Investigating the effect of realistic projects on students' motivation, the case of Human-Computer interaction course

Jaime Urquiza-Fuentes, Maximiliano Paredes-Velasco

Computers in Human Behavior 72 (2017) 692-700
DOI: http://dx.doi.org/10.1016/j.chb.2016.07.020

Investigating the effect of realistic projects on students' motivation, the case of Human-Computer interaction course

Jaime Urquiza-Fuentes, Maximiliano Paredes Velasco

LITE - Laboratory of Information Technologies in Education, Universidad Rey Juan Carlos

C/ Tulipán, S/N, Móstoles, 28933 Madrid, Spain

{jaime.urquiza, maximiliano.paredes}@urjc.es

***Abstract*— Most of the subjects in computer science degrees can be taught using a theory+practice approach. The aim of this study is to test the effect of a concrete way to use practical exercises in a human-computer interaction course. The general approach to teach human-computer interaction is using theoretical sessions explaining concepts and examples together with lab sessions where concrete exercises are proposed. Our approach is based on replacing these concrete exercises with realistic projects based on collaborative work, long term duration (the whole course instead of concrete labs) and multidisciplinary design interacting with real end-users. The realistic projects approach supports the practice of theoretical concepts together with professional skills development, e.g. social skills needed to interact with end-user without technical background. In order to assess this approach we have conducted a comparative study with three different groups involving 133 students. Two groups followed the realistic projects approach, the difference between them was end-users recruitment. End-users were recruited by teachers in on group and by the students in the other. The third group followed the general approach. We think that the effect of our approach cannot be simplified to a grade. This is the reason why our comparative study is based on students' motivation. Besides, positive motivation improves students' learning process. We have chosen the Situational Motivation Scale as the measurement instrument. Results show that, independently from the end-user recruitment, students involved in realistic projects are significantly more motivated than students involved in the general approach. Following the Situational Motivation Scale framework, students involved in realistic projects perceive that these activities are important and necessary because they think that these activities are useful or important for them.**

Keywords- Realistic projects, Multidisciplinary, Motivation, Human-Computer interaction, Collaborative learning

I. INTRODUCTION

The educational context of this work is a Human-Computer Interaction course taught at the Computer Science Engineering degrees of the Universidad Rey Juan Carlos. This subject is focused on software user interfaces. Two different approaches can be used to teach this subject: implementation and design. The former deals with software development libraries from different languages used to produce graphical user interfaces. The later deals with the user centered design (UCD) process. This work is framed in the later approach. Thus, UCD assigns end-user the main role throughout the user interface design process: from the requirement phase, through design and implementation, to the evaluation phase.

Most of the subjects within the computer science scope can be taught using methodologies that mix theoretical sessions and simple practical exercises. Thus, these exercises exemplify the concepts explained during theoretical sessions. Instead of following this classical methodology we use a more active approach based on realistic experiences related to the subject. Instead of simple exercises, these experiences are based on real problems where students have to face the whole development process of a user interface, from requirements to evaluation.

As we have said, UCD assigns a main role to end-users throughout the development process of user interfaces. In order to make these experiences more realistic, our approach also includes the participation of end-users. Usually, the end-user role has been played by other Computer Science (CS) students, even belonging to the same course. This approach is easy to use because teachers do not need to recruit non-CS students. On the other hand it hides an important problem that an interface designer will face in real life, i.e. communication and cooperation with end-users without technical background. Consequently, our approach integrates non-CS students as end-users. These students are enrolled in Infant and Primary Education Degrees. In terms of the UCD, this mixture of participants with different technical background is called a multidisciplinary approach.

Finally, following the realistic approach, these experiences will be faced by CS students as a group work task using a collaborative methodology. Thus, each member of the group will be on charge of different parts of the development process, but sharing the main objective with the rest of the members of the group.

In our opinion, integrating non-CS students as end-users increases the realism of these experiences. Thus, this realistic approach could improve students' motivation towards these experiences and the subject where they are integrated. Both, student's engagement and motivation significantly impact on the learning process. Therefore, the more engaged the student, the more effective the learning. In order to measure the effect of this approach on the students' motivation, we have used a Situational Motivation Scale (EMSI) (Martín-Albo, Núñez & Navarro, 2009). Finally, in terms of students' motivation, we will compare our approach against two other groups where different approaches have been used.

The rest of the work is structured as follows. Section two reviews related works regarding HCI teaching and the role of motivation in education. The third section describes the educational context together with the design of our realistic approach. Section four details how motivation has been measured and section five explains the experiment that we have conducted to assess our approach. The results of this experiment are detailed in section six and discussed in section seven. Finally, section eight draws the conclusions of this work.

II. Related Works

A. *Human-Computer Interaction curricula*

Human Computer Interaction (HCI) is a recent discipline in CS degrees. HCI is defined as "a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them" (Hewett et al., 1992). HCI has a multidisciplinary character and involves technical methods from CS together with social methods.

HCI curricula have diverse contents due to its multidisciplinary character. Churchill, Bowser & Preece (2013) surveyed and interviewed more than 300 researchers, practitioners and educators of different continents regarding the core issues of HCI. This survey concludes that core issues of HCI are varied, e.g. social media, natural language processing, social network analysis, robotics, etc. ACM SIGHCI provides an HCI Curricula based on three main aspects: Human-computer Interaction and Human Characteristic, Computer System and Interface Architecture and, Development Process (Hewett et al., 1992). However, educators focus on different aspects; for example, Cockburn & Bell (1998) focuses on human disciplines like elemental psychology, ergonomics, UCD and task models (e.g. GOMS). Feng & Luo (2012) and Moroz-Lapin (2008) focus on requirement analysis and usability evaluation. Other HCI courses deal with requirement specification, design and evaluation with low and high fidelity prototypes (Koppelman & Dijk, 2006; Culén, Mainsah & Finken, 2014; Lorés, Granollers & Aguiló, 2006). Our HCI course also deals with these contents using two main textbooks (Dix, Finlay, Abowd & Beale, 2004; Shneiderman & Plaisant, 2010).

B. *Teaching methodologies in the Human-Computer Interaction course*

Usually, the duration of the HCI course ranges from ten to twelve weeks. The instruction methodology includes theoretical lectures, practical lectures and laboratory sessions distributed in two sessions per week one or two hours long (Moroz-Lapin, 2009; Koppelman & Dijk, 2006). Both, theory and practice are considered essential in HCI teaching (Churchill, Bowser & Preece, 2013). Some educators incorporate seminars involving participants from the industry (Culén, Mainsah & Finken, 2014; Winograd & Bennett, 1992). Many HCI pedagogical approaches include requirements analysis, design, development and evaluation (Greenberg, 2009) so the practical assignments consist of practical projects where students have to work on these contents. These practical projects are faced by students as teamwork (3-6 students per group) (Chambel et al., 2009; Feng & Luo, 2014; Culén, Mainsah & Finken 2014; Cockburn & Bell, 1998; Hartfield, Winograd & Bennett, 1992) and it is usually based on case study methodology. Several case study techniques can be used in this approach: history review, problem-based learning or decision-making cases (McCrickard, Chewar & Somervell, 2004). Furthermore, case study methodology provides a opportunity to design real-word artifacts, which is an important aspect in HCI learning (Culén, Mainsah & Finken, 2014).

Students play several roles in practical projects methodology: designers, developers, users, clients, etc. (Chambel et al., 2009; McCrickard, Chewar & Somervell, 2004; Cockburn & Bell, 1998), but this approach limits the development of social skills in HCI. Students think social tasks are more difficult that technical tasks (Moroz-Lapin, 2009), so they should be used in HCI teaching (Hewett et al., 1992; Moroz-Lapin, 2008) like debate or discussion. Moroz-Lapin (2008) points out that students should work with real end-users, thus they could have a sound experience of collecting clients' needs and perceptions. Koppelman & Dijk (2006) sign out "student need to understand how a client feels and acts during the development of a system".

Realistic projects provide a context where students have to carry out social and technical assignments. Rosson, Carroll & Rodi (2004) point out that projects should be realistic but manageable in an educational context. Hartfield, Winograd, & Bennett (1992) provide a pseudo realistic project approach based on mentors. These are participants with a solid industrial background regarding software development and consulting , their main responsibility is to lead and suggest students, but sometimes they play the end-user role as well. Koppelman & Dijk (2006) and Moroz-Lapin (2008) provide realistic projects inviting people from industry, they play two roles clients and end-users. Realistic projects support students in getting deeper understanding about realistic settings and the industry domain (Moroz-Lapin, 2008). In addition, Hartfield, Winograd & Bennett (1992) point out those realistic contexts provide an environment where students can improve their workgroup skills. Given that user interface development is part of interactive software development projects, from a software engineering point of view, realistic approaches provide students with knowledge and skills needed to design and create software products that satisfy clients and users (Koppelman & Dijk, 2006).

However, the realistic projects approach in HCI teaching presents some problems (Koppelman & Dijk, 2006). Student-user communication is difficult because the user is kept at a distance and students feel little need to involve the user in the design process. Students sometimes interact clumsily with the user: they present reports focused on technical details, while the user is interested in the look and feel of the interfaces; or they present an extensive detailed reports while the user is only interested in a summary. Students usually think that the user is easy to please, so they do not take into account users' needs or expectations (Polack-Wahl, 1999).

C. Motivation in Education

Literature about the role of motivation in education is wide. Thus, here we only mention those works that are closer to our domain. Motivation is a core aspect in active learning processes ((Pintrich, 2003; Rienties, Tempelaar, Van den Bossche, Gijselaers & Segers, 2009; Serrano-Cámara, Paredes-Velasco, Alcover & Velazquez-Iturbide, 2014; Wang & Lin, 2007) like realistic projects approach. In this learning environment, motivation is an essential component that encourages students getting involved in realistic projects keeping in mind end-users throughout the design process.

Motivation has been a central issue in the study of human behavior. In the real world or in a practical sense, motivation is highly valued because of its impact: usually it helps to produce positive results (Ryan & Deci, 2000). Motivation is also a core factor in the learning-teaching process because it supports active learning (Pintrich, 2003). Finally, motivation concerns energy, direction, persistence and equifinality –all aspects of activation and intention (Ryan & Deci, 2000).

The authors have not found many related works regarding students' motivation in computer science learning and collaborative learning. Some works focus on associations between motivation and team-interaction, concluding that they exist between motivation and relationship among students (García et al., 2009; Rienties et al., 2012; Tapola et al., 2001). Other works study technical scaffolding and its impact on students' motivation using Academic Motivation Scale (Rienties et al., 2012; Vallerand, 1992). Finally, the relation between motivation and student's environment (Howley, Chaudhuri, Kumar & Rosé, 2009; Eales, Hall & Bannon, 2002) or students' frustration in teamwork (Capdeferro & Romero, 2012) have been studied. These works do not study students' motivation in computer science.

III. EDUCATIONAL CONTEXT

This study has been carried out in an HCI subject. The main aim of this subject is that students acquire, totally or partially, the following competencies. Students will be able to:

- Solve problems in an autonomous and creative way with a proper decision making process and initiative.
- Communicate and transmit knowledge, skills and abilities associated to the CS engineer profession.
- Design and evaluate human-computer interfaces so they can guaranty accessibility and usability in systems, services and software applications.
- Develop and evaluate both, interactive systems and presentation of complex information systems. Use them for solving human-computer interaction design problems.

First and second competencies are focused on problem solving and knowledge communication, while third and fourth competencies are more closely related to the contents of the subject. Our aim is that students acquire these competencies due to the multidisciplinary, active and collaborative approach of the teaching methodology based on realistic projects.

A. Syllabus

The syllabus of this subject covers the most important aspects in user interface design (Shneiderman & Plaisant, 2010; Dix et al.2004). These aspects are distributed along three blocks. The first block is titled "User Centered Design". Topics included in this block provide an introduction to Human-Computer Interaction and UCD. Then, visual controls used in software interfaces are explained. Finally, the interface design methodology is described.

The title of the second block is "Usability and accessibility". It is made of two topics dealing with both concepts. First, different versions of the definition of usability are discussed. Next, design principles that lead to usable interfaces are explained. The same organization is used to cover the accessibility concepts.

The third block deals with user interface evaluation. Four topics are covered in this block. The first one focuses on evaluation design and documentation. The second and third topics details two families of evaluation methodologies: analytic methods (e.g. heuristic inspection) and empirical methods (e.g. experimental evaluations). Finally, technologies related to user interface evaluation are explained, e.g. eye-tracking or user logging systems.

B. Grading the subject

Usually, realistic projects are time consuming for students. The grading scheme of this subject highlights the students' effort dedicated to work on these practical experiences. Of course, theoretical concepts must be represented in the grade of the course, but practical experiences will have a significant weight. Thus, the weight of the practical experiences and theoretical concepts will represent 60% and 40% of the final grade respectively.

The practical experiences will be designed as a long term project where students work in groups throughout the course. Since this activity is compulsory in the course, students' engagement is as high as their willingness to pass the course. In addition, given the important role that end-users play in the UCD, we have decided to include non-CS students to play this role. In order to ensure non-CS students' engagement, their participation will be motivated with extra credits.

C. Design of the practical experiences

The main aim of practical experiences is to involve students in a realistic use of the theoretical concepts. Therefore, these experiences follow the same knowledge path used in the theoretical classroom sessions regarding user interface design. Students will face these practical experiences distributed in groups of maximum three members.

The practical experiences are designed to complete the design of a user interface following the three main phases: (1) requirement collection and analysis, (2) interface design and (3) interface evaluation. Each group must complete a deliverable for each phase. Besides, end-users will be enrolled in these phases with the following tasks: (1) answering CS students' questions to collect their opinion, (2) improving designs with their domain knowledge and (3) participating in empirical evaluations designed by CS students.

The first phase consists in requirement collection and analysis. Its result will be the main objectives of the interface and a low-fidelity interface. During this phase end-users will be interviewed by CS students. At least, students will have two hours dedicated to face to face meetings with end-users (see Figure 1). Each group designs their own requirement collection instrument (oral interviews and/or questionnaires), thus the amount of end-users interviewed differs from one group to another in a range from three to nine. In addition, students can contact end-users either to increase the number of different end-users or refine the previously collected information.

Figure 1. Face to face meeting session

Thus, the first deliverable must provide detailed information about the collection and analysis process together with a list of the main objectives of the interface and the low-fidelity prototype.

The title of the second phase is Usability and Accessibility. During this phase, students have to use their knowledge about usability and accessibility. Therefore, the main task of this phase is to improve the low-fidelity prototype using the main design usability and accessibility principles. The result will be a high-fidelity prototype. Given the non-CS students' background (infant and primary education) they will use their pedagogical knowledge to assess the resulting prototype design developed by the CS students. Thus, the prototype developed mixes usability design principles together with pedagogical recommendations. This is a clear situation showing how the multidisciplinary approach works on interface design. The deliverable of this phase must show the usability principles and pedagogical recommendations taken into account, explaining their role in evolution from the low-fidelity to the high fidelity prototype, including the later as a software piece.

The third phase deals with user interface evaluation. CS students have to demonstrate their skills planning and conducting interface evaluations with end-users. This phase is divided in three sub-phases: planning, debate and execution. Firstly, CS students have to produce a detailed planning of the interface evaluation, e.g. tasks to be completed by end-users, dependent variables, measurement instruments or analysis methodology. Then, each group has to present its planning answering questions and comments from the teacher and the rest of groups. This is the debate sub-phase, where groups can receive ideas in order to improve their evaluation planning. Thus, students realize that planning is a significant task in interface evaluation. Finally, they have to conduct the evaluation following their planning. Now non-CS students will play the role of pure end-users. They have to execute tasks proposed by CS students, in addition to other details like giving/denying recording permission or answering usability questionnaires/interviews. Figures 2, 3 and 4 show three different groups with three different measurement instruments. Figure 2 shows how a group writes down notes and even user's time-on-task using their smartphone as a chronometer. Figure 3 shows another group using laptops to write down notes and record the user's comments. Finally, figure 4 shows a highly engaged group. They developed instrumentation software in their prototype so they can log all users' interactions. Furthermore, they used their own smartphones in order to record user's interaction from the three interesting points of view: user's expression, context and screen.

The deliverable of this phase is an evaluation report providing information about evaluation planning, execution and conclusions. Students also have to include all material that supports their conclusions, e.g. voice/video recordings or hand-written answers to questionnaires. Usually, students face interface evaluation trying to demonstrate that their interface will get a good evaluation. But we highlight that the main aim is to detect as much actual errors/improvements as possible so they focus on the evaluation itself instead of the evaluation of “their” interface.

Figure 2. Evaluation session, manual note taking

Figure 3. Evaluation session, manual note taking and voice recording

Figure 4. Evaluation session, recording end-users experience from three points of view: user's context, user's face and computer screen

IV. Measuring Students' Motivation

Student's engagement with the learning process is a key factor on the effectiveness of such process. Student's motivation along the learning process could be a proxy for the engagement level. There exist a number of theoretical frameworks to study student's motivation. Among them, we have selected Self-determination theory (Deci & Ryan, 1985), a well stablished one.

A. Self-determination theory

Self-determination theory structures motivation in three different levels: intrinsic motivation, extrinsic motivation and amotivation. Intrinsic motivation refers to a situation where individuals perform a task just for pleasure, interest or willingness to complete it, without any other external factor affecting that interest.

Extrinsic motivation appears when individuals complete tasks because of incentives or rewards instead of their own interest. Two different levels can be differentiated in extrinsic motivation: external regulation and identified regulation. Thus, individuals driven by external regulation just take into account reward or punishment. Identified regulation occurs when individuals feel that they are obliged to complete a task due to two reasons: others consider that task an important one, or the individual believe that it is beneficial for her/himself.

The last level is amotivation. In this case individuals do not perceive relation any between their behavior and the result of the task performed. The subject does not perceive any benefit related to performing the task. This level of motivation corresponds to the lowest level of self-determination.

Different motivation levels are differently interpreted by individuals depending on the effects they can cause. Thus, intrinsic motivation and identified regulation are perceived as positive effects, while external regulation and amotivation are perceived as negative effects.

B. Measurement instrument

There are several instruments in order to test motivation (Vallerand et al., 1992; Vallerand, Blais, Brière & Pelletier, 1989). In this study, the Situational Motivation Scale (SIMS) (Guay, Vallerand & Blanchard, 2000) has been used, particularly the Spanish version (called EMSI (Martín-Albo, Núñez & Navarro, 2009)) due to the fact that our students are Spanish natives and EMSI is also validated in educational contexts (Martín-Albo, Núñez & Navarro, 2009). The EMSI scale has 14 items grouped into the four subscales mapped to the four dimensions of motivation mentioned in the previous section: intrinsic motivation, extrinsic motivation via identified regulation, extrinsic motivation via external regulation and amotivation. Each item responds differently to the question: “Why are you performing this activity?” and is rated with a Likert scale, ranging from 1 (absolutely disagree) to 7 (absolutely agree), with an intermediate score of 4 (moderately agree). There are some items where a high score is considered negative, for example, the item “Because I am supposed to do it” represents negative motivation. The remaining items are related to the previously mentioned four dimensions.

V. THE EXPERIMENT

In order to assess the actual effect of the proposed design of practical experiences, we have conducted an experiment that will be detailed in this section.

The effect will be measured in terms of students’ motivation. Therefore our hypothesis is: within a pedagogical framework of active learning, implemented with collaborative and project based learning methodology, the use of the multidisciplinary approach via realistic projects in the HCI course will improve students’ motivation.

A. Subjects and variables

The subjects are enrolled in CS degrees at the Rey Juan Carlos University. The number of students was 147, their participation was compulsory since the activities performed were needed to pass the course.

Subjects were distributed in three different groups. Each group would receive different treatments regarding the practical experiences, they were called: Experimental, Control-1 and Control-2. All groups were taught with a common pedagogical framework, active learning with collaborative and project based methodologies. The difference among the groups is the use of the multidisciplinary approach (and the realism of the project). Therefore, the independent variable is the teaching methodology received by each group:

- The Experimental group is our treatment group. It received the treatment described in section II. Thus, CS students interacted with non-CS students, recruited by the teachers, playing the role of end-users.
- The Control-1 group was taught using a similar approach to the Experimental group but with the following difference. End-users were recruited by CS students, either among their mates or other different persons.

Thus, CS students could interact with end-users, but the multidisciplinary approach could not be ensured because these end-users could be other CS students.

- The control-2 group represents a pure control group. It received a more classical methodology, focusing on specific problems mapped to concrete concepts of the syllabus. Thus, neither they interacted with end-users nor the multidisciplinary approach was used with them.

Regarding the dependent variables, we will use the measurement instrument mentioned in section III.B Thus, the engagement of each group will be measured in terms of the four motivation dimensions: intrinsic motivation, identified Regulation, External Regulation and amotivation. In section III.B we presented the measurement instrument to assess students' motivation. This instrument poses a question. Since this question must be absolutely clear what is it asking about, it will be different for each group:

- The Experimental group: "Why are you performing this activity based on realistic projects and carried out multidisciplinary?"
- The Control-1 group: "Why are you performing this activity based on realistic projects?"
- The control-2 group: "Why are you performing this activity based on different HCI exercises?"

B. Protocol

The protocol was based on theory contents and practical activities. Theory contents were the same for all student groups; however practical activities were different depending on pedagogical framework. The students groups alternated lecture sessions (classroom) and practical sessions (computer classroom). The Experimental Group carried out three types of practical activities:

- Design. CS students have to coordinate non-CS students in order to specify and design the software application.
- Usability. CS students make use of usability and accessibility concepts of HCI and non-CS students play the end-user role.
- Evaluation. CS and non-CS students work together in order to test software application developed by CS students.

Similar practical activities were carried out by the Experimental and Control-1 groups, except that non-CS students did not participate in the Control-1 group experience. Thus, students from the Control-1 group proposed persons in order to play the end-user role and the teacher had to give approval. Two aspects differentiated the practical activities carried out by the Control-2: no end-user was involved in the experience, so students themselves played user role; and there was not a global project throughout the course, instead the teacher proposed two practical statements for Usability and two practical statements for Design and Evaluation activities.

We tested students' motivation at the end of course, once students had completed all sessions (theory and practical sessions). Thus, students had to complete a questionnaire in order to measure students' motivation. The Figure 5 shows protocol used in the experience.

Theoretical and practical instruction was alternated throughout experience. Instruction used in theory sessions was similar in all groups (Experimental, Group-1 and Group-2) but instruction used in practical sessions had different educative methodology in each group based on the use of multidisciplinary and realistic projects.

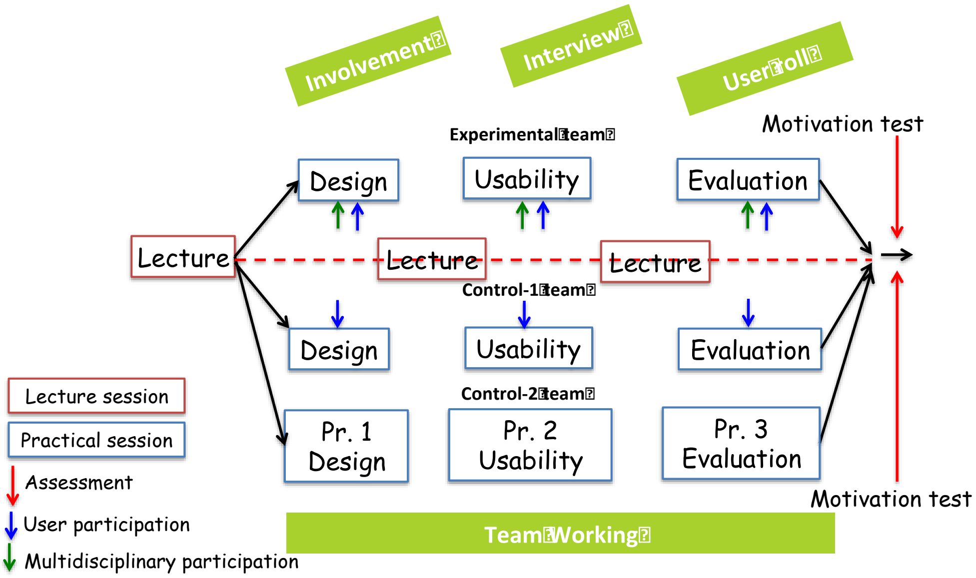

Figure 5. Evaluation procedure used in the experience

VI. RESULTS

A total of 147 students and 4 teachers participated in the experience. We had to exclude 14 students in statistical analysis because of invalid data collection, therefore 133 students made up the population sample. We tested the four dimensions of motivation according to self-determination theory: intrinsic motivation, extrinsic motivation via identified regulation, extrinsic motivation via external regulation and amotivation. We tested these dimensions of motivation in each group and compared data collected. Table 1 shows population means, deviation and size of population sample for each group (Experimental, Control-1 and Control-2) and dimension of motivation.

Table 1. Descriptive statistic

Population sample		Intr. M	Iden. M	Ext. M	Amot.
Experimental G. N = 70	Mean	4,62	5,27	3,67	5,65
	Deviation	1,07	1,02	,59	1,08
Control-1 G. N = 26	Mean	4,77	5,53	3,86	6,05
	Deviation	,86	,82	,82	,84
Control-2 G. N = 37	Mean	3,85	4,60	3,81	4,94
	Deviation	1,22	1,17	,54	1,32

In order to prove our hypothesis, students' motivation should be different using different educative methodologies. We carried out a statistic test of means for each group. Firstly, we tested whether there are significant differences among the three groups and dimensions. Secondly, we tested significant differences between pairs, in order to identify which group got significantly different motivation than other groups, Table 2 shows whether or not there are significant differences among groups for each dimension. It can be seen that the means are significantly different in three dimensions of motivation: intrinsic motivation, extrinsic motivation via identified regulation and amotivation; while no significant differences have been detected in extrinsic motivation via external regulation dimension ($p>0.05$). Therefore, we discard null hypothesis (Ho: means are equal).

Table 2. Hypothesis test schedule

	Null Hypothesis	Test	Sig.	Decision
1	Distribution of the intrinsic motivation is the same among the categories of population sample	Kruskal-Wallis independent population samples	,002	Reject null hypothesis
2	Distribution of the identified Motivation is the same among the categories of population sample	Kruskal-Wallis independent population samples	,001	Reject null hypothesis
3	Distribution of the External Motivation is the same among the categories of population sample	Kruskal-Wallis independent population samples	,309	Accept null hypothesis
4	Distribution of the amotivation is the same among the categories of population sample	Kruskal-Wallis independent population samples	,001	Reject null hypothesis

*Asyntotic significance are showed. Significant at .005 level.

Next, we analyze the statistical significance of differences by pairs of groups (Experimental vs. Control-1, Experimental vs. Control-2 and Control-1 vs. Control-2) in intrinsic motivation, extrinsic motivation via identified regulation and amotivation. Here, we reduce p threshold to 0.017 value (0.05/3) according to Bonferroni's (1936) adjustment. Results show that no significant differences exist between the Experimental and the Control-1 groups (see

Table 3). But there exist significant differences between the Experimental and the Control-2 groups (see table 4) and between the Control-1 and the Control-2 groups (see Table 5).

Table 3. Comparative analysis between Experimental and Control-1 groups

Comparative GE- GC1	Intrinsic Motivation	Identified Motivation	Amotivation
U of Mann-Whitney	854,5	780.5	712,0
Sig. asymp. (bilateral)	.101	.646	.101

Table 4. Comparative analysis between Experimental and Control-2 groups

Comparative GE- GC2	Intrinsic Motivation	Identified Motivation	Amotivation
U of Mann-Whitney	833,0	827,5	864,5
Sig. asymp. (bilateral)	**.002***	**.002***	**.005***

Table 5. Comparative analysis between Control-1 and Control-2 groups

Comparative GC1- GC2	Intrinsic Motivation	Identified Motivation	Amotivation
U of Mann-Whitney	258,0	244,5	226,5
Sig. asymp. (bilateral)	**.002***	**.001***	**.000***

VII. DISCUSSIÓN

First, we analyse results of the Experimental group. We can notice that students in the Experimental group feel high intrinsic motivation with value next to 5 (*Mean=4.6250*). Therefore, we deduce that students engaged with the practical tasks being attractive and interesting for them. With regards to dimensions with the highest self-determination score (intrinsic motivation, extrinsic motivation via identified regulation and extrinsic motivation via external regulation), extrinsic motivation via identified regulation has got the highest value (*Mean=5.2667*). Therefore the students perceive that practical activities are important and necessary because they think these activities are useful for them or they consider that activities are important for them. Students have minor perception in extrinsic motivation via external regulation (*Means =3.6714*) so students do not practical activities because it leads to a separable outcome, i.e. to obtain a reward or to avoid a punishment. However, practical activities influence in the final grade of the course so this may affect to the value of extrinsic motivation (students may perceive the task like a reward or punishment).

The amotivation dimension has got the highest score (*Mean=5.6536*). Here, we have to take into account that items related to amotivation are inverted in the statistical analysis in order contrast the motivation dimensions. Therefore, this value of the amotivation dimension denotes that students in the Experimental group have low amotivation (1.3464 on 1-7 scale). Thus, students perceive the benefits of performing practical activities, but they also perceive that their behaviour influences on the results of the task.

Next, we compare the Experimental group with the other two groups. First, we focus on the Experimental and Control-2 groups (realistic projects vs. classical educative methodology). Regarding to intrinsic motivation, the score of the Experimental group is significantly greater than the one of the Control-2 group. Therefore, students enjoy more when they are working on realistic projects and multidisciplinary than when they are working with a classical educative methodology. Besides, students in the Experimental group involve in practical activities because they are inherently interesting or enjoyable. However, no significant difference in intrinsic motivation has been detected between the Experimental and the Control-1 groups, so multidisciplinary character has not influenced on student's motivation. We think that students in the Experimental group have to manage the communication with several non-CS students in multidisciplinary environment and they have to carry out additional tasks like meeting and producing extra documentation. Students may perceive these additional tasks as negative, affecting their intrinsic motivation. Now, we focus on extrinsic motivation via identified regulation. The mean of the Experimental group is significantly greater than the mean of the Control-2 group. Therefore, when the students are working with realist projects and multidisciplinary (similar to professional environment) they identify benefits and important issues for them. This perception is minor when they are working with short and concrete activities without the realist project approach. This effect may be due to a key feature of realistic projects: they provide students with a working environment similar to a real professional environment. This experience is interesting and beneficial for them because they will work in this professional context. Regarding extrinsic motivation via identified regulation, means of the Experiment and Control-1 groups are not significantly different. Therefore, as mentioned above, this issue confirms that multidisciplinary character has not influenced on student's motivation.

Regarding extrinsic motivation via external regulation, means of three groups (Experimental, Crontrol-1 and Control-2) are not significantly different. Therefore, students perceive that they have to carry out practical activities because it leads to a separable outcome –to obtain a reward (pass the course) or to avoid a punishment (not pass the course), and this perception is independent the approach, whether students work with realistic and multidisciplinary projects or with non-realistic short and specific practical activities. We think that students associate carrying out the task with the requirement to pass the course (note students have to pass 4 in practical activities assessment).

Finally, we focus on the amotivation dimension. We can see that population means of Experimental and Control-1 groups are greater than the mean of Control-2 group. Therefore, students are more unmotivated when they work with short and specific practical activities than when they work with realistic projects. It may be due to the fact that students perceive realistic project environment similar to professional environment (this perception is interesting for them). Again, the multidisciplinary approach do not influences on students' motivation (means of the Experimental and Control-1 groups are not significantly different).

VIII. CONCLUSION

We have presented an evaluation of students' motivation with realistic projects involving 133 college students. Our purpose was to evaluate the students' levels of motivation with respect to three pedagogical approaches. In light of our results, we conclude that realistic projects combined with collaborative learning approaches encourage students. Additionally, this approach produced more motivation than the approach based in short and specific practical activities.

Other related works about collaborative learning are focused to analyze interaction and dialog between members of group (Tapola, Hakkarainen, Syri, et. al, 2011; Howley, Chaudhuri, Kumar, et. al. 2009) or analyze students' feeling, for example frustration (Capdeferro & Romero, 2012). However, there are not works focused on analyze the influence of pedagogical approach in students' motivation within a collaborative learning context. In future works, we will analyze whether students' motivation in each of pedagogical approaches improve students' learning outcomes.

REFERENCES

Bonferroni, C. E. (1936) Teoria statistica delle classi e calcolo delle probabilità, *Pubblicazioni del R Istituto Superiore di Scienze Economiche e Commerciali di Firenze*.

Capdeferro, N., & Romero, M. (2012). Are online learners frustrated with collaborative learning experiences? *The International Review of Research in Open And Distance Learning, 13*(2), 26-44.

Capdeferro, N., & Romero, M. (2012). Are online learners frustrated with collaborative learning experiences? *The International Review of Research in Open and Distance Learning, 13*(2), 26-44.

Chambel, T., Antunes, P., Duarte, C., Carrico, L. & Guimaraes, N. (2009). Reflections on Teaching Human-computer Interaction to Blind students. In P. Kotzé, W. Wong, J. Jorge, A. Dix & P. Alexandra (Eds.), Creativity and *HCI: From Experience to Design in Education, IFIP International Federation for Information Processing* (pp. 123-142). Springer US.

Churchill, E. F., Bowser, A. & Preece, J. (2013). Teaching and Learning Human-Computer Interaction: Past, Present and Future. *Interactions, 2(20)*, 44-53.

Cockburn, A. & Bell, T. (1998). Extending HCI in the Computer Science Curriculum. In ACSE '98 Proceedings of the 3rd Australasian Conference on Computer Science Education (pp. 113-120). New York, NY USA: ACM Press.

Culén, A. L., Mainsah, H. N. & Finken, S. (2014). Design Practice in Human Computer Interaction Design Education. In L. Miller and A. L. Culén (Eds.), *Seventh International Conference on Advances in Computer-Human Interactions* (pp. 300-306).

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic Motivation and Self-Determination in Human Behavior*. New York: Plenum Press.

Dix, A., Finlay, J., Abowd, G.D. & Beale, R. (2004). *Human-Computer Interaction*. Edingburh: Pearson Prentice Hall.

Eales, R. T. J., Hall, T. & Bannon, L. J. (2002). The Motivation is the Message: Comparing CSCL in different settings. In *International Conference on Computer Support for Collaborative Learning*. Colorado, USA.

Feng, G. & Luo, B. (2012). An Experience of Teaching HCI to Undergraduate Software Engineering Students. In *2012 IEEE 25th Conference on IEEE Software Engineering Education and Training* (pp. 125-129). IEEE.

Geyer, C. & Geisler, S. (2012, October). *A Project-Based Learning Setting to Human-Computer Interaction for Teenagers.* Paper presented at the International Association for Development of the Information Society (IADIS) International Conference on Cognition and Exploratory Learning in Digital Age (CELDA), Madrid, Spain.

Greenberg, S. (2009). Embedding a design studio course in a conventional computer science program. In P. Kotzé, W. Wong, J. Jorge, A. Dix, & P. A. Silva (Eds.) *Creativity and HCI: From Experience to Design in Education* (pp. 23-41). US: Springer US.

Guay, F., Vallerand, R. J., & Blanchard, C. (2000). On the assessement of situational intrinsic and extrinsic motivation: The Situational Motivation Scale (SIMS). *Motivation and Emotion, 24*, 175-213.

Hartfield, B., Winograd, T. & Bennett, J. (1992). Learning HCI Design: Mentoring Project Groups in a Course on Human-computer Interaction. In Editor *23th SIGCSE Technical Symposium on Computer Science Education* (pp. 246-251). New York, NY USA: ACM Press.

Hewett, T., Baecker, R., Card, S., Carey, T., Gasen, J., Mantei, M., Perlman, G., Strong, G, & Verplank, W. (1992). *ACM SIGCHI Curricula for Human-Computer Interaction*. Technical Report. New York, NY, USA: ACM Press.

Howley, I., Chaudhuri, S., Kumar, R., & Rosé, C. (2009). Motivation and Collaborative Behavior: An Exploratory Analysis. Poster paper presented at *Computer Supported Collaborative Learning.*

Howley, I., Chaudhuri, S., Kumar, R., & Rosé, C. (2009). Motivation and Collaborative Behavior: An Exploratory Analysis. Poster paper presented at *Computer Supported Collaborative Learning (CSCL)*.

Koppelman, H. & Dijk, B. V. (2006). Creating a Realistic Context for Team Projects in HCI. In Editor, *11th Annual SIGCSE Conference on Innovation and Technology in Computer Science Education, ITiCSE 2006* (pp. 58-62). New York, NY USA: ACM Press.

Llorés, J., Granollers T. & Aguiló, C. (2006). An Undergraduate Teaching Experience in HCI at the University of Lleida. Paper preseted at *HCIEd.2006-1 inventivity: Teaching theory, design and innovation in HCI*. Limerick (Ireland).

Marcos, J.A., Martínez, A., Dimitriadis, Y., Anguita, R., Ruiz, I. & Rubia, B. (2009). Detecting and Solving Negative Situations in Real CSCL Experiences with a Role-Based Interaction Analysis Approachin Intelligent Collaborative e-learning Systems and Applications. *Serie Studies in Computational Intelligence* (Serie vol. 246). Berlin-Heidelberg.

Martín-Albo, J., Núñez, J.L., & Navarro, J.G. (2009). Validation of the Spanish Version of the Situational Motivation Scale (EMSI) in the Educational Context. *The Spanish Journal of Psychology, 12*(2), 799-807.

McCrickard, D. S., Chewar, C. M. & Somervell J. (2004). Design, Science, and Engineering Topics?: Teaching HCI with a Unified Method. In D. Joyce and D. Knox (Co.), *35th SIGCSE Technical Symposium on Computer Science Education* (pp. 31-35). New York, NY USA: ACM Press.

Moroz-Lapin, K. (2008). Active Learning in the Education of HCI. *WSEAS TRANSACTIONS on Advances in Engineering Education*, *8*(5), 570-579.

Moroz-Lapin, K. (2009). Role play in HCI studies. In Editor *International Conference on HCI Educators: Playing with Our Education* (pp. 64-67). UK: British Computer Society Swinton.

Polack-Wahl, J.A. (1999). Incorporating the Client's Role in a Software Engineering Course. In 30th SIGCSE Technical Symposium on Computer Science Education (pp. 73-77). New York, NY USA: ACM Press.

Rienties, B., Giesbers, B., Tempelaar, D. T., Lygo-Baker, S., Segers, M., & Gijselaers, W. H. (2012). The role of scaffolding and motivation in CSCL. *Computers & Education*, *59*(3), 893-906.

Rienties, B., Tempelaar, D., Van den Bossche, P., Gijselaers, W., & Segers, M. (2009). The role of academic motivation in computer-supported collaborative learning. *Computers in Human Behavior, 25*, 1195-1206.

Rosson, M.B., Carroll, J. M. & Rodi, C.M. (2004). Case Studies for Teaching Usability Engineering. In *35th SIGCSE Technical Symposium on Computer Science Education* (pp. 36-40). ACM Press.

Serrano-Cámara, L.M., Paredes-Velasco, M., Alcover, C.& Velazquez-Iturbide, J.A. (2014). An Evaluation of Students' Motivation in Computer-supported Collaborative Learning of Programming Concepts. *Computers in Human Behavior, 31*, 499-508.

Shneiderman, B. & Plaisant, C. (2010). *Designing the User Interface: Strategies for Effective Human-Computer Interaction* (5th Ed.). Boston, MA, USA: Addison-Wesley Publ. Co.

Tapola, A, Hakkarainen, K., Syri, J., Lipponen, L., Palonen, T., & Niemivirta, M. (2001). Motivation and Participation in Computer-supported Collaborative Learning. In P. Dillenbourg, A. Eurelings & K. Hakkarainen (Eds.), *European Perspectives on Computer-Supported Collaborative Learning*, (pp. 585-592). McLuhan Maastricht, the Netherlands: Maastricht McLuhan Institute.

Tapola, A, Hakkarainen, K., Syri, J., Lipponen, L., Palonen, T., & Niemivirta, M. (2011). Motivation and Participation in Computer-supported Collaborative Learning. In *First European Conference on CSCL* (pp. 585-592).

Vallerand, R. J., Blais, M. R., Brière, N. M., & Pelletier, L. G. (1989). Construction et validation de l´Échelle de Motivation en Éducation (EME). *Canadian Journal of Behavioral Sciences, 21*, 323-349.

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Hriere, N. M., Senécal, C. & Valliéres, E. F. (1992). The Academic Motivation Scale: a Measure of Intrinsic, Extrinsic and Amotivation in Education. *Educational and Psychological Measurement*, *52*, 1003-1017.

Wang, S-L., & Lin, S. S. J. (2007). The effects of group composition of self-efficacy and collective efficacy on computer-supported collaborative learning. *Computers in Human Behavior, 23*, 2256-2268.