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INNOPOLY: DESIGN STEPS TOWARDS PROFICIENCY IN INNOVATIVE PRACTICES

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ABSTRACT
This paper presents design steps to bundle innovation skills in an educational model that in our previous research involved ideas and construct foundations rooted in a game plan ideology that aims at examining innovativeness [1]. In this paper, our ambition is to deepen students' abilities for self-governed innovative practices within a team. The paper presents an educational model towards embracing design creativity building on the foundations of a game plan ideology formed to examine innovation-driven practices. It also sets out to find a way to communicate a coveted and sustainable knowledge and to motivate the learning since it will affect the momentum of a self-driven learning process. We have used a series of workshops, focus groups and course analysis with engineering design students to frame and concretize the 'Innopoly' educational platform. The educational prototype 'Innopoly' consists of an inclination model inspired by Bloom's taxonomy whose ambition is to prepare our students for future challenges. The implementation efforts of specific interdisciplinary design elements aim to strengthen the acknowledgement of how to carry out a common and open innovative process and a holistic perspective. The ambition to examine innovative practices is fulfilled by incorporation of skills applied to manifest an autonomous level of performance and integrity. 'Innopoly' carries the outline logics from the innovation process – identification, research, ideation, concept, prototyping, testing and commercialization – similar to the increase of value that can be traced back to the original game form. In summary, the proposed 'Innopoly' prototype comprises both an operational (i.e. course activity) level of description and a strategic (i.e. course design) level rooted in Bloom's taxonomy to leverage students' innovation-related experiences and knowledge. In this paper we focus on the operational level; the learning and game fundamentals.

Keywords: Examination, innovation, play, creativity, engineering design, Innopoly

1 INTRODUCTION

What constitutes 'Education in product innovation''? This is a fundamental question and an alarming notion that needs to be seriously addressed when looking at current educational structures. Can we fit a model or elements attached to innovation that support the development of skilled engineers equipped with a 21st century mindset that is characterized by connectedness – to one another and to industry trends? The idea of capitalizing on the advantages that are encapsulated in ill-defined, ill-structured design problems [1] proposes an instrumented way to practice the skill to define, re-define and change the 'problem-as-given'[2]. Embracing innovative practices involves creating awareness of how distinct development phases correspond to individuals – e.g. professionals educated with different processes, using different methods, and working in different organizations – in order to more effectively build skills to leverage and apply the brainpower available to them [3]. Studies today require students to be active in the learning process where recurrent issues and reflections on existing knowledge occur. Problem-based learning in conjunction with others can lead to students experiencing knowledge at a greater depth, as well as complementary learning from the conversations involved [4]. A learning process that allows students to be the active party, more or less defining their own objectives and methodology, gives the student more control over the learning situation.
The basis of team requirements concerns individual and mutual accountability, commitment to a common purpose, shared leadership and autonomy. These can influence and encourage behaviour because they increase individual and team-level performance [5]. Working in a group can open up a

broader set of perspectives and refinements of ideas for each individual. Work group creativity can also be enhanced when a work environment provides rich knowledge stimuli, sufficient resources and a challenging workload [6]. Encouraging openness to a variety of approaches makes team members share their thinking and ideas more freely. Once this openness is achieved, the team's innovative capability begins to emerge, taking advantage of the different thinking styles, rather than experiencing them as conflicting forces [7]. The social architecture and social structure are connected to a team's level of performance. But the difference between perspectives, methods and processes can also inhibit high creative performance if the interaction and integration between members in a group fail. The divergent process needs a social interaction between different knowledge and processes to result in innovative output. It is our experience that engineering education trains too few of these skills. To better grasp and utilize and train individuals' innovative abilities, personal disbeliefs and mental obstacles have to be overcome. Interpretation and ways to facilitate creative thinking and innovative practices may be supported by frequent use and training. In this process a familiarity and pattern of recognition would make it easier for connectivity between irregularities as well as providing crucial experience between methods and context applications. The ambition of this paper is to propose an educational model that explicitly puts forward action-based learning formats to attain condensed innovation experiences. Our educational model, 'Innopoly', presents a perceived and preliminary tested outline of how to address innovative practices in a student-oriented learning context. Empowered by a dynamic operational set-up, it is derived from design situations and situated practices. The overall ambition is to examine innovative practices as these are redeemed in the reflection of skills applied that manifest an autonomous level of performance and integrity.

2 STEPS TAKEN – FRAMING THE DESIGN ELEMENTS

Our concept development phase started with workshops involving students with prerequisites in innovative processes on a basic level. We used brainstorming with discussions, reflection and prototyping as methods to understand how students interpret examination of teamwork in an innovative process. The workshops were designed to allow multiple ways of input where students made 'material talk-back' prototypes, charts and sketching to visualize their thoughts and discussions. By observing and taking notes during the sessions besides making photo memos throughout the whole session, the reliability of descriptions and thought in expressions was made stronger. In the workshops, students from Integrated Product development participated. Industrial Design Students participated in later seminars evaluating the prototypes. The workshops each had a distinctive purpose and were divided in two parts with two months in between: (i) The first workshop was intended to provide a student perspective on how creativity and innovation could be approached in a course format. This session comprised several clustered post-it chunks and physical prototypes describing elements of concern. One question of concern came to be *how* fun and excitement could influence the learning, asking in terms of 'What if you could play a game about creativity in a team – what will that look like and contain?' (ii) The second workshop was intended to build on the previous question, taking it a little bit further. At this time a loose game concept was orally presented and the task was to discuss different scenarios about innovative process, teamwork and innovative project work. Thereafter a review of all scenarios was conducted together with Industrial Design students in screening with a dozen students involving an open discussion evaluation.

3 RESULTS, TESTING THE DESIGN CONCEPT

The outcome of the first workshop was analyzed to end up with nine statements. These were then transformed, on a pedagogical and innovative research foundation, to a game structure. In the second workshop the game structure was further explored in relation to innovative processes for individuals and teams. First statement: The examination and learning shall concern the competence of working with innovativeness and the holistic knowledge to be able to perform an innovative process. Second statement: The game shall be performed as a workshop with some students from one or more disciplines. Third statement: A collaborative partner from industry shall be involved in either the process, the project or evaluating the result. Fourth statement: The complexity of the task shall be increased in the progression of the play. The complexity follows the progression of a learning taxonomy, e.g. Bloom's Taxonomy. Fifth statement: The examination shall take the form of different reflections as reflection-on-action and reflection-on-reflections-on-action [8] and be overseen by the examiner of the course. Sixth statement: The game consists of a frame and a structure but the students

develop the game when they play and therefore drive the project. Seventh statement: The students shall form 'swift teams' [9] and therefore they do not need a historical background as a study background together and after the concept the teams split up. Eighth statement: The game shall result in and be communicated with an oral presentation, e.g. 'pitch' for the result to the collaborative partner and examiner. Ninth statement: The playing shall be seen as an iterative process of performance, learning and examination.

4 INNOPOLY, THE GAME CONCEPT

We propose a primary model consisting of two primary levels: an operational level (e.g. activity-oriented course elements) and a strategic (course design and curriculum-driven) approach. Our intention is to stepwise explain elements of involvement and game logics from the operational level. The strategic course design level guides the long term application, yet this part is beyond the scope of this paper. Thus, the next sections display learning basis of the designed game idea as it is played.

4.1 The Operational Level

Project teams create a design logic that is not built on a known sequence of actions that need to be executed based on standardized procedures. The logic follows an assigned project mission where operational autonomy of participants is combined with an enabling role to match specification requirements (e.g. specific course elements). At this level, derived activities comprise the centre of attention and thus serve as a guide and curriculum-driven correspondent with intervening actions, objectives and examination in a fundamental and balanced learning situation (i.e. constructive alignment) [10]. Self-examination, peer-examination and real-life experiences play an important role for the students' awareness and visibility of their competence and knowledge. Examination performed by reflection increases the progression and places the knowledge test high in Bloom's taxonomy, e.g. designing their own process and methods. The importance of the tutor or examiner being present during parts of the play was crucial for the students' confidence for the examination and to ensure the legal quality of the examination process. But the relationship between teacher and student became less hierarchical when the tutor/examiner was given a less prominent role. The game concept supports sustainable lifelong learning, as it supports holistic learning and examination instead of atomistic learning and examination. When students focused on how to create the game they preferred to include playing principles instead of managing grading criteria, thus opening up for enjoyment and easiness when participating in the course. In summary, the game could be used both as a learning tool and for examination of competences and knowledge. They thought that the idea of playing would motivate students to have fun and explore rather than compete with each other.

4.1.1 Examination

One key to achieving greater awareness and reflective learning is through those activities that align the learning objectives with the examination requirements. We want a learning process that combines the student being an active subject of learning with an approach of knowledge building and experience learning. This should be done with a high level of awareness, actions, thoughts and reflection and a creative team process where students are mutually accountable, share leadership committed to a common purpose and have a high level of autonomy [5]. Embracing innovation at the operational level puts emphasis on sharing knowledge and keeping openness between peers and clarity and self-guiding purposes of activities performed. This stresses that content, or rather what possibly might go into the curriculum, needs to be revised in order to match innovation. Looking at the procedure and attained knowledge, i.e. reassurance of skills that each individual should have when finishing the course, enables the foundations of examination to be questioned. Derived from a notion of maximized learning, the examination is not given beforehand; instead a multiple assessment tool is proposed. Innopoly makes an attempt to examine the innovative process within a team but also at an individual level; moreover the examination needs to identify the level of the outcome of that process. The game examines divergent thinking, for example, using four categories: *flexibility, originality, elaboration and fluency* [11]. Performance-derived group-level innovation should be evaluated on the basis of the actual implementation of the creative idea or product by the group.

4.1.2 Workshop I: Individual learning

Our workshop sessions opened up some difficult areas to solve. Our experience after the workshops

with the students was that we must resolve the differences that exist in a group of students. One example is that an artistic education is a selection of competence and skills through work samples and interviews, while an engineering education is a selection by competence through scores. Student groups are represented in varying degrees for students who have talents and abilities to be stimulated by working with creative and innovative processes. Problems with group dynamics and ways to solve the task may appear which in turn affect divergence and communication within the team. They can affect the learning process and make demands on how the individual examination shall be conducted. The students felt it was important that confidence or, at least for the students, clarity is reassured. Here, performed examination and individual learning outlines a plethora of possible activities that could be played out to match specific program criteria. This in sum corresponds to the well-known guiding principle of constructive alignment where the activities involved have distinguished purposes [10].

4.1.3 Workshop II: Enabling scenarios

In line with contemporary research on team processes, students train themselves to work in teams having the competitive element that triggers the team to utilize each other's skills to succeed. Negative competition between the members that threatens to disrupt the team structure can be avoided by shared leadership and joint responsibility for the task and process. Depending on the complexity of the game where the team is dependent on the process, implementation and knowledge as to differences between members, all members need to cooperate and benefit from each other's differences and the common discussion. This can lead to a more open process if members are capable of interacting with each other and integrating the variation between members. In fact, they will struggle to manage to weave each other together. If the students do not succeed they will fail in a way, but since examination is based on both execution of activities involved and reflection upon their performed activity, opportunities to be rated high exist for all participating students. Such reflections would then tend to relate more to thorough reasoning than to merely characterizing explanation of actions. Based on the statements and discussions, some game scenarios were developed. The frame for the game concept is a plan with four sides, and the progression or complexity will be built on different layers that will be put on top of each other during the play. To proceed while playing involves a possibility to break up and interfere with a thought-out line of events; therefore even a roll of dice could fulfill this purpose. Allowing randomness reminds members to move forward in the play in regard to e.g. time constraints, but also to add unexpected phase-specific knowledge inputs or tasks. Cards or video clips with questions or assignments are examples of additional randomness that is part of the preconditions for the play.

1) Scenario Creative Methods: The duration of the play is short, about 3-5 hours, and the aim is to explore different creative methods and get the experience of using various methods together with other individuals. The result will be evaluated on the competence and experience in reflection, but also on the divergent thinking in the result. The objective is to build up an individual toolbox of different methods. At the first layer, methods will be presented randomly through the cards or placement on the plan. Different layers increase the progression and complexity of knowledge and experience. The last layer places the competence high in Bloom's taxonomy and demands new designs of creative methods based on the knowledge that has been examined in previous layers.
2) Scenario Innovative Process: The duration of the play is about 24 hours and the aim is to trigger a team to work in a deadline-driven process. They will be challenged with risk-taking and manage to integrate knowledge from each other as well as from the outside. The result will be evaluated in individual reflections, not only during the process in the form of feedback cards, reflections-on-actions and reflections-on-reflections, but also with an oral presentation of the result like a simulated pitch for a company or press. The objective is to manage to work with emphasis on team processes and innovative elements such as prototyping, involving users, keeping concepts open longer but also including intellectual rights/patents. Different layers represent different phases in the iterative creative process: Identification, research, analysis ideation, evaluation, refinement and communication. The complexity and progression of the play is regulated with deck cards and dice.
3) Scenario Collaborative Project: The duration of the play is fairly long and can be extended to one term. The aim is to involve a collaborative company in the process and work tightly in its organization. The result will be evaluated by the collaborative company together with the

examiner. There will also be an examination with individual reflections and peer reviews between students. The objective is to put emphasis on generic skills and involvement of different professionals in the process. Different layers represent different phases in innovative development processes, and the game will be developed by the teams during their process. Just the frames are given from the start, as the contact with the collaborative company, the abstract idea of different layers, toolboxes for prototyping, and deck cards and the dice for random inputs.

After the second workshop and subsequent discussions, the game concept developed based on the following foundation: (i) The team can get a "challenge" or find the "problem" by themselves. (ii) The play shall include different toolboxes, such as for e.g. prototyping. (iii) The game shall consist of different layers such as play plans. (iv) The time span for the play extends from four hours to two days. Shorter play duration is for playing with closed innovative process or an emphasis on theoretical examination of theoretical knowledge rather than skills and competences. Longer play duration is for a game with an open innovative process and to implement a critical mass of knowledge from the outside of the team and with emphasis on competences to use the toolboxes to come up with a result.

4.1.3 The Game Plan

For the interaction mode, enthusiasm and deep learning intercept, we present the idea of allowing playfulness when examining innovativeness. The idea is to build on one of the most familiar board games that have ever existed – Monopoly. Instead of just playing it together with friends, the idea is to put together a game plan under the label *Innopoly* where students themselves put together and play the game as preparation and a part of their examination. The game plan is divided into four acts: first, students assemble the game they are to play. They start with mutual problem identification based on given course materials and collecting research material specifically in visual format and with a holistic approach to the problem. Secondly, they define a mutual process and a time plan. Third, they start to play the game with a time perspective from one day to one week. Fourth, they orally present the process and results. The outline of the game plan should carry the logic from the innovation process – ideation, concept, prototyping, testing and commercialization – similar to the value increase that can be traced back to the original game form. The knowledge construction is supported in their performance, behaviour, thinking and reflections during all four phases.

Innopoly does comprise some alterations to pre-existing elements: video clips that the students themselves have been responsible for are used instead of the decks of cards (e.g. *Chance* and *General*). Students engage in interactive exercises ranging from idea generation exercises, rapid prototyping and patent investigations to idea/road show/sales pitch presentations. It is important that they get sufficient resources and that powerful knowledge stimuli are created to facilitate cross-fertilization and a broader set of perspectives. An additional focus is the way team members interact with each other and with the material, using reflection-in-action to frame problems and create solutions. If input material is too small, additional material can be supplied. Innopoly involves a class working in groups playing games in parallel and competing with one another. Still, the set-up could be used for individual examination, covering both individual ability and team performance. In both cases, the subsequent reflection-on-action and meta-reflection will be an important tool to examine team process, learning process and result vs. problem identification. For high performance results, incubation and individual idea generation sessions are suggested after group sessions to allow for individual reflection, to avoid limiting the opportunities for expression of ideas and activating related associations.

4.1.4 Multiple Modes of Learning

A key factor for Innopoly is student control and active participation in the learning situation. Together with other students they practice and build/construct their own learning path. This also stimulates the creative team process that strengthens the innovative performance and creates autonomy in the team – through intrinsic factors such as motivation and the understanding of skill variation – and supports the learning process of competences. What sort of competence do the students gain from this? Working together in a group or a team involves group dynamic skills. Every time a new group session starts, there are unknown situations and new challenges ahead for all involved.

From an educational perspective, the process is not static, competences are dynamic, built on individual skills and experience and reflection, enabling deeper learning through a reflective process. With reflection-on-action, reviewing past experiences, a particular situation is given allowing a

'dialogue' of thinking that can contribute to a more developed understanding and generate insights and conceivable new solutions [8]. Playing Innopoly with all the inbuilt possibilities and opportunities also opens up for reflection-in-action, as it is not a static game. On the contrary, the whole idea with the game is that it requires the team to come up with new solutions both in terms of divergent thinking and at a process level. This is also one of the cornerstones of why the game includes visualization and prototyping. Through visualizations and prototypes the "reflective conversation with the situation" is possible with back talk from the material [8], opening up for ideation and problem-finding, divergent thinking and creating a common platform for the team to discuss and experiment with. Based on that, we suggest that reflection-on-action as well as meta-reflection should be used as a method for examination. To what extent could the progression and completion of the learning outcomes be measured? What pedagogical methods can be used for both learning and examination? We suggest that performing a process as a team, combined with deriving a solution to a problem connected with reflection-on-action text and meta-reflection, should be a qualitative way of identifying both knowledge and competences in a dynamic process. In essence, we want the students to write a reflection-on-action individually after every phase, as a part examination but also a meta-reflection after the whole game process. We suggest that the learning outcomes should be defined as the ability to reflect upon and critically review the working and the team process, but also to generate various ways of future work.

5 CONCLUSIONS

This paper presents Innopoly, a game methodology in learning processes that corresponds to innovation in higher engineering and design education. The methodology puts emphasis on self-driven education and leaves the responsibility to the student team. Inspired by game plans, the methodology puts forward the integration of course activities, learning objectives and course requirements in a completely new format – an evolving game platform that students themselves proactively put together and provide with peer evaluation. More important is to work in close collaboration with external parts from companies that give credibility to the play but also enhance the motivation level. The game methodology helps students to learn new ways of applying knowledge in various situations, e.g. game scenarios, and ultimately to test and evaluate different solutions as part of a team.

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