

Modelling the motivational state of the learner in a Vygotskyan inspired ITS.

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Abstract. An analysis of the influence of motivation on the ZPD is being carried out. To investigate the impact of motivational factors on the ZPD the inclusion of a motivation differentiator layer into the Ecolab [11] is proposed. The mechanisms and values to measure the motivational states of the learners and scaffold the motivational strategies to adjust them to individual pupils are outlined. The main research question on which this proposal is centred is: How can motivational factors be incorporated within a Vygotskyan framework for an ITS?

1. Introduction

This proposal discusses the incorporation of a motivational module into a Vygotskyan inspired ITS. The main issue is the relationship of the concept of the 'Zone of Proximal Development' [18] and motivational variables. Although such a relationship is not directly addressed by Vygotsky, it is argued here that some motivational aspects such as effort or confidence are implicit in the ZPD. This relationship is made explicit in this proposal in order to be able to include a motivational module into the Ecolab [11]. The Ecolab is an ITS designed within a Vygotskyan framework with which children aged 10 and 11 years can investigate food chains and webs. Another important aspect of this proposal is the claim that the use of motivational strategies should increase the child's learning within the ZPD. In order to do so, a relationship between metacognition and motivational variables is established and a mechanism to measure the motivational state of the pupil is proposed. The relevance of this work over that of Del Soldato [5] relies on the fact that this proposal describes a model of motivation in a Vygotskyan ITS while trying to establish a relationship between motivational factors and the ZPD., the main research questions governing this investigation are: Does a relationship exist between Vygotsky's ZPD and theories of motivation? If so, how do they relate in the frame of a Vygotskyan inspired ITS?

2. Motivational variables and the ZPD

The theoretical basis of this work can be found in Motivational Theory [2, 5, 8] and Social Cognitive Development Theory [11, 16, 18]. Motivation theory in general and motivational instructional design in particular address ways of understanding motivation and its mechanisms. The inclusion of motivational modules into instructional systems has dealt with topics such as the diagnosis of the learner's motivational state to create a learner model. The work of Vygotsky is also reviewed in order to identify points in common with

the concepts of motivation. The analysis of the Ecolab reveals important features that, together with an understanding of motivational variables and social cognitive theory, constitute the research proposal.

2.1 Motivation and instructional design

Practical aspects of motivation to learn have been studied by Keller [9] who presents the ARCS model of how to make the learning experience more appealing. His approach to instructional design is important because it offers a systematic motivational design process and provides specific motivational instructional strategies. The acronym ARCS is made of the initial letters of four major dimensions of motivation: Attention, Relevance, Confidence and Satisfaction. These characteristics are used in the model to characterize the motivation of students. The ARCS model also provides a methodology that help designers and instructors organize the learning experience around the learners' motivations. Keller [9] refers to motivation as the magnitude and direction of behaviour relating both choices and goals people entertain or avoid and the degree of effort they exert in achieving them. In order to achieve better learning the motivational design for instruction emphasises making the learners put more effort into the activities they are engaging in. However the ARCS model does not provide an objective way to measure the motivational state in the students.

Instructional design and motivation are determining factors in the construction of ITSs and ILEs which recognize affect. One approach has endowed the computer with personality types and the work done in the University of Stanford [6, 7] gives some evidence about the influence that computer personalities have on humans. Their results suggest that, under some circumstances, humans feel more comfortable and have more positive attitudes towards the systems than they do towards other humans. Another approach considers the learners' motivation as the driving force behind learning [3, 4, 14]. The work by del Soldato and du Boulay [5] represents a starting point for the consideration of motivational issues in ITSs. Their construction of a motivational module followed objectives such as the selection and implementation of a set of practical strategies and tactics that could be formalized and included into a 'motivational planner' and the formalisation of techniques in order to model the learners' motivational state. In order to model the learners' motivational state, del Soldato [4] used three parameters: effort, confidence and independence. De Vicente and Pain [2] present an interesting approach towards the detection of motivation. Their approach is to elicit and formalize human tutors' knowledge on how to detect their students' motivation. In their study different human tutors were asked to infer a student's motivational state when the only information available was a pre-recorded screen interaction between the student and the ITS. They provide a motivational model containing the variables considered earlier plus independence and effort, grouping them into two sets: trait variables (control, challenge, independence and fantasy) and transient variables (confidence, sensory interest, cognitive interest, effort and satisfaction). The results of this experiment offer a set of 85 inferred motivational rules.

2.2 Social Cognitive Development Theory

The work of Vygotsky [18] is referred to as a socio cultural approach due to the emphasis that he gave to social and cultural influences on children's learning and development where the focus is on the relationship between culture and cognition. In the context of schools, Vygotsky was particularly interested in the collaboration between adults and children and the way this relationship explained the children's learning and development. For Vygotsky

learning and development are neither identical nor separate processes, rather teaching and learning processes play a major role in development. Vygotsky created the term 'Zone of Proximal Development' (ZPD) to explain the way children's social interactions through learning and teaching processes with more experienced member of their culture influence their development. This term defines the "distance between the actual development level as determined by independent problem solving and potential development as determined through problem solving under adult guidance or in collaboration with more able peers" [18]. According to Social Learning Theory, the child's cognitive development occurs within the context of participation in activities slightly beyond his competence. The duty of the more able partner is to structure and model the learning situation. Both the child and the more skilled tutor are active participants and responsible in the learning activities where the child interacts at a level which is comfortable for him but to some extent challenging. As development occurs, the child takes more and more responsibility for managing the tasks within the learning situation, gradually leading to further development. The idea of the ZPD has led to the creation of computerised systems that play the role of a more able partner. These ITS offer collaborative assistance with the belief that the activities carried on by the child as part of the learning process are beyond the range of his independent ability. The more able partner must provide appropriately challenging activities and the right quantity and quality of assistance. The support for the activities within the ZPD is referred to as "scaffolding" [19] and can be provided by humans or computers. It is important that the more able partner not only provides the learners with appropriate help and assistance but also possesses the ability to withdraw the support when the child is ready to continue by himself or when learning has occurred. In order to do so, the more able partner, whether a human or an ITS, needs to construct a good model of the performance of the learner in order to provide or withdraw assistance.

Ecolab [11] was developed to explore the way in which a computerised more able partner might offer adaptive scaffolding through the operationalisation of the ZPD. This work was centred on the scaffolding at the domain level (Ecology), assisting the child in the process of learning about feeding relationships and food webs. Ecolab was tested among children and showed that learning gains were obtained when the children were given the appropriate level of collaborative support through the adaptive scaffolding techniques used in this software. A further development of the Ecolab has been developed [12]. This new version of the system focuses on the design of scaffolding activities at the meta cognitive level. The aim of Ecolab II is to create an environment that provides metacognitive scaffolding regarding help seeking and task selection skills so that students could perform better both at the metacognitive and at the domain level.

3. Research Proposal

An investigation of the role of motivation within the ZPD which implies both the role of motivational variables and strategies to further develop the Ecolab [11] was carried out. This suggests that with the use of motivational techniques common in instructional design [9] it is possible to scaffold the motivational state of the learner and to adjust the system's reactions according to it. But what is the nature of a relationship between the Zone of Proximal Development [18] Keller's [9] ARCS model? The ZPD refers to the discrepancy between the child's actual mental age and the level he reaches in solving problems with assistance. Vygotsky emphasized the difference between learning and development which are neither separate nor identical processes; teaching and learning both play an important role in the development of the ZPD. The goal in a Vygotskian framework consists of making the child take more responsibility for managing the learning activities alone, in

other words making development go from other-regulation to self-regulation. In order to self-regulate the child must be aware of higher order processes governing learning which is known as metacognition. On the other hand motivation and its influence on the learning process is important for this study. Keller [9] points out that learners confronting a new learning situation, could be motivated by the use of novel presentations or approaches. He suggests that with the use of strategies, a tutor can make the learning process more motivating with enduring effects.

In principle there is not a clear and explicit relationship between these two theories. Vygotsky did not address motivational issues, the social situation surrounding learning in the ZPD could have been considered motivating enough to encourage the child to learn. However, if the duty of the more able partner is to maximise the child's learning and self regulation within the ZPD then awareness of the motivational state of the pupil and the appropriate use of motivational strategies needs to be used. In human - human learning interactions, particularly those envisaged by Vygotsky, this premise seems obvious because human tutors being more able partners, are skilful in noticing the mood of the learner and reacting accordingly. However in Vygotskian ITS this premise is not necessarily true. In a Vygotskian framework, metacognition indicates the degree of self-regulation and awareness of the learning process which is desirable in children learning within the ZPD. Self-regulation includes a clear mastery of the task at hand and a high degree of independence from the more able partner. These characteristics also involve high degrees of confidence and control over the learning process. It is possible then to argue that high displays of four motivational variables: effort, independence, control and confidence are all characteristics of developed children learning in the ZPD which implies that in order to scaffold motivational issues within the ZPD, the duty of the more able partner is to increase the learner's effort and the feelings of independence, control and confidence during the learning situation, trying to maximize the child's potential within the ZPD. However, these four variables are not the only ones identified as relevant; researchers [3, 5, 9, 10] have identified others such as challenge, quantity, quality, persistence, relevance, fantasy, sensory and cognitive interest which are likely to influence the motivational state of the learner in a learning situation. Which of these, along with effort, independence, control and confidence could be used to model a motivational state in a Vygotskian ITS?

The consideration of a wider set of motivational variables in the model will make it more robust. To do so the variables identified as relevant (effort, independence, control and confidence) will be related to rest (persistence, quality, quantity and challenge). The model will also use two variables already maintained in the learner's model in the Ecolab, the metacognitive ability and the collaborative support tags. The metacognitive tag provides an indication of the learner's ability on how to look for information by himself rather than turning to the tutor. In motivational terms this indication is important because as Tobias and Everson [17] suggest, learners with higher metacognitive abilities feel less anxious about the learning situation which can be related to confidence as anxiety can inhibit learning. The collaborative support tag in the Ecolab indicates the degree of help that will be provided by the tutor.

The relationship proposed in order to build the motivational model to support the scaffolding of motivational issues within the Ecolab is made up considering the values of effort, independence and confidence. The modelling of effort involves a relation of quality, quantity and persistence which is the degree of engagement to overcome erroneous behaviour. Independence considers the collaborative support tag and finally confidence involves the metacognitive tag and the degree of challenge that the learner is willing to undertake. This motivational model will be updated in line with the student model so that every time the student performs a new activity, all the values will be re-calculated.

Another important aspect of this study consists of the reactions that the system will provide so as to “scaffold” the motivational state of the learner if the model detects a low state. Keller’s ARCS model [9] provides a set of reactions that will be taken into account to build the new motivational layer for the Ecolab. In order to scaffold low effort behaviours, the new layer will react based on Song and Keller’s [15] ideas: “keep activities short with progressive disclosure”, “use visual enhancement to support the activities” and “intermingle information presentation screens with interactive screens”. To scaffold independence this work will use Song and Keller’s[15] tactics: “use words and phrases that help attribute success to the learner’s effort and ability”, and finally to scaffold confidence, “tell the learner to solve a quiz specifying how many items there will be and whether it will be timed”. Fig 1 for example shows an example of a reaction based on “intermingle information presentation screens with interactive screens”.

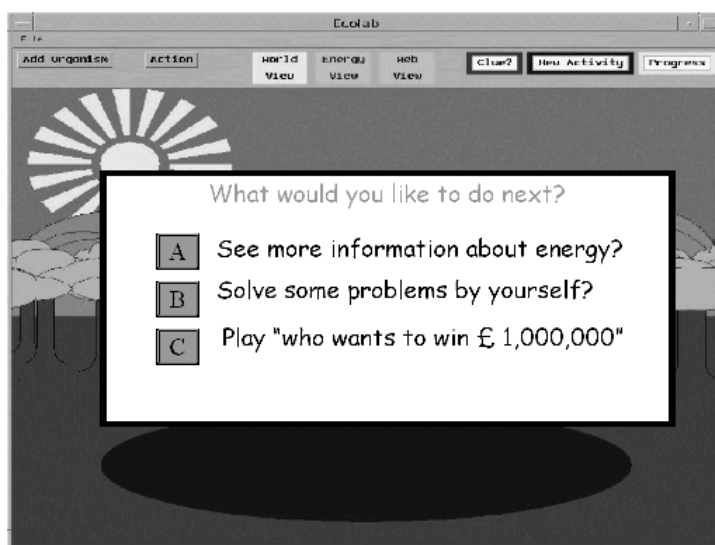


Fig. 1 Reaction of the Ecolab to increase effort.

4. Discussion and work for the future

The previous sections have suggested that the notion of the ZPD does not take motivational issues into account. It is assumed that this apparent lack of consideration of motivation is not a flaw in ZPD theory but rather it is assumed to be true if two conditions happen: that the learning situation happens in a social context and two people take part in it, a pupil and a more able partner and that the more able partner, being more able, is competent enough to pull the pupil’s learning within the ZPD possibly with the use of motivational strategies if it is necessary. A new motivational belief tag in the Ecolab is proposed to expand the learner model to acknowledge motivational issues within the ZPD. This tag would use some of the values already maintained in the Ecolab and some new ones. It has been proposed that if the Ecolab, a Vygotskyan inspired ITS, is going to be further developed to consider motivational issues, then it should include a new layer which measures the motivational state of the learner and reacts accordingly. Different learners require different reactions following the value of the variables influencing motivation. The use of Keller’s [9] ARCS model is useful to create a set of strategies that would vary the nature of the activities offered in the original Ecolab. Work for the future include the design and implementation of such tactics. The design process will involve learners in a “Wizard of Oz” [1] study which will lead to the creation of evolving prototypes. The final product will be tested with end users and two conditions are suggested. Condition One will test the learning gains in learners in a version of the Ecolab which includes new interactive features but no

motivational model controlling the systems reactions. Condition Two will test the learning gains in pupils using the new version of Ecolab including the motivational modelling and the set of strategies and the system reacting according to the model. The outcome expected is that subjects under condition two will acquire better results in a post test than those learners under condition one and that their motivation to learn is higher than those learners under condition One. If there exist an influence of motivation in the ZPD more research could be done to establish the effect of individual differences such as the learner's goals [13] in the learning process.

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