Adaptive Learning Environments as Serious Games

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Abstract

In former concepts for programmed instruction (PI), intelligent tutoring systems (ITS), adaptive learning environments (ALE), and pedagogical recommender system (PRE) learning is understood as similar to algorithms - as a clearly describable, logical, and in this respect serious process. With this background it is attempted to create a complete description of teaching and learning for a precise support and control of learning processes in order to replace teachers. In contrast to this concept, learning in pedagogy is usually conceived as a process that cannot be fully described or understood. Teaching and learning require human understanding and thus human communication is necessary to foster learning. From this perspective, the possibilities for PI, ITS, ALE and PRE are restricted. It is assumed that within these restrictions reasonable concepts can be developed. As one approach it is suggested to refer to the pedagogical theory of play and the understanding of pedagogical actions as art. Based on these approaches we understand the design of automatic educational reasoning (AER) systems for learning like the creation of tools for artists. As tools we suggest a pedagogical ontology, a learner model and a reasoning engine. With these tools, teachers can create playground equipment that is played with by students.
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Keywords: Automatic Educational Reasoning, Pedagogical Recommender Systems, Creativity, Serious Games, Didactics

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1 Introdution

If feedback is considered as a criterion for automated support in learning, the device presented by Pressey in 1923 was the first teaching machine (Ludy 88). Skinner picked up Pressey's design as well as the foundation in the theory of Thorndike. Based on Skinners concept machines and systems for programmed instruction (PI) were developed. Skinners concept is well known as the basis for behavioural learning theories.

Extended computational power and general problem solving theories lead to the idea of intelligent tutoring systems (ITS) and adaptive learning environments (ALE). The idea was first based on the concept for the General Problem Solver (GPS), where the knowledge of problems and strategies to solve problems were separated. When the GPS failed for any relevant problem, the concept was replaced by expert systems. The core architecture of the DENDRAL expert system (knowledge base, explanations system, inference engine) became the starting point for SCHOLAR (Burton 1989), which was build as a semantic network and based on the architecture of expert systems. These concepts are closely related to cognitive learning theories.

Despite the effort invested in ITS, there are hardly actually working systems available or real world applications reported. ITS seem to have failed due to the high effort necessary to develop such systems and the lack of theoretical foundations (Schulmeister 2007).

In the last years, the successful application of recommender systems in marketing led to the idea of transferring those systems in the didactical field in the form of educational recommender systems (ERS) (Duwal 2011). This often takes place in the context of informal learning processes. The concepts seem to be related to constructivistic learning theories, while explicit references are rare. While most of the suggested ERS are in the early stages of development, the expectations are high. At least, these expectations appear to be similar to the systems discussed before.

With systems for programmed instruction, intelligent tutoring systems, adaptive learning environments, and pedagogical recommender systems concepts for automatic educational reasoning (AER) have been developed. These AER systems haven been developed for many decades. Despite the effort invested in AER systems there are hardly actually working systems available or real world applications reported. AER systems seem to have failed due to the high effort necessary to develop such systems and the lack of theoretical foundations (Schulmeister 2007). This might be connected to one concept all the systems developed so far share: Learning is considered as a formally describable and controllable process.

2 Objective

We assume that the learning theories behind AER systems developed so far should be seriously rethought. The theoretical perspectives applied yet prohibit meaningful views on the possible functions of AER systems in educational contexts. Thus the objective here is to develop a new perspective on possible functions of AER systems in teaching and learning processes. Our thesis is, that the theories of Schiller and Herbart are suitable to understand and design AER systems.

3 Method

In order to develop a new perspective on the function of AER systems in teaching and learning, we cannot refer to empirical data, since there are no systems that are developed based on the perspective to be developed available yet. But there are other pedagogical theories about teaching and learning available than the ones applied in the development of AER systems so far. The theories picked up here are the theories of Schiller and Herbart. These theories have been chosen since they are broadly accepted and discussed in educational sciences. Additionally, a relevant difference to the the-

ories applied so far can be assumed. In order to test the thesis that the theories of Schiller and Herbart are suitable to understand and design AER systems two methods are applied: At first, a hermeneutic analysis with a transformative intention is conducted. That is, we try to understand the function of AER systems for teaching and learning with these theories. Secondly, we try to develop a model that considers the developed perspective with OWL (Motik et. al. 2009). The background for the second step is that converting theories into practise always includes heuristic decisions. Thus the development of a model can be considered as a first step towards the necessary empirical testing of the perspective developed.

4   Results

4.1   Play @ Pedagogy

Schiller is well known for his theory of play. Playing is a cultural phenomenon that appears all through history. In ancient times, playing games has been considered as not very relevant. It appears in paintings sometimes, but is not emphasised as a relevant subject for theoretical discussions. In medieval times playing games was even considered as bad, since it degrades working power and promotes sin and vice (Parmentier 2004).

An important change in the perception of games is expressed in Bruegels painting "Kinderspiele" (childrens games), which was first published in 1553. Playing games was more and more considered as a sphere with a value of its own. The right of people to play became accepted – as long as playing contributes to something useful, like the stimulation of mental abilities (Parmentier 2004).

This understanding of playing games was picked up in pedagogical considerations by Basedow in the 18th century (Overhoff 2004). Basedow suggested to convert all games children play into something useful. Therefore, Basedow applied games to teach subjects like latin or biology. This idea to

apply games for teaching something useful is still widespread today, particularly in concepts for digital game based learning (Pivec 2007) or serious games.

At the end of the 18th century the understanding of games was changed and extended substantially. This change culminates in the famous words of Schiller: "Denn, um es endlich auf einmal herauszusagen, der Mensch spielt nur, wo er in voller Bedeutung des Wortes Mensch ist, und er ist nur da ganz Mensch, wo er spielt [For, to finally speak it out at once, man only plays when in the full meaning of the word he is a man, and he is only completely a man when he plays]" (Schiller 1795). With this sentence, Schiller identified play as the area where people can become people, and thus as the central place for human development and education.

Schiller discussed this place in the context of arts. He considers arts as a context where human activities have to be understood as play. A necessary condition for this context is freedom, not usefulness. For Schiller, this freedom means beeing free of being forced by other peoples reasoning (kings, priests etc.) and of being forced by nature (food, housing etc.). Being free from external forces opens up a room for creative actions, and these creative actions are by no means intended to be useful or profitable. In our context the important point is, that play as an existential aspect of human development fundamentally refers to human freedom. Due to this, it cannot be controlled from the outside, but only be done by people themselves.

This changes the pedagogical perspective in contrast to Basedow. Basedow tried to control learning processes by creating games. With Schiller, playing is understood as an activity that cannot be controlled. Still, playing some sort of playground. A room where playing is actually possible is needed, but it cannot be forced that a room for playing games is actually used to play. With Schillers theory it is possible to understand teaching and learning as a game where people play with content - and the media that are used to express the content.

Another fundamental problem for pedagogical theories is the theory-prac-

tice- transformation. This problem was introduced by Herbart in 1802. Herbart differentiates pedagogy as an academic discipline and as an artistic practice. Academic theories are derived from principles and made of broad concepts. Artistic practice has to deal with individual circumstances. Since education in practice always takes care for individuals, for Herbart acting as a pedagogue is an art form. Thus teachers are artists. And according to Schiller, artists do play.

From this point of view it is obvious, that teaching and learning can not be controlled or steered by knowledge that can be expressed in algorithms. One consequence is, that designing an AER system is not like creating an actual game, but to create a room where teachers and learners can play. This might be connected to the difference between game and play that is discussed in video game studies: "Play is an open-ended territory in which make-believe and world-building are crucial factors. Games are confined areas that challenge the interpretation and optimizing of rules and tactics" (Walther 2003). Games need to consider the rules of the game, while play is a free activity, where freedom is created by open up a make-believe world. If play in this sense actually happens can not be predicted, but we can assume that toys are more likely to be played with than other objects (Swertz 1999).

Another point is that computer technology is neither capable of creating art nor able to play. Thus, computer technology can never replace teachers. This leads to a different status of AER systems. While previous concepts tried to replace teachers, we try to create tools for teachers so they can add automatic educational reasoning to learning environments. These tools are intended as toys, that suggest to teachers to play with their teaching methods and the media they apply. If teachers play with teaching methods and media and offer differences and varieties, they again open up a playground where students can learn while playing with these teaching methods and media.

From this perspective, designing an AER system places us in the position of designing tools for creating games. These tools can be used to create a playground for teachers that act as artists who create games for learners. Pictori-

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ally we create brushes and colors that are used by teachers to paint pictures that are shown to the learner.

Thus the challenge is to design tools for the creation of teaching and learning processes that open up spaces for creative actions. The fact that the contradiction between compulsory rules and open creativity is unproblematically solved while actually playing games shows in turn that the association of gaming for teaching and learning is suitable.

4.2   Material for playgrounds – the OWL challenge

We suggest to provide a metadata system, a learner model and a reasoning engine as tools to create learning environments. The metadata system allows to describe different possibilities to learn certain content. It is formulated logically in an ontology in the (Web Ontology Language).

The flexible elements are circled around learning pathways. Learning pathways are considered on three levels within one course: Concept Containers (about 60 minutes learning time), Knowledge Objects (about 10 minutes learning time) with certain knowledge and media types (Meder 1998). The learning pathways, defined as relations between concept containers, between knowledge types, and between media types can be altered by teachers and by learners. If a teacher, for example, prefers other steps than suggested by a didactical model, he can mix those steps with steps from other pathways or create steps. While doing so, he plays with the teaching and learning models that were applied while creating the metadata system.

Some basic teaching and learning models are suggested (Inquiry Based Learning, Multi Stage Learning), but the teacher neither has to follow these models nor to apply these models at all. He is always free to create his own learning pathways and offer them to the learner. Thus, the metadata system allows teachers to play with various teaching models. Still, he has to describe his learning material with this metadata. In his game he still uses the metadata system, but as a toy. Since the teacher uses the meta data system

an automatic reasoning engine is still able to react on the results from teacher's play.

Since the learning material and the metadata developed by the teacher is offered to learners they can use these to play too. If for example a teacher creates a learning sequence, the learner can learn the material backwards or in any creatively created order. This order can automatically be identified, converted in a personal learning strategy and applied to further material. Since the different learning pathways and the descriptions are offered to the learner, a flexible room is created where learners can play with learning models.

5 Discussion

It is obvious that a supplier of brushes and colors has hardly any control about the created artwork that will be presented to the audience. The only thing he can assume is that the color will be present in the artwork – in which form ever. This is considerably the case if you think about something like audience participation in non scripted performance art.

Since we consider AER systems as tools for teachers and not as a replacement for teachers and according to Herbart acting as a pedagogue is an art form it does not make any sense for developers of AER systems to even try to control learning environments and learning outcomes above all. A consequence of this is that learning outcomes can not be applied as a measurement for a successful design of an AER system. Still, this measure has been applied as the only measure in recent decades. Thus it is necessary to develop new criteria for the success of AER systems.

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