MODELING EDUCATIONAL QUIZZES AS BOARD GAMES

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ABSTRACT

In last decades, online computer games are used for e-learning purposes with significant success which determines steadily increasing interest in game development. Board games are special group of computer games where figures are manipulated on a surface according predefined rules. The paper presents a new, formalized model of traditional quizzes, puzzles and quests as multimedia board games created for facilitating the construction process of games of such types. By several examples authors show the model is quite general in order to support not only quiz, puzzle and quest presentation but also any instructional set of teaching activities presented as a race game. An adaptive game control strategy is proposed where dices are used for random selection of complexity of next questions. The model is going to be used as a basic paradigm for construction of a software platform for multimedia game development for adaptive education.

KEYWORDS

Quiz, board game, TEL, adaptive, quest

1. INTRODUCTION

There are many successful e-learning stories proving that technology enhanced learning is a must for contemporary education starting with early childhood up to universities and professional training. In order to turn modern e-learning to be more effective and engaging, there are proposed many approaches complementing traditional instructional learning design with educational games (Siang, 2003; Prensky, 2006). Nowadays, educational games are regarded as a mean for definition of activities involving one or more players into targeted issues with well stated goals, constraints, payoff, and consequences (Dempsey, 1996). They are more and more widely used thanks to the added value they offer. According Mark Prensky (Prensky, 2006), it can be summarized within several important characteristics:

- Games are a form of fun and play, thus, they give pleasure and emotions
- Games provide structure and motivations by using rules and setting goals
- Games are interactive and may be adaptive which helps learner's engagement
- Games gratify learner's ego by having win states
- Games increase creativity by imposing conflicts, competitions and challenging problem solving

The great challenge for designers of educational games consist in presenting educational content within the game play in order to take learners into real problems by involving them into scientific, mathematic, or engineering practices, and also to make them thinking creatively and communicating their ideas (Salen, 2003). Most of the existing educational games are quizzes, puzzles and problem solving staging (Batson, 2006; Ferreira, 2008). Unlike quiz games, board games suppose moving figures across a surface (board) using counters or dices. Although board games may be played by single users alone or against an artificial agent presenting a real opponent (Bontchev, 2001), they are played most often by multiple players providing interactive learning experiences as far as players learn from one another while playing for fun. There are designed educational board games using board rules for navigation within a quiz and for control of the questions (Feng, 2005; Retalis, 2008).

The present paper aims at creation more general, multimedia-rich and problem-oriented quiz games by means of board game instruments. It explains a new, formalized model of traditional quizzes, puzzles and quests as multimedia board games which will facilitate the construction of such games. There are encountered practical examples authors showing that this general model does support quizzes, puzzles, quests, logical problems and also any instructional set of teaching activities presented as a race game. Authors propose an adaptive strategy for game control using dices for random selection of complexity of the next question. The model is going to be used as a basic paradigm for multimedia game development for adaptive education.

2. RELATED WORKS

Quizzes enjoy great popularity in technology-enhanced learning because they can be applied successfully for playing games for fun, self-assessment or final exams. Quiz games can be designed by means of a plenty of commercial tools such as Tanida Quiz Builder[1], Wondershare QuizCreator[2], Quiz Center[3], and many more. At the same time, there have been constructed several frameworks and tools for design of educational quizzes. Some of them allow creation of quizzes by authoring tools (Dalziel, 2008; Retalis, 2008) while others propose automatic generation of questions and, as well, automatic assessment of answers (Guetl, 2005). There are also available authoring tools with possibilities for parameterized questions (Hsiao, 2009).

In last decade, some approaches for adaptive quiz control have been proposed. QuizGuide and QuizJet (Hsiao, 2009) have been developed as an adaptive systems helping students select self-assessment quizzes most relevant to individual learner. Both the systems make use of adaptive navigation support to select most important course topics. Authors have found that such adaptation helps weaker students to make better progress. Other game in the area of adaptive e-learning system is ELG (Retalis, 2008). It has elements of racing board game. The goal of ELG is to improve the performance of a particular learner as he/she takes participation in different learning activities in the form of board games. Moreover the ELG has authoring tool whereby teachers can personalized each game depending learner's goals, level of knowledge and preferences. Personalization or adaptation is realized by describing rules for transition from one level of the game to another and a level corresponds to one single goal.

A modern trend in quiz presentation and control are some newly proposed map (or board) rule-driven approaches, where profound knowledge of the teached course material assusers safe navigation throught a map (board). The quiz questions may be stayed written on the walls while navigating through a maze, or shown on the cards of a deck (Feng, 2005; Retalis, 2008). Though the usage of board rules for controlling players answering questions seems to be too narrow, the concepts provides a lot of advantages - questions may vary in terms of difficulty, players make take turns by rolling dices, and there could be applied various strategies for selection of question card for each player. Such games can be played by a single user alone as a normal quiz, by a single user against a simulated player (by an artificial engine) or by multiple users together.

Other class games are so called active learning games. They are a pedagogical method where students are actively involved with key concepts of a problem. An example of such game is the implementation of "Genetic Algorithm Game" (Weck et al., 2005). This game is used in the context of engineering education and reported positive results in conceptual learning and student experience.

3. QUIZZES AS MULTIMEDIA BOARD GAMES

The approaches described in previous chapters of this article treat two orthogonal issues – quizzes (and logical puzzles) and board games. Usually, quizzes are designed and run as test for self-assessment and/or official assessment for a given course or for a specific topic. Although some quizzes are referred as quiz games, in fact they continue sticking to traditional quiz format, presentation and run time control. Unlike quizzes, board games are created by special game design tools and are based on specific strategies which should be followed in order to resolve problems or achieve given configuration, under given race conditions. Both quizzes and board games may played by a single user and/or multiple users. More often, run time is divided into steps (passes, paces) which cannot exceed predefined time duration.

[1] http://tanida-quiz-builder.smartcode.com
[2] http://www.sameshow.com/quiz-creator.html
[3] http://school.discoveryeducation.com/quizcenter/

In this section, we argue a quiz can be represented as a special board mini-game, with board of any form, positions, figures, manipulation rules and effects. Such games are designed to support the educational process as a whole. This means, they should allow representation not only of quizzes but also allow description of problems to be solved and, in general, of any learning activities and their workflow.

3.1 Modeling quiz questions as board games

Normally, a quiz is composed by separate questions following in given time order. Dynamic quizzes are based on selection of quiz questions on run time in a random way or using given criteria. Any question refers a specific problem and supposes one or several answers from a predefined answer set or another, more sophisticated type of answer. Some questions may have to be answered by a word or sentence not shown as potential answer (so called filling blank question type), while other may require sorting a list of words or objects. Finally, there are question of different type stating a general problem to be solved. Usually, they operate with graphical abstractions (figures) and the person solving such a quiz has to move, reorder or rotate them in order to solve the problem.

Our goal is to define a general quiz model, which could be able to present all the quiz questions and their answering processes mentioned over. The presentation is supposed to be attractive one, with high level of dynamism and appealing multimedia elements. On other side, the model should be general enough to allow description of any situational problem and its solution suitable for e-learning purposes. As well, it should allow presentation of a wide range of e-learning activities such as visiting a virtual museum and shooting pictures of some pieces of arts (White, 2005), collecting or selecting objects of given type residing specific locations, discovering a specific object (e.g., a treasure) on a map, finding a way within a labyrinth, etc. Last but not least the model should allow a straightforward realization.

The proposed model of quiz uses a non-restricted board, presented as an image map with given configuration of positions of various types over it. Usually, the capacity of each position is 1, however, for some games different capacities may be defined. The configuration is defined by functions of neighborhood for all the positions. On some of the positions or out of the map there are allocated objects (figure) of different types (classes) and power for each one of the types. For most of the games, the object classes are singletons, i.e. may have no more than one instance. Both the positions and the object are allocated over a game background which defines the context of that quiz game. This contextual background also specifies what should be done by the games (i.e., the learner). He/she is supposed to do some actions over the objects such as drag and drop, single or double mouse click, or rotate. Each action for given object may be executed only some pre-defined rules for the given object type, possibly, with some conditions met. Such preconditions may concern the manipulated object itself (whether objects of its type could be moved, clicked, rotated, etc.) and/or the destination position and positions between the initial and destination one (for move, i.e. drag-and-drop actions). Such conditions may check if the destination positions and positions in-between are free, or other facts. Finally, after each allowed action, one or more result events may be fired depending of the action success. Together with these result events, the game engine (which controls the game process) should check if the final objective of the game is achieved. This check should be done at the end of each action in order to verify the finish conditions, i.e. it is one of the resulted effects for the action. Thus, if we define the following:

- GB – Game Background,
- $P = \{P_1, P_2, \ldots, P_N\}$ – set of positions, probably of different types (colors),
- $O = \{O_1, O_2, \ldots, O_M\}$ – set of objects types (classes),

then we may define

- Config(P, GB) - given (initial) configuration of positions P over the Game Background,
- $CapacityP = \{C(P_1), C(P_2), \ldots, C(P_N)\}$ – capacity ,
- $PowerO = \{P(O_1), P(O_2), \ldots, P(O_N)\}$ – power of each object type (class) – gives the number of object instances for each object class as an integer number,

- InitAllocP = {∀ functions Alloc(P_i) for i=1..N} – initial allocation of objects of all the types over the positions; each function Alloc(P_i) returns a n-tuple of the number of objects of given class allocated initially over P_i. Thus,
  Alloc(P_i)={AllocOverP_i(O_1), AllocOverP_i (O_2), …, AllocOverP_i (O_N)}.

Next, we have to define the rules for object type manipulation at each position as far as rules may differ from position to position. For the drag-and-drop action from position P_{source} to P_{dest} for object of type O_i (i=1..N), the rules and the effects will be as follows:

- Rules = {∀ Rule(Action, P_{source}, P_{dest}, O_i)}, where each rule states for a predefined Action a set of conditions which should be met in order to move the object of type O_i from P_{source} to P_{dest}, of course if such an object is available at P_{source}, and each Rule(P_{source}, P_{dest}, O_i) is a set of conditions of various types (e.g., maximum capacity checks for P_{dest}, check for admissibility for allocation object of type O_i over P_{dest}, etc.)

- Effects = {∀ ActionEffect(Action, P_{source}, P_{dest}, O_i)}, where each rule states for the given Action (e.g., drag-and-drop) a specific multimedia effect, possible increment and check of result, etc. If the game finish check returns true, the game is over.

Thus, the quiz board game as {P, O, Config(P, GB), CapacityP, PowerO, InitAllocO, Rules, Effects}.

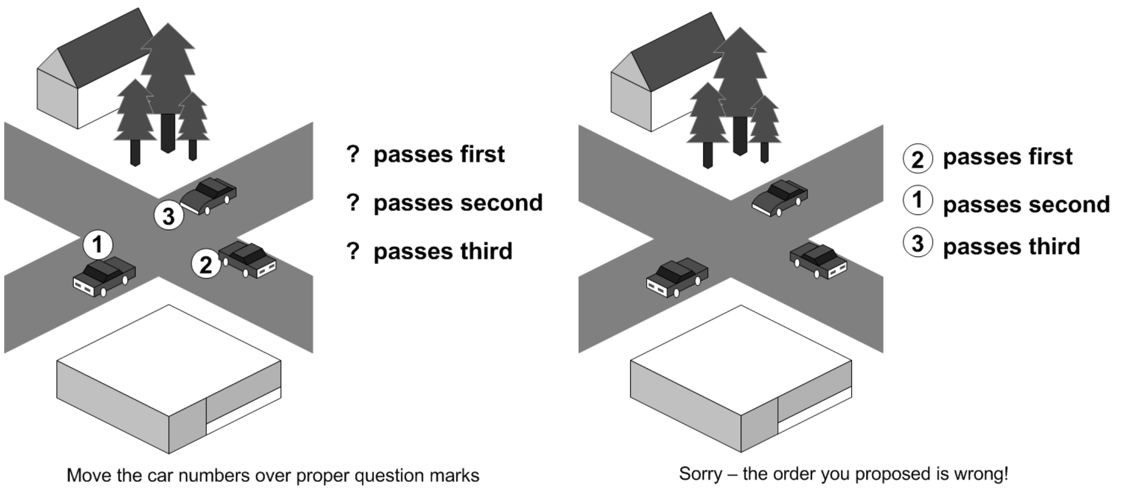
3.2 Quiz, puzzle and quest examples of board games

The model of quiz and puzzle games described over provides a powerful paradigm for facile and rapid construction of rich multimedia games of such types in a uniform way. The unification comes from the fact that educational games as quizzes, quests, puzzles and even instructional sets of e-learning activities can be represented as board mini-games. It may serve as a base for construction of graphical designer of games of such types with various levels of multimedia enrichment and complexity. The complexity of such a game will depend on the complexity of the rules and conditions and checking functions used for rule definition. Moreover, even more complex position board games as chess and backgammon can be defined by the model sketched over, however, they are not appropriate for educational purposes. For this reason, the examples of games designed by the authors and available in this section of the paper are in the area of quizzes, puzzles and quests.

In the case of quizzes, each mini-game will present a given quiz question. Unlike traditional quiz games, here the questions will appear in an appealing way, with advanced multimedia. Moreover, such board mini-games can represent not only quizzes but also specific logical problems to be solved. As well, they may present any set of teaching activities organizes in a list or set with random choice.

The following pictures show some of the possible quiz questions developed as board mini-game. Question with answers of type one of many, many of many, and filling blank have a straightforward and easy presentation. For such types of questions, answers are going to be represented as textual or multimedia objects and the player have either to select them by clicking or to move one or many of them to the position of right answers. Presentation of question of type "order of answers" and matching problems supposes more interesting presentation. The figures below show a situation analysis on a board game regarding the public transport rules. The answer is of type list, or "order of objects", and the list on the left side of the figure is empty at starting the game (a) and filled-in in a wrong way after game finish (b).

Fig. 2.a represents the start view of another positional quiz board game similar to puzzle games. Here, the question is of type "concept matching" – players have to discover the right matches between dark polygons over and white stars below and, next, to move each of the stars over the right polygon. The three matches are of type 1 to 1 mapping between positions (polygons) and objects (stars). Fig. 2.b depicts a successful game finish. Both wrong and successful finishes may be accompanied by multimedia effects as well as each right/wrong placement of a star over a polygon.



(a) (b)

Figure 1. Quiz board game with answer of type "order of objects" at starting the game (a) and after game finish (b)

(a) (b)

Figure 2. Positional quiz board game with 1 to 1 mapping between position and objects at starting the game (a) and after game finish (b)

Next figure shows similar quest problem where players have to sort animals as herbivores and carnivores by moving them to one of two boxes. Unlike previous example, here the mapping between positions (boxes) and objects (animals) is of type N to M. The game rules should prohibit dropping animals at other position than the boxes. Thus, as far as the objects may be dropped only at one of the boxes (and possibly disappear after dropping within the box), the condition for game end simply checks whether there are no animals at the starting positions and the position of each boxes contains only the right animals.

Classical image or word puzzles have easy construction process as board mini-games. The image building parts or the letters of a work puzzle are represented as objects, which should be moved o the right positions (wrong moves are possible). Logical quest may require action types different than move – such as simple and double clicks onto objects and object rotations, horizontal or vertical flips. Fig. 4 gives a view of a positional quest board game for matching musical instruments with minimum number of mouse clicks, for shortest time possible. The gamer has opened the first box containing a picture of mandolin, and now has to open a second such box by a single click. While trying to match the other instruments, he or she had to remember where is located the second violin box. So, if the gamer will open it with a single click, both the mandolin boxes will stay opened with melody played on the shown instrument, otherwise they will both close with disappointing noise and the number of wrong clicks will increase by one. The figure shows the situation after seven successful matches, when the player has opened a box with a mandolin as a candidate for the next, eighth, pair. The game helps developing memory but also makes gamers to remember form, name and timbre of most popular music instruments.

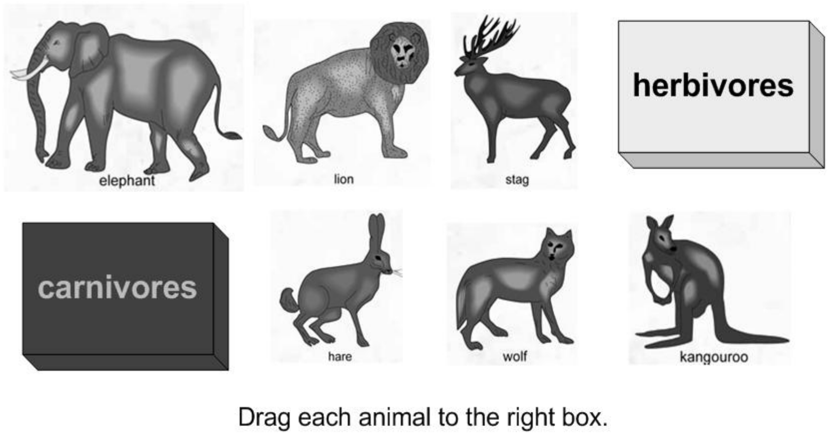


Figure 3. Positional quiz board game with M to N mapping between position and objects

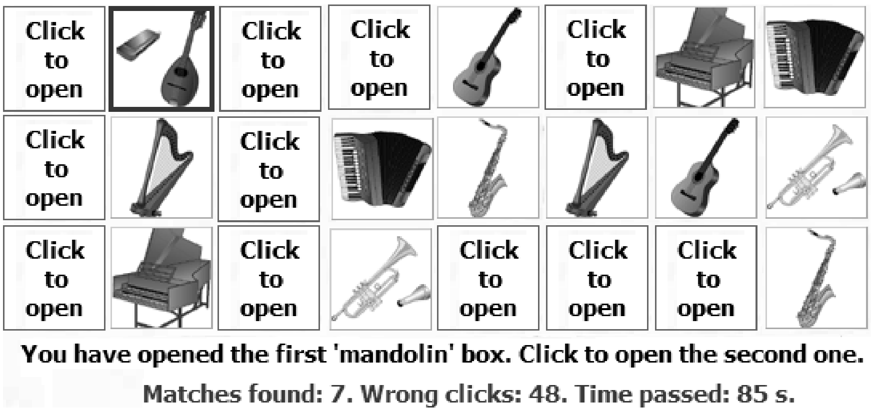


Figure 4. Positional memory quest board game for matching musical instruments with minimum number of mouse clicks

With similar design there may be constructed board games with instructions of educational tasks such as finding the solution within a book, assembling a plant cell by its building blocks, searching and finding a treasure using a map and encrypted instructions, and many more.

3.3 Strategies for adaptive game control on run time

After proposing a new principal model for building educational quizzes, quests, puzzles as a sequence of board mini-games, it is time to consider design of strategy for game control. The approaches discussed within first two sections of this paper use a sequence of quiz questions following one after another. The game may show intermediate results and possibly, the right answers, or may only present the final score at the end. Usually, quizzes are ingle player games but some approaches allow multiplayer quiz games which introduces dynamic races. As well, for selecting the next question (problem), some games use dices as a random element (Retalis, 2008).

The approach proposed here uses adaptive strategy for selection of next question (problem) for the game, similar to the adaptive assessment. Like in (Retalis, 2008), the adaptivity here is according student interests and knowledge level. For this purpose, questions have to be ranked in design time and, therefore, questions with greater ranks will give more points to the gamer than these of lower ranks. The game starts with very simple questions and, after correct answers, continues with questions of greater complexity. If an answer is wrong, the next question will have a lower rank. Fig. 5 presents the process of playing such a game as climbing up a pyramid of success, where a trace of questions for given player is shown by small white circles (depicting the answered questions) allocated on a poli-line. The questions located higher on the pyramid have a greater rank. The pyramid itself is separated in levels of difficulty and reaching given level, the gamer cannot go down even when his/her answer is wrong as accepted within the game “who wants to be a millionaire”.

The adaptive selection of ranked question according correctness of the last given answer may be with a fixed increase of the rank, however, a better appeal for gamers (in fact – learners) is possible by throwing dices. By using dices, the increase (in case of right answer) or decrease (otherwise) will depend on a random value which will not change the adaptive strategy itself but will make the game more interesting for the students. In such a sense, dices could be used not only for fun but also even for self-assessment. Unlike the approach of (Retalis, 2008) dices here are not controlled by the instructor but truly random in order to give sense for a real dice play.

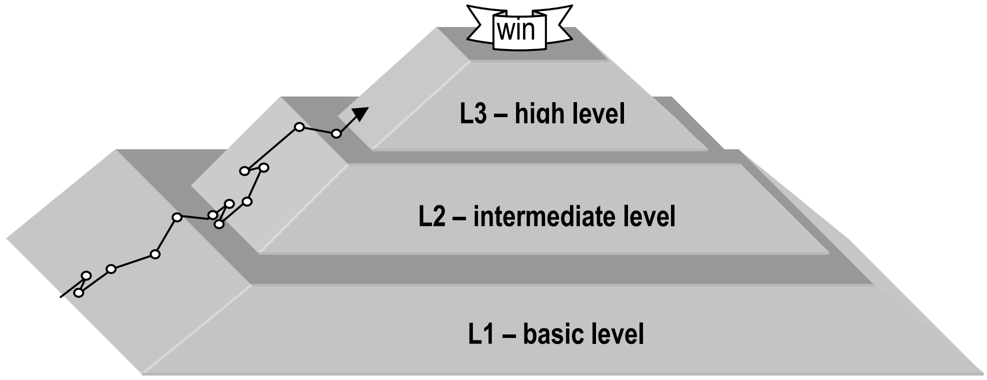


Figure 5. The game pyramid of success and a trace of questions for given player

4. APPLYING BOARD GAMES FOR ADAPTIVE E-LEARNING

Adaptive e-learning systems try to improve online teaching processes by providing different educational content and activities for different individual or groups of learners. Some of the modern adaptable platforms adapt delivery of courseware according the learning styles of students. Example of such a system is a platform for building edutainment (education plus entertainment) services called ADOPTA (Vassileva & Bontchev, 2008), which stands for ADaptive technOlogy-enhanced Platform for eduTAinment. ADOPTA is a modular system and includes: authoring tool for establishing the e-learning course content, instructor application (subject of this paper), and software engine, which is responsible for adaptable content delivery to every individual learner. It makes use of learning styles to provide adaptive courseware delivery by means of adaptable navigation through the storyboard and adaptive content selection. Instructors can update on Internet navigation in narrative graphs and page content by a user-friendly Flash interface using drag-and-drop of learning objects and games from particular domain ontology. Content and link metadata are widely used in order to be used for controlling adaptive content selection and adaptive navigation

ADOPTA is planned to make use of games of various types in order to select the proper game type for a given learner's character. Some of these types are planned to be the quizzes, puzzles and quests. As far as the model presented over and illustrated by several examples of games does support of quizzes, puzzles and quests, authors plan to use it as a building paradigm for construction of a tool for designing such games. Moreover, the tool will allow construction of a more complex problem solution game with involving within various teaching activities such as visiting some online course materials, instruction how to do some tasks, provisioning of auxiliary material, etc.

5. CONCLUSION AND FUTURE WORKS

Following the model proposed over various mini-games could be developed which supposes the need of construction a game framework for building such board mini-games. The model offers a plenty of advantages which should be proven in real practice. First at all, it allows presentation of several important educational game types such as quizzes, puzzles, and quests. The model allows presentation of more complex logical problems which have to be solved by several actions delivered by the player according some rules and context conditions. Such resolution of logical problems is suitable for active online learning. Finally, a complex set of instructions and activities within given domain context can be represented as a board game using the same model. Examples for such scenarios are activities typical for visiting virtual museum, following a receipt for preparing a dish, locating and discovering an object using geographical map, and many more.

The future work will continue with designing a functional interface for game rule creation and, therefore, creation of an online tool for authoring and generation of Flex board games complaint with the proposed model. By means of ADOPTA instructor tool and using game metadata descriptions, such games will be incorporated within narrative storyboard and will be delivered to learners with appropriate profile (learning style, preferences, etc.). An important research topic is studying usability of different game types for different learning styles.

Authors plan also to make use of artificial intelligence agent - one as virtual opponent to the player within given game and, next, as virtual supporter of the gamer helping him/her in finding the right solution of the stated problem.

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