INTELLIGENT TUTORING IN INFORMAL SETTINGS: EMPIRICAL STUDY

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Abstract

Modeling and realization of an intelligent tutor for informal situations in support of formal education is a new and challenging problem relevant to the learning performance and efficacy. It needs further exploration regarding the factors that distinguish tutoring and learning in a formal classroom and informal places. The paper presents the results from an empirical study identifying the environmental conditions, cognitive states and emotional charge of students that influence learning in informal places like a cafe, a park, home and public transport. The techniques for attention concentration after task breaking and during task performance are determined according to the gathered students' opinion.

Keywords: informal learning, intelligent tutor, environmental conditions, affective state

1 Introduction

One direction for increasing personal effectiveness in learning is applying a strategy of intelligent tutoring. The research society is looking for a computer tutor combining the advantages of the human teachers' capabilities and multi-tasking and multi-modal techniques of machine learning in the form of web-based and mobile applications. Such computer tutor is described not only as a domain expert and instructional designer who guides step-by-step and advises a learner on demand but also as a good psychologist, adapting pedagogies and content to the emotional state. There are several solutions proposing adaptive tutoring according to the personal cognitive and affective charge of a given learner, realized by the integration of facial expression methods, sound recognition, text typing mood, observation of learner's physical characteristics.

Learning occurs not only during the planned classes according to the curriculum but also very often it continues in informal settings in cafe places, libraries, home, etc. in the time between classes and after that. Also, Csanyi et al. found the indicators through empirical study for interface between formal and informal learning. They agree that "informal learning is not only autonomous activity, but also can be influenced by teachers or trainers" and that the power of informal learning could be taken only if it is related to formal learning (Csanyi et al., 2008). Furthermore, Chang et al. report for specially created places for informal learning in the School of engineering at the University of Melbourne where students immediately after formal classes could feel comfortable to continue their learning in a "student-friendly" environment (Chang et al., 2009). The findings after a survey point increase use of the informal places if they are available for students.

Modelling and realization of an intelligent tutor for informal situations in support of formal education is a new and challenging problem relevant to the learning performance and efficacy. A motivated learner is looking for knowledge receiving in informal spaces or outside the university in a time and place suitable for him. The environmental conditions and the specificity of the places for informal learning are different than these for lecture or practice classes. There are many variables for disturbing and interrupting a started learning activity. The conditions and causes for interruptions in an informal

learning session and techniques for easy transitions from pauses to learning are still not studied and algorithmized well. The main factor for improving the learning breakdowns is attention concentration on the learning content according to research reports. Also, there is evidence that emotions influence on learner's attention and concentration focusing on a given learning item (Chaffar and Frasson, 2004). Another problem is related to motivation increasing for learning after interruptions and fast returning of attention to the current studying point.

The aim of this paper is to identify the variables important for the realization of an intelligent tutor supporting informal learning through empirical study. The explored variables are grouped in five categories: (1) influence of environmental factors on attention concentration; (2) attention allocation techniques, (3) identification of suitable cognitive level of learning in informal places, (4) influence of emotional charge on learning (5) factors for improvement of motivation for learning.

2 Method

The aim of this empirical study is to identify disturbing and favorable factors that impact on learning in informal places. For this purpose, survey tools are developed to gather the opinion of students. In this exploration 22 male and 7 female students are involved. They are in their third year of bachelor degree study in Computer Science. The survey tools include questions related to:

(1) How the environmental conditions influence on the process of learning? The conditions at four often used places for informal learning are examined: cafe, home, park and public transport vehicles. The used scale for evaluation is ranged from 5 – this factor possesses very high influence on learning to 0 – this factor does not influence on learning.

(2) How the emotional states of a student contribute to the motivation for learning? The emotions are divided in positive and negative and their imprint on the task concentration is identified. Students' vote range from 5 – this emotion is very important for my learning to 0 – this emotion is not important.

(3) How does personality influence on informal learning? The students' personality is classified in 6 different groups: *group1* includes students with intensive social life, who like to be in the centre of attention and who in their activities is influenced by positive emotions; *group 2* collects quiet, reserved, self-controlled students who think intensively before every single step, their attention is concentrated on their inside and specific personal life, they are slightly engaged in social relationships; *group 3* gathers students who are easily affected by the conditions of the environment, they easily can be discouraged, the typical emotions for them are: anxiety, angry, guilty, envy, depression.; *group 4* characterizes very impulsive persons who usually perform risky activities, they do not plan their steps, they are at enmity with each other, they are with spirited mood.; *group 5* are persons who respect social laws and rules and these rules are a base for their activities; *group 6* – it includes students who cannot categorize them-selves in the above mentioned five groups.

(4) What kinds of techniques are suitable for attention concentration when learning occurs in informal settings? The techniques are classified in 3 groups: appropriate techniques for attention returning when a disturbing factor emerges, techniques for attention allocation during the task performance and techniques for motivation to learn in informal situation.

(5) What is the maximal achieved level of cognition when a student learns in a café, at home, in a park, in public transport vehicles? Bloom's taxonomy with its 6 levels: knowledge, comprehension, application, analysis, synthesis and evaluation is used. This will point the level of task complexity suitable for serving to students when they decide to learn informally. It is important for motivation improvement and for induction of positive emotions.

3 Influence of environment

At the foundation of this research the main hypothesis is that: the sound level, light intensity, temperature, dynamics of people stream, furniture comfortableness, weather conditions, GSM ring, food/coffee smell and secondary computer/mobile applications are among the factors that could disturb or support learning when it occurs outside the formal classes. In order to prove or reject this hypothesis the results of students' votes are summarized in Table 1 in the cases when they use mobile computers or smart phones for learning in a cafe, at home, in a park or in public transport. The opinion of male and female students for the interference of the surrounding conditions on a learning process differs. To identify the most disturbing factors the average values of male and female students are calculated. The findings point that in a cafe: the loud talk (4.35) and loud music (3.5), intensive stream of people (3.84), additional computer applications (3.01), GSM ring (2.96), hot room (2.81) and poor light (2.65) are among the interventional factors with the biggest value. When students are at home, they break off their task doing because of influence of the above mentioned factors typical for a cafe plus the feeling of nice sunny weather (2.85), feeling the comfortless of the furniture (table – 2.63, chair – 2.5) and the low temperatures in the room (2.51).

Factor	In a cafe			At home			In a park			In transport		
	score male	score female	score average	score male	score female	score average	score male	score female	score average	score male	score female	score average
Loud music	4.14	2.86	3.5	3.86	3.43	3.65	3.55	2.14	2.85	3.86	3.57	3.72
Quiet music	1.59	1.71	1.61	1.36	2.57	1.97	1.23	1.14	1.19	1.82	2.14	1.98
Loud talk	4.41	4.29	4.35	3.73	4.71	4.22	4.36	4.29	4.33	3.91	4.14	4.03
Quiet talk	2.18	2.71	2.45	2.09	2.57	2.33	1.91	3	2.46	2.18	3.14	2.66
Intense light	2.41	2.29	2.35	2.45	2	2.23	2.41	2.29	2.35	2.5	2.71	2.61
Poor light	2	3.29	2.65	2.14	3.29	2.72	2.23	2.71	2.47	2.23	2	2.12
Hot room/cabin	3.05	2.57	2.81	2.86	2.57	2.72	-	-	-	4.59	3.86	4.23
Cold room/cabin	2	1.58	1.79	2.59	2.43	2.51	-	-	-	3.05	3.43	3.24
Intensive stream of people	3.68	4	3.84	3.36	4.43	3.9	2.86	4.14	3.5	3.64	4.14	3.89
Low stream of people	1.82	2.71	2.27	1.4	3.86	2.63	1.36	3	2.18	1.91	2.86	2.39
Comfortable chair/bench	2.55	1.71	2.13	2.86	2.14	2.5	2.55	2.29	2.42	2.45	1.57	2.01
Comfortable table	2.14	2	2.07	2.68	2.57	2.63	-	-	-	-	-	-
Nice sunny weather	2.14	2.71	2.43	2.41	3.29	2.85	2.91	3.14	3.03	2.36	2.43	2.4
Nasty rainy weather	1.77	2.29	2.03	1.77	1.57	1.67	3.55	4	3.78	2.64	2	2.32
GSM ring	2.91	3	2.96	2.5	3	2.75	2.23	2.86	2.55	2.73	2.71	2.72
Strong food/coffee smell	2.18	1.43	1.81	2.27	2.29	2.28	2.09	1.29	1.69	2.45	1.29	1.87
Week food/coffee smell	1.23	1.14	1.19	1.45	1.14	1.26	1.23	1.14	1.19	1.23	1.86	1.55
Computer/mobile applications	2.73	3.29	3.01	3.36	3.43	3.36	2.41	3.29	2.85	2.5	3.29	2.9
Stops frequency	-	-	-	-	-	-	-	-	-	2.55	3.14	2.85

Table 1. Students' vote about the influence of environmental conditions on their learning

During the time in the park students' attention is drawn aside from the loud sound (talk – 4.33 and music – 2.85), the weather conditions (nasty rainy weather – 3.78 and nice sunny weather – 3.03), intensive stream of people (3.5), additional computer/mobile applications (2.85) and GSM ring (2.55). When students travel via a public transport vehicle they feel intervention of temperatures in the cabin (hot cabin – 4.23 and cold cabin – 3.24), loud sound (loud talk – 4.03 and loud music – 3.71), intensive stream of people (3.89), additional computer applications (2.9), stops frequency (2.85), GSM ring (2.72) and nice sunny weather (2.4). The repeated factors in the four described cases for informal learning: in a café, at home, in a park and in public transport are shown on Figure 1. As it can be seen the students are very sensitive to the loud sound, intensive stream of people, additional computer/mobile applications installed locally on their devices and GSM ring. These factors should be taken into consideration when an intelligent tutor is designed in support of learning in informal situations.

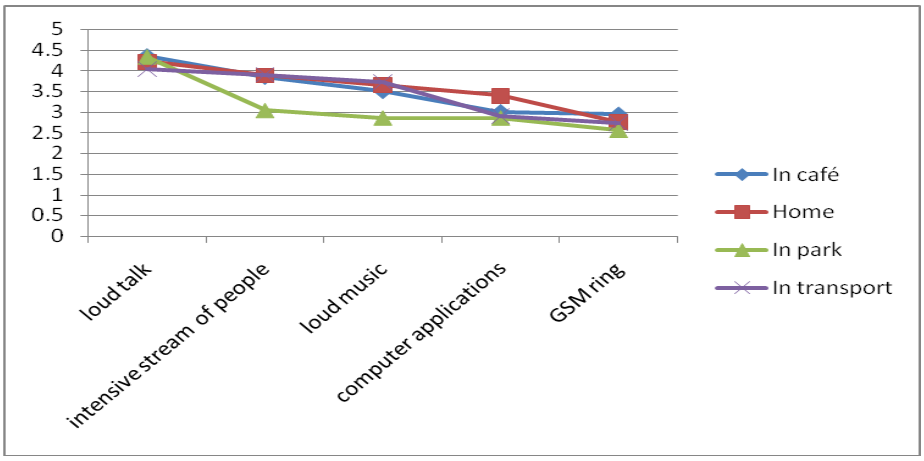

Figure 1.The common factors disturbing learning in a cafe, at home, in a park and in public transport

4 Techniques for attention concentration and motivation

Different interventions could interrupt the students' task doing or problem solving and researchers are looking for suitable techniques that can easily and fast return the students' attention on the working item. Roda and Nabeth discuss four levels for attention focusing in an online learning environment: (1) perceptual level - techniques for facilitating the access to the important parts of a web page, for selection the needed information as well as techniques for attention focusing after interruption; (2) deliberative level - tools for performing control on tasks and tasks priorities, techniques for motivation and attention returning; (3) operational level - techniques and tools for context keeping after interruptions, for information filtering, for reducing the level of complexity, (4) meta-cognitive level - tools for self-diagnostic, techniques for attention allocation (Roda and Nabeth, 2008). Techniques, tools and strategies for attention focusing suitable for an application at the above described four-level model are extracted from the book "Human attention in digital environments" edited by Roda (2011) and this information is analyzed and visualized on Figure 2.

For the purposes of this exploration the techniques for attention concentration are divided to: (1) techniques for attention returning when a task is interrupted and the student gives up to continue at this moment and (2) techniques facilitating task performance and attention allocation. According to the students' opinion when a factor breaks a task it would be very useful for software to remember the last used item and to select it in different color or in another way (77% of all surveyed students). When a student decides to return to this task it will be easy to continue from the selected item. The students also appreciate help (72.5%) and advice receiving (64.5%) how to continue with the problem solving, hint how far it gets last time (58%) and summary describing the work to this moment (53.5%). From the survey it becomes clear that students do not like software interventions in the form of reminder saying that they *must* continue (only 35% of all students give their vote for this technique). Among the

techniques enhancing task performance with the highest rate are: availability of instructions for task performance (90.5% of all voted students), structuring the tasks according to different criteria (53.5%), receiving appropriate advice (62.5%) and help (58%), a kind reminder about the goal of this task (60.6%), and decreasing the task's complexity when it is needed (53.5%). The students do not appreciate enough the power of techniques like: tracking of affective states (face and facial expression recognition) (49%), eye tracking (9%), and hands tracking (26%), although there are several developed intelligent tutors reporting promising results. They integrate methods for affective state recognition (Whitehill et al., 2008; Alexander et al., 2006; Ntombikayise and Robinson, 2011) and hand gestures tracking (Bustos et al., 2011; Abbasi et al, 2008).

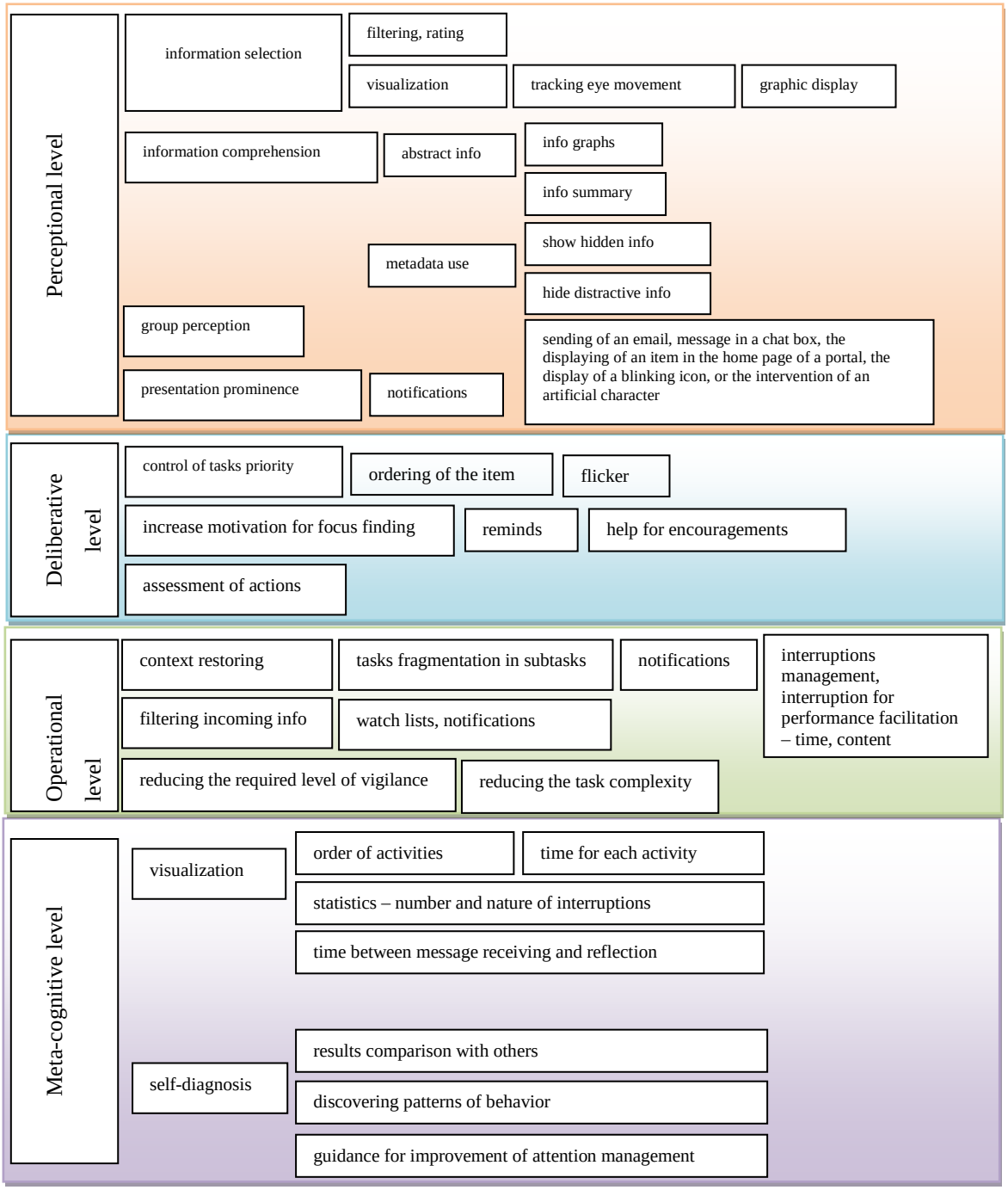

Figure 2. Four levels for attention management in digital environment according to (Roda and Nabeth, 2008) and (Roda, 2011)

The tutoring system M-Ecolab uses a mechanism for adaptation of the learning resources according to the individual student's motivational state (Rebolledo-Mendez et al., 2011). The degree of motivation is identified automatically through measurement of the students' participation in solving problems, the level of tasks difficulties, and according to the requested help during a task doing. The effect of the applied motivational techniques on learning are evaluated through statistical tests that show "significantly higher scores in the domain knowledge" achieved by students.

Among the directions for motivation improvement the students think that the following techniques could contribute: time limiting for every single task (70.5% of all responders), comparison of learning achievements among all participant in a lesson (62.5%), creation of a report summarizing the students' current progress (56%), usage of messages notifying the current tasks' status and student's progress (53%). The techniques like creation of a rating list (42%) and usage of messages for encouragement (37%) are not rated very high by students.

5 Cognitive states

The Bloom's taxonomy with its six levels for achievement of given cognitive skills is used to determine the types of tasks suitable for serving to students when they are placed in informal settings. According to the learning objectives the tasks are classified into 6 groups: *group A* includes tasks for existing knowledge recalling, *group B* contains tasks for new knowledge understanding, *group C* – tasks that require applying old and new knowledge in problem solving, *group D* – tasks that are connected to the analytical students' skills, *group E* consists of tasks that require skills for knowledge combination and creation of new solution, *group F* includes tasks for evaluation and judgement of knowledge, concepts, solutions. According to the responders the best learning tasks in a cafe should be focused on existing knowledge recalling, comprehension of new concepts and applying this knowledge to solve a problem (tasks from A, B and C groups). In a park and in transport the suitable tasks are not so complex tasks - they require repetition of existing knowledge and understanding new concepts (tasks from groups A and B). Home proposes the best conditions for informal learning and students could solve complex problems including tasks at the levels of analysis, synthesis and evaluation (tasks from all groups).

6 Affective states

Nowadays, ITSs are improved through modules for recognition of the student' affective states and possibilities for the induction of suitable emotions for learning. Several of them can predict the emotional state of a student, dynamics in his behaviour and in this way different strategy for motivation could be applied and the learning path could be optimized.

Rishi (2009) discusses the influence of emotional state on attention in task doing – negative emotions (anger, anxiety, or distress) do not allow focusing on the learning item or moving the attention to the new one and in this way the learning performance is decreased. Positive emotions like joy and pride could facilitate thinking and learning. The author proposes a rule-based dynamic method for ensuring the best emotional conditions for learning, including detection of emotions and provoking suitable affective state for performance improvement.

Chaffar and Frasson (2004) present a system ESTEL (Emotional State towards Efficient Learning system) that has features to predict the optimal emotional state for learning according to the learner's personality. It can induce the appropriate emotions to improve the processes memorization and comprehension through applying different techniques like guided imagery, music and images. The learners' personality is divided into four groups: (1) extraverts are active and communicative persons who could easily be influenced by positive emotions; (2) neuroticism is typical for people who are easily affected by the conditions of the surrounding environment and who are easily discouraged; (3) psychoticism are impulsive and hostile people; (4) lie group includes sociable persons with respect to

the societal laws. The authors show the connection between a learner's personality and optimal emotional state. As it can be seen the common affective states that could play a catalizator role for learning are positive emotions like: joy, confident, pride, anxious, self-gratification. The authors propose a six module architecture including: emotion manager - responsible for emotions monitoring, distribution and tasks synchronization; emotion identifier - recognizes and predicts the emotional state of the learner according to his color preferences; personality identifier - identify the personality of a learner through a questionnaire and communicates with the emotion manager module; optimal emotion extractor determines the optimal emotional state according to the learner personality using a set of rules; emotion inducer - induces the suitable emotions for learning; learning appraiser evaluates the learner' s performance in his current affective state through a pre-test and evaluates the performance in his optimal emotional state through a post-test. The Naive Bayes classifier is applied for optimal emotional state prediction in correspondence of the learner's personality.

du Boulay researches the factors that could support the design of motivational modules in ITSs (Boulay, 2011). The author explores three negative emotions: frustration, anxiety and boredom and searches for suitable pedagogical strategies according to the three motivational states: values (personal, social and cultural background of a student that stimulates his participation in a learning process), expectancies (expectations of a student for performing learning) and feelings (the emotion emerging from the previous experience).

Another study addresses the influence of positive emotions on learning performance and facilitation of the cognitive process (Um et al., 2007). The findings show significant impact of positive emotions on cognition and learning. The authors agree that instructional design and instructional learning objects can be used for induction of a positive mood, to improve students' experience, satisfaction and performance.

For the purposes of this study a set of emotions – positive and negative is proposed to students to cast their vote about the influence of emotions on learning in an informal situation. As it can be seen on Figure 3 and Figure 4 the positive as well as the negative emotions have the power to drive learning and to motivate or not the students. The positive emotions with the highest scores that support meaningful learning are: joy, happiness, enthusiasm, and confidence. Among negative emotions that influence learning with the highest scores are: angry, perturbed, anxiety and hopelessness.

The students' personality is explored too according to self-report of responders. 31.9% of male students and 28.6% of female students self-describe as quiet, reserved, self-controlled students; they prefer to learn alone, concentrating all their attention on the learning item. 22.7% of male students and 42.8% of female students are classified in the group of social, active and communicative persons; they are easily influenced from the positive emotions.

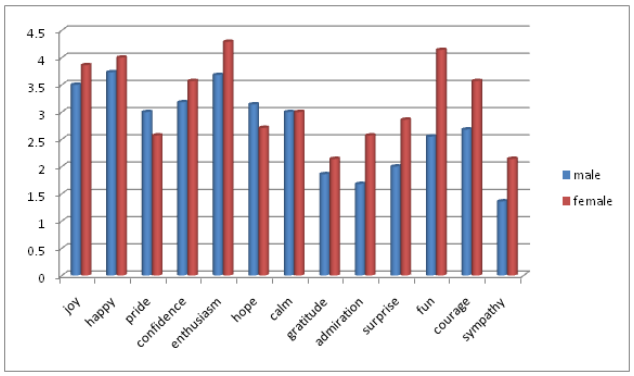

Figure 3. Students' vote about the influence of positive emotions

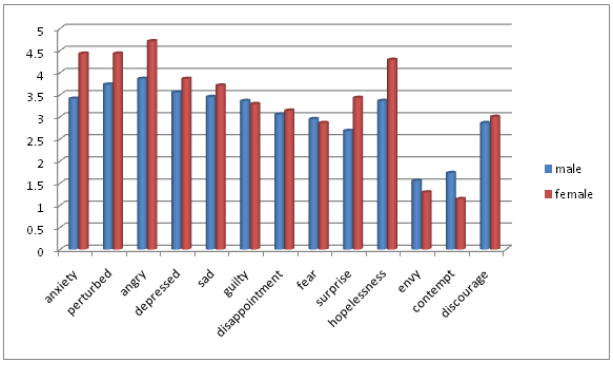

Figure 4. Students' vote about the influence of negative emotions

The rest of the students (the smaller part of the responders) define them-selves as students who are easily affected by the environmental conditions (13.7% of male students and 14.3% of female students); as very impulsive persons who usually perform risky activities (13.7% of male students and 14.3% of female students); as persons who follow social rules in their activities performance (9% of male students) and as students who combine features of the above mentioned personality groups – showing one or other feature according to the conditions and situations (9% of male students).

The results from the empirical study and findings from literature point that an intelligent tutor with an intention to support informal learning has to integrate techniques for induction of suitable emotions predisposing students to continue their work on tasks and achieving the planed outcomes.

7 Conclusions

The paper presents the results from an empirical study with focus on the main factors that impact on learning efficacy when students are placed in informal settings according to their vote. The findings show that there are many different factors that disturb and interrupt learning. Several of them are so strong and they could lead to task breaking for a long time or refusal of further problem solving and task doing. Therefore, suitable techniques for motivation and emotional charge have to be selected very precisely and used for realization of an intelligent tutor. This study stresses strongly the main factors that should be taken into consideration when learning occurs in an informal situation and they are found in environmental conditions, the level of cognition, the emotional state, attention concentration and motivation for learning. A model is developed to summarize variables that influence learning in informal situations (Figure 5).

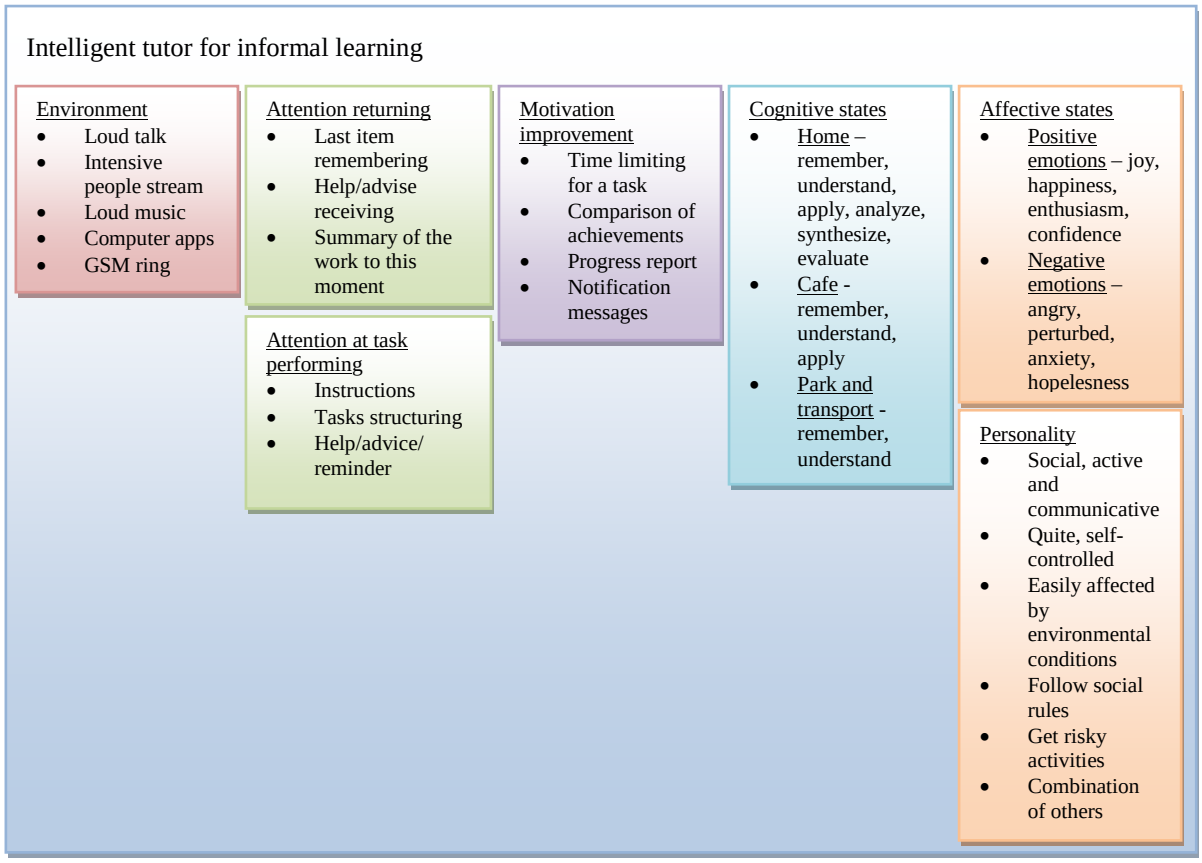

Figure 5. Factors influencing learning in informal situations

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