

Motivation in Narrative-Centered Learning Environments

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Abstract. Narrative-centered learning environments hold much promise for education and training. Much of the appeal of narrative-centered learning lies in the belief that narrative context provides a meaningful structure integrating pedagogical objectives into a unifying, coherent form that serves as a powerful motivating force for students. This paper explores the relationship between narrative-centered learning and student motivation. Connections are drawn between motivational factors and narrative context through an examination of the CRYSTAL ISLAND narrative-centered learning environment. Drawing on the results from focus group studies of middle school students interacting with CRYSTAL ISLAND, we consider the hypothesis that narrative can simultaneously promote learning and increase students' motivation.

1. Introduction

Narrative pervades human cognition. Stories provide a compelling, natural, and causal structure through which humans model experiences for communication and learning. This natural relationship contributes to the emergence of work focused on narrative generation [8, 19] and interactive narrative [11, 29, 36] with a variety of applications in education [1, 21], training [12, 28, 30, 34], and entertainment [4, 17]. Because of the motivational aspects of narrative, it is believed that story-based learning can be both engaging and effective. Consequently, narrative learning environments have been created for a variety of purposes, such as facilitating story creation [16], social behavior education for bullying [26], language and culture learning [7], interactive health education [15], and microbiology education [23].

Narrative is especially well suited to alternative learning paradigms such as guided discovery learning. It is growing apparent that narrative is a potentially effective tool for exploring the structure and process of "meaning making," as evidenced by psychologists adopting techniques from narrative analysis [3]. One can imagine narrative-centered curricula that leverage students' inherent meta-cognitive apparatus for understanding and crafting stories, an insight that has led educators to recognize the potential of contextualizing all learning within narrative [35] in contrast to more didactic approaches. Narrative-centered learning environments may offer motivational benefits over traditional learning experiences. Student motivation is critical in educational environments; software that fails to engage its audience will often go unused.

This paper explores the relationship between motivation and narrative. After discussing key concepts of motivation, we introduce CRYSTAL ISLAND, a narrative-

centered learning environment testbed in the domain of microbiology and genetics. We explore the components of intrinsic motivation and draw ties to narrative-centered learning and ongoing developments in CRYSTAL ISLAND. We then discuss implications from focus group studies (both with individual and group formats) with middle school students using CRYSTAL ISLAND.

2. Motivation

Motivation is a powerful force; it drives humans to act [33]. There are two types of motivation that have been studied extensively, extrinsic and intrinsic motivation. *Extrinsic motivation* refers to engaging in a behavior because of external influences such as tangible rewards or pressures [31]. Extrinsic motivation does not stem from one's internal interests. Instead, extrinsically motivated behavior can often be attributed to acting for the reward of pleasure or security manifested by something other than the task itself. *Intrinsic motivation* refers to engaging in a behavior because it is inherently interesting [13, 14, 31]. The behavior is undertaken solely for the challenge it poses, the enjoyment it yields, or the curiosity it satisfies; the act has some internal utility. Intrinsic motivation is favored because it has been associated with quality learning and creativity [31]. Further, it is believed that pedagogy that cultivates interest in a subject matter is more likely to lead to self-initiated learning beyond instructional experiences [2].

Malone and Lepper's taxonomy of intrinsic motivations [14] consists of both individual and interpersonal factors. We focus on the four individual intrinsic motivators: challenge, control, curiosity, and fantasy.

- *Challenge*. Tasks that are too easy or impossibly difficult will foster little or no intrinsic interest and may lead to student boredom or frustration, respectively. Designing optimally challenging tasks will maximize student motivation.
- *Curiosity*. Student interest can be maintained by controlling for an optimal level of discrepancy between the student's current knowledge and skills and the expected knowledge and skills following engagement in particular activities.
- *Control*. Humans have a basic tendency to want to have a hand in their own fate. Providing mechanisms that allow students to manipulate the learning experience results in a sense of power and choice.
- *Fantasy*. Playing to students' abilities to develop mental models of situations that are not present contributes to motivation. Fantasies can evoke each of the other intrinsic motivators in ways that otherwise are unavailable to the student in reality.

It has been determined that supporting the perception of student autonomy and devising tasks with optimal challenge levels is critical in student motivation [10]. Computational models of narrative may serve as the basis for narrative-centered learning that supports student autonomy with optimal task levels. The next section presents a prototype narrative learning environment being developed for science learning. This is followed by a discussion of how each intrinsic motivator can be utilized to promote learning and motivation.



Figure 1: CRYSTAL ISLAND.

3. Crystal Island

We are exploring issues of motivation in a prototype narrative-centered learning environment, CRYSTAL ISLAND [24] (Figure 1). The environment serves as a testbed for inquiry-based learning in the domains of microbiology and genetics for middle school students. CRYSTAL ISLAND's narrative takes place at a research outpost situated on a previously unexplored volcanic island. The student is cast as a visitor to the island and the child of the lead scientist. The narrative unfolds as members of the research team begin to fall ill, leaving the student to solve a developing science mystery, thereby saving the expedition. The student progresses by analyzing the genetic makeup of chickens responsible for transmitting an unidentified infectious disease through their eggs. In doing so, the student is free to explore and interact with the world, its objects, and other characters. Throughout this process, the structure of the developing narrative is characterized by the inquiry-based learning activities of question development, hypothesis generation, data collection, and hypothesis testing. To solve the mystery the student must navigate the island, which includes the lead scientist's house, the laboratory, the infirmary, the dining hall, and the men and women's living quarters; manipulate objects, such as eggs, food, books, and mechanical devices; and interact with other research team members to gather relevant information. Ultimately, the student must deduce the breed of the chicken that is responsible for the epidemic, and solve the mystery.

The CRYSTAL ISLAND world, interface, and semi-autonomous characters were implemented with Valve Software's Source™ engine, the 3D game platform developed

for Half-Life2. CRYSTAL ISLAND's narrative planning is performed by a Hierarchical Task Network (HTN) planner based upon the SHOP2 planning system [25]. Method and operator libraries for both the genetics and microbiology domains are under development, as is a decision-theoretic "director" agent based on the U-DIRECTOR architecture [22], which guides narrative and pedagogical progress when confronted by uncertain user actions [23].

Consider a "typical" interaction with the CRYSTAL ISLAND environment: a student navigates the world for a period of time, interacting with characters, gradually gathering information about infectious diseases and related topics. As members of the research team fall ill, the accumulated information allows the student to conclude that an infectious disease is the culprit. After learning this concept, an interaction with the nurse suggests that the island's eggs may be responsible for the spreading illness. If the student can deduce which chickens are responsible for the infected eggs, the mystery may be solved. The student interacts with several of the remaining healthy research team members to learn the relationships between the eggs and chickens and develop the necessary genetics background. The student also utilizes an apparatus in the laboratory to perform tests on potentially contaminated eggs. Eventually, the student concludes that white-feathered chickens are responsible for the bad eggs due to a codominant trait. The student solves the mystery and reports the finding to the nurse.

4. Motivational Design Implications for Narrative Learning Environments

The design of narrative-centered learning environments demands careful consideration of the factors promoting student motivation [20]. Exploiting various motivational features during a narrative learning experience can influence factors such as student focus and depth-of-involvement [27]. As noted above, challenge, curiosity, control, and fantasy are key factors affecting intrinsic motivation [14]. We consider how each factor can be facilitated by narrative-centered learning environments and illustrate the discussion with examples from CRYSTAL ISLAND.

4.1. Challenge

Theories of intrinsic motivation suggest that humans often equate objectives that are challenging with objectives that are meaningful. Overcoming a challenging task provides a student with a personal sense of achievement and a test of her abilities. Challenge depends on student characteristics, such as efficacy, prior knowledge, and skills, as well as inherent task difficulty. Maintaining optimal levels of challenge throughout a learning experience is important. Excessively low-challenge periods may cause the student to feel bored, but high-challenge periods may bring about frustration and feelings of hopelessness.

Pedagogical and narrative goals serve as natural embodiments of challenge in narrative-centered learning environments. While pedagogical goals generally surface as tasks that reveal information to be learned or provide valuable, practical experience, narrative goals involve interactions that advance the plot. The exploratory learning structure of CRYSTAL ISLAND is goal-based, unifying pedagogical and narrative goals into singular objectives that drive the experience. The learning environment utilizes fixed goals and emergent goals, as well as short-term goals and long-term goals, in defining the interaction. *Fixed goals* are specific, system-dictated objectives that appear in the lower left corner of the screen in various versions of CRYSTAL ISLAND. Examples include, "Talk

to Jin,” or, “Test the egg.” These are also short-term goals for the student, and can be accomplished with only a few actions. In contrast, *emergent goals* [5] are student-defined tasks that arise as a function of the narrative path chosen. Interactive narrative environments such as CRYSTAL ISLAND permit several paths to progress through the story, each of which may be supported by different plot points and realizations of pedagogical objectives. One interaction may require the student to find and test a banana for contamination, whereas a separate interaction may not involve bananas at all. These goals emerge from the chosen path through the story, and can be tailored to the experience and the student. Finally, long-term goals in CRYSTAL ISLAND arise through complex, multi-step objectives posed to the student, such as “solve the mystery” or “cure Bryce.” Long-term goals provide a driving force behind the story, and serve as a baseline motivator.

Uncertainty is useful in conceptualizing optimal goal challenge. At a given time the student should be unsure about whether she can accomplish a goal or will fail. This unpredictability provides an incentive to attempt a goal, coinciding with an innate student desire to test one’s own abilities [14]. The mystery-based plot of CRYSTAL ISLAND provides a deliberate embodiment of goal uncertainty, incorporating variable goal locations and difficulty levels. The interaction also begins with the student having no knowledge of the epidemic’s cause, nor any sense of whether the mystery can be solved. Gradually revealing the secrets underlying the mystery drives the entire experience.

Performance feedback and student self-esteem also influence a student’s perceived challenge. The characters of CRYSTAL ISLAND manipulate student perceptions of challenge level through dialog and vicarious experiences in which characters demonstrate or hint at the level of difficulty for a particular task. Capitalizing on the task-oriented nature of CRYSTAL ISLAND, models of affect [9] are likely to aid in understanding the affective responses to student appraisal of goal progression. For example, affect models can detect student frustration indicating that the challenge level may be too difficult. The student’s experience can then be adapted, perhaps through character acknowledgement of the task’s difficulty or comments on the student’s expended effort. Further, models of student efficacy [18] may provide useful insight to a student’s perceived challenge level through recognition of self-beliefs about the ability to manage the task at hand.

4.2. Curiosity

Curiosity is inherently motivating. It is typified by an individual’s drive to explore and discover some unknown subject, a compulsion exemplifying motivation. Narrative provides additional sources for curiosity beyond the core subject matter. However, narrative learning environments must be carefully designed so that context-centered curiosity does not distract from pedagogical demands.

Curiosity involves both sensory and cognitive influences [14]. *Sensory curiosity* is triggered through appeals to the student’s senses, such as striking colors, ambient lights, and engaging sounds. CRYSTAL ISLAND promotes sensory curiosity through its use of rich graphics, physics, and behaviors for the surrounding world. Non-player characters are realistically rendered with detailed facial expressions and high-polygon models, and the surrounding world is realized with high-resolution textures and atmospheric sound effects. This high fidelity experience provides strong sensory stimuli.

In contrast, *cognitive curiosity* centers on the desired modification of cognitive forms into well-formed structures, like completeness, consistency, and parsimony [14]. A student will pursue a subject in hopes of removing incompleteness and inconsistency from her understanding. Again, this is concretized in the mystery constituting CRYSTAL

ISLAND's narrative, where students have an incomplete understanding of the elements responsible for causing members of the research team to fall ill. The spreading illness is inconsistent with a student's desire that the team members should be healthy, instigating the desire to solve the mystery.

4.3. Control

Control is one of the major tenets of interactive narrative environments such as CRYSTAL ISLAND. Narrative environments are specifically constructed with the objective of generating stories that react to a student's decisions and actions. The student's influence on the developing story reinforces feelings of competence and self-determination, both of which contribute to intrinsic motivation [6]. Similarly, perception of control, in contrast to actual control, is an integral motivational factor [14].

Responsiveness, choice, and power contribute to the student's sense of control in narrative-centered learning environments. Nearly all events in CRYSTAL ISLAND are contingent upon previous student actions: when a student approaches a door and presses the 'Use' key, the door perceivably opens; when a student approaches an NPC and engages in conversation, the character will respond appropriately. The environment responds to student actions in clear and observable ways. This seemingly simple behavior is imperative for fostering a sense of responsiveness and power. Furthermore, students are free to choose how to navigate the world, interact with the environment, and solve the mystery. This flexibility provides them with a strong sense of choice, similarly advancing feelings of empowerment and motivation.

4.4. Fantasy

By definition, the context provided in narrative-centered learning environments introduces fantasy elements to learning. Fantasy has previously been shown to significantly influence motivation in elementary school students [27]. However, design that does not consider both audience interests and fantasy themes can actually be detrimental to intrinsic motivation [14]. Therefore, careful authoring and adaptive narrative are important for stimulating intrinsic motivation.

Endogenous, emotional, and cognitive factors contribute to fantasy as an intrinsic motivator [14]. *Endogenous fantasy* refers to a bi-conditional relationship between the skills being learned and the fantasy supporting learning. Such environments neither tolerate the variation of pedagogical components without modification of the fantasy, nor vice versa. This is in contrast to *exogenous fantasy*, where the context depends on the skills being learned, but the skills do not depend upon the fantasy. The fantasy inherent in CRYSTAL ISLAND is endogenous. One of the primary objectives for the environment is learning through exploration and the scientific method, which is central to the actions necessary for solving the mystery. Removing either the mystery elements or the exploratory elements of CRYSTAL ISLAND would fundamentally change both the pedagogical and narrative content of the experience.

Fantasy can elicit emotional reactions in students that support enhanced intrinsic motivation. Narrative context introduces opportunities for vicarious, affective experiences, such as fame, adventure, and intrigue. Story worlds may also introduce non-player characters with which the student may identify and potentially develop empathetic relationships. The prototype narrative learning environment introduces a narrative context that we hope is appealing to a wide range of student types. CRYSTAL ISLAND's remote

island environment, its empathetic characters, and the mysterious, spreading illness, were designed to elicit emotional reactions, thereby influencing intrinsic motivation. Models of student affect [9] might also be used to influence narrative and pedagogical planning, ideally enhancing student motivation online.

Cognitive fantasy is frequently connected to endogenous fantasy, as it prescribes fantasy elements that provide cognitive benefits to learning. Often these types of fantasy serve as analogies or metaphors for the material being learned. Moreover, strong fantastical images and associations may enhance learning [14].

5. Focus Group Studies

In two sets of focus studies, one with individual student sessions and the other with groups of four students, 14 eighth grade students solved the CRYSTAL ISLAND mystery and then participated in conversations reflecting on their experience. Discussions centered on the topics of plot, characters, and setting. The findings of these studies as they relate to intrinsic motivation are summarized below:

- *Plot:* Students enjoyed the science mystery but concluded that more conflict would evoke greater curiosity. Recommendations included developing conflicts between characters and even misleading storylines, such as a rogue researcher accused of poisoning the sickened team members. Students also focused on the story's introduction, recommending that a "training" level be utilized to establish plot, characters, and setting. Discussions emphasized an interactive scenario over a scripted cinematic sequence, providing exercises to establish navigational controls and foreshadow task objectives.
- *Characters:* Students suggested that CRYSTAL ISLAND characters needed to be more expressive and active. They wanted the learning environment to be populated by characters with whom relationships can be developed, perhaps as active collaborators in the pursuit of solving the mystery. There was also an interest in further developing character-student conversations. Students related to other games that provide multiple-choice responses where the player has control of the dialog and perceived control of plot progression. Several students expressed interest in being able to design their own characters along several possible dimensions including role, gender, and physical features (e.g., hair, eyes, and clothing). Selecting and even creating their own characters may allow students to better identify with the character, immersing them further into the fantasy.
- *Setting:* During group sessions, students worked together to draw new maps of CRYSTAL ISLAND. The students designed the world to include areas that would evoke interest, curiosity, and opportunities for science learning. Beyond the base camp, where the current CRYSTAL ISLAND mystery is set, students envisioned a rich landscape replete with volcanoes, mountains, woods, caves, lakes, and streams.

In addition, students suggested that the environment should provide learning resources such as books and the Internet. There are currently books in CRYSTAL ISLAND that present information about a number of diseases, enabling students to interpret sick characters' symptoms. However, students emphasized the need for resource materials to be interesting, concise, and relevant to the task at hand. They wanted access to books with pictures and diagrams. Similarly, the Internet has become a daily resource for students in the classroom. Thus, embedding a browser into the game would provide access to

information from students' science classes. However, since many students recognized the potential for the Internet to be distracting, they further suggested crafting a "virtual Internet" to provide restricted, relevant content.

Based on their experiences with commercially available games, students repeatedly recommended utilizing "mini-games" as a means for further integrating learning into the overall experience. Students provided numerous suggestions for mini-games, e.g., labeling parts of a cell when examining contaminated food under a microscope. Students were strong advocates of incorporating rewards for successfully completing mini-games, a recommendation that, if followed, should take into account the extensive literature on rewards, e.g., [32].

6. Conclusion

Narrative-centered learning environments appear to be a promising vehicle for promoting student motivation. The strong connection between narrative and intrinsic motivation grounds arguments advocating narrative-centered learning environments through the constructs of challenge, control, curiosity, and fantasy. Focus group studies of middle school students suggest that the narrative elements of plot, characters, and setting can contribute to experiences that motivate students to learn. In the future, we intend to incorporate many of the suggested narrative elements into CRYSTAL ISLAND. To further understand the effects of narrative on motivation we plan to investigate real-time diagnosis of student motivation and devise techniques to create adaptable narratives tailored to learning episodes of individual students.

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