Storyboarding for Playful Learning

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Abstract: Currently, e-learning systems as well as learning environments are still suffering from a lack of explicit and adaptable didactic design–an issue of quality management. Students complain about insufficient adaptability of e-learning offers to the learners' needs. This is especially the case in university teaching. University professors are usually topical experts, but not necessarily experts in the didactics of teaching their subject. As a way out of this dilemma the authors utilize their formerly developed storyboard concept. Storyboards are an explicit representation of a didactic design, which enjoys simplicity, clarity, visual appearance, and the chance for standardized development. Thus, everybody may easily become a storyboard author–a step toward pedagogical engineering. By representing didactics explicitly, the actors in learning environments are supported to find their individually appropriate way to learn. Besides this processing issue, storyboards have the potential to identify successful didactic patterns. This is, in fact, the vision of knowledge discovery in didactics. In the authors' experience, embedding topical content into game adventures appears to be a promising didactic mean when properly linked in a related didactic pattern. The success of the authors' approach is demonstrated by an application to one of the authors' real life courses.

Learning and Playing – A First Approach

There is a large variety of opinions about game and play, in general, and about learning and playing, in particular (see, e.g., [Huizinga, 1949], [Suits, 1978]), [Spitzer, 2002], [Salen and Zimmerman, 2003], [Fritz, 2004], [Koster, 2005], and there is not much consensus.

On the one hand, there is no doubt that learning may be a rather tedious task and can't be fun in all conditions. Don't cheat your students and tell them that their will be never again any need to invest power and will in learning. It is obvious that information and communication technologies in pervading our daily life have an enormous impact on human behavior, on thought and, thus, also on learning. However, the thesis that the 'twichspeed' generations *do not learn the way previous generations did because they do not think the way previous generations did* [Prensky, 2001] is questionable. Other authors claim that there is neither psychological nor neuro-physiological evidence [Spitzer, 2002].

On the other hand, everyone knows that young animals and human infants may learn quite a lot when playing. There are obvious cases where learning may be fun, and it is an old dream of pedagogy to make learning easier in different ways [Comenius, 1638] (Czech version published in 1628) including didactically motivated game playing.

We are neither interested in using standard games for learning purposes such as the development of problem solving skills [Wallace, 2006] nor in dedicated game design for learning (see [Gaither and Luckhardt Redfield, 2006] for a very recent survey). Instead, we focus the purposeful integration of variants of play actions into didactic design.

Motivation and Introduction

Teaching is a highly interdisciplinary process. It requires besides the topical expertise of the current subject didactic experience, (mostly IT-related) skills in handling the material and equipment, as well as ”soft skills” in dealing with all the other actors of the teaching process. Most of all, it requires the teacher’s personality [Damasio, 1999].

In particular university teaching is typically performed by teachers, who are outstanding topical experts in their subject, but not always really good teachers of it. University teaching often suffers from a lack of didactic knowledge. Here, we refrain from discussing reasons for that, but focus the issue of involving it a little better. We propose an approach to improve the didactic issue for successful teaching by discussing questions such as:

- *How to include didactic variants of presenting materials?*
- *What determines the variants?*
- *How to choose an appropriate variant according to particular circumstances?*
- *How to expatiate didactic intentions?*

In fact, facing these issues requests an explicit high level representation of didactic items like these. High level, in this context, means that every topical expert should be able to implement such items, even if he/she is not familiar at all to any software technological implementation concepts and/or specific purpose-built tools.

Our suggestion to overcome this problem is a modeling concept for didactic knowledge called *storyboarding* [Jantke and Knauf, 2005] and our suggestion to ensure a wide dissemination is using a standard tool to develop and process this model, which is Microsoft^{TM} Visio. However, tools do not matter, but concepts do.

The use of storyboards in teaching supports the identification of an individually appropriate way through a network of didactic variants for each of the actors involved in a learning environment. Moreover, by a statistic analysis of both the individual way of learners through a storyboard and his/her associated individual learning success (estimated by some examination result, e.g.), storyboards bag the potential to identify successful didactic patterns and, thus, to explore didactic knowledge.

Despite it couldn’t be shown this way (so far), the authors’ experience in university teaching revealed that embedding learning content into game situations is a successful didactic means. Thus, we built in game adventures along with explanations of their didactic intentions into storyboards. An example storyboard that reflects this (and other) insight(s) is outlined in the present paper.

The paper is organized as follows. Section 2 is a short introduction to the storyboard concept as introduced in [Jantke and Knauf, 2005]. Section 3 discusses the issue of involving game situations in storyboards. In section 4, an exemplary storyboard of a university course of one of the authors’ teaching subject is outlined. It really works.

The Storyboard Concept

The storyboard concept [Jantke and Knauf, 2005] is built upon standard concepts which enjoy

1. clarity by providing a high-level modeling approach,
2. simplicity which enables everybody to become a storyboard author,
3. visual appearance as graphs,
4. the chance to be implemented by simple standard tools.

A storyboard is a nested hierarchy of directed graphs with annotated nodes and annotated edges. Nodes are scenes or episodes; scenes denote leaves and episodes denote sub-graphs. Edges specify transitions between nodes. Nodes and edges have (pre-defined) key annotations and may have free annotations. A storyboard is interpreted as follows:

- *Scenes* denote non-decomposable learning activities which can be implemented in any way: It can be the presentation of a (media) document, or an informal description of the activity.
- *Episodes* denote a sub-graph.
- *Edges* denote transitions between nodes.
- *Key annotations* specify actors and locations. Depending on the application, more annotations are admissible.
- *Free annotations* can specify whatever the storyboard author wants the actors to know: didactic intentions, useful methods, necessary equipment, and so on.
- (Key and free) annotations to nodes are inherited to each node of the related super-graph.

In fact, the storyboard is a semi-formal knowledge representation for applied didactic knowledge and, thus, a firm base for modeling, processing, evaluating and refining this knowledge. Furthermore, this concept is not limited to electronic content material. Storyboards should not be restricted to and confused with concepts for organizing learning material. There are sufficient concepts of software engineering which are well-established and deeply investigated. Instead, a storyboard is a concept to represent and–most importantly–to anticipate didactic experience.

Storyboards such as the top level storyboard of the third author's course EEL 4872 on display in figure 1 are not only an e–Learning concept, but a more general concept of modeling didactics. Of course, e–Learning concepts are very desirable as an item under the roof of storyboards.

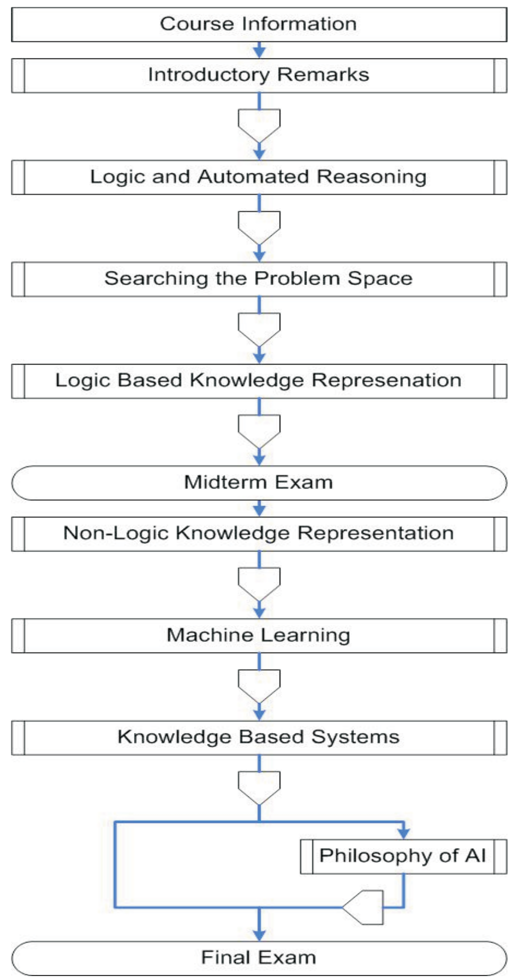


Figure 1. Storyboard EEL 4872

The following list is just a proposal of further supplements. Vice versa, some of the features might not be applied to particular storyboards. Many of them are implicit in the general concept. We discuss those details only for the readers' convenience, to become familiar with our ideas, aims and intuition. In italics we provide details about our current technological representation of storyboards in Microsoft^{TM} Visio. Readers may use any other appropriate tool at hand.

- Because those nodes that are called episodes may be expanded by sub-graphs, storyboards are hierarchically structured graphs by their nature.
  Double clicking on an episode opens the corresponding sub-graph on a separate sheet.
- Comments to nodes and edges are intended to carry information about didactics. Goals are expressed and variants are sketched.
  Clicking to a comment opens a window with the text, including author information and date.
- As far as it applies to a node, educational meta–data may be added.
  Visio built–in object properties are used to represent general information and meta-data.
- Edges are colored to carry information about activation constraints and any variants of their adaptive availability. Certain colors may have some fixed meaning like usage for certain educational difficulties.
  Again, Visio built–in object properties are used to represent such information.
- Actors and locations inclusive those in the real world are assigned to elementary nodes only.
  Through programming, actor and location information may be propagated automatically.
- Certain scenes represent documents of different media types like pictures, videos, PDFs, Power Point slides, Excel Tables, and so on.
  Double clicking on a scene opens the media object in a viewer, i.e. plays the film, e.g.
- Scenes may have different implementation variants.
  Different (alternative) Implementations of the same scene might be implemented by various hyperlinks on the related scene. A hyperlink may
  – open any local file (a text describing the scene, or any file of any type that provides content material) with the appropriate tool,
  – open a web page with the local standard browser, if it is an URL, and
  – open the local standard mail tool, if it is an e-mail address[1].

[1] Indeed, asking colleagues or friends for some information or material may also be implemented as a didactic item.

Involving Game Adventures in Storyboards

Clearly, the sophistication of storyboards as sketched in the preceding chapter can go very far. The concept allows for deeply nested structures involving different forms of learning, getting many actors involved and permitting a large variety of alternatives. Though this is possible, in principle, the emphasis of this concept–driven by the goal of dissemination–is on simple storyboards designed quickly by everyone. We refrain from discussing those details and direct our attention to the issue of playful learning.

There is no doubt, playing is much more enjoyable than doing some unpleasant work. Therefore, people tend to arrange the first and to avoid the latter as good as they can. However, whether we realize an activity more as a play or more as unpleasant work, is not a feature of the activity itself, but of our mental relation to it. Thus, the same activity may be realized by the one individual as an exiting play and by another one as real hard work. This is especially true for learning activities. The problem relates to the question whether or not a certain activity belongs to some game class. As the underlying class concept [Jantke, 2006] is determined by the human's ability to navigate between the poles of self-determination and indetermination, the answer to this question depends very much on the human. The most obvious case may be Tic-Tac-Toe which is algorithmically trivial and mastered by most adults without any effort. It does not appear as a game, but simply as nonsense. However, to many children and to some adults, it is still a game.

We are not going into a general theory of game and play such as [Huizinga, 1938, Huizinga, 1949] and refrain from historical studies such as [Kent, 2001] as well. For the purpose of integrating play into (e-)learning, a deeper understanding of the origin of fun is deemed important. Csikszentmihalyi has introduced the concept of flow to characterize a human's deep immersion in an activity [Csikszentmihalyi, 1991] such as some game play. Recently, Koster has focused even more sharply on fun in game play [Koster, 2005]. So what makes learning playful?

Indeed, a course that just consists in listing up facts on the subject to teach, is not exiting. From the authors' experience in teaching at universities there are some typical means to let learning become some sort of play.

Leaving a very last small gap in a chain of subsequent argumentation that ends in an interesting (unexpected, surprising, . . .) conclusion is one of the ”plays” we implement in learning scenes. Here, the learner is led to a situation to derive a topical conclusion by himself instead of being told this conclusion as a matter of fact. If the learner derives the conclusion by completing the argumentation chain towards a new insight, he/she is in a mental situation that is similar to a ”smart move” towards winning in a game.

Another means to make learning playful is including illustrations, metaphors, examples, and the similar to theory. Items like these are often realized as some cultural supplement and thus, learners don't tend to follow them with the bias to get confronted with difficult content. The more such items are amusing, exiting or surprising, the more they serve as material to nicely wrap difficult content. This increases the entertainment factor of the learning situation – just like in a play. Illustrating theory with such items is a useful means of better understanding it. Since understanding is the ”aim of the game” in learning, understanding better is like getting closer to win the game. An also enjoyable side effect is that it rises the insight that the theory itself is not that difficult as it looks like. In many cases, it provokes the ”game” of utilizing theory as a means of also clearly expressing knowledge by the learners. In other words the learner tries to copy the style of presenting content in some sort of competition with the other actors (co-learners and teachers). Isn't that a game situation as well?

In many subjects of learning there are ”toy applications”, i.e. applications that are not really useful, but a game by their nature. In one authors' subject, Artificial Intelligence (as the course EEL 4872, see figure 1), there are some ”intelligent” software systems that only have the purpose to entertain people (see next section for examples). Including them in a course is including games and, thus, a contribution to playful learning.

Often, a general idea of an approach to be introduced as learning content, can be mentally prepared by some kind of game in which this approach is the key of successful playing the game. An example for this game implementation into learning processes is also shown in the following section.

Another valuable source of utilizing the entertainment factor of games for playful learning is providing tools that allow some experimentation and thus, a trial and error game to simulate own ideas. A popular example of implementing such games in learning activities are planning games in finance and business administration. By simulating the impacts of learners' ideas influence a (finance-, products-, service-, labor-, . . .) market, they are sent into game situation. An example for an entertaining experimentation tool for the Artificial Intelligence course of one author is also presented in the next section.

A Storyboard on a University Course

Here, we outline a storyboard that we developed for a course on Intelligent Systems that is at the University of Central Florida. At the starting point of the development, we had the course material and "experience sources" as used so far, such as (1) a course announcement (including references, grading rules, class policy, and a tentative schedule as a linear sequence of topics over the semester), (2) the books referred in this announcement, (3) a huge amount of slight collections for each part, and (4) two individuals with some topical background: two of the present paper's authors.

Nodes and edges

Besides the *Scenes* and *Episodes*, we defined two more node types: *To Do* -s, which define anything to do for the final grade, and *Off Page References*, which are points to jump back and forth between sub- and related super–graphs.

Symbol	
Behavior when double clicked	• opening a document (**.doc, *.pdf, *.wav, *.vsd, *.ppt, *.xls* , . . .) • nothing, if just verbally described scene
Behavior when following a hyperlink	• opening a document (**.doc, *.pdf, *.wav, *.vsd, *.ppt, *.xls* , . . .) • visiting a website with the standard browser, if it is an URL • opening the standard mail tool, if it is an e–mail address
Key annotations	
Scene	scene name: *free text*
Key words	key words: *free text*
Educational difficulty	degree of complexity: *any* | *basic* | *advanced*
Educational presentation	style: *any* | *theory based* | *illustrated*
Media	media documents needed: *free text*
Unspecified media	media documents to be specified: *free text*
Actors	human actors: *instructor* | *students* | *both*
# slides	# of slides: *integer*
Estimated time consumption	approx. time needed: [*h*]:[*min*]
Location	location and equipment requirements: *free text*

Table 1. Scenes

Each node has different meanings and behaviors. In Microsoft^{TM} Visio, so called hyperlinks can be defined on any graph object to open either a local file of any media type with the appropriate tool or to open the standard browser with a specified URL respectively mail tool, if it is an e–mail address. We made use of this opportunity for the *Scenes*, *Episodes* and the *ToDo*-s. In particular, the nodes, their behavior and their key annotations are as specified in Tables 1, 3, 4, and 2.

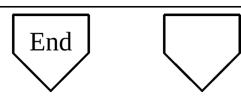
Symbols	
Behavior when double clicked	jumping back and forth
Behavior when following a hyperlink	• opening a document (**.doc, *.pdf, *.wav, *.vsd, *.ppt, *.xls* , . . .) • visiting a website with the standard browser, if it is an URL • opening the standard mail tool, if it is an e–mail address
Key annotation:	name of sub– or super/graph: *free text*

Table 2. Off–Page References

For edges, it is not meaningful to define double click actions or hyperlinks. In our storyboard, they have exactly one key annotation: a field, where the author can specify a condition to follow this edge. Edges may have different colors. A storyboard author is free in the choice of colors; there is only one requirement to meet: The colors must mean anything. Wherever a new color is introduced for several edges going out of one node, it must be noted as the "key annotation" which color of the upcoming path is recommended under which conditions. The storyboarding practice of the authors indicated that introducing new colors is useful, if the "fork-situation" continues for a path of several nodes. In case both ways merge back to one after visiting one node, we did only mark the condition as a key annotation, but did not use a new color and did not see a lack of visual overview and clarity. We feel the opposite is true; too many colors cause lack of overview.

Symbol	
Behavior when double clicked	opening the sub-graph that specifies the episode
Behavior when following a hyperlink	• opening a document (**.doc, *.pdf, *.wav, *.vsd, *.ppt, *.xls* , . . .) • visiting a website with the standard browser, if it is an URL • opening the standard mail tool, if it is an e–mail address
Key annotations	
Episode	episode name: *free text*
Key words	key words: *free text*
Educational difficulty	degree of complexity: *any* | *basic* | *advanced*
Slides	slide file in the conventional course: [*file name*].*ppt*
Equipment	equipment needed for the episode: *free text*
Media	media documents needed: *free text*
Unspecified media	media documents to be specified: *free text*

Table 3. Episodes

Symbol	
Behavior when double clicked	• opening a document (**.doc, *.pdf, *.wav, *.vsd, *.ppt, *.xls* , . . .) • nothing, if just verbally described scene
Behavior when following a hyperlink	• opening a document (**.doc, *.pdf, *.wav, *.vsd, *.ppt, *.xls* , . . .) • visiting a website with the standard browser, if it is an URL • opening the standard mail tool, if it is an e–mail address
Key annotations	
Type	type of activity (homework #, midterm exam, final exam, ...): *free text*
Topics	topic of homework or exam: *free text*
Material allowed for students	things allowed to use (calculator, dictionary, . . .): *free text*
Material needed by instructor	things needed by instructor (docs with tasks, . . .): *free text*
Relative worth	% of worth w.r.t. the final grade: *free text*
Date	scheduled date and time for activity: *free text*
Location	location of activity (home, seminar room, . . .): *free text*
Maximal time consumption	max. time given for activity: [*h*]:[*min*]

Table 4. ToDo-s

Figure 2 shows two of the graphs in the storyboard for EEL 4872 (see figure 1) for this course exemplary. These twographs are subject of further consideration in the following section.

Course structure

The graph of figure 1 is the top level storyboard. At this level, there are not much alternative paths. It is quite typical, that didactic decisions to follow one out of several alternative paths are more tactical in nature and driven by circumstances, which are related to particular topics. Here, only for the very last chapter (on philosophical issues) there is the alternative to visit or skip it, depending on (1) the time left, (2) the degree of discussing those issues in previous chapters already, and (3) current actual news that rise such questions. As mentioned above, (1), (2), and (3) is expressed as an annotation to the different paths leaving the episode *Knowledge Based Systems*.

To show the opportunities of including didactic variants and intentions and the opportunities to build in game situations, we next have a closer view to two 3rd level storyboards on *Machine Learning*.

Examples from the Machine Learning chapter

The two sub-graphs considered in this chapter are dedicated to learning episodes dealing with the research fields of *Case Based Reasoning* (*CBR*, for short) and *Inductive Inference*.

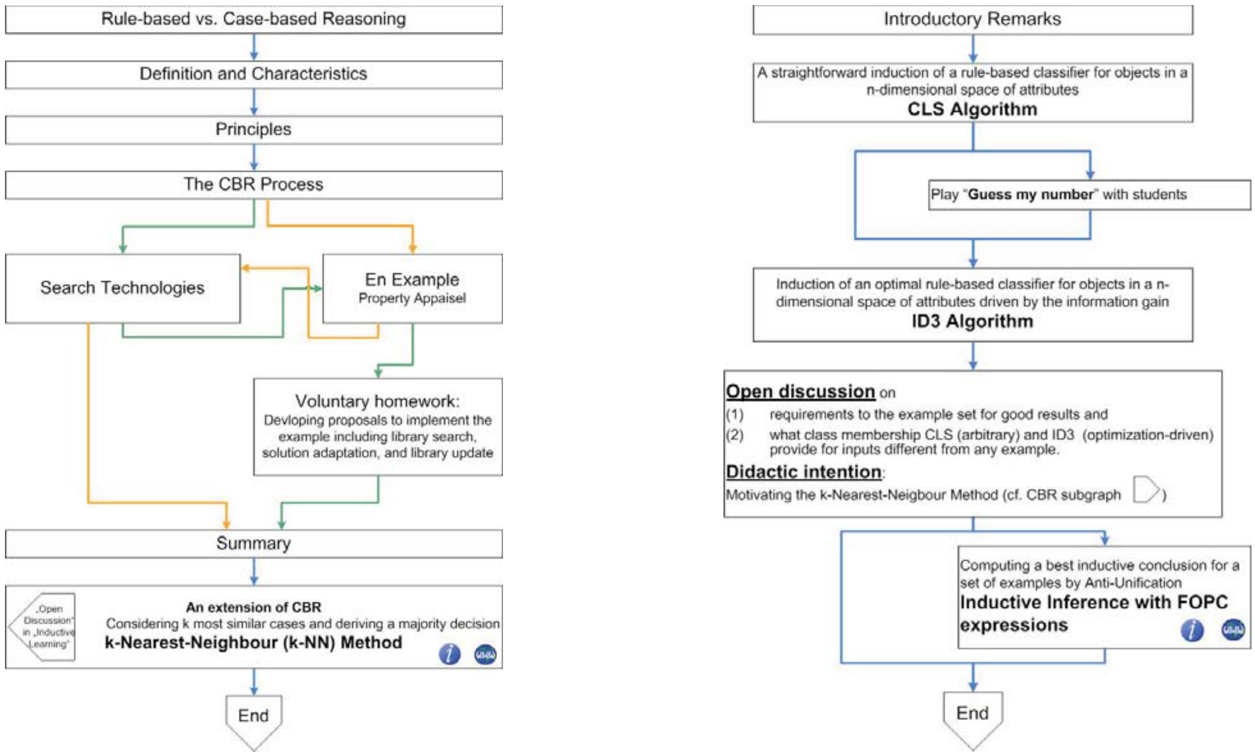


Figure 2. Two episodes of course EEL 4872

The first one (*CBR*, see left part of figure 2), shows a little more structure than the top level. Here, different paths are defined depending on a tactical decision: If the teacher realizes that the *CBR* process is well understood, he can proceed to the search technologies in Case Libraries (green path), otherwise he needs to include the example before doing that (orange path). Moreover, for the "smarter students" who follow the green path, an additional optional node is visited. Besides the different colors of these alternatives, the condition to follow the one or the other is annotated to the edges. In fact, immediately illustrating some theory by an example when seeing felling faces, is a didactic decision, that is offered explicitly by means of the storyboard.

An example for variants to link the graphs (besides the sub–/super–graph relation) is the final scene of the graph on CBR on the k*–NN method*. There is an additional linking between the *CBR* graph and the graph on *Inductive Inference* (see right part of figure 2). Since the k*–NN method* is some sort of *CBR*, which overcomes some drawbacks in Inductive Inference, there is a reference back and forth. Depending on whether this scene is visited as a supplement to *Inductive Inference* or as a regular part of *CBR*, the related *Off–Page Reference* needs to be clicked to jump back.

A nice example for including didactic intentions can be seen in the storyboard of *Inductive Inference* (right part of figure 2). Here, the simple play "Guess my number" is intended to give the students an idea, what the term *Information Entropy* means, because this concept is utilized in the subsequent scene. A teacher might decide, whether such a (entertaining) bridge towards the next topic is appropriate. It is just a didactic variant that is modeled in the storyborad and a way of involving games to keep students motivated.

Moreover, the open discussion on requirements the so–called *Example Set* in *Inductive Inference* should meet for *CLS* and *ID3* (both are methods of *Inductive Inference*) and the impact of these sets on the quality of inference results, if they are not met properly, leads directly to a concept to adjust these drawbacks: the k–NN method. Since k—NN is not a method of *Inductive Inference*, but of CBR, an *Off-Page Reference* to the related node in the CBR storyboard is placed here.

An example from the Introduction chapter

Another example to involve games is used in 2nd level graph on Introductory Remarks. As a game situation, we let students play in three different groups with three different ”toy applications” of *Artificial Intelligence*. These ”toys” are the one idea to involve games. Their intention is entertaining people by simulating real human behavior when talking to these computer programs.

After this (more or less passive) amusement phase, the groups are asked to introduce their particular ”toy” to the other students. Although it is not consciously to the students, it brings them into another sort of an (active) game. It opens some sort of competition on the issue, which group had the ”coolest” example ”toy system” the thus, the most fun when playing. In fact, competition in ”toy subjects”, which don’t have an impact on the ”real life” is the very nature of most games. So what they do is a playing a game.

Summary and Outlook

Storyboards in general, and the one introduced in this paper in particular, are an approach to make the didactic design of university courses explicit. Since their scenes are not limited to the presentation of electronic material, but may represent *any* learning activity, the application of this concept goes far beyond the IT approaches to support learning so far.

The idea to represent knowledge at a high level with a modeling concept that is appropriate to be used by topical experts (university teachers, in this case) without the need of an IT– or even software technological background is very much AI–driven. Here, the term ”topical knowledge” is not related to the learning content, but to its didactics instead. In particular, didactic intentions and variants can be specified as a nested graph-structure. One essential property of this concept and its implementation is its simplicity in terms of both the concept itself and the tool we used to implement it. Everybody, also university teachers of subjects that are far away from Information Technology, are able to develop storyboards.

A big advantage in learning can be reached, if the related activities leads the learner into a mental state that is similar to the one while playing an exiting game.

We don’t claim, that learning hasn’t been exiting so far. The point is, that our storyboard concept enables to explicitly represent the patterns that model exiting learning activities. Moreover, it has the potential to identify such patterns and, as the final aim of this research, to intentionally build in such patterns into learning activities.

Especially if teachers don’t have that much didactic skills and experience, which is often the case with university professors, this approach is like a launch pad towards a quality leap (not only) in university teaching.

Driven by their university teaching experience, the authors suggest embedding game situations as a means to attract the willingness of learners and sketched some ways to implement this in the didactic design of a course.

Of course, we won’t stop this research after having a high level modeling concept for didactic design and asking university teachers to perform their ”knowledge processing” with it. Our upcoming research on this issue is as follows:

1. A short term objective is, of course, promoting the development and use of this concept.
2. After that, as a medium term objective, we plan to develop an evaluation concept for storyboards based on the learning results of the students as acquired from the final grade they achieve for the storyboarded courses.
3. Our long term objective is to identify typical didactic patterns of successful storyboards.
   Since the learning result of a particular student is associated to a particular path through the storyboard, we should be able to identify successful storyboards in general, but also successful paths within storyboards in particular. By Machine Learning methods we finally might be able to find out, what these successful storyboards respectively paths have in common and in which properties they differ from the less successful ones. Thus, we might be able to identify success didactic patterns.

The latter is, in fact, the vision of knowledge discovery in didactics. By utilizing the didactic insights acquired by this approach for the upcoming storyboards, we intend to close the loop of the never ending storyboard developing spiral.

Acknowledgement

The authors are grateful for the support from the Laboratory of Interdisciplinary Information Science and Technology (I2-Lab) at the School of Electrical Engineering and Computer Science at the University of Central Florida. Thanks to this support we could build the exemplary storyboard, which is an important source of experience for the authors.

References

Comenius, J. A. (1638). *Didactica magna*.

Csikszentmihalyi, M. (1991). *Flow: The Psychology of Optimal Experience*. Harper Perennial.

Damasio, A. (1999). *The Feeling of What Happens. Body and Emotion in the Making of Consciousness*. Hartcourt, Inc.

Fritz, J. (2004). *Das Spiel verstehen. Eine Einführung in Theorie und Bedeutung*. Weinheim & München: Juventa.

Gaither, D. and Luckhardt Redfield, C. (2006). Survey of electronic games that teach. In Crawford, C. M., Carlsen, R., McFerrin, K., Price, J., Weber, R., and Willis, D. A., editors, *Society for Information Technology & Teacher Education (SITE), 17th International Conference, Match 20-24, 2006, Orlando, FL, USA*, pages 1367–1371. Association for the Advancement of Computing in Education (AACE).

Huizinga, J. (1938). *Homo ludens: proeve eener bepaling van het spel-element der cultuur*. Haarlem: H.D. Tjeenk Willink.

Huizinga, J. (1949). *Homo Ludens: A Study of the Play Element in Culture*. London: Routledge & Keagan Paul.

Jantke, K. P. (2006). Digital game knowledge media (Invited Keynote). In Tanaka, Y., editor, *Proceedings of the 3rd International Symposium on Ubiquitous Knowledge Network Environment, February 27 March 1, 2006, Sapporo Convention Center, Sapporo, Japan, Vol. of Keynote Speaker Presentations*, pages 53–83. Hokkaido University of Sapporo, Japan.

Jantke, K. P. and Knauf, R. (2005). Didactic design through storyboarding: Standard concepts for standard tools. In Baltes, B. R., Edwards, L., Galindo, F., Hvorecky, J., Jantke, K. P., Jololian, L., Leith, P., van der Merwe, A., Morison, J., Nejdl, W., Ramamoorthy, C. V., Seker, R., Shaffer, B., Skliarova, I., Sklyarov, V., and Waldron, J., editors, *First International Workshop on Dissemination of E-Learning Technologies and Applications, DELTA 2005, in: Proceedings of the 4th International Symposium on Information and Communication Technologies, Cape Town, South Africa, January 3–6, 2005*, pages 20–25. Computer Science Press, Trinity College Dublin, Ireland.

Kent, S. L. (2001). *The Ultimate History of Video Games*. New York, USA: Three Rivers Press.

Koster, R. (2005). *A Theory of Fun for Game Design*. Scottsdale, AZ, USA: Paraglyph Press, Inc.

Prensky, M. (2001). *Digital Game-based Learning*. New York: McGraw-Hill.

Salen, K. and Zimmerman, E. (2003). *Rules of Game. Game Design Fundamentals*. MIT Press.

Spitzer, M. (2002). *Lernen. Gehirnforschung und die Schule des Lebens*. Spektrum Akademischer Verlag.

Suits, B. (1978). *The Grashopper: Games, Life and Utopia*. Godine Press.

Wallace, P. (2006). Using standards-based adventure software to enhance problem solving skills. In Crawford, C. M., Carlsen, R., McFerrin, K., Price, J., Weber, R., and Willis, D. A., editors, *Society for Information Technology & Teacher Education (SITE), 17th International Conference, Match 20-24, 2006, Orlando, FL, USA*, pages 1422–1426. Association for the Advancement of Computing in Education (AACE).