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# Developing Self-Regulated Learning in ICT-based Narrative Environments

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**Abstract.** Based on the analysis of a plain narrative learning environment (NLE), in this paper we discuss what features of NLEs can support the development of self-regulated learning (SRL) abilities in primary school children. The analysis is performed by means of a tool developed within the European project TELEPEERS, aiming to evaluate the potential to support SRL of technology-enhanced learning environments. We evaluate the considered NLE as granting an average support to SRL. We spot several aspects where improvement would be necessary, and we point out that several of these changes would be best addressed by means of an AI approach.

## 1. Introduction

Self-Regulated Learning (SRL) consists of a set of cross-curricular abilities which allow people to make the most of their learning activity by controlling all variables that have some influence on it. It is not surprising, hence, that teaching self-regulatory skills in addition to subject-matter knowledge is currently a main goal of education. Although some research studies show that SRL abilities usually increase with age, there is evidence that it does not increase naturally but rather because of suitable training [1]. Research also indicates that students who lack skills in self-regulation tend not only to achieve poor academic results, but also to have behaviour problems and difficulties in their social relations, both in expressing their thoughts and feelings and in attempting to understand others [2].

SRL is mostly addressed in the literature in relation with adult or young adult learners, probably because it involves a good amount of meta-cognition, which adults seem to grasp easier than younger people. There is no evidence, however, that children are not able to start self-regulating or to reason at meta-cognitive level. We think that it would be important to introduce elements of SRL from primary school, since the development of these abilities appears to be an incremental process, that develops faster and faster after the initial steps.

Focusing on children's education, it is widely recognized that narrative is a privileged way for organizing knowledge and helping develop cognitive abilities. Stories are familiar to children from early age [3], and hence a way of learning that results particularly natural for most primary school pupils. For these reasons, we thought it would be interesting to analyse the potentialities to support SRL offered by an increasingly widespread way of working with narrative, that is, Narrative Learning Environments (NLEs), so to pinpoint strengths and weaknesses of these tools, as well as to discuss what improvements could grant a better support to SRL.

For this analysis, we selected as NLE a well known commercial software environment, rich of features and suitable for various age levels, but not an “intelligent” one. We made this choice<sup>1</sup> since this program is simple and has many affordances as concerns narrative creation by children. Analysing a more complex program, or an intelligent one, would introduce variables not strictly related with the core concept of narrative, and thus make it more difficult to highlight the very relation between NLEs and SRL. Our study, on the other hand, can constitute a basis to analyse more complex software tools, which very likely include all the basic functions of the considered one. With our work, we aim to spot *categories* of functions useful to support SRL in NLEs, rather than particular implementations of such categories.

In this paper we present the suggestions arising from this study and some reflections that we hope can give impulse to new research bridging the fields of Narrative Learning Environments and Self-Regulated Learning. Since many of the improvements suggested could, in our opinion, result more effective if realized by means of an AI approach, we think that our work could give some contribution also to the field of Intelligent NLEs.

## 2. What is self-regulated learning

Self-regulated learning is being considered with increasing attention in the literature [4], [5]. Among the many authors working on this topic, there is general agreement that it depends on a compound set of aspects, including not only cognition (what school systems are currently mostly focused on), but also social behaviour, motivation, emotions [6]. According to Zimmerman [6], self-regulation involves three phases (forethought, performance, and evaluation) that take place repeatedly during learning. By becoming able to manage the mentioned aspects in the three learning phases, people acquire the ability to develop knowledge, skills and attitudes which enhance and facilitate future learning [1].

An important point to mention when talking about SRL is that self-regulating strategies are linked to positive emotions and have a self-maintenance function. Research has shown that negative emotions, such as anxiety, fear, irritation, shame and guilt hinder learning, because they temporarily narrow the scope of attention, cognition and action. Negative emotions are rather related to self-control, not to self-regulation [7]. In order to support students’ SRL development, the literature underlines the importance of creating and structuring favourable learning environments offering opportunities to control the essential dimensions of learning [8], as well as opportunities for feedback [9], reflection and revision [10].

## 3. Evaluating the SRL potential of a narrative learning environment

### 3.1 The evaluation tool

In order to analyse the SRL potential of the considered NLE, we used as evaluation tool a questionnaire developed within the European project TELEPEERS<sup>2</sup>, aiming to evaluate, *a priori*, the support to SRL granted by Technology-Enhanced Learning Environments (TELEs).

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<sup>1</sup> We selected the software among the titles available at the Library for Educational Software (BSD) of ITD CNR, <http://www.sd2.itd.cnr.it/>, containing about 3500 titles of educational software.

<sup>2</sup> “Self-regulated Learning in Technology Enhanced Learning Environments at University Level: a Peer Review”, Grant agreement 2003-4710-/001-001 EDU-ELEARN, <http://www.lmi.ub.es/telepeers/>

By the term TELE it is meant any learning environment that makes use of ICT tools, along with other components whose presence and form depend on the teaching methodology and learning situation. Hence, a TELE may consist in any of the following possibilities: a whole course, including a technological platform as well as the setting prepared by the teacher and the overall environment determined by the use made of it; a simple multimedia program, used by a student individually; any of the various possibilities between these two limit cases.

This evaluation tool was developed through an extensive bibliographical research on SRL. It includes: general information on the TELE; a set of 43 statements on features or possibilities of use of the TELE, to be graded on a 6-point scale (from 0 to 5); a section of summarizing questions. The 43 statements include items related to a variety of aspects that contribute to the TELE learning impact, such as: general layout and materials presentation; functional architecture; kind of activities and communication allowed; presence of feedback and assessment tools; etc. As an example, the first statements are shown in Fig. 1.

<b>(1) Planning</b>	
<b>Cognitive aspects</b>	
This question refers to the possibility for the student to easily get an overall idea of the content of the TELE.	
1	<i>The TELE helps the learner to structure the learning content.</i> Not supported 0 1 2 3 4 5 well supported
2	<i>The TELE has an easy and intuitive interface.</i> Not supported 0 1 2 3 4 5 well supported
A history shows information such as who has created or edited a file or feature, who has read or used it, etc.	
3	<i>The TELE records a history of learner activities.</i> Not supported 0 1 2 3 4 5 well supported
4	<i>The TELE allows the student to plan her/his learning with the help of activity plans, personal development plans, progress reports etc.</i> Not supported 0 1 2 3 4 5 well supported

**Fig. 1** A small portion of the evaluation questionnaire

The statements are structured so as to reflect a widely accepted theoretical model of SRL [6] that distinguishes among the main components of the learning process, that is, planning, execution+monitoring, and evaluation. Planning refers not only to the preparation before starting to use the TELE, but also to the day-by-day work organization that normally occurs in any learning process. Execution consists in the activity carried out with the TELE, while monitoring refers to checking the adequacy of one's work during the development of the learning process. Evaluation includes not only final assessment but also the (self-) evaluation that students should constantly carry out during learning experiences. Within each of the mentioned learning phases, the relevant aspects of SRL are highlighted, that is, cognitive, emotional, motivational and social aspects.

The evaluation tool is general-purpose, hence suitable for any kind of TELE. It may happen, though, that some statements are not applicable for some TELES or need to be interpreted in the context of the TELE. For instance, Statement 3 in Fig.1 may seem "not supported", since there is no explicit History function in the TELE considered in this study. However, considering that keeping track of the student's activity in this context can

be made by saving successive versions of the narrative under construction, we see that this function is at least partially present.

This evaluation tool can be downloaded for free, for study and research purpose, from the web site <http://www.lmi.ub.es/taconet/>. It does not interfere in any way with a TELE's content, but can help one to evaluate a TELE from the point of view of "learnability", by spotting strengths and weaknesses as concerns SRL. As far as we know, this is currently the only available tool to evaluate SRL support within TELEs.

### *3.2 The TELE analysed*

The software environment considered, Story Maker<sup>3</sup>, is a Narrative Learning Environment which allows the users to create multimedia stories. It has a rich menu of backgrounds, characters, props, sound effects, mostly thematically organised (for instance, it is possible to choose plants and flowers from a group "garden", as well as gardeners, garden furniture, etc.). All elements can be combined in different ways as basic components of each scene. It is suitable for children of very different levels of cognitive development, allowing the production of narratives of various degrees of complexity, from simple, linear ones made of a sequence of pages up to hyper-textual narratives with animations.

It can be a valid tool from the point of view of children's learning, since it is suitable for a wide range of applications in the first years of primary school and it can support the development of a variety of cognitive abilities. Just to mention a few of them, it can help develop competencies on narrative itself and communication skills, consolidate reading and writing in one's own mother tongue. It also can be used to develop initial linguistic abilities in a foreign language, since the program includes language features for English and French, and several other languages (German, Spanish, Italian, etc.) are available on separate CDs.

As pointed out above, a TELE is not composed only by a software tool, but includes also configuration and mode of use set up by the instructor. Due to the wide range of possible applications of the considered program, it was important firstly to decide clearly what aspects should be considered as part of the TELE, in order to avoid mixing the potentialities of different modes of use, which would all together correspond to no actual application. Since our aim was to focus on narrative learning environments, we limited the TELE examined as much as possible to the mere program, in order not to detect strengths and weaknesses that could be rather ascribed to a particular way of using it, instead of to the characteristics of the program itself. Hence, we supposed a situation where a child is working on his/her own on a precise assignment (the creation of a narrative with some data given but free plot), with an educator around just for quick instructional support. The learning task, in this case, is learning to develop a narrative with some constraints.

## **4. Outcomes of the analysis**

We evaluated this TELE as supporting self-regulated learning to a full medium degree, offering its best on the cognitive aspects, showing its weakest on the emotional aspects, remaining on average level on the motivational aspects, and with the social aspects almost

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<sup>3</sup> Published by SPA Software, 2003, <http://www.spasoft.co.uk/>

undeveloped . As concerns the phases of learning, the TELE gives its best at planning, scores average at execution and monitoring, while results rather low in the evaluation phase. Also the explicitness of SRL support was evaluated as rather low. Fig. 2 shows a summary of the evaluation made. The complete analysis is reported in [11]. These results appear quite good if we consider that the development of SRL abilities is not among the explicit aims of the software environment on which the considered TELE is based. This confirms our hypothesis that it makes sense to put into relation SRL and NLEs.

<b>Planning</b>	not supported 0 1 2 <b>3 4</b> 5 well supported
<b>Execution and monitoring</b>	not supported 0 1 <b>2 3</b> 4 5 well supported
<b>Evaluation</b>	not supported 0 1 <b>2</b> 3 4 5 well supported
<b>Cognitive aspects</b>	not supported 0 1 2 <b>3 4</b> 5 well supported
<b>Motivational aspects</b>	not supported 0 1 <b>2 3</b> 4 5 well supported
<b>Emotional aspects</b>	not supported 0 1 <b>2</b> 3 4 5 well supported
<b>Social aspects</b>	not supported 0 <b>1</b> 2 3 4 5 well supported

**Fig. 2** Summary of the evaluation made of the considered TELE.

The main points of strength as concerns SRL resulted to be:

It is easy to use (at least at the simplest level). Ease of use can beneficially influence not only the cognitive aspects (favouring the concentration on resources at disposal in relation with the task to be solved, hence facilitating work planning), but also the motivational ones (allowing the user to reach some meaningful results fast) and emotional ones (avoiding frustration and decrease of self-efficacy beliefs).

It offers a rich choice of features for narrative creation. Moreover, it allows the user to enrich the menus by modifying the given features and by importing pictures and sounds from other programs. This influences the cognitive aspects at planning and execution, by giving the user freedom to decide how to proceed in his/her work; it influences also the emotional aspects, since personalization of elements is likely to increase learners' pleasure to create narratives

It offers a rich variety of possible productions. This influences emotional aspects during the execution phase, since it allows to graduate the complexity of work according to the abilities of each user.

It includes a library of previous productions, which entails the possibility to compare one's own work with the works of others, which thus act as models. This supports the cognitive aspects both in the execution and in the evaluation phases.

The above richness makes the program very likely interesting for young users, hence supporting motivation in all learning phases.

It allows the user to see a same scene in different modes, i.e., playing mode, construction mode with visible elements, construction mode with hidden elements (links, paths and actions). Viewing in different modes the work one is constructing supports cognitive aspects at self-monitoring level. Viewing in different modes the examples in the archives can give suggestions on how to proceed and unblock the learner in possible moments of difficulty, hence influencing both the cognitive and motivational aspects of execution.

It offers the possibility to save one's work, including different versions of a same story corresponding to successive phases of development. This can help one

evaluate the amount of work made and the progress attained by comparing successive versions, with obvious influence on the cognitive aspects of the evaluation phase, and possibly also on the motivational ones.

The main weaknesses as concerns SRL resulted to be:

Many resources are implicit: if the user does not know the program well it is difficult to guess the existence of some functions.

The feedback is very limited, in particular there is no formative feedback.

Help facilities are only on technical questions, scarcely suggestive and suitable to adults but rather difficult to use for children.

The social aspects are almost completely missing (no tools for communication or collaborative work are included, the only contact with the work of others is realised through the archives).

The results of this evaluation are not surprising, if we observe in depth the characteristics of the environment analysed.

The *cognitive aspects* of SRL are the most emergent ones since the program offers a rich choice for all the elements which are cognitively relevant (characters and actions) in relation with the task at hand (learning to make narratives). In comparison with simpler narrative environments, this one does not only allow the user to define situated dialogues, but also to set up a whole context where actions take place, and to define time-related links among events and actions, which implicitly underlines a temporal sequence in the story.

The *motivational aspects* of SRL are supported by the fact that this TELE is a project-oriented environment; producing simple narrative reasonably easily turns out motivating for most children. Moreover, a narrative is created as a sequence of scenes, each of which is a complete product in itself, and the users can proceed in story construction following their own personal style, that is, working out scene by scene or developing a narrative as a global project. What keeps motivational aspects only average is the fact that several functions of the program are not in the icon menu and their use is difficult to be learned intuitively, which may result frustrating for not experienced users.

As concerns *emotional aspects* of SRL, their management is left completely to the user. In particular, we note the absence of feedback (other than the obvious actions following the selection of commands), whose impact is made worst by the fact that the user is working alone (in the hypothetical learning situation analysed), without support of educator or peers.

As concerns *social aspects* of SRL, the low score we gave to this TELE depends on the fact that this is not a collaborative environment. This problem can be somehow overcome if the software tool is merged in the stream of classroom work, hence giving rise to a TELE where the social aspects are realized by letting the pupils work with peers on narrative construction. In this respect, educators should always remember that a lack of social learning experiences is considered to be the first important source of self-regulatory dysfunction [4].

As concerns the support to SRL in the different *learning phases*, we evaluated planning highest due to the freedom users have in structuring their work, the presence of thematic menus which implicitly suggest possible developments for a story, the collection of stories and story starters. The evaluation phase turned out to be the lowest, due to the lack of elements explicitly stimulating reflection on the work done.

## 5. Improving the narrative environment

It is clear from the above analysis that several aspects of this TELE should be adjusted in order to support SRL to a wider extent. Adding the following functions could, in our opinion, achieve this aim:

- (a) Several help functions, suitable to be used by young children, possibly of different kinds, to answer the different needs a child may have during narrative creation: cognitive-creative (“I need help to invent my story”), emotional-motivational (“I feel discouraged/lost”), methodological (“I don’t know how to make what I want to do”) and technical (“I don’t know how to use a command”). Providing emotional and motivational help is particularly important in an environment like the considered one, where the child is left more or less on his/her own. In different TELEs, where the child collaborates with peers and receives support and guidance by the teacher, these kinds of help may also be provided by the human component embodied in the environment. This possibility, though, does not decrease the importance of having such a support in the program.
- (b) Possibility of defining the distinctive features of all characters, to be added to the implicitly predefined features of well-known “types” (e.g, a witch is universally considered wicked, etc.). This could have several influences on the cognitive level. Having at disposal such descriptions as reference while creating the narrative, the child is in a better position to create logically consistent stories and to make inferences on the actions in his/her narration. Detecting inconsistencies between definition and behaviour of a character leads to the introduction of what Bruner [3] calls exceptions, i.e., unexpected behaviours due to some precise reason; guiding the children to reflect on exceptions helps them to gain awareness of, and monitor, the consistence of the narrative under creation. It would be interesting to realize definitions in an articulated way, that is: define characteristics on a continuous scale instead of as discrete values (only seldom people are completely bad or good); allow also definitions of moods, which are local to single scenes and can influence actions.
- (c) Some kind of support to story general design, to help the child to keep under control the overall development of the plot of a story.
- (d) Some kind of support to reflection on the work done.
- (e) Making some resources more explicit. For instance, it would be useful to have more than two levels for the iconic menu bar, so to include in it all commands, since the presence of buttons calls the attention on the existence of functions that otherwise could ever go neglected. The possibility to have an overall view of the available resources is an important point to support SRL, since it has a positive influence on planning.

As concerns implementing the above suggestions, we think that an AI approach would be particularly effective, especially for help functions, definition of characters, support for work planning and reflection.

Help functions (a) could be suitably realized by means of intelligent agents with different specializations, called by the child or automatically activated in particular cases. A general help function should co-ordinate the specialized ones, and guide the child to the selection of the necessary help.

The definition of the main features of the characters (b) would give the TELE data on which a non-trivial support could be constructed in order to help children reason on story consistence and make meaningful inferences. An example of a function of this kind is offered



by the “Hot-seating” of the NLE Teatrix<sup>4</sup>, where the child can be asked to justify some character’s behaviour.

The support to story general design (c) should include two different levels:

a basic level, consisting in giving some kind of summary, showing the sequence of the scenes already realized or at least initialized ;

an “intelligent” level, where this function should help the child build an overall idea of his/her plot, with scenes and characters to use in it, similarly to what children do when working collaboratively on the creation of some story.

Such design control may result meaningful also in the case of a collaborative work on narrative creation, as a guide and control of the group work.

Finally, an intelligent agent would turn out useful to support reflection on the work done (d). This should help the child become aware if the story created is consistent in itself, with the assignment, and with the personal expectations as concerns the story itself.

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<sup>4</sup> <http://gaips.inesc-id.pt/teatrix>