Using Project-Based Learning to Teach Learning Game Design: The Example of LIFE Project

Martin Sillaots, Mikhail Fiadotau
Tallinn University, Estonia
martin.sillaots@tlu.ee
mikhail.fiadotau@tlu.ee

Abstract: Making a digital game requires a sustained, coordinated effort of a team comprising many roles and a diverse range of skills: developers, artists, designers, producers, etc. This means that interpersonal skills such as communication, management, and leadership are also crucial. But can these skills be taught at the university? While traditional subject-based education can be effective at teaching technical skills such as programming and art creation, this paradigm "provides little opportunity for students to acquire skills for <...> cooperative learning and problem solving" (Mandl et al. 1996: 396).

One way of addressing this challenge is through project-based learning (PBL), an approach to education that emphasizes student engagement, collaboration and hands-on learning through engagement with complex tasks based on real-life applications (Krajcik & Blumenfeld 2006).

This paper introduces an application of PBL to learning game design in the framework of LIFE (Learning in an Interdisciplinary Focused Environment), an initiative at Tallinn University which provides an alternative to subject-based education by inviting students to collaborate on interdisciplinary projects. Using self-reflection and semi-structured interviews, we surveyed LIFE participants whose projects focused on educational games in order to identify what competencies they believed the project helped them develop and what skills were still underdeveloped.

While LIFE proved effective at producing a tangible outcome (i.e. a game) and facilitating participants' technical skills, the evidence of improvement in interpersonal skills is not as clear: some students reported significant improvement, while others were less enthusiastic. LIFE seemed to have little impact on management skills, as participants with previous project work experience were satisfied with their performance and growth, whereas those without it felt less motivated to manage projects again. The results may be indicative of the organizational aspects of LIFE project itself, whose self-organising nature can lead to a mismatch in existing technical and interpersonal competencies, as well as levels of motivation in the teams. These factors need to be taken into consideration for a successful application of project-based learning to educational game design.

Keywords: PBL, project-based learning, game design, game education, LIFE, ELU

Introduction

Digital games are a complex, multimodal art form which combines a variety of media and technologies and, as such, requires a diverse range of skills and competences to create. This complexity also means making games is a time-consuming process, most often undertaken in teams. The integration of various domains including programming, visual art and game design places great importance on interpersonal skills such as communication, management and leadership.

Early game designers and developers learned their skills by themselves, but following the exponential growth of the videogame industry, many universities and schools started to offer game-related courses and programmes. However, many of these emphasise technical skills such as programming without focusing on "soft" (i.e. interpersonal) skills to the same extent (Hagan 2004).

At the same time, some game design and development curricula are utilizing problem-based and project-based learning, allowing students to improve their interpersonal skills through collaborative practical work (Hogue et al. 2011; Morozov et al. 2012). Yet, at present, evidence of the learning outcomes of this approach remains largely anecdotal.

In 2016, Tallinn University started an interdisciplinary project-based course called LIFE (Learning in Interdisciplinary Focused Environment), or ELU in Estonian, aiming to motivate students from different fields

to collaborate and learn from each other. Thanks mostly to the participation of Digital Learning Games MSc students, a number of team projects developed within the framework of LIFE have involved creating digital games.

Using two such projects as case studies, this paper aims to investigate the effects and outcomes of project-based learning in a game design context. Specifically, it focuses on whether and to what extent LIFE contributed to the development of the following:

1. Technical skills;
2. Interpersonal skills;
3. Autonomous growth.

An additional research question concerns the organisational dimension of LIFE: how adequate is the existing framework for developing soft skills and preparing students for future careers, and how can it be improved?

The case study is based on a qualitative approach, utilising self-reflection and semi-structured interviews as data collection methods.

1. Theoretical background

Recent years have seen increasing recognition of the importance of non-technical ("soft") skills and competencies in ICT education. These include interpersonal communication, teamwork, leadership and management — in short, "attitudes, behaviours and interactions among people in the work environment" (Vodd 2014). In much of contemporary scholarship on technology education, soft skills are deemed crucial for a successful career, a perception that the industry appears to share. Studies by Ahmed et al. (2010) and Hamilton et al. (2015) confirm that interpersonal communication and teamwork are among the most sought-after skills by IT employers.

At the same time, it cannot be said that university education has fully succeeded in integrating soft skills in ICT curricula. For example, in an Australian study of employer satisfaction with recent ICT graduates, interpersonal and team skills, as well as project work, were among the most common suggestions by employers as areas for improvement (Hagan 2004).

In line with this broader picture, soft skills are in great demand in the videogame industry, accounting for about a quarter of the skills mentioned in job advertisements (McGill 2008); and as such, they have been increasingly integrated into game design and development curricula (McGill 2009). However, there is little research on how soft skills are taught in game education programmes and whether existing approaches are effective and adequate.

A common approach to fostering communication, teamwork and management skills in technical education is through project-based learning (Hadim & Esche 2002). Project-based learning (PBL) is a form of situated learning that emphasises student engagement, collaboration and hands-on learning through engagement with complex tasks based on real-life applications (Krajcik & Blumenfeld 2006). It is rooted in the constructivist theory of education, which posits the learner as an active subject and creator of knowledge, in contrast to the passive recipient role that students occupy in the traditional (Socratic) method of instruction (Savery & Duffy 1995; Grant 2002). Pioneered by such scholars as Vygotsky and Piaget, constructivism views knowledge as arising from learners' interaction with their environment and the teacher as "a facilitator, not a dictator" (Holbrook & Rannikmae 2011).

Project-based learning usually begins with identifying and analysing a problem, defining the project scope, and forming teams comprising different roles. The teams then work to produce a tangible outcome which addresses the problem. This requires planning, self-regulated learning, communication and reflection. The last three skills are particularly difficult to acquire through conventional classroom instruction, while at the same time highly valuable professionally.

A related approach is that of problem-based learning, which shares many commonalities with its project-based counterpart but does not necessarily involve multi-disciplinarity or result in a finished product (Larmer 2014).

As videogame creation is a complex project that requires a coordinated effort of a team of members with diverse skill sets, project-based learning appears to be a method well-suited to teaching game design and development. A study by Brown et al. (2009) specifically employed PBL in a game design course with the aim of developing soft skills to better prepare the participants (Computer Science students) for the job market. A similar study by Claypool & Claypool (2005) highlighted the strong motivational effects that the combination of project work and game design had on Software Engineering students.

An implementation of PBL in a dedicated game design curriculum was described by Hogue et al. (2011), who found the approach to boost students' motivation and improve the retention rate. They also observed an increase in the quality of students' works on an anecdotal level, but their study did not specifically investigate the change in skills facilitated by PBL. This is the territory the present study attempts to cover: investigate the effects of PBL on soft skills development in the context of student-led videogame projects.

2. Methodology

2.1 Study Object

LIFE (Learning in Interdisciplinary Focused Environment), or ELU in Estonian, is a semester-long project-based course at Tallinn University which invites students to solve real life problems in interdisciplinary teams (see Jõgi et al. 2018). The teams generally comprise six to eight members with expertise in least three different areas. The purpose of LIFE is twofold: on the one hand, students can deepen their knowledge and apply it to a practical problem; on the other hand, they learn how to plan and run a project. Ideas for LIFE projects can be provided by both students and teaching staff and are advertised through LIFE Portal (http://elu.tlu.ee), which serves as a platform for team member recruitment.

In the case at hand, the idea of making learning games was initiated by the teaching staff of Digital Learning Games Master's programme (DLG, http://www.tlu.ee/en/DLG) in the autumn semester of 2017. A total of 12 students signed up for the project.

The process was organised in the form of project meetings. The first meeting introduced the objectives and the general framework of the course. At the end students got a home assignment: to generate ideas for a new learning game.

In the beginning of the second meeting, everyone had a chance to present an idea for a new learning game. Altogether four ideas were presented. Students were then invited to choose ideas that appealed to them in a hackathon-like format akin to Garage48 (Jervan et al. 2011). Ultimately, two teams were formed around the two most popular ideas. The remainder of the second meeting was dedicated to team building. After getting to know each other, team members were asked to decide on the role distribution within the team, making sure that the following roles were represented:

1. Producer (project management);
2. Designer (conceptual design);
3. Teacher (instructional design);
4. Artist (graphic design);
5. Programmer (code development);
6. Other responsibilities, depending on the project nature: e.g. sound editing, marketing, etc.

It was suggested that the author of the idea could be entrusted with managing the project (in retrospect, this may have been a mistake, as discussed in the following section). The home assignment was to refine the project idea and to put together a game concept document (Adams & Rollings 2006: 59).

The third meeting focused on project management and planning, while subsequent meetings mostly involved reporting on the progress of the project and its evolution compared to the initial plan. At the end of every month, each team reported on individual members' contributions using a timesheet. There was also a mid-term progress review meeting, whereupon teams presented their project plans and current status.

At the final meeting in December teams presented their projects and evaluated the development process. For this meeting, the teams were asked to:

1. Create a project poster;
2. Present the final result (prototype);
3. Reflect on their experience of LIFE project.

2.2 Research Design and Process

To elucidate the project dynamics and outcomes in their complexity, a qualitative case study was adopted as the research strategy. The choice was motivated by case studies' capacity to investigate phenomena and processes in their natural environments (Yin 2003). In the case at hand, the study focused on the effects and outcomes of project-based learning within the framework of LIFE project.

The case study was conducted according to the following procedure:

1. Defining research problems and questions;
2. Selecting the research object;
3. Selecting methods for data collection;
4. Data gathering;
5. Data analysis.

As the limited number of participants was evident from the onset, the study was conceived as exploratory in nature, offering no claim of generalisability but aiming to trigger a longer and larger-scale reflection. It was our hope that the validity of the findings could in part be corroborated by existing research on PBL (as elaborated in the Discussion).

2.3 Data Collection and Analysis

In order to evaluate the effects of LIFE project on participants' game development and project management skills, the students' feedback was collected in two iterations:

1. Individual self-reflection;
2. Interviews.

Individual reflection

After the end of the project, each team member was asked to evaluate their individual contribution and personal development. The evaluation was incorporated into the structure of the LIFE course at large and the procedure was identical for all projects. We decided to use it as a starting point of the study, allowing the results to inform the next iteration of data collection. The self-reflection was free in form but the following guidelines were suggested:

1. What was your **role** in the team?
2. What was your **contribution** to the project?
3. What was your **objective** in joining this project?
4. To what extent did you manage to **achieve** your goals?
5. To what extent did your goals **change** during the project?
6. What new **knowledge** did you acquire during this project?
7. What went **well**?
8. What could be done **differently**?
9. What could the **supervisor** have done differently?
10. Any other feedback?

Self-assessment reports were ultimately submitted by 8 out of 12 project participants.

Interviews

Individual semi-structured interviews with the participants were organised as a follow-up three to four months after the conclusion of the course. The interviews focused on the change in participants' skills and competencies over the course of the project. Delineating a set of skills to focus on proved challenging even following an analysis of existing materials on game development roles and interpersonal competencies (Adams

2003; Coll & Zegwaard 2006; Dede 2010) and specialised personality tests such as DiSC (www.discprofile.com/what-is-disc/overview). This was mostly due to the need to integrate specific technical skills in a single continuum with generic interpersonal ones.

Being unable to identify a framework for skill assessment that would readily lend itself to the task, we decided to adapt a framework designed for a different context, namely, OECD Key Competencies (as discussed in Dede 2010). The original framework comprises three sets of "21st century skills" — using tools interactively, interacting in heterogeneous groups, and acting autonomously — each of which is further divided into three competencies. By connecting technical competencies to soft skills and individual autonomy, it encompasses the full range of abilities required for a successful career in ICT. We adapted this framework to the context of game design education, which resulted in the following set of evaluation criteria:

1. I learned how to **use game development methods and tools** (corresponds to "Using tools interactively" in OECD Key Competencies):
   - 1.A. I furthered my game development/design competencies (game design, coding, art, writing, sound, quality assurance, instructional design, other).
   - 1.B. I was able to implement my competencies in practice.
   - 1.C. I know how to implement my skills in my professional life.
2. I learned how to **interact with the game development team** (corresponds to "Interacting in heterogeneous groups"):
   - 2.A. I learned how to relate well to others (how to find connections with other team members, build relationships, network, other).
   - 2.B. I applied this knowledge for cooperation and teamwork (taking initiative, communication, negotiations, delegation, supporting, scheduling, managing tasks, socialising, other)
   - 2.C. I learned how to avoid and resolve conflicts (I established communication rules, assigned clear roles, negotiated, other).
3. I learned how to **act autonomously**:
   - 3.A. I understood my role in the bigger picture (clear project idea and scope, clear development process, clear division of roles, meeting deadlines).
   - 3.B. I understood how to manage my personal growth (I can see the connection between my personal objectives and project goals).
   - 3.C. I learned how to defend and assert my ideas during the project.

In March 2018 five project participants (three members of one team and two members of the other) were interviewed, with the above criteria serving as a basis for semi-structured interviews. Interviews ranged from 30 to 60 minutes in length.

The results of the reflections and the interviews were analysed qualitatively using open coding. The answers to competency-related questions were then quantified by the researchers using a simple estimation scale: No (skill not furthered), Somewhat, and Yes (skill considerably furthered). Based on the codes and scales, frequency tables were created, primarily for illustrative purposes.

3. Results

The study results were structured according to the three groups of interview questions representing the main categories of development within the project: 1) technical skills, 2) interpersonal skills, and 3) personal growth. The results of individual reflections were integrated with the interview results. Quantifying the results with the use of a simple estimation scale resulted in the following table:

Table 1: Quantified interview results ("+" standing for "Yes", "~" for "Somewhat", and "–" for "No")

Student	Team	1A	1B	1C	2A	2B	2C	3A	3B	3C
S1	T1	+	+	+	–	~	–	–	~	–
S2	T1	+	+	+	–	~	–	–	+	–
S3	T1	+	+	~	–	–	–	~	–	–
S4	T2	+	+	+	+	–	~	+	–	–
S5	T2	+	+	+	+	+	~	~	~	+

3.1 PBL and Technical Skills

The purpose of the first set of questions was to find out what kind of game development skills students managed to acquire during the project-based course. In total, students provided 14 positive answers and 1 hesitant one.

The most frequent answer to interview question 1A and the reflection question "What did you learn?" was coding (mentioned 4 times out of 5 in the interviews and 5 times out of 8 in the reflections). The specific development tools and languages mentioned included *Unity*, *Game Maker Studio*, C# and JavaScript. Respondents also mentioned that the project was good for learning the general game development process (3/8 in reflections and 2/5 in interviews) and game design (mentioned 2/5 in interviews).

All interviewees reported being able to implement their technical skills in a specific role during LIFE project (1B). In the reflections, the most frequently mentioned roles were: programmer (mentioned 4 times out of 8 in the reflections), conceptual designer (2/8) and 2D artist (2/8). A number of other roles (project manager, sound designer, level designer, character designer, animator, narrative designer and team manager) were mentioned once. Students' contribution to the project consisted of the following activities: prototyping (mentioned 3 times out of 8), coding (3/8), art design (2/8), character design (2/8), sound effects (2/8), creation of interactive objects (1/8), conceptual design (1/8), writing dialogues (1/8), educational content design (1/8) and project management (1/8).

Respondents were also mostly positive regarding their expected ability to apply the acquired technical knowledge in their professional lives (1C). One student was certain that he could have a career in the game industry but said he needed to study game development more. Another respondent pointed out that the general model of the game development process can be applied in upcoming projects. A third participant found his new skills useful for writing his final thesis. Only one student (out of five) did not see a clear connection between the skills she had learned from the project and her professional plans, mentioning that she was more interested in conducting theoretical research than developing actual games.

3.2 PBL and Interpersonal Skills

The aim of the second set of questions was to find out how project-based learning had supported the development of the interpersonal skills. In total, students provided 2 positive examples, 4 hesitant answers, and 8 negative ones.

To interview question 2A ("Did you learn how to build connections with team members?") students provided 2 positive and 3 negative answers. On the positive side, one student mentioned that the team had organised additional project meetings (outside of the meeting times provided by the project supervisor). Another student commented that he had to learn project management due to his as a manager in the team. Respondents in team T1 universally reported that they had been unable to develop their interpersonal skills because of the communication and management issues in the team. In the individual reflections, 3 students out of 8 did report learning how to work in teams.

With regards to 2B, T1 members said they had no chance to implement interpersonal skills during LIFE project due to management issues (1/5), or otherwise felt no need to build new connections, instead choosing to interact with the team members whom they had known from before (2/5). When asked about their failure to establish stronger relationships within the team, they cited other members' lack of involvement or lack of interest in the project. One respondent from team T2 mentioned that he relied on the project manager to take care of networking. Only one student felt the need to implement his interpersonal skills, as he was the project manager in question.

All students experienced bigger or smaller difficulties in avoiding conflicts (2C) during the project. The project manager for T1 stated that she had been unable to avoid conflicts, largely caused by unclear role division: the team had three developers and two artists, who did not coordinate their work well and often ended up working on the same task in parallel. Furthermore, the three developers could not reach a consensus regarding their platform of choice and ended up using different technologies: *Unity* + C#; *GameMaker*; and JavaScript + HTML5. Conflicts were also caused by unclear communication, with some decisions in the early stages being made without consulting some of the teammates. This led the group to break into two fractions, with the more numerous one pushing their agenda through voting. While the situation was not as dramatic in team T2, the project manager there did have to use his role to oversee and control the process, with some tensions arising due to certain members' needing to be reminded to deliver the work assigned to them.

3.3 PBL and Personal Growth

The third set of questions was aimed at establishing how project-based learning supported individual growth. Those questions generated mixed responses among students. In total they provided 3 positive answers, 3 hesitant answers and 8 negative answers.

Most participants reported lacking a clear understanding of their role in the bigger picture of the project (3A). In team T1, where the project manager did not enforce strict management, team members felt at a loss due to unclear role division and frequent changes to the project plan. On the other hand, the project manager of T2 reported feeling at a loss due to the need to take up various responsibilities not covered by the other team members. One of the T2 members, however, reported having a clear picture of his role and contribution, citing "crystal clear" assignments by the manager.

Only one student provided a positive answer when asked whether they had been able to manage their personal growth during the project (3B): she had found a practical use for the general model of the game development process. Another respondent replied that he had already had a clear understanding of his professional development prior to LIFE project, which the project helped facilitate. Neither of the project managers wanted to take up this role again in the future, although one did state he had learned a lot from the experience. The other one had hated the role, in which she had found herself unwillingly and without preparation. One student, whose answers to the previous questions were largely positive, this time pointed out a negative aspect of LIFE project, saying that he chose to attend this course mainly because of the large number of ECTS credits it offered.

Most respondents reported having no opportunity to defend their ideas (3C). The only exception was the project manager from team T2. The others lamented various organisational issues: decisions were based on voting or were made behind their backs; team members provided no feedback to ideas. One participant mentioned that towards the end she (and other team members) "switched off" and stopped discussing project ideas altogether. Another student put a positive spin on it, explaining that he did not need to learn to defend his ideas because all of his ideas were all accepted by the team.

3.4 Suggestions for PBL Coordinators

In their reflections, as well as during the interviews, students provided many suggestions on how to improve the design of the PBL-based course:

1. Share more information about the game development process prior to the commencement of the course. (Only a third of the participants were experienced in game design or development at the start of the course.)
2. Provide a clear overview of the expected project outcome: is it a working product or just a teamwork experience?
3. Students suggested that teams should be formed according to project requirements and candidates' skills, not based on voluntary selection.
4. One student suggested adopting an agile approach and using placeholders to enable parallel development for all the team roles. This was in response to the recurring problem his team faced: programmers had to wait for the art assets, while artists waited for specific guidance from game and instructional designers, etc.

4. Discussion

The participants' accounts of LIFE project appear to confirm that project-based learning is a suitable strategy for teaching and implementing technical skills, which, most students feel, can be used in their professional careers. In the particular implementation discussed in this article, coding was a particularly central skill. It should be noted, however, that new skills sometimes had to be learned due to unclear role division or the lack of a particular competence in the team. Regardless, it does seem that working on a project is a fruitful environment for technical skill acquisition and development.

Somewhat counterintuitively, project collaboration in the case of LIFE was not as effective at facilitating interpersonal project management and communication within the team, and it should be noted that neither project manager in the study had previous experience in the field. However, their approaches were dramatically different: one instilled firm discipline and managed well; the other sought to "be soft" and avoid conflicts, which did not work as well (in terms of team relationships at least, as the group did manage to finish the project and deliver a game prototype in the end). It seems to be a question of balance: on the one hand, students are looking for a strong project leader who tells them exactly what to do; on the other, they do not like to be pushed around. A major challenge in terms of project organisation is identifying a skilful manager at the very inception of the project, and neither the respondents, nor the authors of this study have a clear answer as to how to accomplish that.

The success of the project and team members' satisfaction depends strongly on how clear role descriptions and assignments are. But learning to define roles and delegate work is itself part of the learning curve in PBL, so some negative responses may be inevitable. The varying levels of motivation present another challenge: in an educational context, some students will only take the course for the credit hours it offers, not the experience it provides. One possible solution is to ask students to set a clear personal goal for themselves at the start of the project. This could motivate them to learn more.

Although the expected outcome of the course—a playable learning game—was introduced in the beginning of the course, some students seemed to have lost focus in the process. Perhaps the course objective needs to be reiterated throughout the project.

Students also asked for more guidance in game development and project planning. This to some extent is specific to the context of the particular PBL-based course under consideration; perhaps in the future it should have subjects such as game design, game development and project management as prerequisite courses. Yet that seems to contradict the intention behind LIFE (and perhaps PBL on a wider scale): learn from each other in a heterogeneous team and discover additional sources of knowledge and growth when needed. This ambition, however, does need to be balanced with the realities of formal education.

A related challenge is establishing a balanced team where all the necessary skills are represented. What can be done if a team fails to attract members with a certain skill required for the project? A likely answer is that the scope of the project should be changed. For example, if none of the team members have programming skills, then the digital game can be replaced with a card or table game. Another option is for team members to do additional recruitment and identify suitable candidates to join the team, but this can be problematic as the students come from different study fields and do not always have the necessary connections. A further

complication stems from the fact that some team members may possess none of the required competences, but in a university context they too need to be afforded a place in the team. This would necessitate finding a role that makes use of their particular skills. This could be the responsibility of the project manager, but that brings us back to the issue of identifying a competent manager in the first place. Can a good manager be selected based on a personality test? For one thing, it is clear that a good project manager is not necessarily the same person as the author of the project idea. What is less clear, though, is how to navigate the relationship between the "proprietor" of the idea and the manager of its implementation. Maybe teams could be formed around tandems of a manager (producer) and a lead designer, which is an approach that may be adopted in future iterations of LIFE.

Building a team spirit is another important consideration: long-term project-based learning courses can likely benefit from ice-breaking activities to help participants establish new connections and not socialise exclusively with the people they already know.

The results of the present study will be used to improve the quality of future LIFE projects coordinated by Digital Learning Games faculty. Due to the limited scope of the study and the inherent context-specificity of the case study as a methodology, it is problematic to make far-reaching generalisations regarding the use of project-based learning in game design curricula. However, the main considerations voiced in the paper (team composition, skill representation, relationship-building, etc.) are likely valid for other similar contexts and in fact mirror many findings of existing studies on project-based learning beyond games education. Rosenfeld and Ben-Hur (2001), for example, discuss the difficulty of team formation and resolving participants' personal differences; Mills & Treagust (2003: 12) raise the issue of some "members of groups who did not pull their weight," as well as the risk of fragmentary and uneven development of fundamental skills in groups; Sultan & Javaid (2018) point out the difficulties in time management experienced by many team members; while Harmer & Stokes (2015) describe some students' struggle with individual autonomy and the limited guidance from the instructor. With regards to this particular implementation of PBL in game design education, our main takeaway was that more advanced management methods should be used in order to facilitate students' interpersonal skills in future LIFE projects.

Summary

Project-based learning is a risky and challenging undertaking. In many cases, project outcomes and the quality of the process depend widely on factors such as team composition and skill representation, which are difficult to control in the context of formal education. Educators need to deal with the resources available to them and it is highly possible that the outcome and the process of the project may be totally different from their initial plans. On the other hand, even if a project does fail, it occurs in the safe space that is education, not in real life with money involved. That in itself can be a helpful learning experience. As one of our students said: "LIFE project was the first big challenge during my studies at the university, and completing it was a great learning opportunity and necessary."

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