Student Motivation in
Distributed Software Development Projects

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ABSTRACT
In this paper we discuss challenges faced in conducting distributed student projects within a scope of a distributed software development university course. Student motivation and demotivation factors, along with perceived cultural differences, are identified and analyzed on the basis of data collected from a number of student projects.

Categories and Subject Descriptors
D.2.9 Management, D.2.10 Design

General Terms
Management, Human Factors, Teaching, E-learning

Keywords
Education, Software Engineering, Motivation, Cultural Differences, E-learning

1. INTRODUCTION
There are many obstacles for successful software development, particularly if the teams are distributed over several geographic locations – ranging from another faculty within the same university to another continent [12]. Some of the obstacles are technical, while others are rooted in cultural and language differences. Teams often experience communication difficulties, starting even from very short distances [7], which causes irregular information flow and overhead in exchange of information [8]. Team work virtues, such as trust or cooperation, can be an additional challenge if various cultures are involved [9].

It is therefore important for students of software engineering to experience such work while they are still a part of an educational process. Several courses dealing with global software development exist, such as [2, 4, 6, 10, 11]. These courses can help students to recognize and analyze obstacles through practical work with colleagues from another environment.

Courses described in [2, 11] focus on single development effort within a large system design project building a complex software system for an industrial client. Course duration is, accordingly, a whole academic year, with additional preparation

by the course staff in [2]. Courses in [6, 10] focused on smaller projects with teams working more closely. In order to address the effect of development process iterations, [2, 4] included a handover project phase in which one team would act as a client for the other, developer team, which preceded a reengineering phase. The other approaches focused on main development and didn't address reengineering. The impact of cultural differences was less emphasized in [2] than in [4, 6, 10, 11] as can be expected considering the similarities between Western (German and American) cultures.

Providing such an experience in a sustainable manner to students in a higher education environment has been proven very difficult. Special attention must be devoted to creation of a project framework where students are exposed to characteristic obstacles in a controlled fashion, as to provide valuable and positive experience and not to overwhelm them and jeopardize final project success [3]. Thus, new unobtrusive methods of distributed student project supervision and steering are necessary, allowing both students' freedom to experiment and create, and providing enough project insight and control from the teacher's point of view.

One of the necessary steps towards this goal is gaining better understanding of the factors influencing student motivation on distributed student projects, where those students face much more complex project environment than used to in non-distributed project assignments. Such an insight could equip the teaching staff with enough information to create a general model of student motivation in a distributed project setting and use it to both deploy effective mechanisms of risk detection and conflict prevention, as well as to adjust the existing project framework to provide more supporting work environment.

Another issue is the perception and interpretation of cultural differences by students involved in projects in a multi-cultural setting. Four questions are of a particular interest: what cultural differences are the most commonly observed ones, how particular project characteristics and student location influence perception of cultural differences, how cultural differences influence student motivation and how prior experience on non-distributed projects influences their performance and perception of issues in a distributed and multicultural environment.

In order to address all the mentioned issues, we have started to gather and analyze data from students enrolled on our distributed software development course held between universities in Sweden and Croatia. In the following chapters we present the preliminary results of analysis conducted on data collected from student questionnaires and observations of teaching staff during two semesters in years 2009/10 and 2010/11. Section 2 introduces the distributed development course and methods used to collect and analyze data. Section 3 presents identified student motivating and demotivating factors. Section 4

describes the preliminary results of analysis of student perceived cultural differences. Section 5 proposes a number of mechanisms to influence the project work and Section 6 concludes the paper.

2. DISTRIBUTED PROJECTS

2.1 DSD Course

Distributed Software Development (DSD) course is an elective course developed as a result of cooperation between the University of Zagreb, Faculty of Electrical Engineering and Computing, Croatia (FER) and University of Mälardalen (MDH) from Västerås, Sweden [5]. Conducted successfully since academic year 2003/2004, DSD is a project-based course designed to offer students an experience of working on software development projects in distributed student teams, in geographically dispersed locations, and with several cultures at a time, throughout all development phases of a real-world software project.

The course consists of introductory lectures and project work. In the introductory lectures, emphasis is put on the possible issues teams will encounter in project work, and some of the ways to handle these problems. The lectures take place only in the first five weeks while the remaining three months the course is completely focused on project work. During the practical part of the course, students need to present their progress on several occasions. The presentations are also conducted remotely, with the inclusion of all sides. A more realistic note is given to the projects by employing different types of project customers [1].

2.2 Project Information

Information on students' project experiences is gathered using two principle mechanisms: periodic polling (once a week) during the project work and the final questionnaires submitted by students after the project work has been finalized.

The final questionnaire is a mandatory submission and, together with points gathered in practical part of the course, forms a basis for a student's final course grade. The questionnaire consists of a number of questions divided into six main sections covering their experience in local cooperation, distributed cooperation, communication, project work, perceived cultural differences and a chapter dedicated to project and team leader experiences. The questionnaire uses several types of questions (open/closed, general/specific etc.), requiring students to provide answers in qualitative and/or quantitative form. The tendency to present a positive personal and project group image is compensated by posing questions that explicitly address both positive and negative project experiences. Some questions allow quantitative analysis and cross-comparison of answers thus revealing students with biased/insincere attitude (for example, collaboration matrix analysis where students rate their amount of collaboration with other team members).

Students reveal their perception of cultural differences by providing answers to two questions. The first question ("How would you describe cultural differences you have observed") requires students to describe their overall perception of cultural differences by selecting one of the offered options: *no differences, low, medium* and *high*. The second question ("Describe cultural differences you have observed and rate their impact on project work") allows students to list as many differences as they have observed and rate their impact on project work (0 - no impact, 5 - high impact). Similar questions are used to collect data on motivating and demotivating factors; students list all the factors they consider relevant and assign corresponding impact factors (0-5).

The research conducted is based on a subset of data collected from 2009 and 2010 DSD course instances. Out of total 19 projects, 14 of them were selected for analysis (five have been of different nature), having in total 90 students (40 at FER and 50 at MDH). While the environment at FER was mostly uniform (35 students from Croatia, 2 from Bosnia and Herzegovina and 3 from India), MDH environment was multicultural consisting of students from Pakistan (14), India (13), Iran (4), Nepal (2), China (2), The Netherlands (2), Italy (2), France (2), Germany, Ukraine, Lithuania, Croatia, Eritrea, Bangladesh, Uzbekistan, Jordan and Kenya.

According to the project success, a classification has been made on *green* (projects without or with minor problems), *yellow* (projects with significant problems but producing end results) and *red* (failed projects) projects. Most of the analyzed projects were successful, meeting at least the basic set of requirements and delivering stable products and extensive product and process documentation. Out of the 14 projects, 8 were classified as *green* (51 student) and six as *yellow* (39 students).

Collected data is consolidated and analyzed on the number of the selection of a certain motivating factor, demotivating factor or cultural difference in a student group. Studied groups were *All projects* (all students), location-based groups *FER* and *MDH* (FER students and MDH students analyzed separately) and project-class groups *green* and *yellow* (students belonging to *green* and *yellow* projects were analyzed separately regardless of their location). Impact factors were also analyzed by calculating their average values per each analyzed student group.

3. STUDENT MOTIVATION

3.1 Motivating factors

Figure 1 presents the eight most frequently identified motivating factors selected from 24 distinct factors found in students' final questionnaires. We show the results per site (MDH, FER), for successful and challenging (Yellow, Green) projects, and for all projects.
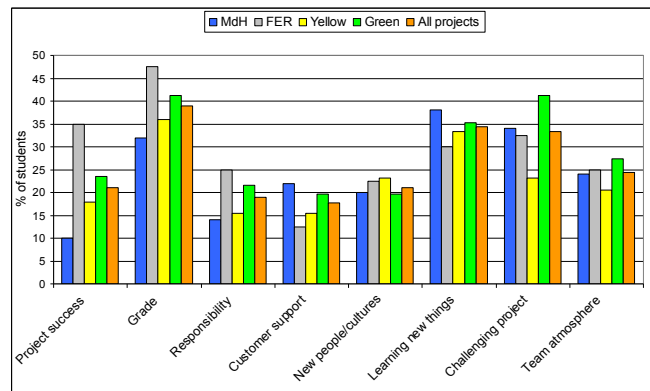

Figure 1. Motivating factors

Motivating factors are classified according to their source (internal/external to the project) and scope of influence (individual/group influence) and presented in Table 1. Internal/individual motivational factors are generally present in student population; its electiveness only contributes to having students with those motivations enrolled on DSD course. Positive team atmosphere tends to be equally important for students at both locations, whereas responsibility (towards teammates) and project success factors are more frequently identified by FER students. Those location based differences can be attributed to

locally dominating cultures (Asian at MDH and Mediterranean at FER), especially when correlated with the customer support factor (more frequently identified by MDH students). The grade factor is the factor with the highest frequency of all factors, but with the smallest impact factor among the analyzed ones (average factor impact=4.27, grade factor impact=3.65).

Table 1. Classification of motivating factors

	Individual	Group
Internal	meeting new people and cultures, learning new things	team atmosphere, responsibility, project success
External	grade	customer support, challenging project

General observation is that most of the factors have slightly higher occurrence frequency in *green* projects, except for *challenging project* factor. *Challenging project* factor is characterized by both high occurrence frequency and second highest impact factor (4.48). However, a gap between *yellow* and green project classes indicates that the factor is less effective in projects already facing other kinds of difficulties.

3.2 Demotivating factors

From students' final questionnaires 23 factors have been identified and eight most frequent ones selected for further study. Figure 2 contains the factors along with their occurrence frequencies in analyzed student groups.
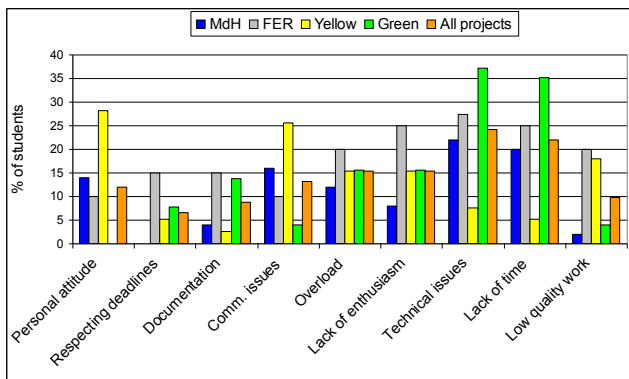

Figure 2. Demotivating factors

Selected factors are classified according to their source (internal/external) and scope of influence (individual/group) and presented in Table 2.

Table 2. Classification of demotivating factors

	Individual	Group
Internal	personal attitude, overload	respecting deadlines, low quality work, communication issues, lack of enthusiasm
External	lack of time	documentation, technical issues

Work overload is an unspecific demotivating factor predominantly caused by lack of technical competences within the project team:

- team members take more workload in order to compensate lack of competences of other team members;
- team members invest additional effort to familiarize themselves with previously unknown technologies and complete their project tasks

Quantitative data on student's invested work hours is available in weekly project reports and the final project report. However, such data cannot be used in serious effort (overload) analysis because (a) it cannot be verified and (b) it cannot be taken as a measure of individual effort due to differing knowledge levels and productivity / real contribution to project.

Personal attitude is a yellow-project specific demotivating factor, representing personal-level conflicts which are hardly ever resolved during project duration. Such conflicts result in broken communication channels and determine project's collaboration patterns, significantly influencing final results (both process and product).

Communication issues are an expected demotivating factor concerning the physical distance between sites and differing knowledge of English language as well as location-specific pronunciations. However, it seems that this issue is much more frequently reported in *yellow* projects, more as a consequence of other problems than as a root problem itself.

According to Figure 2, *respecting deadlines* and *low quality work* factors are location specific, but are in fact caused by a combination of cultural differences between two locally dominating cultures and lack of technical competences at one of cooperating locations. In this context *respecting deadlines* factor seems like a milder version of yellow-project specific *low quality work* factor with technical competence less emphasized.

Lack of enthusiasm factor is closely connected to the *project success* motivating factor, where FER students are clearly more motivated than MDH students, and consequently demotivated by MDH students' lack of such motivation. This factor is a consequence of differences between locally dominating cultures, student structure at MDH (predominantly visiting students) and lack of available time. Surprisingly, this factor is not project-type specific; in *green* projects its negative impact has been efficiently compensated.

Lack of time factor is expected in courses such as this, as project-based courses require a significant portion of student's time. This is an organizational factor and should be addressed in two ways: by warning students prior to enrolment of the increased time demands the course poses, and by formally stating the increased effort required by students within the institution framework, for example by assigning the course with increased number of ECTS points.

Students' antagonism towards producing documentation is a common knowledge; however presented *documentation* factor is more rooted in students' educational background where FER students are keener to coding than following engineering processes. D*ocumentation*, *lack of time* and *technical issues* factors are project-type specific and are predominantly recognized by members of *green* projects.

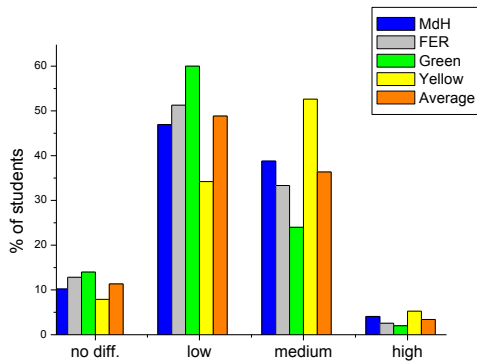# 4. CULTURAL DIFFERENCES

4.1 Overall Perception

Figure 3. Overall perception of cultural differences

Distributions of overall perception ratings are presented on Figure 3, where bar heights represent the percentage of observed student population that selected a particular rating. Concerning the distribution of ratings observed per location (MDH and FER) no significant variation have been found between the two sites, leading to a conclusion that divergence in level of internationalization had no influence on overall cultural difference perception.

On the other hand, significant variation in perception rating distributions has been found when analyzing perception ratings of students from g*reen* and y*ellow* project classes. It seems that the amount of problems students encounter in a distributed project is correlated to their perception of cultural differences. However, due to nature of the analyzed data it could not be determined whether those problems were induced by real cultural differences, or students tried to justify problems by ascribing them to stereotypical cultural differences they had been introduced to in the preparatory classes.

4.2 Individual cultural differences

From the questionnaires we have identified 23 distinct cultural differences the students have observed, described and assigned impact factors. Those differences where analyzed on their frequency of occurrence in the observed population and average impact factor. Out of those 23 differences for further analysis we have selected only 8 of them, setting the cut-off point at the frequency of 8% in the overall population. Table 3 contains the selected differences and their descriptions.

Table 3. Cultural differences

Cultural Difference	Description
Perception of time	Respecting (project) deadlines, not being late on meetings etc.
Dedication	Taking initiative, responsibility, willingness to invest more time and effort etc.
Work habits	Working over day/night, over weekends etc.
Formality	Formal/informal approach in communication etc.
Communication	Ability to express oneself in English, differing accents, being reachable,

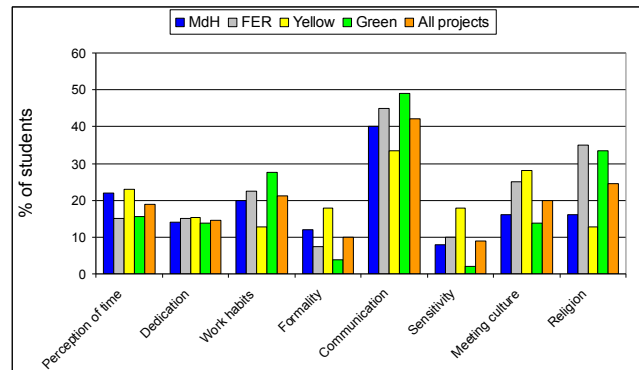|	miscommunication, misinterpretations etc.
Sensitivity	Reaction to criticism/suggestions
Meeting culture	Openness, direct vs. indirect approach etc.
Religion	Difference in religions, religious holidays etc.

Figure 4. Frequencies of cultural differences

Figure 4 presents the frequencies of the eight most commonly recognized cultural differences. As expected, the *communication* difference/issue is the most identified one by students from both locations. Usage of English language as the official course language accompanied by varying language skills and region-specific pronunciations dominates among reasons this difference's frequency is the highest one. This issue has profound implications on other aspects of the course, for example on communication tools used. It has been noted that instant messengers are the students' preferred synchronous communication tool and are used much more often than voice or video conferencing tools. Sensitivity and meeting culture issues are predominantly observed in problematic projects.

The second most frequent difference is *religion*, with the addition of religious holidays and their impact on project work. The reason for this is that many students from Asia have a stronger attitude towards religion. However, the two differences' impact factors (Figure 5) are the lowest ones, effectively marking them (especially religion) as irrelevant to project success or failure.
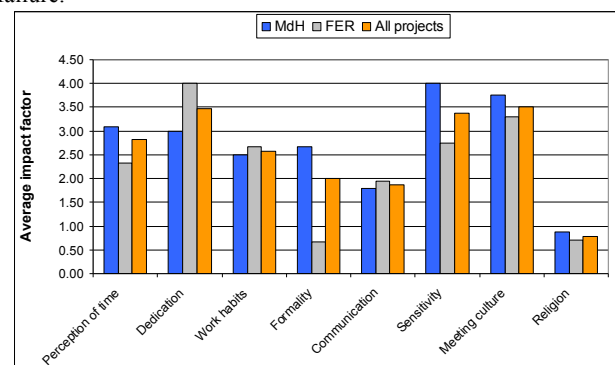

Figure 5. Impact factors of cultural differences

Much more relevant (but less frequently observed) differences are *meeting culture*, *dedication* to project work, *sensitivity* and *perception of time*. Meeting culture and sensitivity

are tightly connected to dominant student cultural backgrounds at MDH. FER students observed that Asian MDH students are very sensitive to direct criticism of their work and that such communication style can lead to personal conflicts with high impact on project work. Such conflicts are not frequent, but tend to remain unsolved.

Perception of time and dedication are also dependant on cultural backgrounds, but are dominantly rooted in technical skills of involved students. There are no significant differences in their distribution between *green* and *yellow* project classes, implying that they had been a universal issue and, although highly valued, had no significant impact on project outcome.

5. MANAGING MOTIVATION FACTORS

Positive and negative motivation factors can be influenced during project team formation phase and during project work. Due to restricted space, we mention only a handful of methods for managing motivation factors.

Forming project teams with balance in technical and social skills of their members is a very delicate task. Forming student teams only on the basis of motivation for a certain project and students technical expertise collected from an initial questionnaire can be misleading. In our experience, it is not uncommon that students tend to greatly overestimate their capabilities, leading to occurrence of a number of negative (internal individual and group) motivation factors later in the project. Projects do compensate for one of such member, but having more of them can significantly influence project outcome. We strongly recommend conducting initial interviews with students whose capabilities teaching staff is not familiar with.

During project work, the factors most amenable to explicit influence are external group factors. We found that frequent and informal meetings of project groups with customers and their positive feedback contributes to overall group motivation more than just positive feedback on formal milestone presentations. However, negative influence on remote project group motivation has been observed in some projects, where customer communicated exclusively with members of local team, not all team members together. Challenging project topics are motivating, but we insist on at least two groups of requirements with differing priorities: if problems arise, negotiating changes in requirements (dropping low priority ones) without directly influencing final project grade eases the pressure off the project group.

6. CONCLUSIONS

In eight years of carrying out DSD course, we have observed that the motivation factor is the most important for the project success. Even in the projects that struggled with serious problem (organization, technical knowledge) the motivation factor led to a project successes (or at least to acceptable results). For this reason one of our tactics to increase the project successes was to increase the motivation. The motivation factors, although different for individuals, are in general similar for all students. We have also observed that in fewer cases strong individuals can significantly influence to the project teamwork, and the results – and in both directions. These individuals would strongly influence the motivation of other students. We have also observed that the selection of students in groups is important – a balance in technical and social skills is important, but it not directly visible when the students form the groups.

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