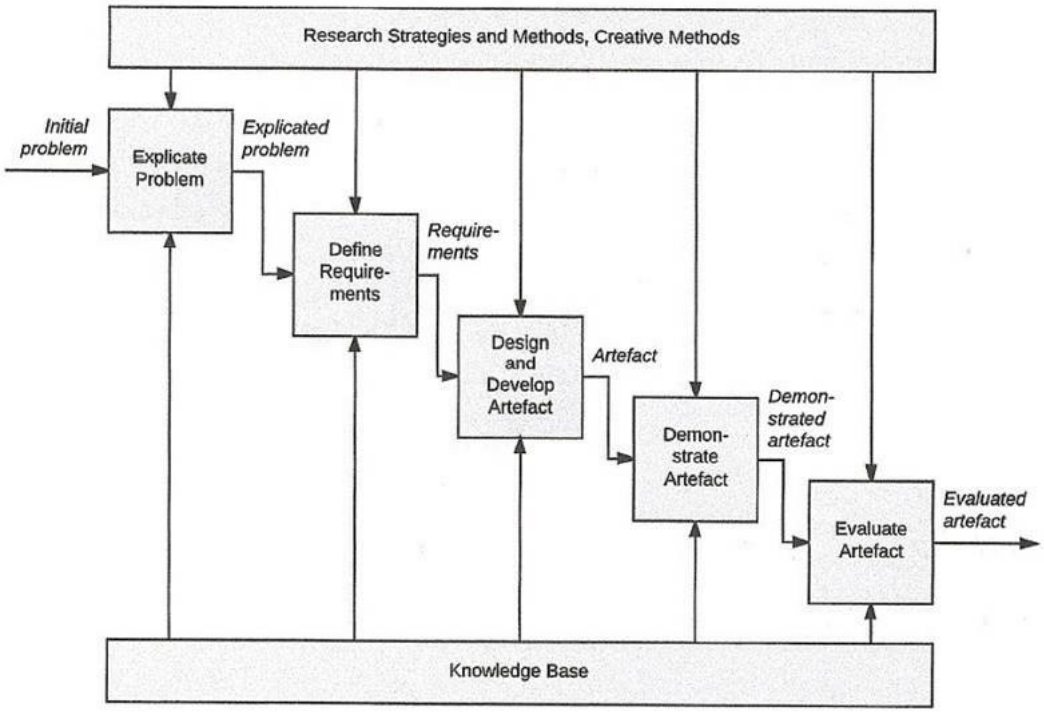

Figure 1: The design science process outlined by Johannesson and Perjons (2014, p. 82)

4. Earlier Development Projects

This study is a part of the project ViSpel, in the HEaD initiative, and builds upon two earlier HEaD projects on GBL, HistoTree and SPEDAT.

HistoTree

HistoTree was a two-year project, the purpose of which was to investigate the potential of using GBL in history education at Mid Sweden university. It aimed to study digital teaching methods and pedagogical tools relevant for the subject of history andthe advantages GBL may bring to students and teachers compared to traditional teaching methods. The technology tree concept was a particular focus. The project included literature studies (presented in Hellerstedt & Mozelius 2023), a survey of students' preferences in gaming (spring 2023; analyzed in Hellerstedt & Mozelius 2024), and a preliminary implementation of a GBL-based assignment written by students in the fall term of 2024.

SPEDAT

The SPEDAT project was a two-year educational development project carried out in a collaboration between Mid Sweden University, and the University of Gävle. SPEDAT is a Swedish acronym that can be translated as 'Games for computational thinking'. The overall aim of the SPEDAT project was to design, develop and evaluate an educational game in which players can learn about computational thinking and fundamental programming. Programming concepts have been implemented without alignment to any specific programming language. The current version of this game, *Programming in Valhalla*, has a Viking theme. Graphics and sound have been created with the use of generative AI. The first preliminary testing results were positive, but the game will undergo through two more test iterations during 2025. In the first round is a large-scale test to evaluate game mechanics and learning outcomes. The second round is a focus group evaluation, to assess the game's gender inclusiveness according to the guidelines presented in Mozelius and Humble (2022). When the described testing is completed, Programming in Valhalla should be deployed as a part of the virtual game lab.

5. Games in History Education

According to our previous findings, two major genres seem to be especially relevant for history education: role-playing games (RPGs) and strategy games. Hitherto, most research on game-based learning in history education has focused on the first category, strategy games. These come in many variations, but most prominent is perhaps the classic *Civilization* series (1991–2025), which in and of itself has attracted a significant number of studies. More generally, the focus has been on 4X games and, particularly, the technology tree mechanic, both of which

are, again, typically associated with *Civilization*. (Hellerstedt & Mozelius 2024; Squire 2003; Slocombe 2019; Ghys 2012) It is clear that such games have a definite number of strengths. They can be very successful in illustrating structural explanations on the societal level, such as the interplay between economy, politics and scientific and technological development. (Wainright 2014; Slocombe 2019; Hellerstedt & Mozelius 2023) Strategy games thus mirror one half of the academic study of history, i. e. social and economic history, with a focus on explanation and causality.

Less attention has been paid to the other important genre in previous research. Our recent study of the gaming preferences of students at Mid Sweden university however, pointed to RPGs as a popular and pedagogically relevant genre. According to our students' responses, such games promise to provide a different, yet complimentary, set of benefits to history education. They argue that RPGs will provide them with the opportunity to experience history, as it were, first-hand. A subjective experience of historical milieux, at best coupled with a focus on interpretation (e.g. of historical documents, in-game) is valuable for learning history in quite a different, but no less important way than the structural understanding afforded by strategy games. (Hellerstedt & Mozelius 2024)

6. Games in Programming Education

What makes GBL in programming special is that there are two different approaches to implementing the concept. One method is to play educational games on programming concepts (Olsson & Mozelius, 2017). In the second approach, students improve their programming skills by building their own designed games (Mozelius & Olsson, 2017). Preferably these two methods could be combined. This may be achieved with having last year students in project courses build the educational games that first year students play in introductory courses. Another often discussed topic of games for programming is about the choice between realism with real-world tasks, and a learning design with stimulating fantasy environments. The PhD thesis by Scott (2015), presents and discusses the idea of an introductory programming lab with fantasy role-play games. The underpinning idea being that fantasy role play can reinforce the real-world identity relating to the activity in the fantasy role.

The opposite is to go for the kind of 'kitchen sink realism' advocated in (Ljungkvist & Mozelius, 2012), with the idea of simulating the type of programming tasks that a student could meet in their future work life. A classic example of a gameplay based on hard and challenging work is the *Human Resource Machine* that was analysed in the study by Heithausen (2020).

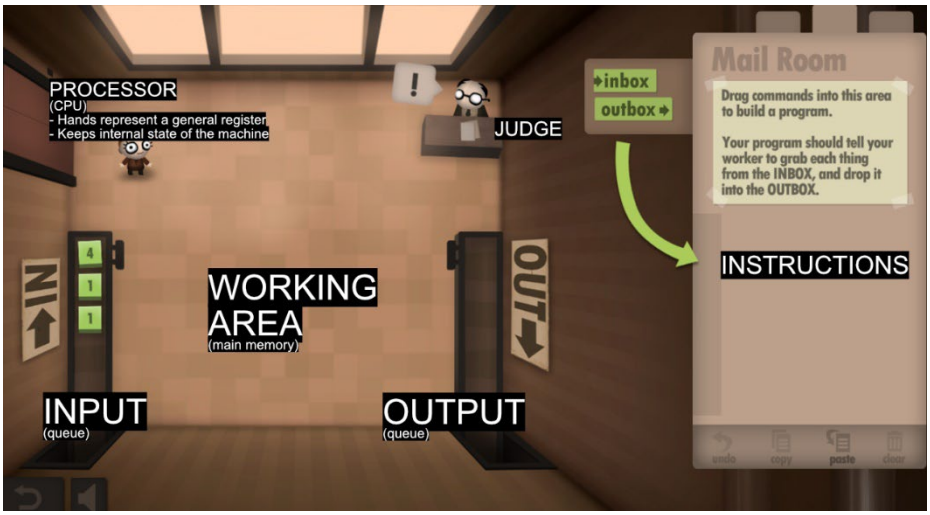

Figure 2: *Human Resource Machine* – a gameplay with concrete tasks and increasing difficulty levels

Moreover, his study discussed how the *Human Resource Machine* game aligned with Seymour Papert's idea of constructionism as a learning strategy. The gameplay has briefly been described as a game where:

> *"The player takes on the role of an office employee assigned with one task per level, 36 of which are included in the game. Each task involves both an input and output conveyor belt, the former supplying numbered or lettered boxes, as well as an assignment as to how the output should be related to the input" (Heithausen, 2020, p. 3)*

With an increasing difficulty and complexity for each level this is a challenging game that also raises the question about how too complex gameplay might scare students from further programming. On the other hand, and to

quote Papert (1998), *"Does easy do it?"*. Looking at the wide variety of educational games on programming and educational thinking there are huge differences in the difficulty levels, ranging from quite childish games such as *Lightbot* (Aedo Lopez et al, 2016) to the complex assembler programming tasks that can be found in the game *TIS-100* (Phipps, 2024). The pedagogical criteria for selecting games here should be the combination of constructionism and engaging games that create flow and an enjoyable learning process. Constructionism in the aspect of selecting games where real-world problems are explored by creative activities. Flow could be stimulated by providing a wide variety of games comprising content from fundamental computational thinking to advanced programming tasks with increasing complexity levels. A combination that is illustrated in Figure 2 where the given input should be processed to a specific output by instructions from the player. Instructions that are easy to put together at the initial levels, but complex and clearly challenging after the first 10 levels.

7. Ideas for a Virtual Game-Based Learning Lab

The ideas of constructionism and how to keep the players in the flow channel presented in the previous section are also valid for other subjects and game themes. While "Easy doesn't do it", a virtual lab must contain games that have a suitable level of challenges for the target group. With the idea of creating flow, motivation and happiness, the games should hit the flow channel in between the boredom of easiness and the anxiety generated by a too high level of difficulty (Csikszentmihalyi, 2013). On the other hand, this should not be based on gaming for the sake of gaming, and the games should have content that is aligned with the content and learning objectives of the courses where they are to be used. Another balance is the one between realism and fiction, that in introductory programming courses could be evaluated with games such as *Human Resource Machine* for realism (Heithausen, 2020), and the fantasy world created in *Code Quest* (Sällvin et al., 2024).

The design idea behind the *Code Quest* game also brings up the question of inclusion and how a game ought to be designed to attract both male and female players. Design factors such as narration, graphics and customization options should be considered. These factors are also important for immersion. The authors expect the high-quality graphics and the detail of the game *The Great Gambit* may contribute to a be successful implementation in history courses. The well-made graphics that could be found in Figure 3 below is a way to create immersion and to make players engage in game worlds with gameplay and content from eras in the past.

Figure 3: *The Great Gambit,* a gameplay set in the pre-World War I era with high-quality graphics and realistic details that stimulates immersion

Based on the principle that the two genres of history games complement each other, it follows that a selection of strategy games should be chosen, together with a selection of RPGs. For strategy games, the *Civilization* series may easily be included, through either use of an older (cheaper and more accessible) edition of the commercial game, or using *FreeCiv*, an open-source alternative with comparable content and game play. Similarly, the *Svea Rike/Europa Universalis* series (as recommended by our students in the previous study) is available in many versions and formats, making it easy to include. The above-mentioned *Great Gambit*, a Swedish-designed learning game for high school students, will complement these games.

For RPGs, the previous study of students' preferences in regard to games for history education (Hellerstedt & Mozelius 2024), has singled out a certain type of historical RPG. We therefore suggest including the commercial game *Pentiment* alongside the non-commercial game *Czechoslovakia 38–39: Assassination*, designed by Cyril Brom of Charles University (Prague). Together, these strategy and RPG games also cover different time periods in a reasonable way (world history, ancient to modern; medieval, early modern, modern).

8. Future Work

More important than the authors' opinions presented in this paper will be the feedback from the students playing the selected games. During the coming year some selected games will be evaluated in different university courses on history, computer science and artificial intelligence. Authors' intention is to present and discuss the

results of these evaluations at the ECGBL 2026 conference. We will also follow the game competition at the conference and include any games with content relevant for our game lab. Game effectiveness will be assessed in a mixed method approach with games involved in teaching and learning activities in various distance courses. Student feedback will be gathered from online gaming webinars, questionnaires and interviews. Quantitative data will be presented with descriptive statistics and qualitative data should be analysed thematically.

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Ethics declaration: This study did not involve any ethical considerations that needed clearance.

AI declaration: No Generative AI tools have been used in the creation of this paper.

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