Influence of Students' Motivation on Their Experience with E-Learning Systems: An Experimental Study

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Abstract. The use of information technologies to support learning is an important study area for both teaching experts and HCI researchers aiming to produce efficacious e-learning systems allowing teachers, tutors and students to carry out their activities in a satisfactory and enjoyable manner. The system the user will interact with must therefore be designed not only on the basis of the classic usability principles but also of those aspects that affect the overall user experience. Aim of the present study is to see how individual characteristics of cognitive and above all motivational type affect learning while using an e-learning system, and to assess their impact on the overall e-learning user experience.

Keywords: E-learning systems, motivation, user experience, evaluation study.

1 Introduction

"Today we don't just use technology, we live with it. Much more deeply then ever before we are aware that interacting with technology involves us emotionally, intellectually and sensually. So people who design, use, and evaluate interactive systems need to be able to understand and analyze people's felt experience with technology" [1]. These words capture the essence of the concept of User eXperience (UX), that goes beyond usability and includes the system design characteristics (e.g. complexity, purpose, usability, functionality, etc.) as well as the user's internal state (e.g. predisposition, expectations, needs, motivation, mood, etc.), and the context (or environment) where the interaction occurs (e.g. organizational/social setting, meaningfulness of the activity, voluntariness of use, etc.) [2].

In recent years, Human-Computer Interaction (HCI) has been the focus of interest of platform and e-learning designers. The system allowing user interaction is an essential part of the learning process and needs to be designed not only in conformity with the classic usability principles but also with UX aspects, to ensure that the experience is efficacious, enjoyable and immersing [3].

Researchers in e-learning assign students' affective/motivational characteristics a fundamental role in their learning processes. They claim that unless students are motivated to interact with an e-learning system, their experience will not be positive and they will probably give up using the system and, even worse, may abandon their learning path.

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The aim of the work described in this paper is to probe to what extent personal characteristics of cognitive and motivational type influence learning by interaction with an e-learning system, and to assess their impact on the overall e-learning experience. We conducted an experimental study involving 50 high school students; to classify cognitive and motivational factors we analyzed their personal profiles using a method derived from the "Questionario sulle Strategie di Apprendimento (QSA)" (Questionnaire on Learning Strategies) [4], that aims to explore the cognitive, affective/motivational processes involved in students' knowledge acquisition. In the framework of this method, the questions were based on the Goal - Question - Metric (GQM) paradigm used in software engineering to assess software quality [5].

The paper is organized as follows: the next section focuses on motivation as an important aspect of the user experience. Then the method adopted to identify the student profiles is described in Section 3. Section 4 reports the experimental study and Section 5 concludes the paper.

2 Motivation as a User Experience Aspect

In recent years the concept of usability of software systems has evolved and, in a certain sense, gone beyond the borders of the HCI field, giving way to a strong focus on the user experience (UX). Many scientific works have already been published on the UX, and congresses, workshops, and forums are endeavoring to draw up a definition that the entire HCI community can universally agree upon [6]. In many cases UX is erroneously used as a synonym of usability, ignoring all the other features that contribute to the overall user experience during interaction with an interactive software system. Naturally, usability is an important factor in this experience but it is not the only aspect involved and cannot alone generate a good experience, although lack of usability will certainly result in a bad experience: in short, it is just one of the prerequisites [3]. The UX is a much wider concept that, in addition to usability, must take into account the achievement of behavioral goals; the satisfaction of non instrumental needs (e.g. esthetic, hedonistic, creative and social); the promotion of positive feelings and a sense of wellbeing [2].

Among all the aspects characterizing the UX, one of the most important to emerge in various works presented at the workshop "User Experience - Towards a unified view" is motivation [7]. This issue takes on a particular relevance in the context of the user/student interaction with an e-learning system, because the system itself plays a central role in the learning/teaching process.

Psychological research distinguishes between *intrinsic* and *extrinsic motivation*. Intrinsic motivation reflects behavior that it is undertaken for its own sake and for personal interest. In other words, intrinsic motivation is what is felt by an individual inspired by his/her own attitudes, skills, and interest. Extrinsic motivation reflects an activity or behavior undertaken for some instrumental value or external reason [8]. For example, an e-learning system (by definition a system which is external to an individual) could be able to motivate the learner better than another system. Learners who are intrinsically motivated not only feel autonomous and self-determined, but also experience high levels of interest. Higher levels of interest and intrinsic motivation stimulate learners to reflect more deeply [9].

In this work we concentrated on the participants' intrinsic motivation to learn the content of the on-line course and tried to explore if and how this affects the user's experience with the e-learning system. For this purpose, our method demanded prior determination of the users' profiles to measure their intrinsic motivation, as described in the next section.

3 Identifying the Student Profile

To identify the students' personal profiles and classify them according to cognitive and motivational factors, the method adopted is based on the "Questionario sulle Strategie di Apprendimento (QSA)" (Questionnaire on Learning Strategies), drawn up by the Pellerey group of the Università Salesiana of Roma (Italy), that has been widely employed since 1996. It starts from the assumption that nowadays students have ever less control of the cognitive, affective/motivational strategies needed to properly acquire the notions imparted at school in a stable, meaningful and efficacious manner. The goal of the QSA is to analyze the cognitive, affective and motivational processes involved in learning [4]. It consists of 100 questions probing two different types of factors: 7 cognitive factors and 7 affective/motivational factors.

The cognitive factors take into account:

C1. *Processing strategies* in terms of the cognitive processes involved in relating what has been studied or heard with what is already known.
C2. *Self-regulation* refers to self-study abilities.
C3. *Disorientation* considers difficulties in organizing and structuring knowledge in long term memory.
C4. *Willingness to collaborate* considers whether the student prefers to study alone or with others.
C5. *Use of semantic organizers* takes into account the use of graphs and schemes to aid understanding, organization and memory.
C6. *Concentration difficulties* considers difficulties in organizing work times and spaces.
C7. *Self-inquiry* considers the student's tendency to ask questions of her/himself, the teachers, companions and to answer the questions posed in the text as a means of gaining a better understanding and long term memory of the concepts.

The affective/motivational factors are as follows:

A1. *Underlying anxiety* refers to difficulties in controlling emotional reactions.
A2. *Willingness and will to persevere* in the set task assesses the student's ability to control his/her learning skills.
A3. *Attribution of success or failure to controllable causes* reveals the student's ability to make an objective assessment of her/his scholastic gain.
A4. *Attribution to uncontrollable causes* reflects a perception of external or internal causes dictating her/his scholastic gain.
A5. *Lack of perseverance* reflects difficulties in carrying out study activities and concluding the set tasks.

A6. *Perception of her/his own skill* reflects the student's positive feelings and pride in successful study.
A7. *Occasional emotional interference* considers particular conditions that could interfere with school work.

To ensure an objective, systematic application of the QSA, the questions in the questionnaire were structured according to the GQM (Goal – Question – Metric) approach [5], as illustrated in detail in [10]. The GQM is one of the paradigms most widely used in software engineering worldwide to derive measurements and metrics pertaining to pre-established goals. It defines a three-level measurement system: the conceptual level (Goal), defining the organizational goals; the operative level (Question), deriving a set of questions or hypotheses from each goal, that serve to quantify the given goal; the quantitative level (Metric), associated with a set of data describing the answer to each question.

In the QSA formulated according to the GQM approach, each factor corresponds to a goal and each question is linked to a metric system that can make an overall measurement of the level of achievement of the pre-established goal. In accordance with the GQM, a measurement plan was drawn up using the same four-level progressive scale proposed by the QSA. The student answers the questions proposed by assigning a value corresponding to how frequently s/he carries out a given action and the level of emotion aroused during interaction with the e-learning system. The last step in our work was drawing up metric sheets comparing the student's scores with reference values extracted from studies conducted in the psychological field reporting the mean profile.

4 The Experimental Study

The evaluation study method is described in the various parts of this section.

4.1 Participants

Fifty students, aged 18-19 years old, attending two classes at the Istituto Tecnico Commerciale “Francesco Calasso” high school in Lecce (Italy) were involved in the study.

In accordance with the ministerial program, the participants interacted with an online course on “Computer Networks” available at the distance learning portal (www.progettotrio.it) that can be accessed free simply by registering (Fig. 1). TRIO is a Web Learning system available to all, completely free, that supplies easy access learning products and services. The course aims to impart a knowledge of computer networks, the Internet and the World Wide Web.

4.2 Procedure

The experiment was conducted in three phases. In the first phase, the participants filled out the QSA questionnaire, administered collectively in class. The researcher administering the questionnaire to the subjects was very careful to engender a serene, cordial relationship so as to prevent any anxiety from altering the results. Firstly, the

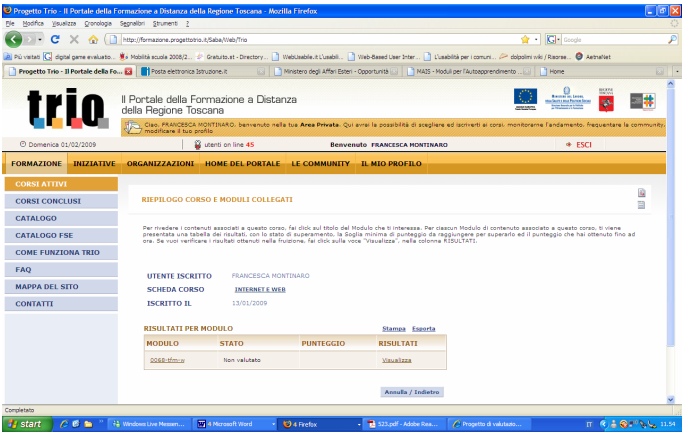

Fig. 1. Homepage of the Trio portal

instructions on the first page were read out in class and the researcher explained the precise goals of the experiment. The introductory talk was presented in the same way in both classes to make sure that all the subjects interpreted the tasks to be carried out in the same way.

In the second phase, the students' learning of the on-line content was assessed. To do this, before starting the course a pre-test was administered, consisting of 20 multiple choice questions including questions drawn both from the Trio project on-line course and from the chapter on computer networks in their school textbook "Informatica: Sistemi Operativi e Reti per il Sistema Informatico Aziendale". After completing the pre-test, the students proceeded to study the on-line e-learning course. This study was done in the lab during curricular lesson hours in presence of their information science teacher, and lasted about 6 hours in all, at a rate of 2 hours per week. At the end of this time, the participants underwent a post-test on computer networks, similar to the pre-test.

Finally, in the third phase the participants answered another questionnaire [11] aimed at evaluating the experience they had gained during study of the proposed e-learning system. Again, the questionnaire was administered in class.

4.3 Results

The results of the study are reported below.

Personal Profiles

The students' personal characteristics, ascertained using the QSA, were codified by means of the stanine (standard nine) scale, a nine-point scale. To facilitate reading and interpretation of the profiles still further, scores were grouped in five ranges, each of which corresponds to a particular level: *low* with mean values ranging from 1 to 2.9; *medium-low* with mean values ranging from 3 to 4.4; *medium* from 4.5 to 5.4; *medium-high* from 5.5 to 6.4; *high* from 6.5 to 9. Fig. 2 shows the relative frequencies of the 5 levels.

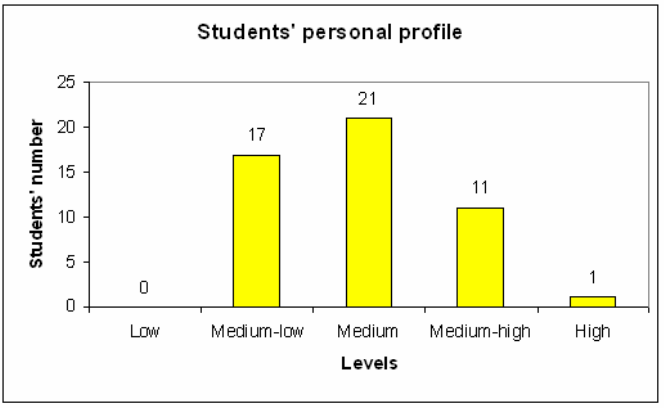

Fig. 2. Levels of the students' personal profiles

As shown in the graph, most students had an average level personal profile, featuring values extending from medium-low through medium to medium-high. No student had a low profile and only one of the 50 students had a high profile.

This result is in keeping with the general typology of students attending a technical high school and was further confirmed by the information science teachers of the two classes involved, who were interviewed after we concluded the analysis of the data obtained with the QSA.

Learning

Comparison of the results before and after studying the on-line course shows that the students demonstrated a slight but not significant improvement in their knowledge of the module contents (Fig. 3). In fact, there was an increase by nearly 2 points, from the mean pre-test score of 7.02 to the mean post-test score of 8.9. This relatively uninspiring result can be explained by analyzing the students' behavior during the lab hours devoted to the on-line course. First of all, the students are not used to employing the pc as a learning tool and prefer to listen to the teachers' explanations. During the lab hours many students explicitly stated that they would have preferred to hear the explanation from their teacher rather than reading it on their pc monitor and then working with the concepts acquired. In some cases, moreover, the students spent their lab time playing games or navigating the Internet, or chatting with their friends, etc., obliging the teachers to call them to order very frequently. In addition, some technological problems unfortunately arose during the study hours, that may also have contributed to the less than brilliant results.

User Experience

Fig 4. shows the means for each item in the questionnaire about the UX. It is clear that the students regarded their experience as positive. In fact, all the items in the categories considered show above average values with the exception of the item “Use special effects” in the category “Expressive aesthetics” that was assigned a value of 3.1, and the item “joyful” in the category “Pleasure” that was assigned the value 3. Both items refer to characteristics that are deliberately played down in an on-line course because they might hinder the natural learning of the concepts by distracting the learner and shifting attention to special effects like winking, glittering etc.

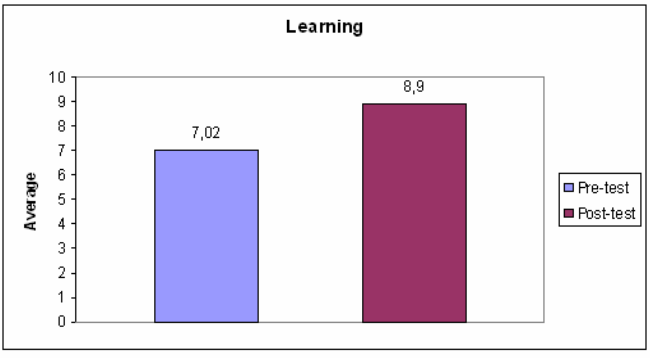

Fig. 3. Comparison of the pre-test and post-test means

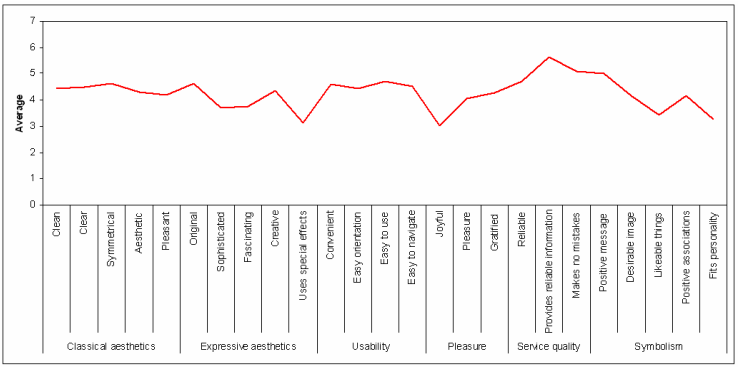

Fig. 4. Means of the questionnaire items on Lavie and Tranctisky's UX [11]

Correlations among personal profiles, learning and UX

To achieve the pre-established goals of the course, we tried to identify the relations between the student's personal profile, learning and the overall experience with the system. This was done by correlating the various questionnaires used in the study.

The QSA data were correlated with the learning data (Fig. 5). As can immediately be seen from the graph, there was no significant relation between the student's personal profile and the learning gain. For example, students n. 8 and n. 16 have the same mean characteristics but completely different learning levels; student n. 8 achieved a lower score in the post-test than in the pre-test, showing improper use of the tool, whereas the computer-student n. 16 interaction yielded satisfactory learning.

To check for correspondences between the results of the two questionnaires, Pearson's correlation coefficient was used. This coefficient indicates a correlation between two variables and can range from +1 to -1 passing through 0. The nearer to +1 the better the positive correlation (a correlation coefficient equal to +1 is only theoretically possible); the nearer to -1 the higher the negative correlation. A coefficient around 0 reflects an absence of correlation among the data, that could only be a chance occurrence [12]. In the present case the Pearson coefficient, r = 0,18, showed a low correlation between the students personal profiles and how much they learned.

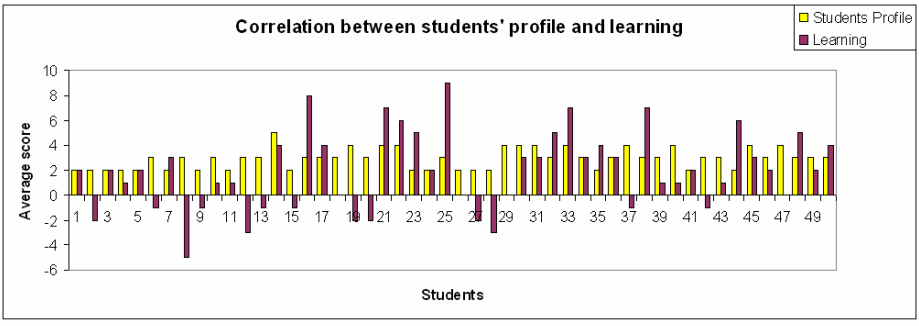

Fig. 5. Correlation between students' personal profiles and learning

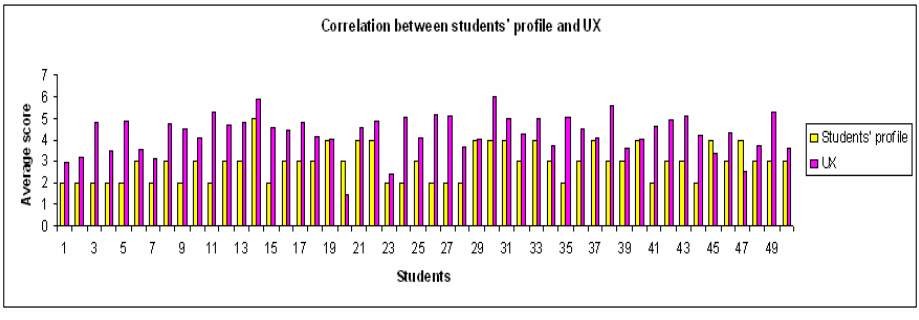

Fig. 6. Correlation between personal profile and UX

The relation between the students' personal profiles and their judgment of use of the e-learning system showed a Pearson's coefficient equal to r = 0,12, again demonstrating a low correlation. In particular, we can see from the graph that students n. 20 and n. 38, despite having the same medium-low personal profile, had a completely different experience with the system. Student n. 20 had a poor view of the interaction with the system, and assigned a mean score of 1.5. Instead, student n. 38 had a very good experience and gave it a mean score of 5.6.

5 Concluding Remarks

This work presents the results of a study carried out to analyze whether and to what extent a student's cognitive and affective characteristics influence her/his overall experience with the e-learning system and level of learning of the new concepts imparted in the course. To identify the student sample personal profiles, the method we adopted was inspired by the “Questionario sulle Strategie di Apprendimento” (Questionnaire on Learning Strategies), proposed by Pellerey for the purposes of analyzing the cognitive, affective and motivational processes involved in knowledge acquisition. To ensure the systematic, objective application of the questionnaire, the questions were posed according to the (GQM) approach.

The student sample consisted of 50 students attending the Istituto Tecnico Commerciale “Francesco Calasso” of Lecce (Italy) , who interacted with an on-line course on “Computer Networks” made available by the distance learning portal www.progettotrio.it. The results of our study showed that most of the students had an average level personal profile. This is in line with the type of students that attend technical high schools in Italy and was further confirmed by the Information Science teachers of the two classes, who were interviewed after we had concluded the QSA data analysis.

In terms of learning gain, we observed that all the students improved their knowledge of the computer networks topic addressed by the teaching module but not to any great extent. Pearson's correlation coefficient demonstrated little relation between the user's personal profile and the learning gain. The results of the questionnaire probing the students' opinions of their overall experience showed that it was judged positive by all; again, the positive judgment was not correlated to the students' personal profiles. In addition to the results obtained for the specific end-points of the study, some other more general comments can be made about the use of technology in schools. In this experiment it is clear that the technology did not yield the expected benefits. This is in agreement with various other studies [13] that have pointed out that one of the main causes for this failure is the way technology has been used up to now. School administrators and teachers are generally rather reluctant to institute new technological tools, partly because they themselves are not trained to use them and partly because they are not sure of how and when they could best be used.

In our study, it is clear that the presence of the teacher has a strong effect on the students' behavior and therefore that no e-learning system could replace the school teacher. The students obviously preferred to interact with a person, who can provide more precise suggestions and a specific guide to the learning pathway. From this standpoint, we conclude that the most efficacious use of a learning system is in those cases where there is no other way of overcoming space-time constraints. For example, if the student cannot go to school for some reason, or when wishing to illustrate situations that cannot easily be reproduced during school hours, such as the use of a telescope when studying astronomy. In any case, new e-learning strategies and techniques need to be identified that can arouse a stronger motivation in students, closer to what can be engendered by a good teacher. For example, Computer-Supported Collaborative Learning (CSCL) tries to effectively recreate the traditional classroom environment facilitating participation and social interaction among students, and primarily among the teacher and students [14].

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