Design for off-task interaction

Rethinking pedagogy in technology enhanced learning

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Abstract— **In this paper, we argue for the design of off-task interaction in technology enchanced learning. This implies a rethinking of pedagogy which can substantially contribute to achieving specific learning goals. We describe a work-in-progress and provide concrete examples of how we deal with relevant issues raised by allowing for off-task interactions in an educational math game as an integrated learning system.**

Keywords: off-task interaction, educational game, conversational agent, teachable agent

I INTRODUCTION

In this paper we argue for the dedicated design of *off-task interactions* in technology enhanced learning. Particularly, we discuss digital learning environments which employ virtual pedagogical agents and how our design considerations for an educational learning game in mathematics correspond to a rethinking of pedagogy in relation to traditional frameworks for virtual learning environments. We begin with a discussion of efficacy goals and task-orientation within educational technologies, comparing virtual learning environments to traditional (classroom) teaching. Then we propose an alternative pedagogical approach, in which off-task interactions are considered in close relation to on-task interactions and how this may benefit the learning process as a whole. Next, we exemplify the implementation of such considerations in the education math game we are currently developing and how we relate specific design decisions to certain pedagogical functions of the game.

II EFFICACY PEDAGOGY RECONSIDERED

Traditionally, the domain of human-computer interaction (HCI) focuses on the goals of *efficacy* and *efficiency*, where users' attitudes towards a system are considered only in relation to these goals only to the extent that the system allows users to complete their tasks smoothly, reliably and quickly [17]. As to learning and education, the successful implementation of technological enhancements allow students to work individually, yet simultaneously on a large scale (e.g. over the internet), while offering access to learning materials at any time and in different formats according to personal preference.

Since 1990's, the HCI community has paid increasing attention to 'softer' aspects, such as user enjoyment, pleasure and aesthetics [e.g. 14, 7]. Correspondingly within the domain of educational technology, learner engagement, enjoyment and experiences have become complementary design considerations to learning efficacy [16, 12, 9].

We hold this to be an important step for creating richer learning environments – but want to take it further. We maintain that engaging and motivating the learner *must not be viewed separately and independent* from learning and teaching efficiency, but are closely related and integrated in the overall learner experience. The true challenge for any learning environment then is, to design for motivating and engaging experiences while keeping or improving the pedagogical functions and gains of doing so. The fact that virtual environments are more or less constrained and reduced representations of reality does not imply that they offer any reduced potential for learning; instead, depending on the specific design decisions made – regarding for instance aesthetics and contextual factors – one may filter out distractors as well as promote supporting elements for learning [19]. How we go about this process is of paramount importance to achieving actual learning efficiency. Our starting point will be a closer look into the potential pedagogical benefits of off-task interactions as they occur in natural educational settings, and how conversational sidetracks can be used purposefully for facilitating learning in virtual environments.

III PEDAGOGICAL GAINS OF OFF-TASK INTERACTIONS

In traditional teaching situations such as lessons, lectures, tutorials, etc., there is practically always a mixture of, on the one hand, *on-task* interactions which strictly pertain to the subject content and tasks of the lesson and, on the other hand, *off-task* interactions which bear no (apparent) relation to the learning material. Instructors, teachers, tutors regularly also speak of other things or digress from the present topic. They may bring up a matter of general interest, comment their own personal or historical relation to the subject of the lesson, tell a joke, relate a news item, give a personal comment to a student, and so on. In fact, it is unusual to find a teacher who is completely focused and does not at all deviate from the task and topic of a lesson. The same holds for many other contexts of communication

and interaction, such as between a physician and a patient, a real-estate agent and a client, etc. [5].

In terms of its pedagogical functions, there is plenty of evidence that bringing off-task conversation into the educational situation can have a number of positive implications:

- A complete *on-task* focus may actually be ineffective for learning, because the time a human being can stay focused on a specific task and content before thoughts wander off or need to take a break is limited. That is, a learner seems to intermittently need some cognitive rest.
- Adding personal comments, jokes, or opening up a discussion of general interest, although non-task relevant, can make learners more engaged and consequently increase their general level of receptivity in the classroom [8].
- Interesting off-task conversations may be used as memory cues, creating additional possibilities for remembering the actual learning material. This is supported by findings that brain processes of memory coding and storage are stimulated by emotional engagement [10].
- Off-task conversation in the form of "small talk" can promote trust and rapport-building, and at the same time bring in task-related information. An example is the chemistry teacher who relates an anecdote about the time she caused a fire during a laboratory lesson as a student [cf. 5].
- Off-task conversation can serve to make a learner feel more comfortable, relaxed and at ease with a learning task or topic and thus release mental blockages which beset some students with regard to certain educational material [18] (e.g. regarding mathematics, "math anxiety" is a well-documented phenomenon; see [11, 13]).

In sum, it is remarkable that the field of educational technology in general has such a strong, or even exclusive, focus on the tasks and content of the material to be learned. The lack of off-task interaction opportunities applies as well to the sub-domain of educational technology that seek to exploit qualities of human-like interactions by including digital characters, such as digital teachers, instructors, learning companions or teachable agents, in educational roles. Next we present our approach to designing a specific educational software which combines off-task and on-task activities while keeping a pedagogically motivated balance between them.

IV IMPLEMENTATIONS FOR OFF-TASK INTERACTION IN AN EDUCATIONAL MATH GAME

In our on-going project, we have aimed to integrate a module for off-task conversation (an 'msn'-like social chat window) in a math learning game for children age 12-14

years. The game itself consists of several different board games that intertwine game play with learning content through visualisations of arithmetic operations (for a detailed account of this environment, see [15]). A crucial aspect in the present context is the inclusion of a human-like *Teachable Agent* (TA) [6], a form of AI-based educational technology, which builds upon the pedagogy of "learning by teaching" [2]. Whereas the on-task activities involve the student "teaching" the agent to play the game by responding appropriately to different multiple-choice questions, we also include the opportunity for the individual student to engage in free conversation with the agent (using the keyboard) between game sessions.

The underlying dialogue architecture is designed to handle conversation topics related to mathematics as well as to other subjects. Accordingly, we distinguish the off-task dialogue content into *on-domain* topics, related to school, math, the math game, etc., and *off-domain* topics, which may regard basically anything. The off-task conversation is implemented as a mixed-initiative dialogue strategy, which allow both the agent and the user to direct the dialogue by introducing new topics and posing questions. The agent keeps a history of the utterances in the dialogue, both the current and previous sessions, and use this to try to balance the on-domain and off-domain topics by (re-)introducing particular subjects of conversation (e.g. if the user has discussed music for a long time the agent can ask about music-lessons in school with the aim to guide the subject back to school-related topics). Note that the approach is unusual for conversational agents with educational roles, since it extends over the traditional instructional and information-providing functions, and also works to establish a social relationship with the user. To our knowledge, this represents the very first implementation of purposely designed off-task interaction in educational software. We wrap up this paper by accounting for how we aim at bridging the gaps between off-task and on-task content and interactions in the game, by relating our specific design decisions to their intended pedagogical functions:

On-task conversation and off-task conversation in an interrelated whole. Importantly, in line with our pedagogical standpoint, we have decided to integrate on-task and off-task activities not as two unrelated, but as two complementary, activities. The interconnecting factor is represented by the persona of the agent, which integrates selected task and domain knowledge with (limited) off-domain knowledge (eg. the agent is a 11-year old that goes to school and is learning math in the game, but also have interests like music and film that it pursues in it's free-time). The free conversation is primarily oriented towards off-task topics but the agent can also comment on the game play.

Admitting students' need for cognitive rest. By incorporating an off-task conversation in the actual learning software, we acknowledge students' natural need for cognitive rest while still keeping off-task activities within the learning context. We use the metaphor of regular breaks

between lessons in school for switching between on-task activities (i.e. playing the game) and off-task activities (i.e. chatting).

*Building a relationship between agent and user.*In the first off-task conversation(s), the agent focuses on getting to know the user by posing questions about the user's personal interests, family and friends, school etc. It can of course answer questions on the same subjects about itself.

Dedicated design of anecdotes and narrative storytelling. As evidenced by the work of Bickmore and Cassell [3, 4], anecdotes and small-talk have a social and trust-building function even when the interlocutor is a virtual character. At the same time, the content of small talk can be designed to convey something relevant about the subject domain. As a future extension we are therefore considering to include anecdotal material relating to school and mathematics (e.g., the agent telling a story about "my crazy friend, who turned the math book upside down and found the homework to be very difficult").

Reframing math tasks in a defusing and generally appealing context. Besides offering a mental break and some entertainment value, engaging off-task interactions may detract 'math anxious' students from perceived inabilities to confront mathematical learning material. The off-task conversation includes motivational comments while conveying generally positive attitudes towards math, to the intended effect of strengthening math self-efficacy [1]. In the future this may include developing special adaptations of off-task interactions for specific target groups (e.g., students with pronounced math anxiety or mental blockage to mathematics) which allow greater elaboration on on-domain topics aimed at reducing any negative feelings toward the subject.

V Conclusions and future work

In conclusion, we challenge the prevalent task-oriented focus of technology enhanced learning systems. In this paper, we have argued that the design of off-task interaction, which implies a rethinking of pedagogy within the field, can substantially contribute to achieving specific learning goals.

We plan on testing this by contrasting two versions of the learning system, one with and one without the off-task conversation. Effects on learning will be measured through assessment tests before and after use of the systems. Data on both students' and teachers' overall experience of the system, attitudes and motivation, will be collected through interviews and questionnaires.

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