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Preface

Narrative has been an important form to transmit knowledge across generations, and is innate to the human nature. Narrative is also a valuable vehicle to structure knowledge and to help us in the process of meaning making. Due to the explorative and complex nature of narrative, an intelligent learning environment (ILE) based on a narrative approach can promote several kinds of activities for learners:

- co-construction: participate in the construction of a narrative;
- exploration: engage in active exploration of the learning tasks, following a narrative approach and trying to understand and reason about an environment and its elements;
- reflection: engage in consequent analysis of what happened within the learning session.

By applying a narrative approach in the development of an ILE, its is possible to attain an application that may help the learners to share ideas and points of view, to experience a particular situation by engaging in a role-playing, or even to post reflect on an action taken within such environment.

The main goal of this workshop is to bring together researchers from different disciplines to discuss the creation of what we call narrative learning environments (NLE). In our view, narrative learning environments are a specific type of intelligent learning environments where narrative is approached and applied. The several applications of narrative and the several ways of conveying it within an ILE are an interesting topic to be addressed within this workshop. By analysing the variety of uses of narrative, it might be possible to devise a set of guidelines to be followed by other researchers when developing a NLE.

The diverse ways in which NLE's have been developed and tested in the past few years (e.g. Puppet, POGO, Teatrix, Ghostwriter, etc.) suggest that the time has come to reflect on these practices and strive for an overview of principles and guidelines that have been applied.

By trying to answer basic questions on the role of narrative in Intelligent Learning Environments, we aim to contribute to understanding more precisely and exploiting more effectively the potential of narrative in education.

27th of May, 2005

Isabel Machado

Contents

Affect Detection and Metaphor in E-Drama: The First Stage

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Abstract. We report work in progress on adding affect-detection to an existing e-drama program, a text-based software system for (human) dramatic improvisation in simple virtual scenarios, for use primarily in learning contexts. The system allows a human director to monitor improvisations and make interventions, for instance in reaction to excessive, insufficient or inappropriate emotions in the characters' speeches. Within an endeavour to partially automate directors' functions, and to allow for automated affective bit-part characters, we have developed a prototype affect-detection module. It is aimed at detecting affective aspects (concerning emotions, moods, rudeness, value judgments, etc.) of human-controlled characters' textual "speeches". The detection is necessarily relatively shallow, but the work accompanies basic research into how affect is conveyed linguistically. A distinctive feature of the project is a focus on the metaphorical ways in which affect is conveyed. The project addresses workshop themes such as improving NLEs, building them, and supporting reflection on narrative construction.

Introduction and Relationship to Other Work

Improvised drama and role-play are widely used in education, counselling and conflict resolution. Various researchers have explored virtual, computer-based frameworks for such activity, leading to e-drama (virtual drama) systems in which virtual characters (avatars) interact under the partial control, at least, of human actors [19]. The springboard for our own research is an existing e-drama system (*edrama*) created by Hi8us Midlands Ltd (http://www.edrama.co.uk), a charitable company. This system has been used in schools for creative writing, careers advice and teaching in a range of subject areas such as history. Hi8us' experience with *edrama* suggests that the use of e-drama helps school children lose their usual inhibitions about drama improvisation, because they are not physically present on a stage and are anonymous. It permits a group of young people to jointly participate in live drama improvisation online. The participants can be in the same room or geographically separated.

In the *edrama* system, the virtual characters on the virtual stage are completely controlled by human users ("actors"), the characters' "speeches" are textual and typed in by the actors, and the characters' visual forms are static cartoon figures. The speeches are shown as text bubbles emanating from the virtual characters. Actors can choose the clothes and bodily appearance for their own characters. Generally, real-life photographic images are used as scenes in which the characters are placed. Up to five human characters and one human director are involved in one e-drama scenario. There is a graphic interface on each actor's terminal and on the director's terminal, showing the virtual stage and the virtual characters. A possible state of the graphic interface is shown in figure 1. Actors and the human director work through software clients connecting with the server. Clients communicate with each other by XML stream messages via the server (see figure 2). For example, if the human actor who plays the character Mayid says “Are you messing with me”, the input is first transmitted to the server and then the server broadcasts it to all the terminal clients. The client displays it as a text bubble above Mayid’s head.

Figure 1. One example of the *edrama* virtual stage

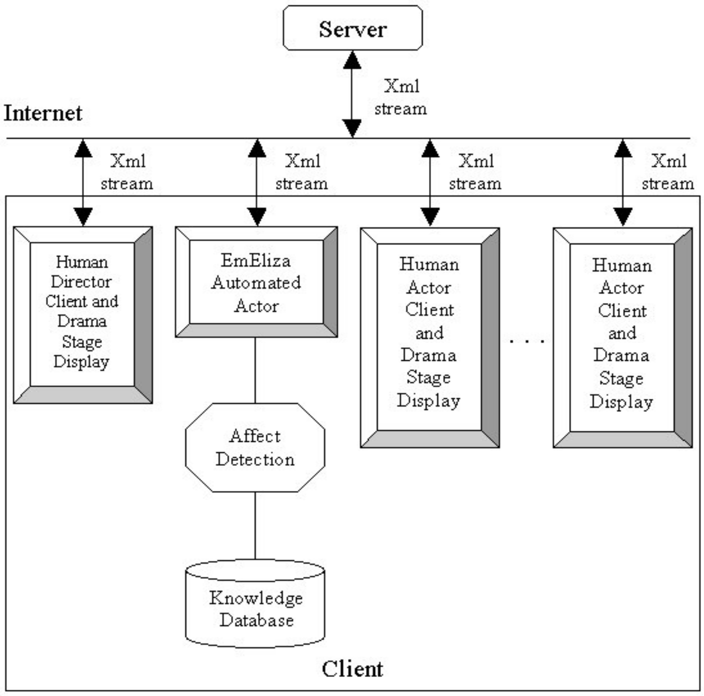

Figure 2. Application architecture

A director commonly intervenes by sending hint messages to actors (singly or as a group) and by introducing a bit-part character that the director controls. Directors intervene when, for instance, actors make their characters express inappropriate emotions, an inappropriate level of emotion (e.g. a bullied character may react too little to the bullying), etc. Directors’ interventions help lead the actors to improvise in a valuable way. However, this monitoring and intervening places a heavy burden on directors. One of our main research intentions is to partially automate the directorial functions. This may help human directors to perform their task more easily, and allow the system to be used with less need for an experienced human director—perhaps even without a human director at all. Affect detection (diagnosis) is an important element of directorial monitoring (not forgetting that emotions, etc. are crucial in most real drama). Accordingly, we have developed a prototype affect-detection module. It has not yet been used directly for directorial monitoring, but is instead currently functioning to control a simple automated bit-part character called EmEliza, which is fashioned after Eliza [20] and is similar to "bots" such as those constructible in the Alice framework [1]. EmEliza could, in principle, be introduced by directorial action, and will be so later in our project, but is currently present on stage all the time.

EmEliza automatically identifies affective aspects of the other virtual characters' speeches, makes certain types of inference, and makes small response speeches relevant to these aspects (examples below). The intention is that EmEliza's responses will help stimulate the human actors to improvise in a desirable way. In autumn of 2005 we will be conducting user-testing in three secondary schools in Birmingham to test the effects on actors of including EmEliza (and other affective processing, if ready), with a pilot run in late May 2005.

Within affect we include: basic emotions such as anger, fear, sadness and liking (although we do not follow any particular account, such as [21], of which emotions are basic); more complex emotions such as embarrassment; meta-emotions such as desiring to overcome anxiety; states such as mood, rudeness and hostility; and value judgments (evaluations of goodness, importance, etc.). We do not see a way of firmly dividing emotions either from value judgments or from other mental states in general, except from the "coldest" mental states such as belief and intention. Hence, we also include mental states such as wanting, and partially mental states such as trying, even though they are often treated as emotionless.

Now, much research has been done on creating affective virtual characters in interactive systems. Emotion theories, particularly that of Ortony, Clore and Collins [9] (OCC), have been used widely therein. Prendinger and Ishizuka [10] used OCC model in part to reason about emotions and to produce believable emotional expression. *eDrama Front Desk* [15] is designed as an online emotional natural language dialogue simulator with a virtual reception interface for pedagogical purposes. Mehdi et al. [17] combined a widely accepted five-factor model of personality [24], mood and OCC in their approach for the generation of emotional behaviour for a fireman training application. Gratch and Marsella [18] presented an integrated model of appraisal and coping, to reason about emotions and to provide emotional responses, facial expressions and potential social intelligence for virtual agents. Egges, Kshirsagar and Magnenat-Thalmann [4] provided virtual characters with conversational emotional responsiveness. Elliott, Rickel and Lester [5] demonstrated tutoring systems that reason about users' emotions. There is much other work in similar veins.

However, few e-drama (-related) systems can detect affect comprehensively in open-ended utterances, although there has been some relevant work on general linguistic clues that could be used in practice (e.g. [3]). Although Façade [8] included shallow natural language processing for characters' open-ended utterances, the detection of major emotions, rudeness and value judgements is not mentioned. Zhe and Boucouvalas [16] demonstrated an emotion extraction module embedded in an Internet chatting environment (see also [22]). It uses a part-of-speech tagger and a syntactic chunker to detect the emotional words and to analyse emotion intensity for the first person (e.g. 'I' or 'we'). Unfortunately the emotion detection focuses only on emotional adjectives, and does not address deep issues such as figurative expression of emotion. Also, the concentration purely on first-person emotions seems narrow.

Our work is distinctive in several aspects. Our interest is not just in (a) the first-person case: the affective states that a (person or) virtual character X implies that it *has* (or *had*), but also in (b) affect that X implies it *lacks*, (c) affect that X implies that *other* characters have or lack, and (d) *questions, commands, injunctions,* etc. concerning affect ("Does that bother you?", "Don't worry", "He ought to be glad"). We aim to make any relatively shallow detection that we manage to achieve in practical software responsive to general theories and empirical observations of the variety of ways in which affect can be conveyed in textual language [3, 6], and in particular to the important case of *metaphorical* conveyance of affect [6, 7]. Our developing e-drama system is in a part a test-bed and empirical guide for the study of affective language as such, as well as being an end in itself.

The limitation to textual expression in our work might appear to be an obstacle, in precluding affect-detection through such things as speech prosody, facial expression, gestures and physiological symptoms. However, such factors would be a poor guide to the intended affect of a character played by an actor lacking dramatic training, as in our situation, and even a trained actor may have affect states irrelevant to those of the character he/she is playing. In any case, we are interested in non-first-person affective aspects of speeches, as in (c, d) above.

1. A Preliminary Approach to Affect Detection and Responding

In the emotion research area, different dimensions of emotion are used in different emotion theories. The OCC model uses emotion labels and intensity, while Watson and Tellegen's [13] two-dimensional affect theory uses positive and negative affects as the major dimensions. Activation (active, passive) and evaluation (positive, negative) have been suggested by Raouzaiou et al. [11]. Currently, we use an evaluation dimension (positive and negative), affect labels and intensity. Affect labels with intensity are used when strong text clues signalling affect are detected, while the evaluation dimension with intensity is used when only fuzzy text clues implying affect are detected.

At present, our affect detection is based on textual pattern-matching rules that look for simple grammatical patterns or templates partially involving lists of specific alternative words. Not only is pattern matching for keywords, phrases and fragmented sentences considered, but also partial sentence structures are extracted. Also, a small set (so far) of abbreviations such as 'im [I am]' and 'c u [see you]' is handled. This approach possesses the robustness and flexibility to accept ungrammatical fragmented sentences and to deal with varied positioning of sought-after phraseology in speeches, but lacks other types of generality and can be fooled when the phrases are suitably embedded as subcomponents in grammatical structures. For example, if the input is "Miss doesn't think I'll scream" or "I doubt she's really angry", rules looking for screaming and anger in a simple way will fail to provide expected results. Below we indicate our path beyond these limitations.

It must be appreciated that the language in the speeches created in e-drama sessions, especially by excited children, has many aspects that, when combined, severely challenge existing language-analysis tools if accurate semantic information is sought. These aspects include: misspellings, ungrammaticality, abbreviations (often as in texting), slang, use of upper case and special punctuation (such as repeated exclamation marks) for affective emphasis, repetition for emphasis, open-ended onomatopoeic elements such as "Owww" and "Aaaaaarghhh" (and notice the iconic use of word length here), and occasional intrusion of wording from other languages such as Hindi. These characteristics of the language make the genre similar to that of Internet chat. There, various linguistic devices have been used to create the effects of tone, linguistic style, emotion and even gesture [14].

The transcripts analysed to inspire our initial knowledge base and pattern-matching rules had independently been produced earlier from Hi8us *edrama* improvisations based on a school bullying scenario. The actors were school children aged from 8 to 12. The background presented to the actors before the improvisation was that schoolgirl Lisa has been bullied by her classmate Mayid. He has called her “pizza” (short for “pizza-faced”). Lisa is a shy child and she is afraid of Mayid. Our use of a specific scenario is just a start and our methods are not intended to be specific to it. We are also working on gaining inspiration from phraseology from other, distinctly different scenarios, and also from the affective phraseology in transcripts and recordings of some television documentaries about people coping with various embarrassing illnesses, produced by Maverick Television Ltd. (another of our industrial partners). One interesting feature in these documentaries is meta-emotion (and cognition about emotion) because of the need for people to cope with emotions about their illnesses.

A rule-based Java framework called Jess [25] is being used to implement the pattern/template-matching rules in EmEliza. When Mayid says “Lisa, you Pizza Face! You smell”, EmEliza detects that he is insulting Lisa. When Lisa says “Mayid called me nasty names and he pushed me so hard”, EmEliza infers that Mayid bullied Lisa. The rules work out the character’s emotions, evaluation dimension (negative or positive), politeness (rude or polite) and what response EmEliza should make. Here are two simple pseudo-code example rules:

```
(defrule greeting
?fact <- (words  $? hello|hi|hey $?)
=>
(CA(greeting))
(obtain emotion and response from knowledge database)

(defrule suggestion
?fact <- (words $? why don't you $?x)
=>
(CA(suggestion))
(obtain emotion and response from knowledge database)
```

When a human character inputs “hello, I am Lisa” or “Oh hi, are you all right”, EmEliza concludes that it is a greeting from the character. Then it will infer the character’s emotional state (neutral) and obtain the appropriate response from the knowledge database. If the character says “Lisa, why don’t you tell Miss about Mayid”, it implies a suggestion communication act.

Multiple exclamation marks and capitalisation are frequently employed to express emphasis in e-drama sessions. If emotion and exclamation marks or capitalisation are detected in a character’s utterance, then the emotion intensity is deemed to be comparatively high (and emotion is suggested even in the absence of other indicators). For example:

<Lisa>Mayid pushed me and I am BLEEDING!!

<EmEliza>((You seem very “scared”.)) Oh, dear. Don’t be afraid. I will help you.

The sentence in double brackets is not part of the linguistic response back to Lisa, but is included above to indicate EmEliza’s private judgment about Lisa’s affective state.

A reasonably good indicator that an inner state is being described is the use of ‘I’ (see also Craggs and Wood [3]), especially in combination with the present or future tense. In the school-bullying scenario, when ‘I’ is followed by a future-tense verb the affective state ‘threatening’ is normally being expressed; and the utterance is usually the shortened version of an implied conditional, e.g., “I’ll scream [if you stay here].” When ‘I’ is followed by a present-tense verb, other emotional states tend to be expressed, e.g. “I want my mum” (fear) and “I hate you” (dislike). The following is one relevant pseudo-code example rule.

```
(defrule threaten
?fact <- (or (words $? i'm|im|iam going to hit|bash|kill|scream $?)
        (words $? i’ll|ill hit|bash|kill|scream $?))
=>
(CA(threaten))
(obtain emotion and response from knowledge database)
```

Another useful signal is the use of imperative mood without softeners such as ‘please’. Strong emotions and/or rude attitudes are often expressed in this case. There are special, common imperative phrases we deal with explicitly, such as “shut up”, “keep your mouth shut”, and “mind your own business”. They usually indicate strong negative emotions. But the phenomenon is more general. For example,

<Mayid>Don’t tell Miss about it! Don’t you forget it!

<EmEliza>((You seem very “rude”.)) Everybody knows you are a big bully.

EmEliza’s response here may simulate the Mayid actor into making him behave yet more like a bully. In such ways, EmEliza can influence the improvisation.

Detecting imperatives accurately in general is by itself an example of the non-trivial problems we face (e.g., note that “Tell Miss about it and he’ll hit you” is not an imperative, and may be a warning rather than a threat). To go beyond the limitations of the text matching we currently do, we are considering using the Plink parser in the GATE framework at Sheffield University. This can deal with certain types of grammatical ill-formedness and may be able to be readily adapted to deal with at least some of the other difficulties noted above. In addition we are considering including automatic access to an electronic thesaurus such as WordNet and to existing dictionaries of affective items [23] so as to avoid having to construct a large lexicon of our own. We are not considering using statistical approaches because, among other reasons, we do not have a large corpus of e-drama transcript text.

EmEliza currently responds to every speech of just one other character, but we are developing some regimes for responding when she is engaged with several others. The choice of regime would depend in part on the scenario. Regimes initially envisaged include: responding when there is sizable dialogue gap; responding to every Nth speech (whoever they are by), where N is a settable parameter; and responding to any character who has only made affectively mild speeches recently (the threshold level of mildness depending on which character it is). Ultimately, however, we wish to work towards automated characters that are given goals for how they are meant to provoke other characters, and reason about how to achieve this. We should stress that the use of an Eliza-like basis for a bit-part character is merely in the interests of getting something useful implemented in the short term.

2. Metaphorical Expression of Affect

The *explicit* metaphorical description of emotional states is common in ordinary discourse and has been extensively studied [6, 7]. Examples of such description are “He nearly exploded” to indicate anger, and “Joy ran through me.” Also, emotion, value judgments and other forms of affect are often conveyed *implicitly* via metaphor, as in “His room is a cess-pit”, where affect associated with a source item (cess-pit) gets carried over to the corresponding target item (the room). In our e-drama project we are studying such language both theoretically and implementationally, the latter both in the e-drama system itself and by further development of an independent, implemented metaphor processing system called ATT-Meta [2].

In our existing e-drama transcripts, one common use of affect-laden metaphor is in insults such as “pizza[-face]”, which implicitly identifies the addressee herself or her face as being a pizza or like a pizza. Indeed, the structures ‘you NOUN PHRASE and ‘you are a NOUN PHRASE’ tend to express insults, in the school-bullying scenario at any rate. Metaphors used with such structuring are exemplified by “you stupid cow” and “you are a fat blob.” Rules have been created for such patterns, but we need a much more general treatment, drawing in part on ideas informing our ATT-Meta system. Related metaphorical phenomena include “Who do you think you are – Benny Hill?” and “That stupid door.”

Physical size is metaphorically used in descriptions of negatively-valued types of people, as in “you are a big bully” (or similarly “you’re a big idiot”) and “you’re just a little bully.” The bigness can be literal but typically (also) indicates the extent or intensity of the person’s bullying propensity. Size adjectives may also be used to convey the speaker’s attitude towards the described object. “The big bully” expresses the speaker’s strong disapproval [12] and “little bully” can express contempt, although “little” can also convey sympathy.

Although in our transcripts metaphor is mostly couched in conventional phraseology, the transcripts also show creative extension and context-sensitive exploitation of metaphor. Striking examples are, respectively, “I am going to hit your topping, pizza” (which enriches the pizza metaphor) and “Lisa, give me a pizza” (which involves an odd shift of view, perhaps metonymic, to Lisa as pizza provider). Such examples are not only practically important but also theoretically and implementationally challenging.

Many aspects of creative extension can be handled in our ATT-Meta approach. This approach deals with source-domain (e.g. food-related) elements of the utterance that have no correspondence in the target domain (Lisa or people in general, say) by doing possibly-extensive reasoning within the source domain, with the intent of linking up with known correspondences between source to target. It achieves great flexibility by avoiding the creation of new correspondences for the correspondence-lacking utterance elements. The source-domain reasoning can include the inference of affective connotations. Such connotations are one of several types of connotation that, in our approach, are mapped over to the target domain independently of the particular metaphor at hand. For example, negative affective connotations of cess-pits are mapped over (by default) to whatever is likened to a cess-pit.

A further useful feature of ATT-Meta is that its metaphorical reasoning is fully integrated into a powerful uncertain-reasoning framework. Practical reasoning about affect, metaphor-based or otherwise, usually needs to be uncertain. ATT-Meta also has special features for reasoning (uncertainly) about (multiple) agents’ beliefs, and could therefore contribute to aspects of the combined modelling of emotional and (other) mental states.

3. Conclusion, Ongoing Work and Additional Remarks

We have implemented some useful if preliminary affect-detection. Work proceeds on generalizing our current algorithms beyond the school-bullying scenario, for instance by taking guidance also from the embarrassing-illness TV documentaries and from career advice scenarios from Hi8us, and introducing more syntactic sophistication and lexical breadth. The rule sets created for one scenario would work efficiently for the other scenarios, though there will be a few changes in the related knowledge database according to EmEliza's different roles in specific scenarios.

Work also proceeds towards achieving flexible metaphor processing. A powerful feature of metaphor is its ability economically to imply multiple, mixed or intermediate connotations about the target. In particular, there will often be a complex bundle of affective connotations arising in the source-domain reasoning, and compromises between or mixtures of affective states that would be difficult to express directly can be handled by metaphor. The affective words in any given language do not necessarily correspond to well-definable real states, and even if they did there would be unlexicalized intermediate or mixed cases.

Our project makes a contribution to the issue of what types of automation should be included in NLEs, and as part of that the issue of what types of affect should be detected (by directors, etc.) and how. Additionally, because a record of an improvisation is automatically filed by our system, and can be used to replay the drama, the system supports reflection on narrative co-construction and its affective dimension.

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Towards Improving Recall and Comprehension in Automatically Generated Narratives

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Abstract. This paper examines the similarity between cognitive models of narrative comprehension and plan based narrative generation to inform the process of narrative generation for educational applications. The situation model, a key element of narrative discourse comprehension, affects reader inferencing, comprehension, and recall in ways that are predictable and widely observed by cognitive psychologists. Mapping the situation model to the data structures of narrative planning, we seek to create guidelines for the generation of educational narratives by a narrative planning method.

Introduction

Generating narratives that convey information to the reader is an important task that could have significant ramifications for interactive training simulations and educational software. Narratives present a unique vector of approach for teaching, given our natural understanding and affinity for narrative structure. In this paper, we hope to increase learning from generated narratives by increasing readers' levels of inferencing and recall. We examine how cognitive models of narrative understanding have been shown to influence reader recall and comprehension. We relate the discourse structure of the situation model to planning data structures used in narrative generation, resulting in guidelines for automatically generated educational narrative. We center our guidelines on the abstract concept of reader expectation, and from these guidelines, we devise an algorithm intended to increase measures of learning from automatically generated narratives.

1. Elements of Story Comprehension and Recall in Cognitive Psychology.

Cognitive psychologists [10] [26] have identified six levels of discourse structure used in the cognitive processes of narrative comprehension. These are the *surface code*, *textbase*, *situation model*, *thematic point*, *agent perspective*, and *genre.* The situation model is a mental representation of the world state; including items such as the events in the plot, characters, settings, and the many complex relationships between these items [10]. This model contains elements that are most closely related to existing computational models employed by AI researchers when reasoning about action and change. It is constantly updated during reading as new information becomes available, and it is the basis for performing inferences and other reasoning about the story structure. The situation model can be broken down into a time related series of individual models. Zwaan and Radvansky (1998) distinguish the (a) *current* model under construction; the (b) *integrated* model comprising the series of models since the beginning of reading the story; and the (c) *complete* model, which is the last model obtained at the end of the narrative. When a new clause or sentence is read, the current model is altered to enclose this new information. The current model is then incorporated into the integrated model, in a process called *updating*.

Psychologists have identified five dimensions of situation models: *space, time, causation, intentionality,* and *protagonists and objects* [4]. The spatial dimension represents the physical layout of the imagined story world. The temporal dimension represents both the timeline in the story and the sequence in which the story is told. The dimension of causation maintains the causes and effects of events in the story, denoting which events cause others and why. The intentionality dimension tracks the goals of the characters in the story. Lastly, the protagonists and objects dimension follows the main character(s), lesser characters, and various items with which the characters come in contact (books, keys, etc.) [26].

Being the most basic of the deeper levels of structure, while still causing direct effects to inference and recall, the situation model serves as a natural embarking point for computational modelling. Furthermore, the situation model is quite close to our current computational models of narrative generation, which allows for straightforward conversion to these models. For these reasons, we choose to focus our analysis the situation model. Other discourse structures would serve as excellent candidates for future work.

2. The Effects of the Situation Model on Recall and Inference

Researchers have found a wide variety of variables affecting reader recall and inference generation in narrative. This section presents how each of the five dimensions of the situation model influences these two measures.

2.1 Space

There is no strong support that readers track spatial information automatically, although they are able to do so on request [26]. When readers do form spatial situation models, they find it easier to recall spatial relationships in the order of vertical, depth, and then horizontal [5]. Readers are also much more concerned with objects and areas that are physically closer to the protagonist [22].

2.2 Time

There has been comparatively little research regarding the aspect of time in situation models. Studies have shown how distancing events in time serves to separate the situation models that contain them, making inferences between events more difficult and time consuming [26].

2.3 Causation

Causation has an interesting relationship to inference generation and recall. Causal relatedness is a measure of how closely connected events are according to the world knowledge of the readers. For instance, pouring a bucket of water on a fire is highly causally related to the fire extinguishing if the events are temporally close and the pouring comes before the extinguishing. However, setting a bucket of water next to a fire is only slightly causally related to the fire extinguishing; in this case, readers will attempt to infer the reason behind the fire going out. Causal relatedness has a curvolinear relationship with recall and inference generation. Low relatedness produces low recall, moderate relatedness produces high recall, and high relatedness produces low recall [14]. Myers et al. (1987) postulated that moderately related pairs both enable and necessitate readers to form inferences about their relations. Active focusing and inferencing improves the reader's comprehension and recall about these events.

2.4 Intentionality

Intentionality has been shown to be a focal point for readers of narrative. Some researchers have even argued that comprehension of narrative is centered on the tracking of characters' intentionality. Significant evidence indicates that goal-related information is more salient in the mind of the reader, especially before relevant goals are realized [26] [19]. Goals are often left implicit in the text; in these cases, readers attempt to make the necessary inferences to determine the intention behind actions. Readers also remember goal related information better and tend to structure retellings of a story around character goals [20].

Intentions see the same curvolinear relationship to recall as causation. Actions or objects are remembered more readily when they play a role in more intentions. The effect persists up to the point of knowledge saturation, where readers stop making inferences due to mental load and thus recall and comprehension suffers [14].

2.5 Protagonists and Objects

Protagonists and objects feature prominently in the situation model. The protagonist is closely tied to the intentionality dimension, and benefits from the same focusing effect by the reader. As we've seen, the other dimensions' effects of inference generation are increased with proximity to the protagonist. Researchers have found direct evidence to support the claim that readers not only actively draw inferences on protagonists, but also the information related to them [1].

3. Expectation

The effects listed in Section 2 can be summarized by the high level concept of expectation. Due to the structure of narrative and the conventions of genre and culture, readers approach narratives with a collection of expectations about each aspect of the experience. We argue that making and breaking these expectations drive the inferencing process. This effect can most easily be seen in the causation dimension. Returning to the fire and bucket of water example, readers expect that pouring the water on the fire will extinguish the fire, but they do not expect that placing the bucket next to the fire will extinguish fire. This expectation arises from the reader's general world knowledge about the causal relatedness of the two events. If the reader is presented with only these facts related to the fire, the reader will attempt to draw inferences about why the fire was extinguished. Perhaps the bucket had holes it, or maybe the bucket was tipped over at a later point in time.

The expectation is more intense when centered on the main focal points of the reader. As we saw before, more inferences are generated when objects are closer to the protagonist spatially or when they affect the protagonist directly. Also, steps along the main causal chain leading to the narrative resolution also are recalled better and generate more inferences. For example, if the hero of our story has the goal to extinguish a signal fire and he places a 'special' bucket of water next to it, should the fire suddenly extinguish the readers of our story will be intensively involved in making inferences about what this special bucket could be. Because of these inferences they will recall this story event better, and demonstrate better comprehension related to this event. The reader's expectation about the fire was broken, and the reader was both enabled and necessitated to draw inferences. These effects would be lessened if the fire was inconsequential to the protagonist or the story's outcome.

4. From Cognitive Models to Computational Models of Discourse Structure

In order to use cognitive models of narrative comprehension to inform the narrative generation process, we must be able to relate the cognitive models to our computational models of discourse structure. Our approach to narrative generation and execution, known as the Mimesis architecture, employs a decompositional partial-order causal link (DPOCL) planning algorithm [24] [25]. The DPOCL plan is a story and author centric approach that maps particularly well to cognitive models of narrative comprehension [7]. This section provides a high level analysis of the similarities between the situation model and the various elements and improvements of the DPOCL plan.

The spatial dimension of the situation model corresponds to the discourse level planning that must be done to generate 3d virtual environments [23]. Given the interactive quality of our narrative, the spatial dimension is also highly determined by the user's actions at runtime. It is the job of the camera planner to focus and constrain the spatial inferences generated by the user.

The temporal dimension relates to the story planning that determines the sequence and spacing of events as they are presented to the user. Each event must be either included or excluded by the story planner, and the planner must also decide the temporal distance between events. Certainly, this planning is key to maintaining user interest and story coherence.

The dimension of causation is best represented by the DPOCL algorithm, as it explicitly manipulates the causal structure of events in the story. In fact, this activity is the sole purpose of classical planners. This direct mapping is a major advantage in using a plan based approach to model story comprehension.

The dimension of intentionality is loosely maintained by the plan's goal state. The goal state describes the exact configuration of the world when the narrative is completed. However, this state does not describe the moment to moment goals that are formed and then discarded by each character in the story. Riedl and Young (2004) have extended the DPOCL algorithm to include the intentionality of characters. This intent-driven partial order causal link (IPOCL) planner creates intentions for each action or sequence of actions performed in the story. With this added information, the mapping to the cognitive model becomes much more straight forward.

The protagonists and objects dimension is represented by the objects bound to parameters in the planning process. The movement and actions of the main protagonist can be abstracted from the plan by choosing only the plan steps that bind to the protagonist's object. Ordinary objects in the story world can be tracked in the same manner. Recent work to bring a stronger notion of character to narrative planning [17] [16] increases the amount of character level information available to the planner.

5. Generating Educational Narratives Using Expectation

Our current work exploits the mapping from situation model to our plan-based computational model to generate narrative sequences that meet or violate user expectations, depending upon the learning context. The narrative's structure exploits the narrative comprehension process to increase inferencing and improve recall regarding key content in the story world. Through these effects, we hope to indirectly increase overall comprehension and learning. To determine likely user expectations, we integrate the plan construction process with a model of plan recognition; the technique used to combine these two elements is sketched here.

Plan recognition is the process of inferring the plan or plan's of an agent via observing that agent's actions [3]. Given a sequence of agent actions, a plan recognizer will produce a set of possible goals and candidate plans that complete those goals. Candidate plans can then be ranked to select the plan that the agent is most likely executing. Plan recognition has been used in the past for intelligent tutoring systems and also for story understanding [2] [6]; in our approach, it serves as a functional model of the elements of story comprehension and situation model construction.

In order to determine the expectation of the reader, a plan recognizer is used to generate candidate plans that naturally follow from the current situation model according to the five dimensions. When the plan recognizer identifies a plan or plans with sufficient certainty, these candidate plans represent the expectation of the reader at the current point in the story. Deviations from these plans should result in the violation of the reader's expectation. The output of this process suggests how alternate plans for completing the story may violate these expectations, thus affecting inference and recall focused around the violations.

Each of the five dimensions of the situation model is accounted for by the likeliness rating of the plan recognizer. For the spatial dimension, the plan recognizer uses objects and settings that are nearby the protagonist in projected plan steps. For the temporal dimension, the plan recognizer groups related events closely in time. For the causal dimension, the plan recognizer uses specified domain knowledge to determine the causal relatedness of events and chooses the sequences which are highly causally related. For the intentionality dimension, the plan recognizer first determines the intentions of the characters and then predicts their actions along these intentions. The intentions of the characters are accessible by performing plan recognition on the characters themselves, similar to the two level approach by Boella and Lesmo (1999). Finally, for the protagonist and objects dimension, the plan recognizer assumes the consistency of the protagonist and the relevance of objects which obtain the focus. The heuristic also takes into account the saturation effect whereby readers are overloaded with the amount of inferencing that must be done and thus decrease the quantity of inferences made.

Our process for narrative generation proceeds as follows. First, the story planner creates a story plan in the usual fashion [25] using the plan recognizer as part of its heuristic.

1. The planner selects both a plan along the fringe and a flaw to fix in this plan based off the plan rankings.
2. The planner generates all of the children nodes and sends them to be evaluated by the heuristic.
3. The plan recognizer evaluates the children nodes based upon how the new addition affects the expectation.
    - 3a. If the expectation about the task material is broken but the plan recognizer is both enabled and necessitated to construct a new plan containing this new information, then the ranking of this plan is increased. This is the case where the reader draws inferences about the task material and comprehension and recall is increased.
    - 3b. If the expectation about the task material is broken but the plan recognizer cannot create a new plan to incorporate this information, then the plan has lost coherency and the ranking is decreased.
    - 3c. Otherwise there is no effect on the ranking.

4. If the plan is without flaws, return the plan, otherwise go back to 1.

This algorithm selects, at each step, the story plan that causes the most inferencing on the part of the reader, according to the plan recognizer.

Consider the following text that grounds the notion of expectation and learning in a narrative. The text is taken from the Star Wars novel Shatterpoint [18]. In the story, Mace Windu, Jedi knight, has spent his first few hours on a strange planet in a detention cell, being interrogated by Major Gepton, planetary security officer. Upon release, he's been followed down a blind alley by two assassins, who level their blasters and attack.

> By the time the blaster bolts were a quarter of the way there, Mace had whirled, the speed of his spin opening his vest. By the time the bolts were half way there, the force had snapped his light sabre into his palm. At three quarters, his blade extended, and when the blaster bolts reached him, they met not flesh and bone, but a meter-long continuous cascade of vivid purple power.
>
> Mace reflexively slapped the bolts back at the shooters. But instead of rebounding from his blade, the bolts splattered through it and grazed his ribs and burst Shot-At(Windu) against the trash bin behind him… he noticed that his blade cast a peculiarly pale light. Much too pale. Even as he stood there starring drop-jawed into the paling shaft, it faded, flickered and winked out. His light sabre was out of charge.
>
> That's not possible, he snarled. That's not.
>
> With a lurch in his guts, he got it. Gepton. Mace had under-estimated him. Corrupt and greedy, yes. Stupid? Obviously not.

When Mace powers up his light sabre, our expectation is that he'll use the weapon to reflect the blaster bolts away from his body and remain unharmed. This expectation is violated with the bolts pass through the blade and weapon powers off, out of power. The explanation for this event that must be inferred, with the help of the discourse, is that the corrupt police chief had drained the power pack while Mace was being interrogated. We suggest that the inferencing that was required to determine how and why the battery could have been drained results in effective learning by the reader of that requirement for light sabre operation. The causal connections involving the draining of the battery fall along the main causal chain of the story and directly affected the protagonist.

Figures 1(a) through 1(b) illustrate the projected planning process for this example. Figure 1(a) shows the partial plan representing the story as told to the reader immediately prior to the occurrence of the exception. This plan is used by the plan recognizer to generate Figure 1(b), the expected plan. When the system plans out Figure 1(c), the actual plan, it makes note of the disconnect between the actual and expected plans, and increases the ranking of the actual plan, since, in this plan, the expectation will be violated but the sequence will still be coherent.

6. Discussion

The techniques presented here have yet to be implemented, and they stand upon their theoretical foundation only. Certainly, we've glossed over many of the finer details concerning the exact implementation of the plan recognizer, the heuristic function, and the method of tracking expectations throughout the planning process. We view these problems as potential future topics of research, with a complete design and implementation being the next step toward validation. Instead, this work presents a general guideline for using the situation model as leverage for learning in narrative planning.

The concepts detailed in section 2, by their nature, must also generalize to other forms of narrative generation. Mapping to other story and author centric systems would be much the same as our mapping above, which is fairly straightforward for the spatial, temporal, causal, and protagonists dimensions while requiring extra steps to represent the intentionality dimension. However, the mapping to character centric systems will most likely have difficulty with the causal dimension, as there is no explicit causal representation in these systems, while handling the intentionality dimension in a straightforward manner. Regardless of the type of narrative generation system, we believe that using cognitive models of narrative as a guide to narrative generation is important for making these narratives more targeted and effective learning tools.

7. Summary

We have examined how cognitive models of narrative understanding have been shown to influence inferencing, recall, comprehension, and learning. Focusing on the situation model, we have related this model to computational models of narrative planning. Using what we know about inferencing and recall in the cognitive models, we have proposed an algorithm for generating educational narratives using plan recognition as a heuristic for expectation and sketched an example of our algorithm in action.

The next step in this research is the complete design and implementation of the described system. Beyond this step is the inclusion of other levels of discourse structure and other cognitive models that influence recall and comprehension. We may consider incorporating additional approaches such as the event indexing model [26] or the constructionist model [10]; this subsequent work may provide additional data about the nature and predictive power of these theories.

8. Acknowledgements

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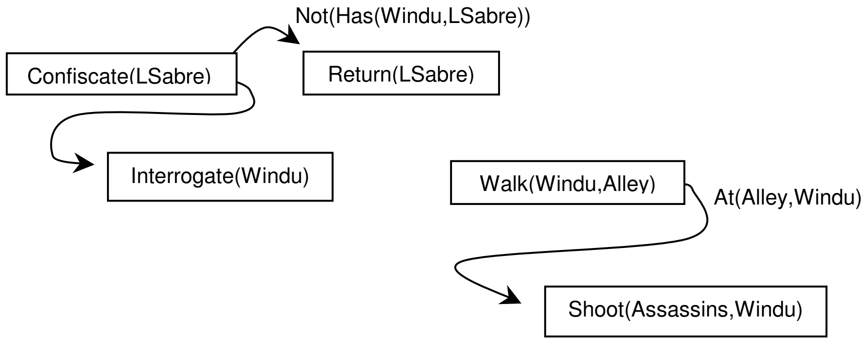
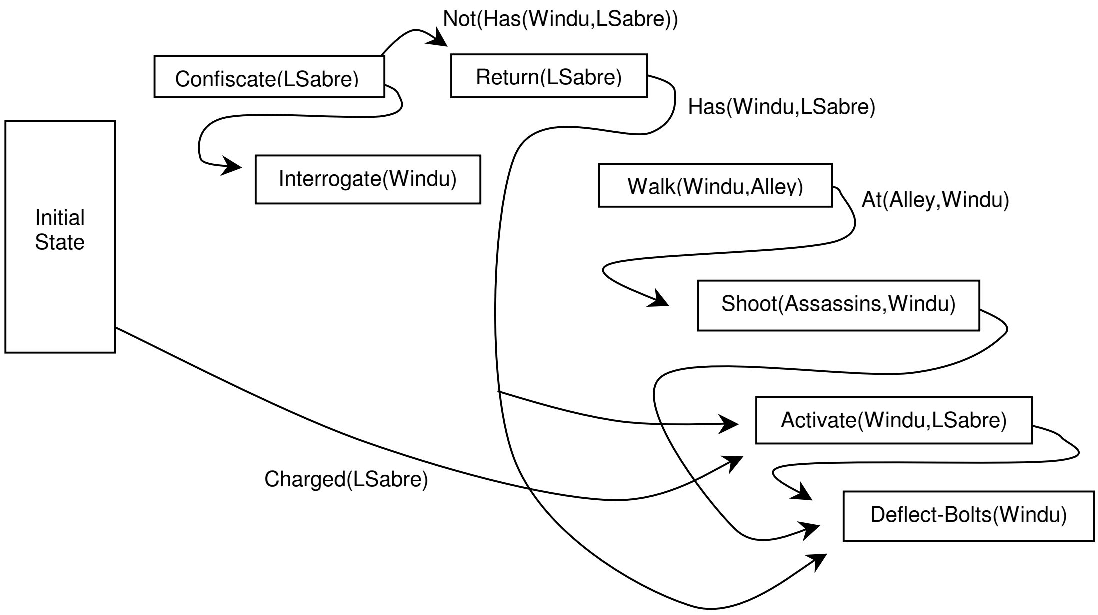
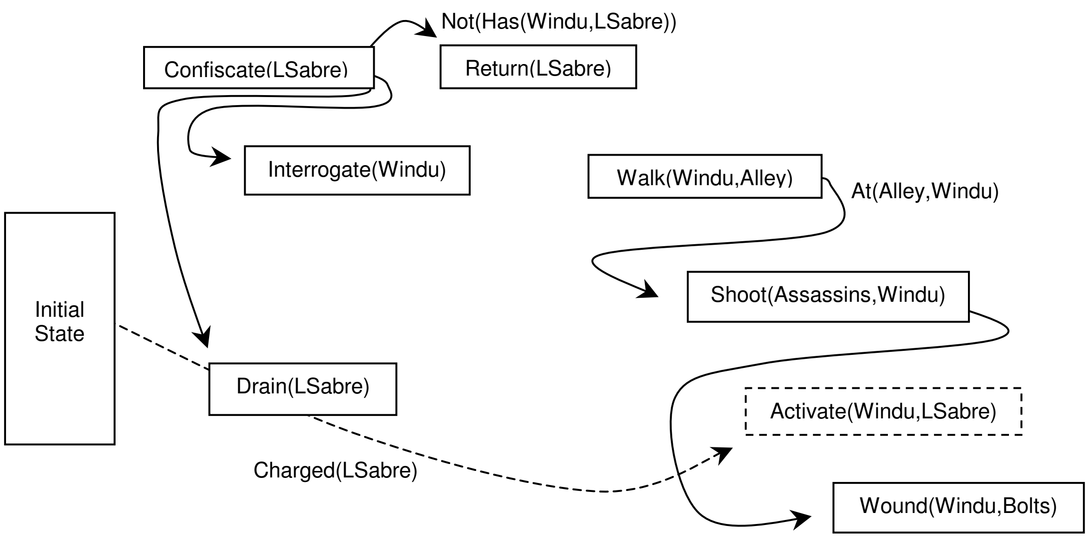


(a). The story as experienced so far.



(b). The expected story.



(c). The story as it unfolds

Figure 1. *Shatterpoint* story plans. Rectangles represent actions, arcs indicate causal connections between actions and are labeled with thecorresponding conditions in the story world.

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Automated Story Direction and Intelligent Tutoring: Towards a Unifying Architecture

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Abstract. Recently, interactive storytelling systems – systems that allow a user to make decisions that can potentially impact the direction of a narrative – have been applied to training and education. Interactive storytelling systems often rely on an automated story director to manage the user's experience. The focus of an automated director is the emergence of a narrative-like experience for the user. In contrast, intelligent tutors traditionally address the acquisition or strengthening of a learner's knowledge. Our goal is to build training simulations that cultivate compelling storylines while simultaneously maintaining a pedagogical presence by incorporating both automated story direction and intelligent tutoring into an immersive environment. But what is the relationship between an automated director and an intelligent tutor? In this paper, we discuss the similarities and differences of automated story directors and intelligent tutors and, based on our analysis, recommend an architecture for building narrative-based training simulations that utilize both effectively and without conflict.

Introduction

Narrative, in the form of oral, written, or visual stories, plays a central role in our social and leisure lives. Although stories are often created with the goal of entertainment, many also *happen* to be educational because of their content. Another class of narratives, the kind we focus on, are those that are *intended* to be educational. In these cases the inherent benefits of narrative, such as increased motivation and improved context for illustration, are leveraged for achievement of the learning objectives. Narrative-centered learning environments [7] have the potential to go beyond traditional, non-interactive narrative forms by enabling a student to be an interactive part of a story. In a narrative-centered learning environment, the purpose of story is to engage the student in a series of challenging problem-solving activities and/or dilemmas. Each of these hurdles is intended to have some educational value. However, when pedagogy becomes entwined with narrative, it becomes unclear as to whether a narrative-centered learning environment is performing storytelling, tutoring, or a little of both. Research in interactive storytelling systems (e.g. [18; 10; 15; 19; 8]) and intelligent tutoring systems [17; 11] has remained largely separate. Recently, training and educational systems such as those described in [9], [14], [12], and [5] involve elements of both.

We are interested in building narrative-based training simulations that accelerate students' problem solving skills in complex, real world situations where quick and successful resolution of problems requires the application of tacit knowledge. For example, training for military leaders deployed into regions where they must interact and negotiate with people of different cultures. Storytelling is an effective means for transferring tacit knowledge [13]. More traditional training techniques involve simulators that run fixed scenarios. Simulators are effective practice tools because they enable a trainee to practice skills, try different strategies, and discover outcomes. However, it can also be advantageous for trainees to be situated in an environment that promotes a more targeted and reproducible experience. The benefit of a narrative-based approach is that the trainee can be exposed to a larger context with multiple learning objectives that are strung together for greater pedagogical impact, providing valuable training experience dealing with life-like successions of interrelated problems. For example, a trainee negotiates with tribal leaders to achieve some effect and then transitions to a seemingly unrelated problem with security lapses only to discover that the side-effects of the first situation impact the way the second situation is resolved. For a simulation to evolve in a globally structured way, some supervisory control is required to coordinate the activities of story participants, such as a "director" of a movie. Specifically, the purpose of an automated story director is to coerce a virtual environment into producing certain events or achieving a certain outcome. The focus of the automated director is on the *experience* of the trainee, not the acquisition or strengthening of knowledge. In contrast, the acquisition and strengthening of the trainee's knowledge is precisely the role intelligent tutoring systems traditionally play in learning systems. But what is the relationship between an automated story director and an intelligent tutor?

We believe that narrative-based training simulations can benefit from having both an automated story director and an intelligent tutor. The purpose of this paper is to explore the similarities, differences, and relationship possibilities between automated story directors and intelligent tutors as they apply to narrative-based training simulations. As a result of our analysis presented below, we believe there must be a clear delineation of responsibilities and an understanding of how each can impact the other (either directly or indirectly). We present one possible delineation of responsibilities for automated story directors and intelligent tutors in a narrative-based training simulation. Finally, we propose an architecture for incorporating an automated story director and intelligent tutor into a narrative-based training simulation that implements our recommendations.

1. Interactive Narrative

In systems that employ storytelling techniques, there are two fundamental types of narratives used: linear narrative and branching narrative. Linear narrative is a traditional form of narrative in which a sequence of events is narrated from beginning to ending without variation or possibility of a user altering the way in which the story unfolds. For a narrative to be interactive, it is necessary to introduce the notion of branching. This is accomplished by introducing decision points into the story such that user actions in the environment can potentially alter the sequence of events that is narrated.

An interactive narrative system is a computer program that manages a branching narrative and provides a facility for a user to influence the story. Typically, branching narrative systems achieve interactivity by situating the user as an embodied character in the story world. There is a distinction, however, between an interactive narrative and a simulation. From the perspective of the user, both simulations and interactive narratives involve the emergence of narrative-like situations. However, most interactive narrative systems employ an automated story director – also called a drama manager [6] – that manages the interactive virtual environment in order to coerce the emergence of narrative to correlate with some path through a given model of branching narrative. The automated story director has a global perspective of the story world which it attempts to reconcile with some representation of branching narrative. There are many approaches to interactive narrative including: traversing a pre-scripted directed graph of scenes and choice-points (e.g. choose-your-own-adventure stories); dynamically generating alternative story branches (e.g. [19]); comparing emergent story to partially ordered event graphs (e.g. [18; 8]); modelling dramatic tension [15]; and dynamically choosing from a pool of scenes (or scene-like constructs such as beats) based on analysis of user interaction (e.g. [10]).

2. Intelligent Tutoring Systems

Intelligent tutoring systems (ITS) are usually defined as systems that use the techniques of artificial intelligence to evaluate student performance and offer suggestions for improvement. ITS has an extensive history spanning about four decades, and a huge number of systems have been developed during this time [17; 11]. The content and form of a tutoring session depend on many factors, such as when tutoring occurs (e.g. before, during, or after an exercise), level of guidance (some exploration vs. tighter control), and the kind of desired interactions (e.g., dialogue vs. graphical gestures), to name just a few. For this paper, we will mostly focus on one common form of tutoring known as *coached problem solving* [16]. Under this definition, the tutor and student collaborate to solve a problem. During this process, initiative shifts back and forth: as long as the student is taking correct steps, the tutor simply indicates agreement or remains silent. If the student becomes stuck or requests help, the tutor provides hints to get the student back on a correct solution path.

An ITS technology related to coached problem solving is *model tracing*, which attempts to understand and track students' actions at the cognitive level [1]. Model tracing tutors require an executable cognitive model of the target skill that is able to solve problems in the domain along with help messages that are displayed when necessary (e.g., when the student is stuck, or after a mistake). A common (but not universal) trait of model tracing systems is *immediate feedback*. When a student makes an error, the system will quickly let the student know about the mistake and help them repair it. Generally, the student is not allowed to continue without fixing the error. To provide this kind of help, model-tracing tutors maintain a step-by-step understanding of where the student is during problem solving. The goal of the tutor is to keep the student on a known solution path much or all of the time.

3. Distinctions between an Automated Story Director and Intelligent Tutor

As mentioned, building a narrative environment for learning naturally raises the question about where to draw the line between an automated director and tutor. There are many apparent similarities and differences between their roles. In this section, we lay out this space of functionality and requirements to act as a backdrop for our proposed architecture.

3.1. Tracking the user

An obvious similarity between automated directors and intelligent tutors is that both tend to maintain representations of valid "paths" through some space, and attempt to track the user as she performs actions in the environment. In the case of a tutor, this is usually a path through a solution space for a given problem – arcs correspond to problem solving steps and nodes to states of the evolving solution. The target knowledge consists of the individual rules for updating the state and the knowledge of how to apply them productively to achieve a *goal state*. The goal of the tutor is to impart its model of expert performance. Acquisition of this knowledge typically occurs through repetitive practice, and thus many ITSs present the student with many problems to solve.

In the case of an automated story director, the representation of valid paths can be a branching narrative as a path through state space of partially ordered steps that constrain the possible narratives. The situation is conceptually similar to that of an intelligent tutor's in that the user moves from state to state by taking actions within the environment. For example, the user may choose to move from one room to another in search of some desired item. However, the actions taken by the user are *not* part of some underlying expert model of performance. The purpose of a director is not to communicate *how* to participate in a story, but rather to ensure that the story remains meaningful without violating the user's sense of control.

3.2. Overt versus Covert Intervention

Perhaps the greatest distinction between automated story directors and intelligent tutors is the nature in which they intervene and provide feedback to the user. Intelligent tutors, in a way similar to the human counterparts, maintain a very clear, overt pedagogical presence. The purpose of a tutor is to provide scaffolding to the student to reinforce the knowledge and concepts required to perform a skill. Tutors intervene when students make mistakes or deviate from known solution paths, although many systems delay this feedback to give the student a chance to self-correct. Human tutors can also provide positive feedback to reinforce correct actions, sometimes through subtle discourse acts, nodding, or even facial expressions.

Automated story directors, on the other hand, influence the emergence of story through *only* covert intervention. That is, a story director subtly manipulates the user through adjustments to the story world environment and through adjustments to the goals, beliefs, and desires of non-player characters (NPCs) in order to encourage the emergence of a story that corresponds to the story director's model of plot development [6]. An automated director is considered successful if the user's experience reaches a desirable outcome and the user is never aware of the director's presence.

3.3. Correcting versus Pushing

How the automated director and tutor handle situations where the user deviates from an anticipated path is also important. An intelligent tutor is concerned more with the performance of the user and attempts to guide through direct intervention. When the student makes a mistake, the tutor may ask a question, provide a hint, enter into a remedial dialogue with the student, or simply give the correct action away. This sometimes involves restoring the solution to some previous state. The tutor has control over the problem-solving environment and this kind of intervention does not violate the student's expectations in any way.

A story director, on the other hand, is concerned with the experience of the user and attempts to guide through subtle manipulation of the environment. Story directors do not intervene or require "undo" actions by the user since this would violate the user's sense of immersion. User actions that do not correspond to any branch in the narrative model are not necessarily problematic. Instead, a story director may push the user towards a world state that facilitates story progression – possibly one that is nearly identical to a previous world state. The subtle difference is that the previous actions remain part of the history and therefore part of the emergent story even while the user is covertly manipulated towards achieving some more desirable world state.

3.4. Scope of Control

For most ITSs the problem-solving environment exists solely to serve the purpose of instruction. It is therefore entirely reasonable for a tutor to intervene and even undo a student's action to give her another chance because there is no aspect of the world that is not controlled by the student or the tutor or both. There are, however, learning domains such as leadership training that involve problems that exist within a larger context of a real-world-like simulation. In such a domain, being immersed in the real-world-like simulation is just as important as solving the problems that occur within the larger context.

In such a domain, there are elements in the world that are not under the control of the student or the tutor such as non-player characters, weather, etc. In order to maintain the trainee's sense of immersion in the environment and in the role she is playing, a certain degree of believability is necessary. Specifically, the trainee must believe that the world is not a "toy" world, meaning the tutor will not encourage or allow "undo" actions when the trainee makes a mistake. The tutor has the ability to influence the trainee's problem solving, such as offering private consultation during a negotiation. The automated story director is, however, well suited to exert control over many aspects of the virtual environment. The story director must be limited so that it cannot influence the world in such a way that trivializes learning objectives, even if the trainee is required to complete a certain task for the plot to progress as the story director desires. That is, the scope of control of the automated director must be limited to only helping establish the conditions in which training objectives become relevant.

4. Building Narrative-Based Training Simulations

We are interested in narrative-based training simulations in which the trainee has a story-like experience. The purpose of such a system is to situate the trainee in a virtual world similar to that in which the trainee will be expected to operate in the future. During that experience, the trainee will be required to perform procedures that meet certain training objectives. The narrative aspect provides a layer of control over the simulation so that certain situations are guaranteed to arise and challenge the trainee. A narrative-based training simulation therefore requires an automated director. Although such a system would have pedagogical value by itself, we believe it is also beneficial to provide an intelligent tutor to help the trainee when necessary and improve the chances that the intended learning outcomes are realized.

4.1. Delineation of Story Director and Intelligent Tutor Responsibilities

Given the similarities between automated story directors and intelligent tutors and the possibility of overlap, we propose the following delineation of responsibilities. The purpose of the story director is to ensure the trainee has a valuable experience that places the trainee in certain pedagogically valuable situations (although it is not the responsibility of the automated director to assess the pedagogical value of the experiences themselves). The story director will achieve this by performing two responsibilities:

1. Representing the progression of the user's experience as a high-level narrative structure that is either linear or branching.
2. Guiding semi-autonomous agents so that they facilitate plot development as well as constraining them so that they cannot perform behaviors that directly conflict with the narrative structure of the automated director.

The story director maintains a representation of the desired plot. Aylett [2] recommends that plot occur at a high level and that everything else below is handled reactively. Here, "high-level story representation" means that the story representation does not contain instantiations of user-performed or non-player character performed operations that are also part of a learning task procedure. A non-player character (NPC) is a character in the virtual world that is not controlled by a human user. Suppose the story director requires a situation in which the trainee must convince an NPC of some fact in order to achieve some effect on the world. The plot representation can include a plot point where an NPC is convinced of the fact but should not include explicit representations of a specific set of low-level behaviors such as appeasement and negotiation that achieve that world state. That way, the story director does not require the trainee to perform a learning task in a particular way, constraining the functioning of the intelligent tutor. It also prevents the story director from pushing the virtual environment in such a way that trivializes a learning objective. For example, the automated director could unknowingly interfere with a pedagogical goal by making NPCs agreeable when the student needs more of a challenge. The high-level representation also makes the automated director resilient to the trainee's fumbling of training procedures. For example, if the trainee struggles excessively during some task, it does not necessarily constitute a deviation from the story director's plot representation as long as the state of the world is such that future high-level plot points remain achievable.

The principle role of the automated director is to coerce certain situations – those represented in the high level narrative model – to develop that ordinarily would not develop in the context of an unguided simulation. This is best achieved through direction of the NPCs. We believe that NPCs should be controlled by autonomous agent technologies in order to be believable – to appear motivated by their own internal goals, desires, beliefs, personalities, etc. Fully autonomous agents, however, may not act in accordance with the story director's plot model and may even cause exceptions. The primary means for the story director to manipulate the world according to its representation of plot is through the NPCs. The automated director directs the agents from time to time to adopt goals that establish world states that facilitate plot advancement. For example, if the plot representation demands that a situation develops where a boy is hurt and needs medical assistance, the story director can insist that the agent controlling the boy NPC achieve the goal of becoming hurt near the trainee. Just as important, the director constrains the agents so that they cannot perform behaviors that directly contradict the narrative. For example, in order to force the trainee to deal with the situation with a boy that becomes hurt nearby, the automated director can require the mother of the boy NPC not seek immediate medical attention even though that may be the inclination of the agent controlling the mother NPC.

Intelligent tutoring can play at least two roles in a narrative-based training simulation. First, it is beneficial to have an intelligent tutor agent acting as an expert that accompanies the trainee to provide feedback and guidance. This tutor could be embodied as a character in the world, or merely a "disembodied voice in the trainee's ear." The distinction of the tutor as an expert is important because it should be able to handle situations as they arise and provide scaffolding for the trainee as she attempts to work through them. The second role intelligent tutoring plays in a narrative-based training simulation is as a reflective tutor during an after action review (AAR). AARs allow the trainee to reflect on (with the help of the tutor) what happened, the quality of the student's performance, and how to improve in the future. With access to the automated director's logs, the tutor can also provide "behind the scenes" clarification on how the plot developed and give explanations regarding the causal relationships between events. This opens up

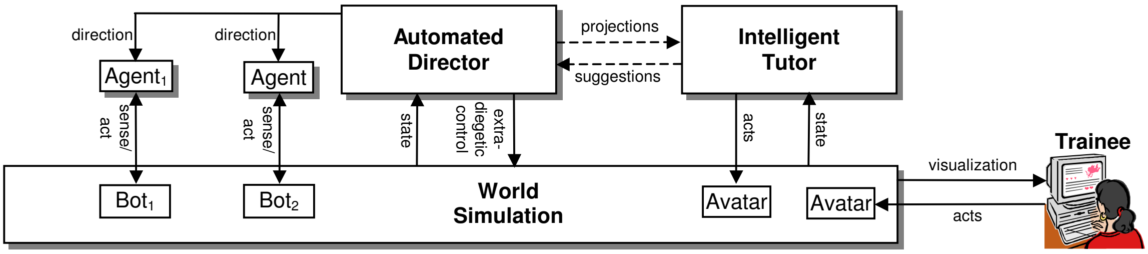

Figure 1. The narrative-based training simulation architecture.

the possibility of discussing 2nd and 3rd order effects of the user's actions as well as actions by NPCs outside the local perspective of the trainee that had a direct causal influence on the situations that the trainee encountered.

4.2. An Architecture for Narrative-Based Training Simulations

An architecture for a narrative-based training simulation that reflects the design decisions and delineation of responsibilities of a story director and intelligent tutors discussed above appears in Figure 1. It is based on four main components: the world simulation, the automated director, the intelligent tutor, and a collection of autonomous agents. The dashed links are optional. The world simulation implements the physics of the virtual world, graphical rendering, etc. Within the world simulation are models of the dynamic objects in the world. Most important of these objects are the user avatar, the non-player character (NPC) avatars – also called "bots" – and the intelligent tutor's world representation (either an avatar or a "disembodied voice"). The user controls her avatar though a user interface and receives a visualization of the virtual world in first-person or limited third-person perspective. The intelligent tutor's world representation can be a fully embodied avatar in the case that the intelligent tutor also plays the role of a character or can be a disembodied presence that can "speak into the user's ear," modify the user's visual interface, etc. The NPC bots are embodiments of characters that are controlled by the external AI autonomous agents.

The automated story director maintains a branching narrative model and monitors the world simulation relative to this model. We believe that the automated director should not interfere with the physics of the world simulation beyond extra-diegetic factors – elements that involve dramatic presentation such as music, lighting, and camera position. In addition to tracking the trainee in the world simulation, the automated director is also responsible for managing the NPCs. The NPCs are controlled by autonomous agents that are believable [3] and directable. A directable agent is one who's reasoning and behavior can be specified or modified by an external process [4]. How to implement directable, semi-autonomous agents is beyond the scope of this paper.

The intelligent tutor, during the exercise, models the user's knowledge structures and learning as they pertain to particular learning objectives. These learning objectives occur throughout the narrative experience although they are not strictly represented as learning objectives in the automated director's narrative representation. The world simulation feeds the tutor relevant information, including learning task start and stop times, details of the environment and NPC actions during the task, and user actions (for evaluation and tracking). When the tutor needs to intervene (to provide solicited or unsolicited feedback), it does so through the world simulation.

The disambiguation of the story director's and intelligent tutor's roles in a narrative-based training simulation means that the story director and intelligent tutor do not need to communicate directly with each other. However, we recognize that it can be beneficial for information to flow between the two components. The intelligent tutor can be more effective if it receives projections of upcoming narrative events so that it can tailor any assistance it provides the user, as long as it doesn't act on this omniscience to interfere with the plot progression. The automated director can also accept suggestions from the tutor to modify the narrative structure to be more pedagogically relevant to the trainee.

5. Conclusions

A narrative-based training simulation can benefit from the inclusions of both an automated story director and an intelligent tutor. Despite the outward appearance of overlap between narrative experience control and knowledge scaffolding and strengthening, there are enough differences to suggest that automated story directing and intelligent tutoring remain distinct in systems that use story to compel and motivate learning objectives. We recommend that a narrative-based training simulation incorporate both automated story direction and intelligent tutoring. We have laid out a proposal for the delineation of responsibilities that facilitates the inclusion of story control and tutoring side-by-side in a narrative-based training simulation.

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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[1] 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[2], aiming to evaluate, *a*

[1] 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.

[2] "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/

priori, the support to SRL granted by Technology-Enhanced Learning Environments (TELEs).

By the term TELE it is ment 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.

Planning

Cognitive aspects

This question refers to the possibility for the student to easily get an overall idea of the content of the TELE.

1 *The TELE helps the learner to structure the learning content.*
Not supported 0 1 2 3 4 5 well supported

2 *The TELE has an easy and intuitive interface.*
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 *The TELE records a history of learner activities.*
Not supported 0 1 2 3 4 5 well supported

4 *The TELE allows the student to plan her/his learning with the help of activity plans, personal development plans, progress reports etc.*
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 contruction, 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[3], 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 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

[3] Published by SPA Software, 2003, http://www.spasoft.co.uk/

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.

Planning	not supported 0 1 2 $\boxed{3\ 4}$ 5 well supported
Execution and monitoring	not supported 0 1 $\boxed{2\ 3}$ 4 5 well supported
Evaluation	not supported 0 1 $\boxed{2}$ 3 4 5 well supported
Cognitive aspects	not supported 0 1 2 $\boxed{3\ 4}$ 5 well supported
Motivational aspects	not supported 0 1 $\boxed{2\ 3}$ 4 5 well supported
Emotional aspects	not supported 0 1 $\boxed{2}$ 3 4 5 well supported
Social aspects	not supported 0 $\boxed{1}$ 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:

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.

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 continuos 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.

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.

Some kind of support to reflection on the work done.

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[4], where the child can be asked to justify some character's behaviour.

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

[4] http://gaips.inesc-id.pt/teatrix

- 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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Using Perspective in Narrative Learning Environments

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Abstract. Several empathic applications have been developed over the last years but can we redirect that empathy to specific characters? This paper focuses on the intention to induce empathy in children and stimulate role taking by presenting a narrative through the perspective of a specific character. The use of perspective is achieved by showing the events that happen in the story but without impartiality.

We will describe a narrative-based application designed to help children cope with bullying situations, the *FearNot!* demonstrator, and an embedded filter that provides the subjective point of view of its characters, by observing the personalities and the relationships between those characters.

1. Introduction

The aim of this paper is to develop a way of influencing the emotional reactions of users of a virtual storytelling environment through the use of "perspective". To study that, we have to contextualise our approach and, therefore, we have applied it within the *FearNot!* application, which is a learning environment used to help children become aware of how to deal with bullying problems in schools.

If we want to increase or influence the empathy felt by the child (user) towards characters in a simulated 3D emergent story, s/he must not feel as an outside observer but, instead, as if taking a role in the narrative. In other words, in order to establish an empathic relation, the child must identify herself with a particular character. For such "role taking" to happen, the perspective that is "absorbed" by the user is quite important. In fact, we all have a need to know different perspectives of a story, whether to understand it as a whole, by gathering different information, or simply because we trust one's version better than someone else's. This is what motivates authors to create *Multiform* or *metalinear stories*, which are narratives that provide the participant with multiple perspectives or different versions of one single plot.

In a story we can identify two important levels, which equally contribute to its success and complement each other: the *narrative level* and the *narration level*, [3]. The *narrative level* corresponds to the events and to what happens in the story. The *narration level* corresponds to the way the events are presented, to the way the story is told (or shown), [10].

Since narration is defined as the way the plot is presented, [10], it depends on who tells the story and on how it is presented. This happens because the person who tells it has perceived the story in a personal way, which implies that when we observe, for example, the reactions of a character through the perspective of a person *A* we will experience the narrative differently than through the perspective of a person *B*.

In conclusion, events in a story can be "seen" differently if they are seen through the eyes of different characters. Based on this, we have built a specific system for presenting a character-based perspective, which will allow the child to experience a different narration according to the character that is *telling* the story.

The solution, here proposed, to introduce perspective without changing the actions of the characters aims at influencing the notion of intentionality. This choice was based on the fact that our perceptions are associated with our feelings of empathy and, according to some authors, empathy derives from intentions.

Jean Decety, [4], has studied empathy through the observation of the process of imitation and has found that "when observing someone's action, the underlying intention is equally or perhaps more important than the surface behaviour itself". His statement is in accordance with what had been studied and suggested by Meltzoff, [11], and Baldwin, [2]. Both authors claim that when we observe others we "look" at their intentions and use that information in our responses.

So, in this paper we will present a system for perspective creation in a virtual storytelling environment.

This paper is organised as follows: we will begin by explaining the bullying problem, in order to contextualise the *Victec* project, and then describe the *FearNot!* application, developed within the same project. Afterwards, we will present our approach to introduce perspective and describe the *Perspective Filter* and its implementation within *FearNot!*. Finally, we will provide orientation for future work.

2. A Brief Description of Victec and the *FearNot!* Demonstrator

The main goal of the *Victec* (*Virtual Information and Communication Technology with Empathic Characters*) project[5] is the prevention of a specific form of aggressive behaviour, that is, bullying situations. Bullying behaviour can be described as an intentional and repeated aggression (not necessarily physical) where there is an imbalance of power, [12]. This behaviour can be divided into two different forms of aggression:

Direct Bullying – also referred to as *physical bullying*, it includes, for example, actions such as hitting, kicking, threatening or taking belongings, [7];

Relational Bullying – this type of bullying is expressed through social behaviours such as social exclusion, malicious rumour spreading, and the withdrawal of friendships, [16].

Bullying represents a global problem, as it has been identified in several countries. It occurs mostly among children in schools, namely in the playground or in the classroom. The decrease of these aggressive situations is a priority in our society. So far, antibullying initiatives have not been very efficient. The *Victec* project introduced a new approach to the problem, as it is based on the use of a virtual learning environment where self-animating empathic characters simulate bullying situations using emergent narrative. The result was a software program designed to help reduce aggressive behaviour of children between the ages of 8 and 12, [14]: the *FearNot!* demonstrator. *FearNot!*, which stands for *Fun with Empathic Agents to Reach Novel Outcomes in Teaching*, is an interactive application embedded in a virtual environment, that uses synthetic cartoon-like characters.

In *FearNot!* the emergent narrative is accomplished through the use of intelligent synthetic characters, implemented with an emotional model and a social memory.

In the context of *FearNot!*, an empathic relation is precisely induced between a child and the synthetic characters. In order to achieve that, the characters play a bullying situation, placing the child as an observer, [13].

[5] All the information related to the *Victec* Project can be found at the official website of *Victec*, http://www.victec.org.

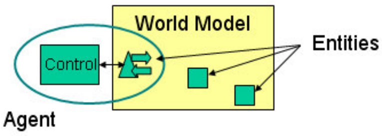

Figure 0.1. The *FearNot!* Architecture.

The aim of this application is to induce affective responses in children during bullying situations, and thus "change their behaviour and cognitions", [14]. *FearNot!* allows an evaluation of the believability of the characters as well as of whether children will develop empathic relations with those characters.

This program creates an episodic narrative, as it generates a sequence of small episodes. The narratives are generated either in the context of direct or relational bullying situations that take place in a school. At the end of each episode, children will interact with the characters and give advice. These pieces of advice will influence the following episodes.

2.1The Architecture

FearNot! was implemented with an agent-based architecture (see Figure 1). This application was built using autonomous agents that decide, as the narrative unfolds, their behaviour and contribution to the narrative itself. At the implementation level this translates into changes that affect the *world model*.

The agents in *FearNot!* have an emotional behavioural model and act in the world according to it (see [8]). Their actions are a consequence of their perceptions of the world, which are a result of interacting with each other or with the child.

This unscripted narrative environment represents a challenge to the creation of character-based perspective as it is impossible to pre-determine the course of the narrative and the actions of each agent.

So, in order to "shape" events that are created by autonomous agents, we propose to generate parameters to model the emergent narrative as the agents produce their behaviour.

3. Providing Perspectives

The approach here presented, in order to create perspective-oriented narrative, consists of influencing the perception of intentionality in a virtual storytelling environment. To achieve that, we aim at "shaping" the intensity of what is seen so as to influence the visualisation, and thus the perception, of the bullying episodes. This suggestion to provide perspective, should be accomplished as the characters in the story decide to perform an action, but without directly affecting or altering the action performed.

To achieve this goal we propose to adapt the intensity of the actions performed by the characters to the appropriate perspective as well as to emphasise those results through the use of a camera. We have created a filtering module so that when it receives the instructions regarding the actions that will be performed, it will filter that information and generate the appropriate instructions to the *world model*. This filtering is applied to the information that is shared by the *control* and the *world* modules (see Figure 2).

The module that we present to create perspective will analyse some of the personality aspects of the characters, the relationships they had with one another and the actions they performed, thus providing the adequate narration of the events.

We do not intend to show accuracy between the intensity of the action and the personality of the character performing the action. Every action is, therefore, filtered in order to make prevail the perception of the “owner” of the perspective or even his distortion of the truth.

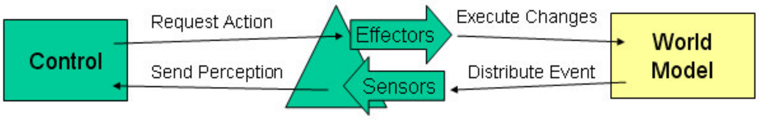

Figure 0.2. The control module interacts with the world module by, cyclicly, receiving perceptions and returning actions that have effect on the world.

All of the choices that were made during the development of this work were based on the Disney principle of exaggeration, [9]. This “ideology” was followed in order to create more impact on the child, rather than trying to achieve realism or simulate real behaviour.

3.1The Perspective Filter

The *Perspective Filter* is the module that interprets every action and “shapes” the way it is displayed during the narrative experience (see [15]). This filter provides a structure that is independent of the narrative itself and the characters who participate in it, since it extracts all the relevant information about those characters from their *functional roles*. In other words, this module is based on the stereotyping of the role of the characters, through their personality traits.

For example, when we choose to see an episode according to the perspective of a character A, and whenever an action is performed by a character B, different parameters will vary according to the relationship between the two characters and according to one or two personality traits of character B.

So far, the parameters that influence the way the action is displayed are: the type of camera shots and the intensity of the action (consider, for example, that when an aggressor pushes a victim we can observe a slight push, from his perspective, or a violent one, from the perspective of his victim).

The way the *Perspective Filter* works is sketched in Figure 3.

3.1.1 Perspective Types

The relationships we build with others influence the way we interpret events as well as our views on them, so it was mandatory to include this influence in our creation of perspective in storytelling.

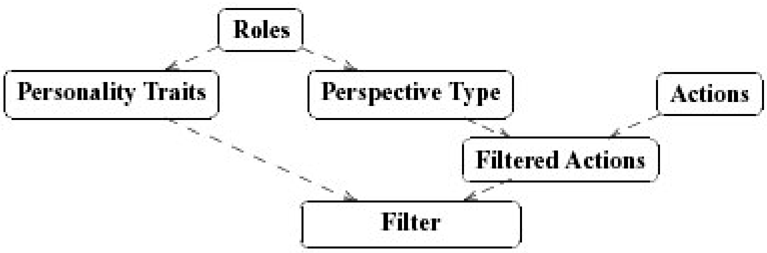

Figure 0.3. Inputs of the Perspective Filter.

The best way to include the information provided by interpersonal relationships in our module was to create different types of perspective. Therefore, we have considered three main types of perspective: a *self-perspective*, a *friendly perspective* and an *unfriendly perspective*. These different types are based on the relationship between the "owner" of the perspective, or *focalizor*[6], and the character who performs the action. The *self-perspective* will obviously occur whenever the character whose perspective we are following performs an action. The *friendly perspective* is shown whenever the focalizor feels empathy for the character who is conducting the action. Finally, we observe an *unfriendly perspective* if the action to be viewed is executed by a character who does not provoke empathy in the focalizor.

The purpose of these different types of perspective is to enhance the negative actions, and to give less importance to the positive or neutral actions, of "enemies" and to do the opposite regarding the actions conducted by friends (or the focalizor's own actions).

The combination of the three types of perspective, based on who is performing the actions, is what provides the subjectivity of the focalizor in the experience.

3.1.2 Character Roles and Personality Traits

The roles play an important part in the decision concerning how to filter the narrative. Most narratives include a structure which allows stereotyping the characters in predefined roles, such as the hero and the villain. So, using roles is advantageous given that they can be used with every narrative, and not just in the case of bullying scenarios.

The use of roles has enabled the definition of relationships between groups of characters and, therefore, the creation of a structure which is independent of the narrative itself. Since each character is always attached to a role, the personality traits of each character are induced by the personality traits defined for his role.

The personality traits defined were the following: Aggression, Hot-temper, Self-esteem, Shyness and Anxiety.

These traits were thought to be appropriate to influence how an action is shown, especially in a context where they represent the most noticeable features in the roles. For instance, regarding the bullying scenario, these personality parameters were the ones that stood out the most when defining the profile of personalities involved in bullying.

Aggression – this trait is very useful to show intentionality when modelling the bullying scenario;

Hot-temper – this characteristic is usually associated with aggression and is used in certain actions that can be seen as impulsive;

Self-esteem – certain actions such as "crying" are commonly associated with self-esteem. This statement does not necessarily mean that those actions are triggered by the level of self-esteem, simply that we often look at them as the behaviour of a person with low or high self-esteem;

Shyness – we regard certain actions as "bold" attitudes for a shy person, therefore shyness represents a strong parameter to influence the emphasis in the actions;

Anxiety – this trait is associated with actions that are viewed as the behaviour of "nervous people".

For each action, one or two personality traits are taken into account. In order to "exaggerate" the results, and thus create more impact when generating the perspectives,

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[6] The term *focalization* was introduced by Mieke Bal, [1], to represent "the relation between the vision and that which is 'seen', perceived". Edward Branigan, [3], defines the *narrator* as the provider of statements and the *focalizor* as the provider of his own experience.

each trait can only assume one of these three values: **high**, **normal** or **low**. As a result of this constraint, we expect to achieve more contrasts between different perspectives.

We are aware of the fact that these five personality parameters are not theoretically sustained as a complete personality model, in opposition to the Five-Factor Model proposed by Costa & McCrae [6], for example. Nevertheless, if we had used the Five-Factor Model of *Extraversion*, *Agreeableness*, *Conscientiousness*, *Neuroticism* and *Openness*, as our personality model, we would have had serious difficulties in determining which traits would influence each of the usual actions available to characters in a narrative.

Therefore, and since we do not want to generate behaviour with our perspective module, instead of considering a (complete) personality model, we just considered some personality traits. This choice was much simpler than the Five-Factor Model, but powerful enough to differentiate the personality of each character present in normal narrative stories.

3.1.3 Perspective Parameters

To provide the perspective of a character during the emergence of a narrative, this work has combined the values of two parameters. The two parameters considered were the following:

- Camera Information – indicating the shot, angle and target framed during the action;
- Action Intensity – the action is shown with more or less intensity, revealing intentionality or the lack of it.

The camera is what allows us to "witness" the story. Some shots can put us in a character's shoes while others can move us away from the story, transforming it into something that produces no empathy and even dissolving any sort of interest we might have in the narrative being told.

Thus, the shots might provide us with either intimacy or indifference towards the events. For example, if we observe from a distance, we will feel more indifferent than if we watch a character in a close-up, as we are given the impression of being inside the story, feeling immersed. Hence the importance of the camera shot to this project.

The power of the shot is taken into account by several researchers, who understand it cinematographical importance to influence the perception of the viewer. For example, the *Mimesis* architecture, [17], includes a *discourse planner* which determines the appropriate camera shots according to the actions performed by the characters.

Furthermore, we also want to induce the notion of perspective through the level of intensity used in the animations. The intensity of an action directly influences the perception we have of the action itself.

Our aim is to manipulate the animations in order to simulate a degree of intentionality, thus originating different perceptions when using different focalizors. For example, when considering the bullying scenario, from the bully's perspective, he will not perform negative actions intentionally as he will not want to emphasise his "bad behaviour", so these actions will be viewed with little intensity. But from the victim's perspective, the bully's aggressive actions were completely intentional, therefore, they will be shown with great intensity.

3.2 Implementing Perspective in FearNot!

Within the scope of the *Victec* project, we have implemented the *Perspective Filter* described above in the *FearNot!* demonstrator. We will now see the character roles and actions that appear in this application and how personality traits were associated with them.

Table 1. Personality Traits of the Characters of *Victec*.

	Bully	Victim	Bully\Victim	Assistant	Defender	Outsider
Aggression	High	Low	High	High	Low	Normal
Hot-temper	Normal	Low	High	Normal	Low	Normal
Self-esteem	High	Low	Low	Normal	Normal	Normal
Shyness	Low	High	Low	Low	Normal	Normal
Anxiety	Low	High	High	Low	Normal	Normal

3.2.1 Roles in Victec

As we have seen before, the *Victec* project is embedded in the bullying scenario, which usually involves six typical roles. Here is the description of each role, as provided in the official site of *Victec*:

- Bully: bully others only and are not victimised;
- Bully/Victim: bully others and are victimised at times;
- Victim: victimised but do not bully others;
- Defender: defend and help the victim when they are bullied;
- Outsider: do not defend or help the victim or assist with the bully. Neutral but may be an onlooker to the incident;
- Assistant: helps the bully in bullying incidents.

The personality traits considered for the *Victec* characters are presented in Table 1. The values of the personality traits are sustained by the information given by the stereotyping of the roles included in a bullying scenario.

3.2.1 Actions in Victec

We have considered one or two personality traits, as mentioned above, in order to change the way an action is displayed. These choices were made according to the traits of personality that we usually associate with certain actions or the way we perform them. For instance, we associate Aggression and Anxiety with the action `Drop`.

Here is the list of all actions included in this work, so far. They are grouped by their valence and associated with the personality traits that influenced their visualisation.

Negative (or non-prestigious) Actions:

- `Cry` – Anxiety, Self-esteem;
- `Drop` – Aggression, Anxiety;
- `Kick` – Aggression, Hot-temper;
- `Mock` – Aggression, Shyness;
- `Push` – Aggression, Hot-temper;
- `SpeechAct` (`Confrontation`) – Aggression.

Neutral Actions:

- `MoveTo` – Self-esteem, Shyness;
- `Pick` – Aggression;
- `SpeechAct` (`Help`, `Socialising`) – Self-esteem, Shyness.

In conclusion, we implemented the Perspective Filter in *FearNot!* by using the specific roles (and respective personality traits) and actions mentioned above.

As for the camera shots, we are planning to create a set of fixed-shot cameras for each character. This means that when the perspective filter orders a change of shot, the active camera will be switched, instead of being moved. The concept of placing a set of cameras to film the same event has been described in [5], although in this case the different cameras also provided the same shot but using different angles.

4. Conclusions and Future Work

The *Victec* project aims at reducing aggressive behaviour in children within schools by inducing empathy. In this paper we have proposed to induce role taking by filtering a narrative through the perspective of a character. By inducing "role taking", we do not aim at promoting bullying behaviour when providing the perspective of the bully, but to allow the comparison between his perspective and the one from the victim and to provide a means of reflection.

This filter is being implemented within the *FearNot!* demonstrator but, for the time being, the camera module has not been implemented yet and, thus, it has not been possible to test the results of our methodology.

If proved to be a successful proposal to increase empathy, the perspective filter could also include new parameters, such as the sound. For example, listening to heartbeats will induce panic or anxiety and using strong and aggressive tunes will emphasise angry actions (whereas a cheerful background tune will "lighten" the perspective).

5. Acknowledgements

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Designing a narrative-based educational game to model learners' motivational characteristics

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Abstract. Recent research points to the notion that motivation is a crucial factor when creating Intelligent Learning Environments (ILEs). Yet the research in motivation in tutoring systems has not considered relationship between features of ILEs and components of learners' motivational structure. This paper proposes to model motivational characteristics of learners while interacting with an ILE, particularly within the context of educational game and narrative. A preliminary model of motivation is presented and a framework for story creation is described along with a story design process that takes into account the issue of a player's empathy within a role-playing educational game.

Introduction

Learners' motivation is now regarded as a crucial aspect in developing an intelligent learning environment. The work by del Soldato & du Boulay [1] was foundational in that it dealt with motivational aspects of Intelligent Tutoring System (ITSs), in particular by including a motivational module which can perform motivational state modeling and motivational planning. de Vicente & Pain [2] also dealt explicitly with motivation in ITSs. They detailed an interesting approach to the detection of motivation and the outcome of their study was a set of 85 inferred motivational rules. However, the above research has not focused on how an ILE impacts on the learner's motivation.

In section 2, we present the aim of our research including our research questions. The proposed modeling technique is also explained briefly. Next, we discuss a possible connection between empathy and motivation. A framework for story creation is illustrated in section 4. We then continue with describing the process of designing the story and characters of the computer-based educational game aiming to teach Entity Relationship Modelling (ERM) concept. We outline the future steps of our research at the end of the paper.

1. Modelling the motivational characteristics in a narrative-based educational game

Since there are no explicit models of how learners are motivated while using an ILE, we have chosen to research the construction of a learner's motivational structure for an ILE in a particular context. The reason for which we need to specify a context when doing the modelling task is that a motivational structure for any intelligent instruction might not be the same in different contexts. Hence, our main research question upon which this paper is centred are: given a specific context for an ILE, can we determine a motivational structure for learners during their interaction? Can we make progress in determining the way this might change during the interaction?. We believe that such a model will be potentially of great benefit when creating tutoring systems that take into account the motivational aspects of the learners. We narrow down our attention to the narrative-based educational game context because from the literature, the association of motivation, educational game and narrative seems to be strong [3-4] and both combined together can have a strong impact on learners' intrinsic motivation [5].

We chose to investigate the relationship between the ILE features which we define as the basic elements that make up an ILE, and a learner's motivational characteristics which we define as motivational variables of the learners which can be placed into two categories: trait (permanent characteristics) and state (transient characteristics) (adopted from de Vicente & Pain' s motivation model [2]) because we believe that there is a strong relationship between them.

We propose to use the qualitative modeling technique to model the motivational characteristics of learners. The motivation for applying this technique stems from our consideration of motivation as a dynamic and complex system which is difficult to inspect. The qualitative approach can be used as a tool for dealing with such a system [6]. When creating a qualitative model in an ILE, there are some main characteristics needed to be identified such as the structure of the model, behaviour and dependencies & causality [7]. From the qualitative modeling approach, we take some important characteristics to apply to our research. An important characteristic which is our focus in this paper is a causal model that shows the cause – effect relationship between a learner's motivational characteristics and ILE features. This model is important in the process of creating a storyline for our educational game. The storyline should be developed consistently with the model structure. Our model is shown in Figure 1 and has been extended beyond that described in [8] by the inclusion of an empathy component to accommodate the presence of characters within the game.

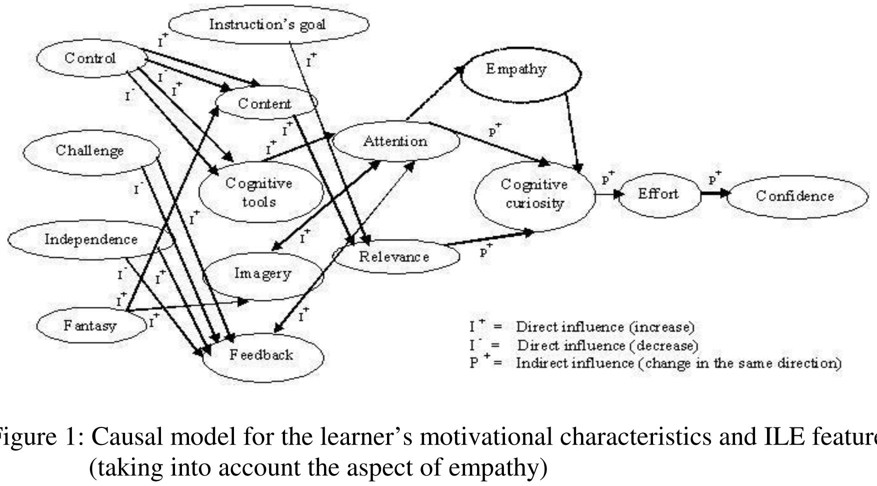

Figure 1: Causal model for the learner's motivational characteristics and ILE features (taking into account the aspect of empathy)

2. Possible connection between empathy and motivation

As stated in [9], the term "empathy" can be defined in a broad term as "An observer reacting emotionally because he perceives that another is experiencing or about to experience an emotion. The researchers also mention about the constructs of empathy in terms of its two different aspects: the mediation of empathy and the outcome of the empathic process. Concerning the mediation of empathy, there are two different ways of mediating: (1) via the situation (2) via emotional expressions. Empathy mediated via the situation means that the observer (the perceiving person) infers the emotional state of the target (the perceived person) from the situation the target is dealing with, whereas empathy mediated via emotional expressions will occur when the observer interprets the target's behaviour; for instance, if a target cries, an observer will assume that he/she is probably sad. These two ways of mediating can then affect the empathic process which may produce outcomes. These outcomes can be cognitive and/or affective. The cognitive outcome concerns cognitive activity of the observer such as obtaining more information about the target, etc., while the affective outcome refers to the observer experiencing an emotion because of his/her perception of the target.

Combined aspects of empathy mentioned in [9] and the definition of empathy as "a subject's state results from the attended perception of the object's state" appeared in [10], we speculate that there is a connection between empathy and motivation. In particular, we suspect that an 'empathy' state is associated with the 'attention' state and the 'cognitive curiosity' state in the model. A learner first gets attention mediated via the situation (an environment – role playing and a storyline). This will arouse the 'empathy' state of the learner which will then lead to the outcome of the empathic process, the cognitive arousal. The outcome of the cognitive arousal concerns cognitive activities; for instance, the player (learner) tries harder to overcome obstacles – this could be represented by the "effort state". If the player succeeds with his/her activity, he/she will gain confidence which will cause satisfaction – or motivation in learning. This connection could be represented in our causal model shown in Figure 1.

3. Defining a framework for story creation

We are applying the above model with the particular type of game, role-playing games (RPGs) which are computer games in which human players assume the characteristics of some person or creature type. RPGs have characteristics that support the new concept of narrative, emergent narrative which is the narrative generated by interaction between characters in the style of improvisational drama [11]. We consider that this kind of narrative can have a great impact on the learner's motivation; as shown in [12] the results from letting the subjects to play with a desktop virtual environment for improvisational dramatic role-play exercises, Ghostwriter were positive. The subjects were enthusiastic and remained focused on the task throughout the session.

The domain knowledge that we aim to teach is the Entity Relationship Modelling (ERM) concept. This domain is of our focus because the concept of ERM is complex for novices; they experience similar problems in: (1) identifying entity types, (2) distinguishing entities from attributes and so on. Because of its complex nature, this can negatively affect a learner's motivation in learning. Even though there are several support tools created to help students such as DBTool, ERM-VLE, COLER, KERMIT, none of them is developed in the form of an educational game. Hence, we think building the educational game aiming to teach this domain could attract students and increase their motivation in learning.

4. Story Design Process

4.1 Requirements

To create a game as a prototype for our experimental study, it is necessary to develop a story that consists of those five ILE features. These features should be designed to take into account the relevant motivational variables. In addition, the situation occurring in the game should assist the player to experience empathy so that the expected outcome – the cognitive one - will occur which leads to some cognitive activities. Furthermore, the behaviours of each character should be created in such a way that take into account the trait characteristics of each player; for example, the feedback given by a character involved in the game towards the player's action must be challenging for the player who loves high challenge. We consider that developing a character according to those characteristics could be regarded as using the idea of proximity as suggested by Barnett ([13], cited in [14]) that children are found to respond more empathically to those that are perceived as similar to the self than those who are perceived as dissimilar. Our aim is to demonstrate that creating the storyline including the characters according to the above characteristics will provide us some information about the model that shows the relationships between learners' motivational characteristics and ILE features which can be used to examine our preliminary model to see if it needs to be changed to make it more consistent.

4.2 Designing the premise of the story

When creating a story, the most important thing seems to be the designing of the central idea (premise) including its plotline. Also, the distribution of teaching points along the plotline should be carefully designed. A storyline for our prototype is already created which takes into account those aspects and the main theme invloves a Player Character (PC)[7] called Alex who tries to help a character called Emma recover from her serious illness by taking drugs prescribed by a cold-hearted doctor, Dr. Brian. Alex has to work with a few Non-Player Characters (NPC)[8] to earn money for buying drugs.

4.3 Mapping the story to the model

According to the model, there are five ILE features which we consider to have relationships with learners' motivation. These features are embedded in various forms of story elements as shown in Table 1.

Table 1: The ILE features and their represented elements in the story

ILE features	*Represented elements in the storyline*
Instruction's goal	Alex (PC) completes all tasks
Content	Tasks given by Dr. Brian (NPC)
Cognitive tool	A talking book

[7] Player character (PC) is a character in which human player assume the characteristics.
[8] Non – Player character (NPC) is a character proposed by the Game-master to perform some interactions with the character assumed by human player.

Imagery	Graphical elements in the game and sound effects
Feedback	Responses from Alan (NPC)

The instruction's goal refers to the specific goal of any particular instruction, in this case, our instruction's goal is to teach the concept of differences between entity type and attribute type. The feature 'content', we mean the domain knowledge aiming to be delivered to the learner in which the represented elements are tasks from Dr. Brian that Alex has to complete. The third ILE feature is 'cognitive tool' which we define as a tool created to aid the learner to learn the knowledge.This tool will appear in the form of a talking book. The talking book will appear after Alex finished the tasks to summarise the knowledge in an academic style. The next feature is 'imagery' which includes graphical elements and sound effects in the game. Feedback is the last ILE feature which can be defined as responses given back to the learner towards his/her action. The responses from Alan towards Alex's action represent this feature.

We also consider that these story elements should be designed not only to mapping with those ILE features, but also to offer the relevant motivational characteristics to the learner as shown in Table 2.

Table 2: The represented story elements of the ILE features and the relevant motivational characteristics

Relevant Traits	Represented elements in storyline	Relevant states			
		State I	**State II**	**State III**	**State IV**
-	Alex completes tasks	Relevance	Cognitive curiosity	Effort	Confidence
Control	Tasks given by Dr. Brian	Relevance	Cognitive curiosity	Effort	Confidence
	A talking book	Attention			
Challenge	Responses from Alan	Attention	Cognitive curiosity	Effort	Confidence
Independence	Responses from Alan	Attention	Cognitive curiosity	Effort	Confidence
Fantasy	Tasks given by Dr. Brian	Relevance	Cognitive curiosity	Effort	Confidence
	Graphical elements including sound effects	Attention			

There are four selected traits: control, challenge, independence and fantasy and two initial motivational states: relevance and attention that can lead to the three consecutive states: cognitive curiosity, effort and confidence. If these states occur accordingly, we believe that the learner is now motivated to learn.

The first trait which is of our interest is 'control' and the story elements designed to offer control are the tasks from Dr. Brian and the talking book. The player is given freedom in deciding which task he/she is going to start with including choosing to/not to listen to the summary from the talking book. By letting the player have control over these two elements, we expect the player's 'relevance' state and 'attention' state should be affected positively; this will then lead to the positive effect on the consecutive states that finally cause motivation. 'Challenge' is the next trait and the elements in the story that offer this variable are responses given by Alan towards Alex's action in doing the tasks. We believe the 'attention' state of the player will be affected positively if these responses are carefully designed. In addition, the responses from Alan are also designed to provide 'independence' for each player. The player is able to begin/end interaction with Alan at anytime; this is based on the assumption that each player is different in the level of the need to succeed by himself/herself. We believe that doing this will positively affect on the learner's 'attention' state. The last trait in the model is ' fantasy' and the elements that we design to offer fantasy to the player are the tasks the player has to complete and the other graphical elements including the sound effects. We believe that using the metaphor to represent the domain knowledge along with the use of graphical elements such as animation will allow the player to sense the fantasy characteristic in learning which can lead to the positive effect on the 'relevance' state and the 'attention' state of the player accordingly.

5. Future steps

The research presented in this paper is ongoing and future works include not only the development of the prototype, but also validation for the plausibility of the model. Currently, we are looking for the engine which can be employed to use with the game to predict the behaviour of a learner's motivation.

As part of the model validation, we plan to deploy our system with a group of students to estimate values of their motivation. The methodology used for capturing these values must take into account the problems of interrupting participants while they are working with the system as this might make it difficult to keep on track with what they are doing. Hence, we need to specify points at which we can easily interrupt the processes and use questions about the variables of interest to get some data for verifying our model in terms of the total model and the seperate components.

Assuming this model of motivation are validated, the potential of the design of narrative learning systems is to engage the learners in learning activities. More specifically, we believe that providing an insight into the mechanism that connects empathy to motivation will be of great benefit for not only the narrative community but also the ILE community in designing the tutoring systems that care about learner's motivation.

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Co-constructed Narratives in Online, Collaborative Mathematics Problem-Solving

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Abstract. Our approach to the study of learning of mathematical problem-solving extends the notion of narrative learning environments to include the dynamics of collaborative dialogs and related emergent narratives. This perspective favours the conception of the dialogical aspects of interaction as shared achievements of co-participants and as central meaning-making procedures, based on our qualitative analysis of transcripts from online collaborative math problem-solving interactions. From these observations we attempt to establish a link between narrative learning environments and dialogical perspectives and explore relevant implications for the design of the Virtual Math Teams collaborative learning environment.

Introduction

Research in the field of Narrative Learning Environments (NLEs) is concerned with questions such as how to characterize the contribution of narratives and narration to learning, and how to use knowledge of narratives to design learning environments. As part of the Virtual Math Teams research project (mathforum.org/wiki/VMT/), we have investigated talk-in interaction within the context of online collaborative mathematical problem solving and have found similarities between the narrative approach and a dialogical perspective on sense-making and interaction. Therefore, we propose to extend the idea of NLEs to encompass collaborative learning environments which, in addition to using narrative structures, also offer the possibility of joint participation and interaction with a diverse set of linguistic and extra-linguistic objects (e.g. mathematical objects and their derivative properties).

1. Narrative Learning Environments (NLE)

Research and development on NLEs explores intelligent learning environments where "narrative is approached and applied" to support learning and the construction of meaning [1]. As such, NLEs build and extend the long held interest in AI for the structuring power that narratives and narration exert on cognition (e.g. [2], [3]). A narrative learning environment is expected to promote three main kinds of activities for learners: ***co-construction*** (the ability to participate in the construction of a narrative), ***exploration*** (engagement in active exploration of the learning tasks, following a narrative approach and trying to understand and reason about an environment and its elements), and ***reflection*** (consequent analysis of what happened within the learning session). To date, research on

NLEs has concentrated on the analysis and use of narrative elements such as virtual storytelling, interactive drama, and participatory narratives, mostly within the context of literacy development and language learning (e.g. [4]) and the exploration of points of intersection between AI, educational technologies and narratology. Generally, this approach treats narrative as an object and a fixed structure of interaction.

2. The Dialogical Perspective on Learning

The *dialogical* perspective pursues meaning-making as an interactional achievement of co-participants, rather than as a fixed property of linguistic objects. Theorists of the dialogical aspect of language and meaning (e.g. Bakhtin [5,6,7], Harré [8], Sacks [9], Schegloff [10]) point to the features of talk as action, and of shared action in itself, as core processes of human meaning-making. These socially shared procedures might point to general sense-making strategies with applicability to particular domains (e.g. fictional storytelling, or math problem solving).

As Wegerif stresses [11], the dialogical perspective on learning attempts to access the creative space of "the interanimation of more than one perspective" that emerges in the dynamics of interactive narratives and collaborative meaning-making. What is common to both narration and collaborative dialogues is *the discourse*; the emergent coherence of the sequencing, projection and referencing of utterances generated within meaning making shared with others and with meaningful artefacts [14]. As such, narration and dialogues as interactive events open up opportunities for participants to engage in *co-construction* of possible worlds, to *explore* them in dialogue, and to *reflect* together on the experience. Participation and engagement are then central to the learning processes conceived as a socio-cultural practice [12], speech and interaction being extremely important mediators in this process. Furthermore, as Vygotsky states in his concept of the Zone of Proximal Development [13], children's potential learning abilities are especially accessible within their interactions with others, a fact that adds practical and theoretical support to the use of collaborative learning.

Participatory or interactive narratives offer opportunities for co-construction of meaning precisely based on the dialogic principle of interactivity resulting on an intermix of classical narrative structures and other frameworks of shared participation, a point we seek to illustrate within the domain of collaborative mathematical problem solving. In summary, we propose to connect narrative learning environments and collaborative learning environments by virtue of their common concern for the role of discourse and interaction in learning and its potential support via designed artefacts.

3. Collaborative Math Problem-solving: Co-construction, exploration and reflection

The Virtual Math Teams (VMT) research program investigates the innovative use of online collaborative environments to support effective K-12 mathematics learning as part of the research and development activities of the Math Forum (mathforum.org) at Drexel University. VMT extends the Math Forum's "Problem of the Week (PoW)" service by bringing together groups of 3 to 5 students in grades 6th to 11th to collaborate online in discussing and solving non-routine mathematical problems. Currently, participants interact using a computer-supported collaborative learning environment which combines quasi-synchronous text-based communication (e.g. chat) and a shared whiteboard among other interaction tools. At the core of VMT research is the premise that primarily, group knowledge arises in discourse and is preserved in linguistic artifacts whose meaning is co-

constructed within group processes ([15]). Key issues addressed by the VMT include the design challenge of structuring the online collaborative experience in a meaningful and engaging way, and the methodological challenge of finding appropriate methodological approaches to study the forms of collaboration and reasoning that take place.

3.1. Data sources and Methodology

As part of the initial exploratory phase of research, the VMT offered more than 20, one to one and a half hour online sessions in which small groups of students used AOL Instant Messenger© technologies to interact and collaboratively attempt to solve a mathematical problem provided. Through these events we have collected a corpus of chat transcripts that constitute our main source of data. The VMT implements a multidisciplinary approach to the analysis of these transcripts, which integrates quantitative modelling of students' interactions as well as ethnographic and conversation analytical studies of collaborative problem solving. A coding scheme has been developed for the quantitative analysis of the sequential organization of postings recorded in a chat log. This coding scheme includes nine content and threading dimensions (e.g. conversation, problem-solving content and threads) of each chat line (see [16] and [17] for further discussion). The analysis presented here represents an example of the complementary ethnographic analysis of these same data.

Several researchers have explored the interdependencies between discourse, narratives, and mathematics in general (Cocking & Chipman [18]) as well as the role of narratives in mathematics learning (Burton, [19],[20]). Our qualitative analysis of collaborative mathematical problem-solving, based on the conversation analysis (e.g. [9],[10]), seeks to understand the methods that co-participants use to organize their shared interactions. The object of inquiry in conversation analysis (CA) is not exclusively conversation as a linguistic entity, but rather talk and social interaction. The interest of CA is "with the local production of [social] order and with 'members' methods' for doing so" ([21], p.19). Using the methods of CA, our analysis of transcripts of online collaborative problem-solving revealed, in particular instances, narrative elements—e.g. the emergence of a narrator and a narratee as well as structured sequences of events, that participants oriented to in their collaborative production of problem solutions.

3.2. Emergent Narrative Elements from Shared Participation.

The following analysis illustrates the ideas proposed by using data from one of the online transcripts of a VMT collaborative problem-solving session. The session presented here has three main participants, SKI, YAG and GOH. "*Press for Time*" is the problem assigned for the session:

> *The Rational Reader, a popular daily newspaper, has to be printed by 5 a.m. so that it can be distributed. Late one night, a major story broke and the front page had to be rewritten, which delayed the start of the printing process until 3 a.m. To try to get the printing done on time, the Reader used both their new printing press and their old one. The new press is three times as fast as the old one, and with both of them running, the printing was finished exactly on time. How long does it take to print a normal edition of the paper using only the new press?*

From the transcript we can infer that, at least two of the participants (SKI and YAG) had worked on the problem prior to their joint participation in the online collaborative session and, as a result, the group members orient themselves to an "expository" mode of interaction in which reports of "ways" to solve the problem are offered in the form of story-like narrations. The process of narrating, the constituting of narrator and narratee voices as well as the resulting narrative, however, are to be considered as an interactional achievement of all the participants. On the other hand, an interactive narrative within the speech genre of mathematics problem solving (in the Bakhtinian sense [7]), has specific characteristics that govern the space of possible transformations of the different "events" of the narrative being produced. The following excerpts allow us to illustrate these ideas:

1.	7:26:10	SKI	i started and solved with a system
2.	7:26:12	SKI	of equations
3.	7:26:14	YAG	let SKI explain...
4.	7:26:24	SKI	lets just say x is the time for the old machine and y is for the new
5.	7:26:29	GOH	ok
6.	7:26:35	SKI	our first equation is like this
7.	7:26:41	SKI	if we atke the recip of x
8.	7:26:45	YAG	*choughSHOWOFFchough*
9.	7:26:55	YAG	:P
10.	7:26:57	YAG	:-D
11.	7:26:59	SKI	thats how much of the job the old one does in one hour
12.	7:27:02	YAG	yep
13.	7:27:12	SKI	and the reciprocal of y is how much of the job the new one does in one hour
14.	7:27:16	YAG	recip [of] y is the new one
15.	7:27:24	SKI	ok
16.	7:27:29	SKI	recip=reciprocal
17.	7:27:33	SKI	anyways
18.	7:27:38	YAG	and, recip y+ recip x = 1/2
19.	7:27:43	SKI	we add 1/x and 1/y
20.	7:27:48	SKI	ya
21.	7:27:50	SKI	what YAG said
22.	7:27:53	SKI	1/2
23.	7:27:56	YAG	in hours and fraction of work
24.	7:28:04	YAG	needed to be done
25.	7:28:05	SKI	cuz they together get half the job done in one hour
26.	7:28:09	YAG	:P
27.	7:28:13	SKI	are u getting our first equation?
...			
57.	7:29:38	GOH	how come 1/x and 1/y added equal 1/2?
58.	7:29:42	SKI	ok
59.	7:29:47	YAG	ummm
60.	7:29:50	YAG	pure luck!
61.	7:29:51	SKI	1/x is how much the old one does in one hour
62.	7:29:57	GOH	right.
63.	7:29:58	SKI	how much of the job it does in an hour
64.	7:30:01	YAG	(frac of job done)
65.	7:30:03	SKI	1/y is for the new machine
66.	7:30:08	GOH	right
67.	7:30:11	SKI	add those up
68.	7:30:18	YAG	and since they do it together at 3-5
69.	7:30:20	SKI	thats how much of the job they do together in one hour
70.	7:30:22	YAG	it took 2 hrs
71.	7:30:25	SKI	ya
72.	7:30:29	SKI	listen to [YAG]
...			
84.	7:31:06	SKI	the whole job took 2 hours
85.	7:31:14	YAG	with both machines
86.	7:31:19	SKI	so in one hour they did 1/2 of the job
87.	7:31:34	YAG	and in the 2nd hour they did the other half
88.	7:31:54	GOH	Okay, I got it. 1/2 is how much of the job they do together in one hour
89.	7:31:58	SKI	rite
90.	7:32:00	YAG	yepyepyep
91.	7:32:06	SKI	u know what x and y represent rite?
...			

As can be seen in these excerpts, even in this "expository" orientation, co-participants take active roles in co-constructing the explanation. Even though SKI initiates his story-like report with the form of a first person narrative ("*i started and solved with a system of equations*"*)*, the shared narrative space of this interaction is constituted with YAG and GOH's uptake of SKI's narrator voice (lines 3 and 5) and their subsequent participation. SKI's narration seems to shift to the first person plural (*"our first equation is like this"*) and subsequently we can observe how SKI and YAG share the narrator role by completing each other postings or interjecting new ones (e.g. lines 23 and 25). SKI and YAG have, at this point, constituted themselves as a recognizable collectivity (Lerner [22]) oriented towards the task of producing an intelligible narrative explanation for GOH (e.g. line 27).

On the other hand, by virtue of the interactional nature of the conversation being produced, GOH is by no means restricted to a passive audience role. One of the interesting peculiarities of our attempt to intersect the framework of narratology and the domain of collaborative mathematical problem-solving, results in a unique instantiation of the idea of "possible worlds." The complex world of linguistic and mathematical objects which SKI, YAG and GOH both access and co-construct (e.g. the proposition "*The new press is three times as fast as the old one*" included in the problem statement, and SKI's posting "*the reciprocal of y is how much of the job the new one does in one hour*), their individual perspectives, and the transformations that they exert on such objects (e.g. SKI use of "cuz" - *because* - on line 25) are governed not by strict logical laws (as is sometimes assumed in narrative semantics) but by the local sense-making procedures of the co-participants and their orientation to joint-activity. For, instance, SKI in line 27 asks GOH for an assessment of her state of participation, and GOH eventually (line 57) requests that the co-constructed narrative be reoriented towards a further sense-making on the mathematical and narrative objects so far established (e.g. 1/x, "*the old one,*" "*how much of the job they do together in one hour," etc.*).

In addition to the co-construction of the narrative explanation in itself, the dialogical orientation opens the space for the exploration of possibilities of the local world of mathematical objects and, what is perhaps even more interesting as far as learning is concerned, to anticipate the intelligibility of the co-constructed narrative. In line 91, SKI's question to GOH seems to represent, both an orientation towards a prerequisite for the intelligibility of the mathematical narrative being produced, as well as an anticipation of a potential problem of understanding. It is in these instances of dialogical interaction where we are able to observe the power of what Feurenstein [23], elaborating on Vygotsky, has characterized as "mediated learning experiences:" interactions through which co-participants place themselves between each other and the world, and co-construct the meaning of their joint activity (i.e. verbal or otherwise). In mediation, stimuli and responses are selected, changed, amplified and interpreted in complex ways that represent a "type of organization (which) is basic to all higher psychological processes" ([13], p. 40). Needless to say this role is also shared among co-participants.

Although we have referred to this context as collaborative problem solving, it might appear that the work being done is closer to an "explanation" than to co-construction of knowledge. Yet, the participants, perhaps influenced by the very nature of dialogic interactions, make such explanations interactive and participatory for all members of the group. The outcome of this approach is that there is a constant interchange between first person singular and third person plural narration, and a consequent change in agency and authorship embedded within certain mathematical objects: "my way" (e.g "*I started and solved with a system of equations")* contrasted to "your way" (e.g. "*YAG its kinda hard to understand ur way*"), and sometimes becoming "our way" (e.g. *"so 8 hours is 480 minute[s], divide by 3, to get 160 minutes our answer!!!!"*). Of central interest to our analysis are the methods used by co-participants to orient themselves to certain forms of participation that guide them in their collaborative sense making. The use of the "expository" mode of interaction here differs slightly from Mercer's [24] conception of the three kinds of inter-subjective talk: *disputational*, *cumulative*, and *exploratory*. In Mercer's framework, *disputational* talk is characterized by the speakers being concerned with defending their own selves, at the possible expense of any attempt at a solution . In *cumulative* talk, each speaker seeks to support the other's self but fails to explore facts and solutions. *Exploratory* talk, according to Mercer occurs when speakers "engage critically but constructively with each other's ideas" (p.98). For a more complete analysis of the two main "participation frameworks" identified in VMT research see [16]. Although one could argue that the structure of the task itself (a word or "story" problem) might contribute to the emergence of narrative elements in the dialogical interactions among participants, similar phenomena has been observed on geometry and other non-word problems.

4. Implications for design, future research.

The analysis presented in the previous section illustrates how certain narrative structures may emerge from the dialogical interactions and the ways participants orient themselves to their shared sense-making during mathematical problem-solving. Although we have presented a single in-depth case, we seek to identify a diverse array of patterns of participation, through discourse and conversation analysis in parallel with statistical natural language processing techniques (e.g. [25], [17]), with the goal of informing the design of the appropriate learning supports for online, collaborative math problem-solving. Engagement, participation, and ultimately, learning might be emergent aspects of distributed activity systems that offer rich opportunities for the learners to construct meaning through language and interaction in true dialogical contexts. Further research and development is necessary to integrate, in the design of future learning environment, theories of sense-making that account for the narrative and dialogical aspects of individual, small-group and community interactions. Additional text processing is envisioned, such as automated narrative summarization and intelligent indexing with the specific intent of facilitating the re-usability of collaborative problem-solving dialogs for specific learning purposes, including the potential support for an online community of math problem-solvers represented as a "narrative of dialogues".

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Adventure Author: An Authoring Tool for 3D Virtual Reality Story Construction

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Abstract. This paper describes an approach to supporting the development of children's storymaking skills using an interactive story authoring tool called Adventure Author. This software enables 10-14 year old children to create interactive stories in a 3D computer game medium in which their peers can participate. Results from an initial evaluation of Adventure Author provided support for this approach, and suggested avenues for further development.

1. Introduction

Although many children find that writing is a difficult and unpleasant chore, most teachers regard it as a key format for creative self-expression. Youth with writing difficulties often experience a spillover effect into other areas, in the sense that "literacy is at the heart of the academic enterprise, and students who have trouble with literacy learning are usually consigned to the lower half of the academic achievement range, to slower groups and lower tracks" ([1] p. 4). This is unfortunate, as recent research shows that some children do not necessarily suffer from a lack of creative and imaginative ideas for stories, but rather their difficulties with writing prevent them from realizing these ideas [2]. Their difficulties may be both motivational, for example, a "fear of the blank page" or worries about teachers' expectations, and intellectual, for example, concern about the form of the story to the detriment of the content. Finally, some children may have problems in using text to express ideas, such dyslexia or an incomplete mastery of English.

In order to address some of these difficulties, we have developed *Adventure Author*, an environment which allows children to create 3D virtual reality interactive stories which can then be played by other children. In so doing, we aim to take advantage of the motivating effect of computer games ([3], [4], [5]), but, more importantly, to allow children to experiment with an innovative means for literary self-expression: interactive storytelling using multiple forms of media.

Toolkits for creating 3D virtual reality interactive story-based games are available in some commercial games (such *as Neverwinter Nights*), although they tend to focus more on combat than on finely-crafted narrative. Furthermore, although previous research has shown that children really enjoy using such toolkits, and are often able to create quite sophisticated games [6] these tools are not built from an educational perspective, and cannot provide the educational scaffolding needed to support children as they experiment with this new, and often complex, form of narrative.

By combining a commercial games engine, *Unreal Tournament 2003*, with a purpose built story creation interface, we have been able to develop a novel environment for children aged 10-14 in which they can create an interactive story, which is then realized in a 3D virtual reality game, playable by the child's friends. The non-deterministic nature of the story means that it can be played more than once in order to experience different encounters within the game world, and different outcomes. Results of a preliminary evaluation suggest that this approach is both motivating for children, and has educational promise.

The rest of the paper is structured as follows: Section 0 briefly describes the technologies used in Adventure Author, while Section 0 provides an overview of the interface, including typical interactions. Section 0 describes a preliminary evaluation carried out with Adventure Author and the paper is concluded in Section 5.

2. Adventure Author system architecture

The Adventure Author system is composed of two primary components: 1) an authoring interface which enables authors to specify an interactive story, and 2) a game engine in which the story specification is rendered. The authoring interface is implemented in Java, and the game engine used in the current prototype is Unreal Tournament 2003 (UT2003). The Java diagramming library JGraph is used for creating visual representations of the story structure. Story specifications created in the authoring tool are stored in an XML format which mirrors the Java data structures used to represent the story. When a story is saved, the XML format is automatically generated from the Java objects using the Castor data binding framework. The advantage of storing the story specification in XML format is that it separates the authoring tool implementation from any particular game platform, enabling us to explore different game technologies in the future. For example, there is a version of Adventure Author which can be used to create text-based game worlds [7], and various prototypes based on different members of the Unreal game engine family (Unreal Tournament, Deus Ex and Unreal 2). It was decided that UT2003 was the most suitable for this version of the prototype because it includes many evocative landscapes which are suitable for storytelling, and it was capable of rendering our custom 3D game characters at a high level of detail.

Integration between the authoring tool and the game engine is achieved through TCP/IP socket communication based on the Gamebots API. Gamebots is a library for integrating Java applications with the Unreal Tournament game engine developed at the University of Southern California. One of the aims of the Gamebots project is to use Unreal Tournament as a platform for artificial intelligence research. Specifically, it was designed to facilitate research into agent architectures suitable for controlling the behaviour of non- player characters (NPCs) or "bots". However, in this project it was adapted for the purpose of communicating between the authoring interface and the game world. It was also updated for use with UT2003.

The interface and content of UT2003 was adapted for the needs of the target user group in an educational context. The game interface was modified to remove inappropriate content, such as the weapons controls and enemy spawn points, and custom tools for authoring within the game world were added. A menu system for in-game conversations was introduced and care was taken that the fonts were legible for less confident readers. A set of five UT2003 game levels (including an ancient Egyptian setting, a snowy landscape and an enchanted forest) were chosen for use in the prototype because they were visually appealing and atmospheric. As UT2003 has a limited set of 3D character models which are inappropriate for story making tasks, we worked with a 3D artist to create a new library of twelve animated human characters which would form a suitable cast for children's stories. These models were created in 3D Studio Max and converted into UT2003 format.

3. Adventure Author interface, game environment and typical interactions

From the interface perspective, Adventure Author consists of two main components: 1) a tool for specifying an interactive story, and 2) a tool for interacting with the story within a 3D game world. The interface for specifying the story structure was integrated with an existing commercial 3D game engine (Unreal Tournament 2003) so that the users could create game worlds with graphics of a similar standard to the commercial games with which many of the users are familiar. Indeed, research suggests that the effectiveness of educational environments may be seriously compromised by a less than commercial look and feel [8].

When specifying an interactive story, a child author uses the interface shown in 1. An overview of the story structure is displayed on the left as a directed acyclic graph. A story consists of a series of *scenes*. A scene can be thought of as a plot episode within a story, and takes place at a game *location*. Scenes are represented as nodes in the graph, with a picture of the location at which the scene takes place drawn within the node. A scene can comprise an overall scene *description* (in the form of text which the player will see upon entering the scene), one of the story *characters* (shown at the bottom left of Figure 1), and quite often an interactive *conversation* between the player and a non-player character (see Figure 1 right hand side). Scenes may also contain plot related *items* (such as a magic book), a feature which is not yet fully implemented. Each story has one start scene, denoted in green.

Stories in Adventure Author have a branching structure, with many possible paths through the story, each having a different outcome. Branching is achieved through interactive dialogue. The author writes alternative conversation choices for the player and specifies which scene in the story should follow each choice. When a user plays through the finished story, she is presented with these alternative conversation choices, which in turn determine the scene which subsequently unfolds.

From a representational perspective, the possible paths in the story are represented by the edges in the graph. Red coloured nodes represent end scenes in the story.

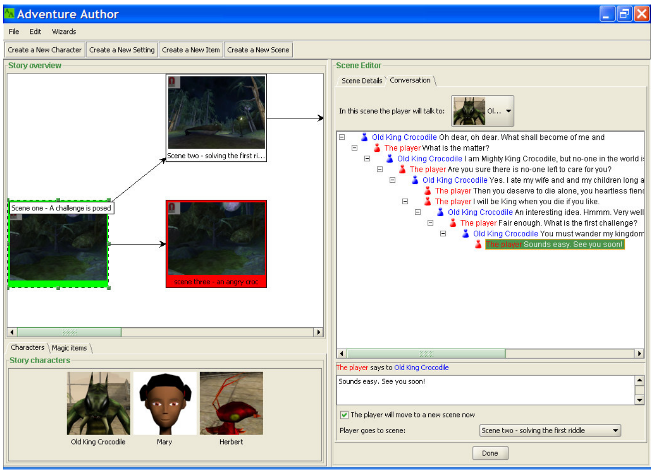

Figure 1. The Adventure Author authoring interface

Figure 2. The Adventure Author game interface

When authoring a story, the user can opt to use a series of wizards to help her to create new characters, locations and scenes for her story. Once she has created more than one scene, she can link the scenes together by writing an interactive conversation.

At any time she can choose to test what her story looks like in the game world. When an author presses the "test scene" button, the authoring tool starts the game level specified in the scene location running on a UT2003 game server on the local host. It then connects to the game server and populates the level with the NPCs and items which are specified for that scene. If the author has previously tested this scene, the NPCs and items will be created in the positions that the author assigned in the previous test. If the scene has not yet been tested, the NPCs and items are spawned close to the player start location. The inventory interface to the game is configured for editing mode, for example the author's inventory will contain the magnet tool which enables her to set the position of the NPCs in the scene. Finally, the game interface is displayed so that the author can interact with the game world.

Figure 2 illustrates the game interface as it will look when the author tests her story. The interface has a first person view – the character controlled by the author is not visible. The character seen in Figure 2 is an NPC. When an author initially tests a scene, the NPC and items for that scene are placed at the starting point for the game location. The author can explore the game environment to decide on suitable locations for events within that scene. Once she has decided where the player should meet the NPC for the scene, she can use the magnet tool (shown in the top left-hand corner) to guide the NPC to that spot. This is achieved by pressing "m" on the keyboard, which causes the NPC to follow the author until the same key is pressed again. Once the magnet has been deactivated, the game sends a message via socket communication to the authoring tool indicating that the co-ordinates for the new location of that character. If the author wishes to change the location of an item, she can pick up the item (by walking over it), carry it to the desired location and then drop it (by pressing the "d" key). A message is sent via socket communication to the authoring tool to update the location of that item in the scene. The next time the game is played the NPC will start in that location. The author can also test out conversations with the NPC by walking up to them, and pressing "t" to activate talk mode. A menu appears with the NPC's first utterance and the choice of responses. The author clicks on the response which she wants to test, which causes the NPC response to that choice to be displayed, and so on. The author can quit the conversation by pressing the escape key at any time. The author can also check that scene transitions work correctly from leaf nodes of the conversation, thereby ensuring that dialogue choices lead to the correct scenes.

Once the author is happy with her story, she can invite a friend to play it. The friend, in the role of player, interacts with the story in the 3D game world. This is technically accomplished in the same fashion as testing a single scene, except that the first scene is always started, and the inventory is not configured for edit mode The player's view will be similar to that shown in Figure 2, apart from the fact that the magnet will not be visible. The player can converse with the NPCs he encounters in the environment, and his conversational choices will cause him to follow one of the paths through the story which was specified by the author. Eventually he will reach an end scene, where he can opt to play the story again. Given that the interactive dialogue in the story has a branching structure, playing the story again has the potential to lead to a completely different experience.

In the current implementation of Adventure Author, the player's interactions in the game world take place primarily through selecting dialogue options. Interaction possibilities will be extended in future versions of the software, for example by enabling the player to use magical objects. However, given our interest in the use of Adventure Author to foster children's narrative development, we decided to focus on developing a clear representation for interactive conversations in the first instance.

The conversation structure is represented in a tree format. Conversational turns between the non-player character and the player are denoted in alternating colours.

4. Adventure Author initial evaluation

By designing and developing Adventure Author, we have built an environment in which children can create interactive stories which take the form of a game that can be played by others. Our aim in doing so is to provide children with a motivating environment in which to learn about and practice narrative skills such as: how to create a plausible character? How to develop a typical plot structure (introduction, conflict, conflict resolution)? How to create multiple plot structures, each of which is coherent, and allows the player to have different story experiences? How can media elements such as scenery and sound effects be used to create a particular mood? Our overall goal is two-fold: 1) to offer a motivating environment for learning about and practicing narrative skills, and 2) to foster narrative skills which will transfer into other forms of narrative.

Our initial investigations have focused on the first aim, looking specifically at two questions: firstly, are children motivated by using Adventure Author, and secondly, do experts in related fields (learning, education, games and media) see the educational value in Adventure Author (and have suggestions for improvement)? The next stage of evaluation will be to conduct a longitudinal study which looks at how children's narrative skills develop over the course of a semester, and whether transfer effects can be observed, in other words, whether these skills translate into improved narrative skills in other venues.

Below, we describe an initial evaluation of the Adventure Author prototype which was recently carried out by NESTA Futurelab, the project funders. Eleven participants were invited by the funding body to try out the prototype and discuss how it could be further developed. Six of the participants were adults (two female and four male), with expertise in relevant domains. The adults defined their expertise as "Teacher trainer:

English" (1); "Researcher: media and community artist" (1); "Programmer" (2); "Learning researcher" (1) and "Games and screen media expert" (1). Of the five young participants (aged between 11 and 14 years old), one was female and four were male. The young people had been recommended to NESTA Futurelab as being interested in storytelling, English and games.

A Futurelab researcher introduced the session, and demonstrated the software with an example story provided by the designers. The participants then used the software for two hours. Four of the young people worked in pairs, with adult assistance when necessary. One young person worked in a team with adults. Participants then played each other's games, completed a written questionnaire and took part in a group discussion chaired by the Futurelab researcher. The participants were asked to describe their likes and dislikes of the game, and to identify any problems they experienced with the software and suggest improvements for the Adventure Author designers, described in turn below.

This formative evaluation of Adventure Author suggests that children do find it motivating to use, and are quite positive about the experience. The young people enjoyed the opportunity to create their own stories in game format - they had authorial control over this new technology. As one child wrote, "It's a fun way to use your imagination. You're the leader and in control. You make your own game and story, it's yours." In the discussion session, another child mentioned that he had previously tried to make his own game "from scratch" but he had found this complicated. He said that designing the game with Adventure Author was easier, particularly for creating conversations. One of the other participants noted that it was "satisfying to see your story in action", a point of view shared by a younger participant, who added, "It's like being a movie director". There were also positive comments about setting stories in a 3D world (e.g. "The use of a game engine makes the story look really good").

The educational aspects of Adventure Author were addressed by the adults in the study, for example, the media and community artist, who noted, "I like the concept - involving 10-12 year olds to think about both game structures and different possibilities for branching narratives". Many of the adults specifically mentioned the types of narrative skill we would like to foster, namely, "creating dialogue", "thinking up multiple plot lines", "the potential to build a multi-linear narrative", and "trying to link character and situation". They felt that Adventure Author scaffolded these skills in various ways, for example, "The dialogue editor is good in that it makes it very easy to create very involved dialogues", and, "Displaying the 'storyline' as a graph is very helpful". In addition to these comments, all participants made a number of suggestions for improvement, many of which will be incorporated into future versions of Adventure Author.

5. Conclusions

This paper described Adventure Author, an interactive story authoring tool which enables children to make stories in the medium of a 3D computer game. Using the tool, children can create any number of stories of a narrative complexity which is limited only by their imaginations. The commercial quality of the game produced is a motivating factor, as is the possibility for others to play the game, and even to play it repeatedly, given that the outcome of the game depends in part on the player's actions. A formative evaluation of Adventure Author suggests that participants found it to be motivating. Young users appreciated the opportunity to author a story in a game world.

The adult members of the evaluation team felt that many of the features of Adventure Author supported the educational aim of scaffolding children's narrative development.

Future research will focus more specifically on how Adventure Author can be used to foster narrative skills over time, and the extent to which these newly developed narrative skills can transfer to other forms of narrative.

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