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Game lab: A Practical Learning Approach for Game Development.

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Abstract: Learning through construction is one out of five projects in our Center for Excellent IT-education (Excited - http://www.ntnu.edu/excited). A course called Game Lab has been run for several years at Nord University, and has proven to be motivating and engaging for most students. This paper analyses what factors students find important within the Game Lab concept when it comes to their motivation for learning. In the Game Lab course, students are put into a situation where they have to act as an actual game company, taking on realistic industry challenges, working with actual customers and having to answer to an executive committee on a weekly basis to report on their progress. To get good grades in the course the students have to prove that they are active in the team through clear tasks and responsibility descriptions, notes on working hours, weekly follow-ups, etc. The model challenges the students in many ways. As the model has proven successful, this paper looks into what specific factors, within this project-based learning concept, seems to increase and decrease the students' motivation and learning outcomes. Based on a survey for the students, teachers and external representatives, the paper looks into what factors are more important in the success of Game Lab as a learning activity, how it should improve and how it can make impact on other similar learning activities within other educational programs. From the research it was found that social element of working together, being given the freedom to work on projects that are perceived as interesting and relevant, seeing the finalized product, being able to specialize, constructive feedback and industry relevance as motivating factors.

Keywords: learning through construction (LtC), problem-based learning (PBL), motivation, engagement, game production, computer science

1. Introduction

Learning through Construction (LtC) is one out of five projects in our Center for Excellent IT-education (Excited - http://www.ntnu.edu/excited). At Nord University, a course called Game Lab – focusing on LtC and Problem-based Learning (PBL) has been run for several years and has proven to be motivating and engaging for most students.

This paper analyses what factors are more important within the Game Lab concept when it comes to motivation for learning.

In the Game Lab course, students are put into a situation where they have to act as an actual game company, producing a digital game, taking on realistic industry challenges, working with actual customers and having to answer to an executive committee on a weekly basis to report on their progress. To get good grades in the course the students have to prove that they are active in the team through clear tasks and responsibility descriptions, notes on working hours, weekly follow-ups, etc. Each team has a team lead who manages the company and balances the resources of time and workers to produce an engaging game.

The Game lab subject is assessed as a portfolio, assessing the process, documented work, work-logs, a reflection note and the final digital game (the digital product).

The model challenges the students in many ways. They may for example, experience a rejection of their games projects if the executives are not pleased. In other cases, a student who is not doing what is expected of him/her could be fired from his/her position in the "company" (student group) and will then have to apply for another position with one of the other groups. As the model is perceived as successful, this paper looks into what specific factors, within this combined LtC and PBL concept, seem to increase the students' motivation and learning outcomes. Based on responds to a survey for students, teachers and external representatives, the paper points out what factors are perceived as more important in the success of Game Lab as a learning activity. The paper discusses how the concept should improve and how it can make impact on other similar learning activities within other educational related programs.

2. Conceptual framework

Although there is substantial research on using game technology in an educational setting as an important factor for engagement (i.e Game Based Learning), there is surprisingly little on the specific topic of student engagement

in computer game development university level courses. With the Center for excellent IT education (Excited), research on students' engagement in a digital computer game development curriculum is highlighted. Our focus is mostly toward the concepts of problem-based learning and learning through construction.

The concept of PBL arose from medical education in the 1950s and has continued its development within the field of education since then. Darus et.al. (2016) define a problem-based learning environment consisting of the following central elements: Self-Directed learning, Self-Reflective Students and the Perception of teachers as facilitators more than knowledge disseminators. Self-Directed Learning implies independence and freedom of choice on the part of the students to determine their own learning objectives and activities.

Kay et.al (2000) summarizes their understanding of PBL to be: open-ended, authentic, substantial problems which drive the learning; explicit teaching and assessment of generic and metacognitive skills; and collaborative learning in groups.

Comparing the Game lab concept to the defining contents of PBL, we can see that the Game lab differs from PBL in the way that the teacher role alternates between the role of a facilitator and a customer / executive. Other than that, the Game lab is open-ended, authentic and seems to drive the learning based on substantial problem solving. Explicit teaching is given, as students and groups can "order" lectures from the teachers on specific topics, depending on their needs. Collaborative learning in groups is also a central element in the Game lab concept.

Another important element of Game lab is the construction of a playable digital game. From the theories of constructivism, learners actively construct knowledge from their experiences, especially in the case of building objects (Kafai 1995; Papert 1980). According to Fengfeng (2014), "prior research on learning by design and making makes learners carry out inquires or investigations, perform problem representation and solving by applying knowledge and skills, reflect on design and problem solving experiences, and engage in self-explanation communication activities."

The concept of Learning through Construction (LtC) does not seem to be very established in the world of research. Our use of the concept relates to the production of a digital product (game, app and similar) which gives students more hands-on and industry relevant experience, thus increasing motivation and engagement for learning. In this paper, the term Learning through Construction is defined as the process of learning when creating a digital artifact (i.e. digital game, digital app or similar).

One of the reasons behind our specific organization of the Game lab is that we believe it increases the students' motivation and engagement toward learning.

Student motivation and engagement has been conceptualized differently throughout the years (Hagel et. al. 2012). Amongst many definitions and conceptualizations, Vibert and Shields, 2003 examines the concept of "student engagement" as an inescapably ideological term. They talk about student engagement as a way of involving students in useful and productive activities determined by educators and guided by government policy or social expectations, where students must have autonomy, choice, and control in order to be genuinely engaged. This is seen as an ideological perspective. Fredriks, et. al. 2004, discussing school engagement, conceptualizes student engagement through behavioral, emotional, and cognitive dimensions, whilst Bryson and Hand (2007) discusses the conceptualization of student motivation through active learning and the relational contexts (towards peer students and teachers).

Blumenfeld, Kempler & Krajcik (2006) identifie four determinants influencing motivation and cognitive engagement. The first factor is Value (Intrinsic, Instrumental and Attainment). Intrinsic value is influenced by interest for the topic and enjoyment experienced when performing the task. Instrumental value refers to students' perceptions of how tasks are related to their future goals and everyday life. Attainment values refers to the personal importance that the students place on accomplishing the task. The second factor is Competence. Competence relates to the expertise and/or efficacy regarding the ability to succeed. The third factor is Relatedness. This factor refers to the students' feeling of belonging (social element). The final and fourth factor is Autonomy, which refers to independence and freedom to make your own choices.

3. Methodology

The purpose of this study was to analyze what factors in regards to the pedagogical concepts of Game lab were supporting the student's motivation for learning and which did not.

The investigation is based on two surveys. One survey is conducted with students of the Games and Entertainment Technology bachelors program at Nord University, and the other survey targets teachers and external industry professionals involved in the Game lab courses.

From a total number of 80 game students, 44 of them responded to the survey that was directed towards them. 3 teachers and 2 external industry professionals responded to the other survey directed. From the 44 student respondents, 44,7% were 1st year students, 22,7% were 2nd year students, 27,3% were 3rd year students. The remaining 5,3% were students that were newly graduated.

As we were uncertain of what factors motivate and which do not, with regard to game lab, we wanted to explore further and therefore designed the surveys using mostly open-ended questions, allowing the respondents to elaborate on the topics.

The following questions were asked in the student survey:

- In what year are you studying?
- Give a short description on what Game lab is.
- Name three things from the Game lab subject that you think increases your motivation.
- Name three things from the Game lab subject that you think reduces your motivation.
- What do you miss from the Game lab?
- If you could remove something for the Game lab, what would you then remove?
- Do you learn more from the Game lab than the other courses? If you answered yes or no to the previous question, please elaborate;
- Would you recommend these studies to your friends? If you answered yes or no to the previous question, please elaborate.
- Is there anything else you would like to comment on regarding Game lab as a concept?

The following questions were asked of the teachers and industry professionals:

- Name three things in regards to the Game lab concept that you think increases the students' motivation.
- Name three things in regards to the Game lab concept that you think reduces the students' motivation.
- What challenges do you see with the Game labs (seen from a students' perspective)?
- What challenges do you see with the Game labs (seen from a teachers' perspective)?
- What can be done to further improve the Game lab concept?

4. Findings

The questionnaire had, as stated earlier, mostly open-ended question, except for a few questions giving direct responses. The analysis of the open-ended questionnaire data (from the student survey) was done with a qualitative approach, manually reading thought it all, looking for themes and categories within the data. No qualitative analysis tools were used when working with the data. The data from the teachers' survey was used to compare and partly validate the findings from the student survey.

Continuing the analyzes and findings, student responses were summarized regarding whether they learned more from Game lab than from other courses and factors that they considered motivating and demotivating. The data from the survey with the teachers and executives was used to compare and support statements from the student survey.

4.1 Learning from the Game lab concept

The majority of the respondents indicates that they learn more from Game lab than from other courses. When asked the question "Do you learn more from Game lab than the other courses", 72,1% of students answer yes. Figure 1 shows the summary of answers from this question.

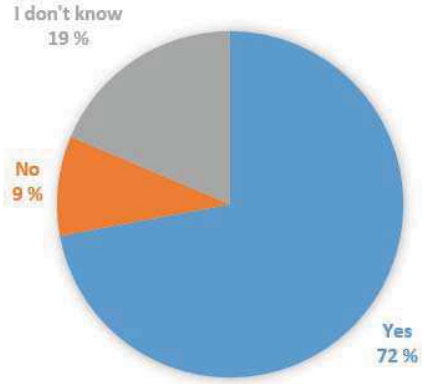

Figure 1: Do you learn more from the Game lab than from other courses

From the questionnaire, the respondents were also asked to give a reason for their answer concerning learning more from Game lab than from other courses. The following citations shows examples of statements made from students concluding that they learn more from Game lab than from other courses and connects it to possible categories: …

> *"In game lab i get to work and learn about things i specifically want to do"*
>
> *"The difference in Game lab is that we get to self-educate and research in the appropriate field we wish to specialize in"*
>
> *"The relaxed environment, group work and chance to improve yourself, gives more enjoyment for learning new skills"*
>
> *"The fact that it acts as a simulation is also nice in terms of preparation for a potential job in the industry"*

From these and similar responses, we can extract categories like: freedom; specialization; group work / social factor and industry relevance. These categories help give context to the overall research findings on motivating factors from the game lab concept in general, shown in the continuing part.

4.2 Motivating factors

During the read through of all the data, a coding scheme was developed, categorizing the statements from the respondents. From the 44 student responses, a total of 113 statements were given in regards to the motivational element.

The social factor of working together and collaborating in groups was the factor most often mentioned (34 times). Connected to this were statements like: teamwork, weekly meetings, working with friends, working together, teammates, the team, getting to know people, closer collaboration, etc.

The freedom factor was mentioned 22 times. Connected to this were statements like: freedom to choose our own game, independence, freedom to experiment, flexibility, being our own bosses; freedom of design, etc.

The positive effects of seeing the finalized product was mentioned 18 times. Connected to this were statements like: to see a full production of a game, seeing people having fun with our game, the teachers' interest in our game, seeing our project come together, the potential of making a finished product / game, making a full game, seeing people getting engaged in our game, etc.

Furthermore, the factor of specialization was mentioned 15 times. Connected to this were statements like: we get to choose what roles to grasp, work on what skills we want to improve and focus on, working on what you specialize in, being able to specialize, specialization, variety of tasks, self-educate, self-study, etc.

Also, statements connected to factors like teachers' and students' feedback (10 times) and industry relevance (9 times) were often mentioned. In the process, 5 statements connected to internal motivation was also found.

Figure 2 shows the summary of factors extracted from the open-ended survey.

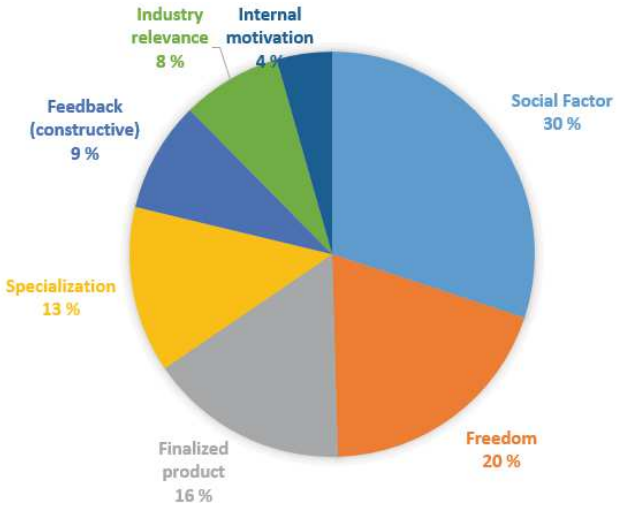

Figure 2: Motivating factor from the Game lab concept

Teachers and executives commented on the following subjects in regards to what seems to motivate the students: Good communication, student lead, regular feedback, the possibility to specialize, team building and students focusing on their interests.

4.3 Demotivating factors

On the negative side, a total of 99 statements were given to explain demotivation. From this, the most often mentioned factor was related to group work. 28 statements given, indicated some negative aspects of working in Groups. Examples of negative statements from group work were: dysfunctional groups, dealing with unmotivated teammates, bad teammates, bad team moral, demoralized team leads (coming from exec meetings), lack of communication, etc.

Negative feedback from teachers and executives was mentioned 23 times. From this category, we find statements like: inconsistent feedback, negative feedback from executives, some exec meetings, exec changing opinions, etc.

Slow progress was mentioned 15 times. Statements like standstill in my project, slow progress, sometimes not enough work, not properly testing the product, pre-mature playtesting, showing our game when we know that it is not finished, etc. are examples from this category.

Elements concerning restrictions were mentioned 9 times. Examples include: restrictions on all things, Execs forcing the project in a direction we didn't want, not enough freedom, etc.

The element of pressure was mentioned 8 times, lack of teacher engagement was mentioned 7 times, lack of competence in the groups was mentioned 4 times, availability of computers was mentioned 3 times and priorities was mentioned 2 times.

Figure 3 shows the summary of factors extracted from the open-ended survey on demotivating factors.

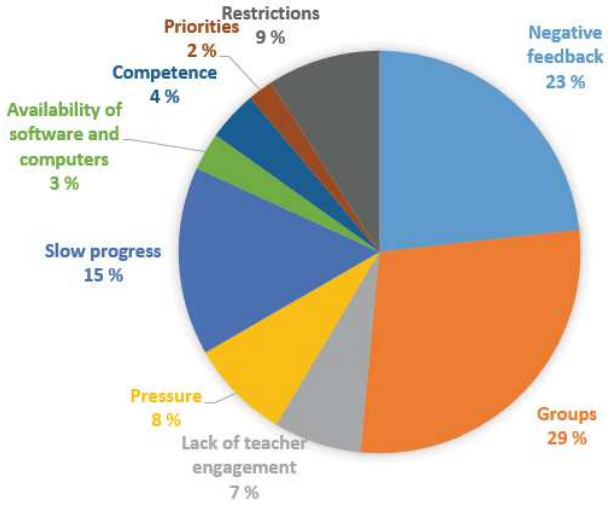

Figure 3: Demotivating factors from the Game lab concept

Teachers and executives commented on the following subjects in regards to what seems to de-motivate the students: un-professional attitudes amongst students, not taking the advice given, bad group communication, poor team leadership, personal conflicts, not handling negative feedback, struggling with time management, simulating real life situations can be tough, peer communication as a hurdle and insufficient skills.

Summarized, for the Game lab concept, we see that the most common motivating factors are Social, Freedom, Finalized product, Specialization, Constructive feedback and Industry relevance. On the negative end, we see that dysfunctional Groups, negative Feedback, Slow progress, Pressure and Lack of teacher engagement are found to be the most common demotivating factors in regards to the Game lab concept. Most of the factors mentioned are supported by the statements given by teachers and executives as well. In the continuation, these factors will be discussed and implications given.

5. Discussions and implications

The survey shows that the vast majority of the students learn more from the Game lab concept than from other courses within the Games and Entertainment bachelor curriculum at Nord University. Some interesting elements are found in the students' statements in regards to motivating and demotivating factors.

The most mentioned factor regarding both motivation and demotivation is the social factor / working in groups. This is not surprising, as it seems obvious that being part of a functional group will have motivating effects as being part of a dysfunctional group will have demotivating effects.

What is it then with the functional groups that makes students more motivated and put more working hours into the Game lab than other courses?

Looking into the details of the feedback from the students it is clear that the social role of being part of a group is very important for the motivation for learning. Many of the most mentioned factors connects to what Blumenfeld, Kempler & Krajcik (2006) identified as the four determinants influencing motivation and cognitive engagement (Value (Intrinsic, Instrumental and Attainment), Competence, Relatedness and Autonomy).

Looking at the findings it is clear to see that the Game lab concept supports these determinants for motivation and cognitive engagement. The Social factor was mentioned 34 times relating directly to the determinant of Relatedness. Freedom (mentioned 22 times) and Specialization (mentioned 15 times) relates to the determinant Autonomy. The factors Finalized product (mentioned 18 times) and Industry relevance (mentioned 9 times) would relate to the Value determinant, specifically focused toward instrumental and attainment value. This means that the Game lab concept as such contains many of the elements needed to heightening motivation (and cognitive engagement) to study.

This also relates to Ibanez et.al (2014) and their conceptualization of student engagement when using gamification as part of the learning activities, where they divide engagement into three sub-categories:

behavioral engagement, related to participation and involvement in learning; affective engagement, related to the willingness to do the work and positive attitudes toward the learning activities; and cognitive engagement, related to the desire to learn and to go beyond the requirements and relish the challenges.

However, there are still many elements that seem to demotivate the students. We therefore need to dig into the demotivating factors and find solutions on how to minimize their effect in the future. The most mentioned demotivating factors are dysfunctional groups – because of unmotivated teammates, bad team moral, demoralized team leads and lack of communication, negative and inconsistent feedback from teachers and executives, and slow progress in the game development.

Blatchford, Kutnick, Baines and Galton (2003) state that "If the relationships between grouping size, interaction type and learning tasks in groups are planned strategically then learning experiences will be more effective. However, research suggests that the relationships between these elements are often unplanned and the 'social pedagogic' potential of classroom learning is therefore unrealized."

Looking further into this part, we found that the dysfunctional group and their demotivation mostly stems from negative feedback from teachers and executives, slow progress, restrictions, pressure, lack of teacher engagement and lack of competence in the group. These things need improvement or need to be highlighted with the aims of giving the students different perspectives on the issues.

Feedback from teachers and executives needs to be more consistent and constructive, making sure that the students perceive the feedback as relevant and constructive. Teachers further needs to guide and help the groups in their game development process, making sure that there is clear progress from week to week. This means that teachers needs to change between the roles as being executives and facilitators. This is also mentioned in the teachers and executives' survey where one statement regarding what can be done to improve the Game lab concept says: "help the student team leads do better management of people and resources and conflicts".

As regards to the mentioned demotivating factors, restrictions and pressure, the action to take here is probably more debatable. From the survey with the teachers and executives, student projects very often loses their direction and goal and tends to be way too ambitious if no restrictions apply. In one possible pedagogical approach to decrease the danger of restriction being valued as a de-motivational factor, teachers could use previous examples more and play upon the senior students to give junior students more insights on the importance of restrictions. In regards to the pressure factor, it is no secret that if you are to take part in the game industry, pressure is something you need to handle. But, when pressure is seen as a de-motivational factor, it probably means that the student does not feel that he or she is in the "flow" and actions needs to be taken to change this feeling. Steele and Fullagar (2009) talks about flow and finds the most important components of flow to be a balance between the challenge of the task and skills of the student, clear goals on the part of the student, unambiguous feedback and a high degree of individual autonomy and self-determination. The mentioning of the de-motivational factor lack of skills and knowledge in the group (competence) also supports this, as it obviously would not give the student the flow feeling, which again is important for student motivation and engagement.

The theme of skills and knowledge is also one of the criticism to PBL, as students do not really know what is important to learn (especially within areas where they have no previous knowledge) (Boud and Feletti, 1997). To handle these types of issues, the students' previous skills and knowledge need to be carefully mapped and the facilitating teacher needs to adapt the PBL course accordingly. Another important issue is teaching the students how to ask the right questions focusing on effective techniques of inquiry. One should therefore also dig deeper into the field of inquiry-based learning and the different phases of the inquiry learning process (Pedaste et.al 2015). In addition, researching strategies for critical thinking would seem useful, making sure that the students act as critical thinkers and uses recommended strategies to dig into deeper conversations on given topics (Brown and Keeley, 2014) hence reducing the level of conflicts in the groups.

Looking at student achievement, Yoon (2009) found that a student-directed and self-regulated learning environment where the teacher acted as a guide to assist the students' learning process was more effective for students who had higher achievement. Then again, low achievers seems to be less motivated and hence not ready for self-directed learning. Teachers were therefore advised to be more deeply involved in the learning

processes for low achievers (Abraham, Fisher, et.al, 2011). However, Han et.al (2014) found that low performing students improved at a higher level than the high and middle performing groups (in the subject of mathematics). This, therefore, needs further research. Continuing analyses showed that one has to consider student background factors and the organizing of groups when designing STEM PBLs, also supporting the previous discussion on PBL and the importance of mapping the students' previous knowledge.

6. Conclusion

Game lab is a successful concept for students studying game development. Using larger elements of PBL and LtC, students are highly motivated. Important factors are the social element of working together, being given the freedom to work on projects that are perceived as interesting and relevant, seeing the finalized product, being able to specialize, constructive feedback and industry relevance. However, with many elements acting as de-motivational factors, actions needs to be taken to further improve the concept of game lab. During the discussion, several actions are mentioned that could help improving the concept or change the students' perspectives on the issue at hand. Shortly summarized, improving actions would be: making sure that feedback to the students is perceived as constructive and valuable; working with elements supporting the flow theory, for instance by adjusting the game lab projects to the skills and knowledge of the groups, but also helping the groups progress on necessary skills and knowledge and guiding them in the process; introducing the concept of critical thinking, making sure that students stay on the task, giving the students a better pedagogical toolbox by introducing them to the field of inquiry-based learning and the different phases of the inquiry learning process.

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