Goal achievement orientation in the design of an ILE

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Abstract

Goal achievement theory investigates how students approach and tackle new learning tasks. According to this theory, students with mastery goals are more keen to expend effort in order to improve their learning and skills, whereas students with performance goals try to demonstrate competence or try to achieve at high levels of normative ability using the least possible effort. Affective computing, in the sense of targeting students' emotional and motivational state, is an approach that needs to be further explored, and so we propose to consider goal theory in the design of an ILE. Our objective is to analyze what role goal orientation plays when students work with an interactive learning environment that attempts to use this as a means to positively affect students' motivation. It is our belief that students who work in a context that matches their goals, perform better. In this paper we describe the design of a system that takes students' goal orientation into account in the choice of its feedback. There are two versions of the system, one emphasizes a mastery goal orientation, the other emphasizes a performance goal orientation.

1 Introduction

In recent years, research has focused on the importance of emotions and motivation in human learning through educational software (e.g. Conati & Zhou, 2002; Georgouli, 2002; de Vicente & Pain, 2002; Kort, Reilly, & Picard, 2001; del Soldato & du Boulay, 1996). This research has been grounded in various theoretical approaches, such as the OCC model (Orthony, Clore, & Collins, 1988), the ARCS model (Keller, 1987), and the Four Quadrant model (Kort et al., 2001). Some of these models take into account students' goals as well as personality traits and have been used to guide the reactions of the tutoring system. Another approach that considers these issues is goal achievement theory.

Goal achievement theory has emerged as a major new direction in motivational research (Ames, 1992; Elliot & Dweck, 1988; Nicholls, 1984). This theory focuses on students' aims or purposes and how they are pursued or perceived in an achievement setting; that is, on how students think about themselves, their tasks, and their performance. Although several experimental studies suggest that goals can be manipulated in the short term, goal orientations appear fairly stable across domains and time (see Urdan, 1997, for a review). Two approaches have emerged from goal theory. On the one hand, a dual perspective believes students are interested either in developing ability (labeled as task-, learning-, or mastery-oriented) or in demonstrating ability (labeled as ability-, ego-, or performance-oriented) (Ames, 1992; Elliot & Dweck, 1988; Nicholls, 1984). On the other hand, a triple perspective has further partitioned the group concerned with demonstrating ability into a performance-approach group and a performance-avoidance group according to whether students construe an achievement situation, as a challenge or as a threat (Elliot, 1997; Elliot & Church, 1997; Elliot & Harackiewicz, 1996).

Several theorists (Ames, 1992; Maehr & Midgley, 1991; Ames & Archer, 1988; Covington & Omelich, 1984) suggest that we should develop classroom styles that are specifically designed to foster mastery goals. However, other authors suggest that we need to understand more about multiple goal perspectives before concluding that a mastery goal perspective is best (Barron & Harackiewicz, 2001; Harackiewicz & Elliot, 1998; Elliot & Harackiewicz, 1996; Harackiewicz & Elliot, 1993). For instance, Valle, Canabach, Nunez, Pienda, Rodriguez, and Pineiro (2003) applied a cluster analysis that identified three groups of students with different motivational profiles: a) students with a predominance of performance goals,

b) students with multiple goals, and c) students with a predominance of learning goals. Their results suggest that students with a predominance of learning goals and students with multiple goals have a more positive motivational approach than those students with a predominance of performance goals.

So far, the goal achievement research described above has been carried out in classroom contexts and has not been specifically concerned with computer based systems. In this paper we describe an initial approach to investigating how far students' goal orientation has an impact on their motivation during an interaction with an interactive learning environment.

2 Goal orientation and motivation in the learning process

The cognitive aspects of learning, such as problem solving, are important, but "affective" aspects are now being considered because the student's emotional state has a great influence over the possible achievement goals established during the learning process (Woolf, Beck, Eliot, & Stern, 2001). Although is is unclear how best to take account of students' affective states and how to select the characteristics that need to be embodied into the systems in order to improve the student's learning, de Rosis (2001) points out that "... we probably don't need to model *all* possible affective states of the user ... ideally, we should accurately select those factors which have to be considered in [the application] domain [considered]".

Several authors suggest that a positive state of motivation is a necessary condition for students to learn from instruction (Lepper, 1988; Schiefele & Rheinberg, 1997; Keller, 1983) since motivation influences or determines (1) students' selection of covert and overt means for interacting simultaneously with the subject matter and with the social features of classrooms, (2) temperamental aspects of this interaction, and (3) how long students will interact (Winne & Marx, 1984).

2.1 Motivational modelling in educational software

It is believed "that by identifying a learner's [motivational] emotional/cognitive state is a critical indicator of how to assist the learner in achieving and understanding of learning process" (Kort et al., 2001). Traditionally in the classroom context, motivational techniques have been used by teachers in order to build the conditions that stimulate students' desire to learn. However, in terms of computer programs, few attempts to model students' motivational state have been made. Establishing this state is hard. As a result, two approaches to motivational issues in intelligent tutoring systems can be distinguished. In the first approach, the goal is to produce more empathetic, enjoyable, and motivating software, which needs to have the richest possible picture of a student's current motivational state (see e.g. de Vicente & Pain, 2002; Georgouli, 2002; del Soldato & du Boulay, 1996). The other approach focuses on determining which motivation-related behaviours most strongly affect learning (Baker, Corbett, & Koedinger, 2004; Aleven & Koedinger, 2001; Wood & Wood, 1999).

Taking into account the first approach, there is the difficulty of obtaining observable clues about the user's emotional state. As a result some interpretations have combined information obtained from the use of the different elements of the interface to derive values for parameters such as effort, confidence, and independence in order to characterize the user's motivational state.

Georgouli's (2002) and del Soldato and du Boulay's (1996) approaches to modeling the student's motivational state are based on the ARCS model (Keller, 1987): a motivational modeller calculates the quantity of effort the student shows in finding the right answers and the overall confidence and independence that is shown during the interaction. A conflict solver reconciles output from the motivational planner and the domain planner, which detects the current state of the student's knowledge, in order to decide what action should be carried out next (e.g. to provide or not to provide help).

In Conati and Zhou's (2002) approach, the system relies on the OCC model (Orthony et al., 1988). This system considers both the possible causes of the student's affect and its observable effects, which are integrated into a dynamical decision network. It assesses affect by predicting how the student's goals, personality, and knowledge influence the student's appraisal of the interaction with the system. The integration with a model of student learning is still under development.

Note that the ARCS model considers that inputs such as motives and expectancy affect the effort, performance and learning outcomes and that the OCC model takes into account student's goals as an

important factor in subject's emotions.

Considering the second approach towards motivation in tutoring systems, whose main aim is to determine those behaviours that affect learning, Baker et al. (2004) have identified a behaviour that is termed "gaming the system", where the user of the system takes advantages of properties and regularities in the system to complete a task successfully, rather than thinking about the material. Although they do not consider student's goal orientation, this behaviour resembles that for a student with a predominance of performance goals. A strong negative correlation was found between students' frequency of gaming and learning. They propose a model to identify students who engage in gaming the system that can be used to re-design tutors to respond appropriately to this behaviour.

Another behaviour that has been studied is the use of help. Aleven and Koedinger (2001) claim that there are systematic individual differences in students' help seeking behaviour. For instance, some students misuse the help of the system asking for hints when they know enough to proceed successfully without help (abuse of help) and some others do not ask for them when really needed (under-use of help). Moreover Wood and Wood (1999) have shown that process measures of student-tutor interactions account for some of the variance in post-test scores; however, the evidence that help seeking aids learning is supported by Wood and Wood's results but not by those of Aleven and Koedinger (2001).

So, in addition to research about ways to cultivate motivation to learn, more research considering students goal orientation is necessary.

2.1.1 Goal oriented context

Sansone and Morgan (1992) suggest that the same information and feedback can either aid or obstruct intrinsic motivation, depending on its match with how students define the goals of their involvement. We want to make clear that we refer to the word feedback as it is defined by Sims-Knight and Upchurch (2001): informational feedback tells the learner if her answer is right or wrong. It can be minimal feedback (right-wrong response) or maximal feedback (e.g. guiadance, praise).

Several claims have been made considering the use of feedback, which include some in relation to students' orientation goals. Harackiewicz and Elliot's (1993) results suggest that by providing feedback consistent with the general goal orientation established at the beginning of task engagement, the perceived competence and task enjoyment can be enhanced: that is, subjects in mastery goal conditions receiving positive, mastery-relevant feedback, and subjects in performance goal conditions receiving positive, normative feedback. These ideas are also supported by Keller's (1983) model of motivation, performance, and instructional influence. So taking account of these studies, we provide self-referenced feedback in the mastery version of our system and normative feedback in the performance one.

Another feature that is being used in order to provide a goal oriented context is the availability of help. Help seeking is regarded as an important metacognitive skill, as it involves, among other tasks, the ability to assess task difficulty, evaluate one's own comprehension and knowledge, decide whether to seek help and so on (Gall & Resnick, 1998). Almost without exception, ILEs provide help on demand, that is, information requested by the student and provided by the system for helping students learn better. In this way, the chance that the help provided is unnecessary or inappropriate is reduced. However, a number of recent studies report evidence that learners are not using the help facilities of ILEs effectively (see Aleven, Stahl, Schworm, Fischer, & Wallace, 2003, for a detailed review). So, should the system or the student control the help given? By giving the control over help to the student, it is assumed that she has got the metacognitive skill to make good use of it. In contrast, by giving the control to the system, its assumption about the nature of the error might not be accurate enough to provide the appropriate help to remedy it.

There is reseach which suggests that help seeking behaviour reflects students' attitudes about learning (Arbreton, 1998; Newman, 1998; Ryan & Pintrich, 1998), so we propose to provide help according to students' goal orientation. In the version emphasizing mastery goals, the system will offer help on demand. However, if the model believes that the student's motivational state is declining, it will prompt her to look for help or provide a hint. On the other hand, in the version emphasizing performance goals, the system will have control over the help, because students might be reluctant to look for help in order to avoid demonstraiting inability. We are aware that some other students might try to use this help as a way to get the tasks done quickly, however as empirical results on the effect of help systems in ILEs is quite small, we try to mitigate this possibility by giving suggestions about the level of help that the

student should ask for.

3 The proposed goal oriented software

The Ecolab system is an implementation of a Vygotskian design framework, where the more able partner (computer program) adapts the way it helps the less able partner (student) by considering her individual characteristics. It is designed for children aged 10 and 11 years to learn about Ecology concepts such as food chains and food webs. The elements of the interface offer the opportunity to build up representations of the feeding relationships which exist in a particular community (Luckin & du Boulay, 1999; Luckin, 1994).

Two new versions of Ecolab have been implemented, one emphasizing a mastery goal orientation and the other a performance goal orientation. Each version chooses an appropriate feedback strategy aimed to keep the student in a positive motivational state. The motivational state is diagnosed in a similar way that used before (del Soldato & du Boulay, 1996), by considering the actions carried out by the student. Aspects such as the level of challenge or help requested, success or failure at tasks, level of confidence and persistence are considered.

For the system to respond appropriately to the user, besides recognizing the user's motivational state, it must also model the student's level of motivation. In our system, motivational modelling is based on Keller's (1987) and Malone and Lepper's (1987) approaches, which consider persistence, independence, challenge, and confidence as the main parameters that need to be considered to model the user's motivational state. These constructs, among others, were observed by de Vicente and Pain (2002) in their model to assess motivation, nevertheless we decided to keep just those mentioned above because of the interface characteristics of the Ecolab.

In order to maintain a favourable motivational state in the student, each of the variables mentioned above is expected to keep a high value. So after the student performs an action, the system estimates the quantity of persistence the student showed in getting answers and the overall confidence and independence that was shown during the interaction, then decides which variable needs to be enhanced and then displays the appropriate motivational feedback. For instance, if a student's persistence is low, her confidence is high and she has made an error, then the feedback provided promotes more persistence. In this case, the mastery system's motivational feedback might be "Learning how to do it requires another attempt", whereas the performance feedback might say "If you want to be the best, try again" in order to emphasize comparative judgements with other students.

It has been suggested that mastery oriented students tend to be more likely to seek help than performance oriented students (Ryan & Pintrich, 1997; Butler & Neuman, 1995; Aleven et al., 2003), since the latter perceive help seeking as a threat to their self-worth. Taking this into account, the mastery version offers help on-demand; that is, the system will provide help only when the student has requested it; whereas the performance version will offer help every time an incorrect action has been performed.

Along with the differences in motivational feedback and help provided, some elements of the interface are used to emphasize a particular goal orientation. For example, the mastery oriented version provides a button to learn more about how an ecosystem works ("Did you know that...?"), whereas the performance oriented version provides a button to see other children's scores.

In order to test our hypotheses, we have run an experimental study with children aged between 9 and 11 years old with some knowledge about food chains and food webs. A week before their interaction with the Ecolab software, we asked them to complete a pre-test to assess their knowledge of the domain and the subscales of the PALS questionnaire (Midgley, Maehr, Hruda, & Anderman, 2000) to assess their goal orientation, as shown in Figure 1. Then, they were allocated randomly to interact either with the mastery oriented, performance oriented or original version of the Ecolab. A post-test was completed after the interaction with the system and a delayed post-test applied after three weeks of this interaction. The data from this study are currently being analysed.

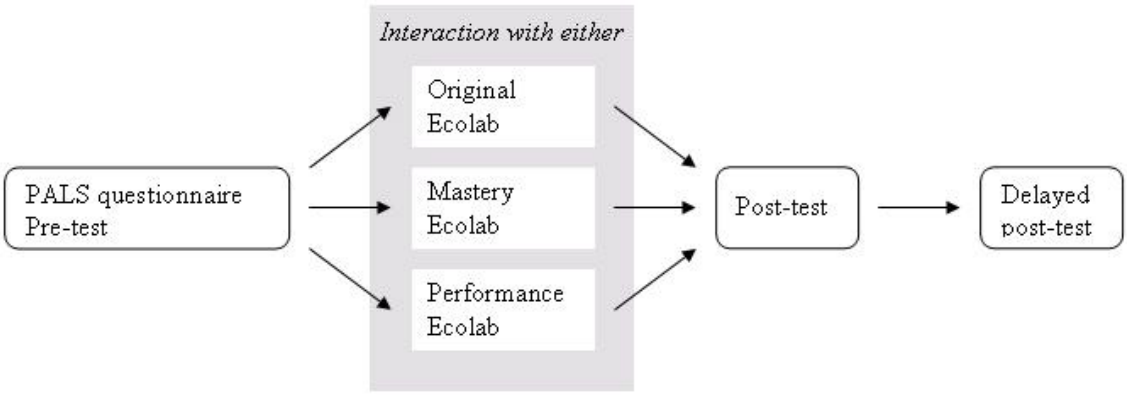

Figure 1: Study structure

4 Conclusions

It has been pointed out by several researchers that we need to be careful about extrapolating results from social contexts, such as classrooms, into the design of computer systems (Aleven et al., 2003). However, we believe that by providing the system with a motivational module, it may be able to make better suggestions about what is the most appropiate next step to follow and at the same time maintain the student's desire to learn.

This paper has focused on an issue that has been neglected by designers of most ILEs: the students' goal orientation. We have described a re-implemented version of Ecolab that detects the student's motivational state in order to provide appropriate goal oriented feedback, with the aim of promoting a positive motivational state in the student. We believe that emphasizing goal orientation in a computer-based learning context will have similar effects to those described in research carried out in a classroom context and that by adjusting the feedback to match the student's goal orientation we can produce a positive motivational state in the student and hence increase learning gains.

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