MOTIVATIONAL FACTORS IN DESIGN-BUILD PROJECTS – CASE: PARTICIPATION IN STUDENT COMPETITIONS

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ABSTRACT

Often, some engineering students appear not to be as active and motivated as they should be to put enough effort into their studies, that is, to do their homework and attend different teacher-facilitated learning opportunities. Accordingly, course examinations can get delayed from the very beginning. Creating a learning ecosystem in which all students could achieve high intrinsic motivation is a difficult task. Yet, these aspects are of major importance when striving towards a flow-type experience in any learning environment. For example, the following factors are mentioned in literature as motivational drivers in learning settings: reinforcement, relevance, interest, self-efficacy and affect. In this paper, these factors facilitating students' intrinsic motivation are discussed in general, and in the context of design-build projects in particular. The paper presents how the presence of project stakeholders and customers affects the learning environment and further facilitates motivational drivers. Participation in an international student competition (Microsoft Imagine Cup World Finals) is used as an example to illustrate the elements discussed.

KEYWORDS

CDIO, Collaborative Learning, Engineering Education, Motivation, Projects

INTRODUCTION

Similar reasons seem to lead to student drop-outs in the different branches of higher education all over the world. According to Liimatainen et al. [1], the most important reasons behind delayed graduation in Finnish higher education concern working during the studies, lack of study motivation, psychological problems and family-related issues. On the other hand, variables like the student's age at the beginning of the studies, parents' educational background and academic performance and success during the studies also often appear to correlate with student drop-out rates [2]. Shuman et al. [3] reported that approximately only half of the students entering engineering education ever graduate, and roughly half of the drop-outs take place during the first academic year. Despite systematic development efforts driven, for example, by the CDIO initiative, these types of figures are still reality.

The first academic year is especially significant in relation to the drop-out problem. Typically, more than 2/3 of the students that eventually drop out will do so during the first academic year, many even during the first autumn semester. The problem is, naturally, complex and there is no single reason behind the discontinuation challenge. However, it is evident that some students do not seem to be as active and motivated as they should be to put enough effort into their studies. Accordingly, course examinations often get delayed from the very beginning and the vicious circle starts to spin. Creating a learning ecosystem in which all students could achieve high intrinsic motivation is a difficult task. These aspects are of major importance when striving towards a flow-type experience in any learning environment.

In this paper, the factors affecting students' intrinsic motivation are discussed in general, and in the context of design-build projects in particular. The paper presents how the presence and participation of project stakeholders and customers affects the learning environment and further facilitates motivational drivers. Participation in international student competitions is used as an illustrative case study. The main goal of the paper is to facilitate discussion on the motivation of engineering students and its importance in educational development efforts.

MOTIVATION AND LEARNING

Lim [4] lists six types of motivation valid for studying the context of online learning. However, the categories can also be utilized to reflect the motivational settings generally:

- *Reinforcement:* Reinforcement maintains and increases the probability of the response it follows. Examples and tools of reinforcement are grades, teacher feedback and peer support.
- *Relevance:* Relevance refers to the value residing in the learning content as reflected in the learners' needs and expectations.
- *Interest:* Motivation promoting learner involvement also requires intrinsic factors to be present. The motivators include challenge, fantasy and curiosity. These elements are especially relevant when aiming to achieve a flow experience.
- *Self-efficacy:* Self-efficacy refers to students' beliefs and feelings of self-worth and ability-beliefs in how well they can perform and be responsible in a learning task. Students who are confident and motivated to learn will often spend more time and effort to gain better learning results.
- *Affect:* Inclusion, attitude, meaning and competence should be present in every learning situation. Affect describes the state of emotional feelings, concerns and passions of the individual while learning. Affect is influenced, for example, by organizational culture and climate, peer opinions, degrees of frustration or determination present, and attitude towards change.

Creating such a learning environment in which all engineering students could achieve a high level of motivation is a difficult task. How can we mediate and reinforce the relevance of the different learning objectives, and facilitate interest in the different subjects and the future profession so that the learner could reach (and further develop) a proper level of self-efficacy and, furthermore, experience a positive attitude and climate?

ITERATIONS OF LEARNING AND PROFESSIONAL GROWTH

Salonen, Lehtinen and Olkinuora [5] presented a model describing the mutual relations of the student/learner and teacher in the context of the student's task orientation, i.e. his/her potential adaptation dominated by an intrinsically motivated tendency to approach, explore and master the challenging aspects of the environment and turn this "curiosity" into learning outcomes. The model describes the core relationships between the student, teacher, the learning task, and the reciprocal effect of the task definition in a socially guided learning situation. This model and the relationships are illustrated in Figure 1.

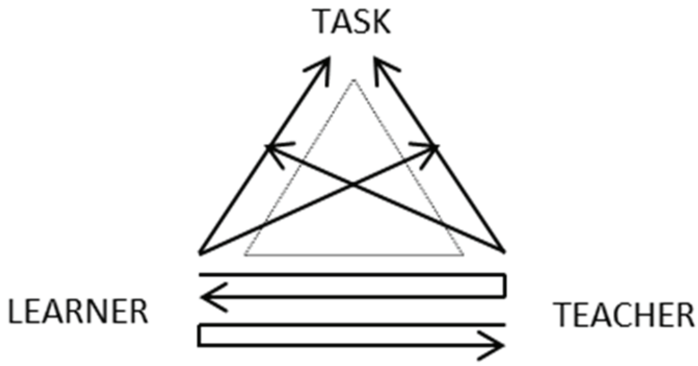

Figure 1. Student's and teacher's complementary motivational task orientation (simplified) [5].

The model helps in the understanding and analysis of the different aspects of a learning situation, and how the dynamics of the system may interfere if either the student or the teacher does not show a high level of task orientation. For example, a socially dependent student has a strong tendency to monitor and adjust to the teacher's performance-related expectations and to seek social approval. That is, the relationship between the student and the teacher dominates. Instead, an ego-defensively-oriented student with difficulties in learning tries to postpone or avoid tension and stressing confrontations with the teacher with, for example, substitute or passive avoidant-type activities. The various degrees of non-task-orientation are especially challenging for many teachers, and the teacher's own tendencies to catalyze or inhibit the student's learning process in a respective situation play an important role in the long run too.

The model of Salonen, Lehtinen and Olkinuora [5] was further developed by Vauras, Salonen, Lehtinen and Kinnunen [6]. They focus not only on the short-term characteristics of the motivational orientations and socio-emotional learning strategies but also on the long-term development of cognition and motivation. They discuss how the learner's learning history formed during a series of learning situations and contexts over a long period of time affects the present learning behavior of the student. These "episodes" of learning create a long-term path developing the individual's cognitive functions and motivational-emotional dispositions. In other words, the iterative cycles of approaching, starting, performing and terminating learning tasks steer the learner's behavior and adaptation in different learning situations. Accordingly, this development may improve the learner's development and growth, or have a negative impact compared with the original situation.

This can be reflected in engineering education learning situations too. Many students with motivational or other learning-related challenges develop significantly during the academic years. There are several examples of students who entered the program with modest entrance examination results and did not succeed very well at the beginning of their studies, but then started to improve and catch up with their fellow learners. Some of these students can in the end present exceptional thesis projects, graduate among the best of their cohort and have no difficulties whatsoever in finding employment. It seems (just based on practical experience, not that much on scientific evidence) that the turning point typically is the work placement period or a successful study project. For example, if a student with various learning and motivational problems happens to obtain a good and inspiring work placement position, the level of task-orientation can sky-rocket, and both the learning results and the adaptation to learning situations can change.

On the other hand, there are examples of students who are not able to develop in a positive direction. Both ego-defensive and socially dependent behavior and clear learning difficulties may often be present in many learning situations. This was surprising to me personally when I started my career as a professional teacher about ten years ago. I had not realized how difficult these types of issues are even in higher education. The teachers' behavior, actions and motivational tendencies also have a significant effect on development. Some are better equipped to support students with these challenges than others.

MOTIVATIONAL SETTINGS IN STUDENT PROJECTS

The CDIO initiative emphasizes the importance of a series of design-implement experiences in an engineering curriculum. They are considered the main opportunity for so-called dual-impact learning, i.e. the opportunity to construct a single learning event that both teaches skills and facilitates understanding of the fundamentals. Many engineering teachers can certainly agree with Young and Hallström [7] that these learning experiences can also be fun, motivating and the central feature of a student's engineering education. It is great to notice the motivation and joy of learning that can be achieved if the environment supports the opportunity and the actors are willing to accept the challenge.

One important element in different design-implement experiences, especially in more advanced student projects, is the presence of a customer or other project stakeholders in addition to the course teachers or other faculty members familiar to the students. The external customer also affects the traditional dynamics between the learner and his/her teacher and their mutual interaction when defining and discussing the learning task (see Figure 1). That is, the model of Salonen, Lehtinen and Olkinuora [5] can be extended to include the customer involved in the learning process in these cases (the extended model is illustrated in Figure 2).

The presence of a customer affects the learning situation in many ways. The customer participates in the definition of the task or assignment, but also affects the relationship between the learner and his/her teacher, which may affect the motivational system too. The customer often represents a potential employer to the engineering student, which can create a new motivational dimension compared to a purely teacher-led situation. Furthermore, the interaction between the teacher and the customer can make a difference. The teacher is no longer the only authority present, and s/he must be able to contribute to the situation in a way that also satisfies the customer. The relationship between the learner and the teacher can change too. Especially if the customer is not happy with the results, an interesting question is which kind of a role the teacher takes and how this is reflected by the learner.

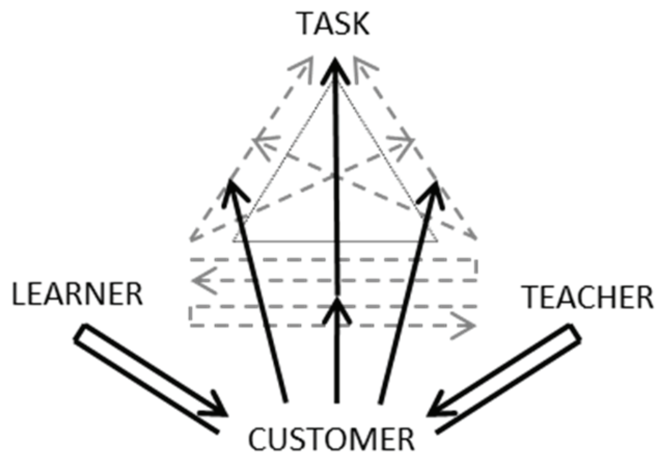

Figure 2. Student's, teacher's and project customer's complementary motivational task orientation model.

ILLUSTRATIVE CASE STUDY: PARTICIPATION IN STUDENT COMPETITIONS

Participation in different design-implement activities and projects are efficient tools to support the students' intrinsic motivation and they can also have a positive effect on the learning outcomes of more theoretically-oriented content when properly integrated together. Utilization of real-life project assignments with external stakeholders often improve the motivational dimension significantly and also provide a tool to strengthen the university-industry network, especially in relation to small- and medium-sized companies.

A Regional Student Competition Concept: ICT ShowRoom

Maintaining a proper project assignment portfolio is a challenging task, especially concerning the design-build activities of younger students. One successful platform is to utilize the potential of different student competitions in order to create a dynamic learning setting including not only the student groups and their teacher but also a customer or other external project stakeholder. For example, for several years Turku University of Applied Sciences (TUAS) has been organizing ICT ShowRoom, a local annual student project exhibition and competition, together with two other universities in Turku. Experiences from this competition have been reported in [8] and [9].

In brief, the event accepts two kinds of contributions: student projects made during the past year as a part of coursework, and research project presentations. For both types of contributions, the organizers provide a poster stand and a table for demonstrations. The student projects participate in the competition part of the event, where a panel of judges consisting of industrial experts evaluates each participating student project and selects a winning team. The competition, and especially the presence of an industrial panel, have improved the students' performance and motivation compared to the time before the event was introduced. The projects get completed on schedule, are more professionally showcased than before, and most groups really invest time and effort in their endeavors.

Participation in International Student Competitions: Case Microsoft Imagine Cup

In addition to local and regional project courses and competitions, there are several international student competitions that provide great opportunities not only to present the students' achievements but also to facilitate the project teams' skills and attitudes as well as to support their professional growth. TUAS teams have participated in several rounds of the Microsoft Imagine Cup (http://www.imaginecup.com/) during the past few years. In 2010, 2011 and 2012 a TUAS team has succeeded in winning the Finnish national finals and has thus been given the chance to represent Finland in the Imagine Cup World Finals. The best achievement so far was a top 6 finish in the main competition series by the TUAS Signbook team (see Figure 3).

Figure 3. TUAS Team Signbook in Microsoft Imagine Cup World Finals 2010.

The Signbook project was a good example of a capstone-level design-build experience that succeeded not only in producing a high-level product output but also greatly boosted the motivation of the participating students. The project dealt with the development of a novel learning platform for sign language learning. The assignment was given by Diaconia University of Applied Sciences (DIAK) that educates sign language interpreters in Finland, and the project itself was implemented by TUAS ICT Engineering students together with DIAK students and professional interpreter communities. In addition, technical experts from Microsoft Finland provided their support to the student team. The project started in autumn 2009 with a pre-study phase and continued to prototype-level implementation and further to an Imagine Cup competition project in spring 2010.

The students' motivation was supported and facilitated in many ways during the project. Originally, two students interested in Microsoft technologies were asked to join the pre-study, and later they recruited two new core team members to join the implementation phase. All the team members were volunteers and joined the project since they were ***interested*** in the technology and the project provided not only a significant challenge but also an opportunity to experiment with new technology, meet industrial experts of the field, and experience an adventure with their friends.

The project was designed and implemented with state-of-the-art technologies and tools, partly with software versions that had not yet been commercially released. Thus working life ***relevance*** was high and they were able to gain knowledge and skills that were not available to their fellow students. The project customer representative, mentor teachers and Microsoft staff were committed to the project and provided support and feedback to the team regularly. This active and constructive ***reinforcement*** was very important, especially in the first part of the project when the team members had to focus on learning the tools, understanding the project requirements and conceiving the vision of the product. Yet, it was made clear that the team had all the authority to make their final design decisions based on their own judgment and ideas. The students' ***self-efficacy*** was challenged several times during the project, but they were able to maintain a very good working spirit and, clearly, when they finally advanced to the world finals, they were already a very confident group of young professionals.

Figure 4. Team Signbook presenting to the judges in the final round of Microsoft Imagine Cup World Finals 2010 in Warsaw, Poland.

The project and competition experience steered the learning path of all the team members in many ways. They not only gained new technical knowledge and skills, but also became surprisingly competent in topics in new product development and business creation since the Imagine Cup experience included many dimensions other than just technical content. A high level of ***affect*** was present in the different phases of the competition process. The team (including the mentors) truly experienced a flow state full of excitement, joy of work and curiosity. The feelings of strength and commitment when proceeding in the competition also generated great disappointment when the team did not ultimately achieve a top-three position. Yet, the agony soon faded; a top-six placement in an international competition with more than 320,000 participants from all over the world was after all pretty good. – All the students of the Signbook team have now graduated, most of them ahead of schedule.

CONCLUSIONS

Student motivation is key to efficient learning outcomes and also an important element in the prevention of drop-outs. Yet, the different aspects of motivation and tools to support students' path from a motivational point of view are not often discussed within the engineering educator community. In this paper, the factors affecting the students' intrinsic motivation in different learning settings were presented and discussed. In addition, the mutual relations and dynamics connected to student-teacher relationships in motivational task orientation were illustrated, and the importance of the presence of an external project customer was especially highlighted.

Intrinsic motivation is vital for the successful completion of studies. As many engineering education programs suffer from a low number of applicants and early drop-outs, facilitating student motivation in different ways is important. Design-build opportunities throughout the curriculum have proved to be significant sources of motivation. Different project assignments with an increasing level of challenge and complexity can provide a platform that affects most of the motivational factors simultaneously, and also helps students with motivational challenges or learning difficulties to find a new boost that carries them further.

According to teacher feedback, it seems that projects with external customers or other stakeholders connected to the process together with natural customer-oriented schedule pressure have the best chance of success in terms of project deliverables, learning outcomes and team spirit. One reason for this may be the customers' effect on the system of reciprocal relations in task orientation. Moreover, these types of projects provide a fruitful arena in which to network, develop engineering and innovation competences, and to experience the joy of work and learning. For example, participation in student project competitions has demonstrated good results in this perspective. Positive experiences from our regional student competition ICT ShowRoom encourage developing the event further. In addition, international student competitions such as the Microsoft Imagine Cup provide excellent and motivating opportunities for committed student teams.

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Janne Roslöf is a principal lecturer in Software Engineering at Turku University of Applied Sciences (TUAS). He holds a D.Sc. in Process Systems Engineering and a M.Sc. in Chemical Engineering from Åbo Akademi University, Finland. Dr. Roslöf is head of the B.Eng. Degree Program in Information Technology at TUAS. In addition to his daily tasks as engineering educator and administrator, he has participated in several national and international educational development projects. He is one of the co-founders of the Turku ICT ShowRoom student competition series held for the sixth time in March 2013.

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