

Game-Based Learning Guidelines:

Designing for Learning and Fun

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Abstract— Currently, games have an important impact on areas other than entertainment. Researchers have demonstrated that games have the potential for creating learning environments toward the improved attainment of educational and training goals. Suitable, clear and easy-to-follow guidelines need to be implemented, especially for the creation of e-learning games for children, to increase the expected benefits of game-based learning (GBL). In this paper, a comprehensive set of guidelines is proposed along with a detailed explanation of each guideline. The proposed set of GBL guidelines can be used with an expert evaluation method to identify possible problems in learning objectives, game designs, user interfaces, and child requirements in the early phases of a game project. This set of guidelines, though mainly targeted at the pre-production of a GBL, can be utilized in post-production phases.

Keywords— Game-Based Learning, E-learning, Usability, Human-Computer Interaction

I. INTRODUCTION

One of the main challenges for instructors in the field of education is to provide a motivating learning environment for their students to effectively achieve important learning outcomes. Recent innovations that have been shown to fulfill instructors' requirements include game-based learning (GBL) and educational games. The idea of using games in education has become increasingly popular as a result of recent technological advancements. More research is required to illustrate how games can be used and applied in a variety of different e-learning environments. According to Baranowski (2008), a game is defined as a physical or mental contest with a goal or objective that is played according to a framework or set of rules that determine what a player can and cannot do inside a game world. GBL refers to the use of computer games with educational value or the use of different types of software applications that employ games for learning and educational purposes (Tang et al., 2009). Recently, to prevent boredom in the learning process, mobile phones have been used with GBL under the label mobile phone game-based learning. Lin et al. (2014) discussed whether mobile phone game-based learning can replace computer game-based learning and compared the learning motivations of students using mobile phone games for learning and those using computer games for learning.

Many studies have supported the effectiveness of using GBL compared to traditional face-to-face learning in classrooms (Ebner & Holzinger, 2007, Kebritchi & Hirumi, 2008, Cojocariu & Boghian, 2014). Although traditional learning practices remain in use, GBL has been widely implemented in many courses. In general, the most important aspect of the educational process in both traditional learning and GBL is to keep the student motivated to learn, thereby preventing boredom with the class or the course material.

II. GBL GUIDELINES AND HEURISTICS GBL

Heuristics and design guidelines are powerful evaluation tools for both software designers and user interface experts. Heuristics have typically been used to evaluate usability and identify problems in a piece of software's interface early in the development process. These guidelines serve as a checklist, thereby helping designers examine the effectiveness and usability-related aspects of a system. They are cost effective, however, they are more subjective and than traditional user testing evaluations because they are heavily dependent on the evaluators' skills (Metra et al., 2002).

A system designer can detect a wide range of problems and possible faults in a complex system in a limited amount of time (Nilsen, 1994, Metra et al., 2002). Applying traditional heuristics and guidelines in evaluations of GBL systems is quite unfeasible. Existing guidelines do not comprehensively address aspects related to children, e-learning, and gaming. In addition, traditional guidelines are not described in detail in such a way that they can be directly adapted for GBL development. Finally, the reliability of the results is often entirely dependent on the individual know-how, expertise and skills of the evaluator. This problem was also noted by various researchers, who have defined more specific guidelines for particular system classes (Reeves et al., 2002, Triacca et al., 2004, Alsumait & Al-Osaimi, 2009).

Song and Zhang (2008) proposed a model that connects theories about the requirements for effective learning environments, theories about flow experience and essential strategy components for stimulating motivation. Desurvire and Wiberg (2009) used a survey method on a game

convention to define the PLAY heuristic list based on an HEP study. It is "...a more refined and updated list of Game Playability Principles (PLAY)". The authors wanted a generalized foundation, modifiable for each game, in which the PLAY list contains 48 heuristics.

Kiili (2011) described a model that integrates the learning process and the design process in an educational game. Amory (2003) developed GOM, which links pedagogical dimensions with game elements. Expanding on GOM, Amory proposed the more concrete GAM, in which the story forms the basis for game design. Quinn (2005) suggested four stages of educational game design: analysis, specification, implementation, and evaluation. Moser (2000) proposed an iterative prototyping cycle for educational adventure games that includes design, prototype, test, and analysis. However, Moser's model fails to provide a clear, easy-to-understand, step-by-step overview of the major issues for the design of educational adventure games. Despite the studies explained above, most models remain quite theoretical.

This paper identifies the most important aspects for the creation of educational games and combined them to develop practical and clear guidelines. We expand on the guidelines and heuristics in the reviewed literature, providing detailed explanations to allow us to focus more closely on GBL and to overcome the above shortcomings. For GBL design, the four factors shown in Figure 1 should be considered: learning objectives, game requirements, user interface requirements and child requirements. Thus, to create an effective GBL, we propose a comprehensive set of GBL guidelines and their explanations based on the current literature and our experience. The set of guidelines were reviewed by several playability experts and game designers to ensure the design of a successful, effective, efficient and enjoyable GBL system for elementary school students.

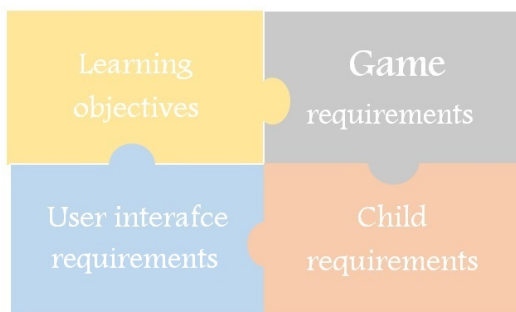


Figure 1: The four factors of effective GBL for children.

A. E-Learning Objectives

A learning activity can be defined as an interaction between a student and an e-learning environment with the objective of accomplishing an intended outcome. The learning activity is developed around the intended outcome. Designing for learning is a complex and creative process that involves identifying objectives, recognizing the needs of students, and selecting the most suitable approaches to

deliver outcomes. An appropriate balance must be established between e-learning and other modes of delivery when working within an interactive technology context. Moreover, recognizing the preferred learning style of the student as visual, auditory, or kinesthetic and aligning the curriculum with these learning styles has been proven to be beneficial. Academic confidence is increased by allowing students to access information using terms with which they are comfortable.

The e-learning component of the game should include general information, a course outline, an evaluation method, and learning style. These components of the e-learning program introduction must be provided to students before they begin the e-learning program to indicate what to expect during the program as well as the expected learning outcomes and anticipated benefits. Moreover, the use of good course management platforms helps the instructor organize the class materials, observe and manage student work, and much more.

The proposed e-learning guidelines (EG) are intended to remove barriers to e-learning, ensure maximum interoperability of the learning system and its content, and maximize the viability, integrity and portability of e-learning resources. The proposed guidelines are based on the literature and our experience (Buzzetto-More & Pinhey, 2006, Shehabat & Mahdi, 2009, McDaniel & Telep, 2009). The proposed guidelines along with their explanations are discussed next.

EG1: Clear Objectives and Outcomes

1. State student outcomes in terms of important student achievements.
2. Ensure that students are aware of the purpose and expected outcomes of the e-learning system.
3. Ensure that e-learning course requirements are consistent with the overall objectives and meet goals.
4. Consider the components learning environment.
5. Ensure that the game requirements are not in conflict with the e-learning pedagogical requirements.
6. Ensure that the child is led toward at least one or more of the course's learning objectives.

EG2: Use Different Learning Strategies

1. Differentiate among the wide range of students, learning needs, learning contexts, and modes of learning.
2. Implement varied, easily accessible, and relevant learning styles and theories to satisfy different students' needs
3. Encourage and motivate the development of independent learning skills.

EG3: Evaluate and assess students

1. Measure the degree to which these e-learning outcomes are being achieved.
2. Use quantitative and qualitative assessments.
3. Change the game logic according to the progress.

4. Use relevant, challenging, clear self-assessments that advance student achievement.

EG4: Effective Learning Content & Teaching Materials

1. Break the content into smaller chunks to be combined in unique ways for each student.
2. Use adequate content to help students achieve the learning goals.
3. Design well-structured and well-organized content to accelerate learning.
4. Write the content at a level appropriate to the students.
5. Use animated, encouraging and entertaining content.
6. Prepare the content with the help of qualified instructors and software design experts.
8. Ensure that the system enables students to benefit from each other's expertise.

EG5: Use Good Course Management Tools

1. Enable instructors and student to access capture class activities and archive course content.
2. Enable students to use various communication and threaded discussion tools to contribute to and enrich the learning experience.
4. Enable collaboration between individual students and groups.
5. Encourage the instructor to communicate with the students through email, and social network applications.
6. Enable the instructor to publish and modify the course materials, enroll students, and conduct tests and surveys without needing special programming skills.

To design GBL, learning objectives, content, materials, and technologies, for example, should be implemented to enhance the learning process and motivate the students to learn.

B. Game Requirements

Game design is the art of applying software design concepts and aesthetics to develop a game that enables communication among players for entertainment, simulation or learning purposes. Game design can be applied both to games and, increasingly, to other interactions. Game design creates players, a storyline, rules, challenges, mechanics, resources and support to define a game that produces desirable interactions among its participants. Useful, practical guidelines are lacking for the creation of e-learning games for children. This section attempts to fill this research gap by developing convenient, precise, and useful guidelines for the creation of e-learning games for children to create broader and deeper experiences. Figure 2 shows the key elements that identify a game: the players, storyline, rules, challenges, mechanics, resources, and game help, which combined define the overall context of a game.

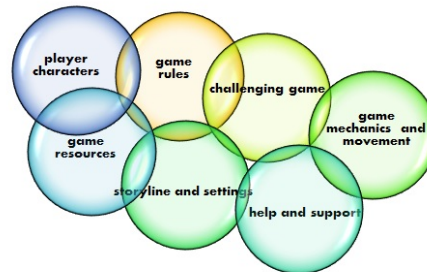


Figure 2. Key elements identifying a game

Next the set of game guidelines (GG) defined around the seven major components and intended for the design of an enjoyable game is presented (Desurville, 2004, Rouse, 2010).

GG1: Player Characters

1. Create game characters that interest the player.
2. Create ethical and interesting player characters.
3. Allow players control over their characters' movements and interactions.
4. Involve players emotionally in the game.
5. Allow characters to advance in level to become more powerful.
6. Encourage players to empathize with game characters.
7. Involve players in thinking about possible story outcomes.

GG2: Storyline and Setting

1. Reveal game characters through the storyline.
2. Design an understandable storyline
3. Design an engaging, clear, and fast-paced storyline
4. Relate the story to the real-world players' experiences
5. Clearly and logically present game settings according to the target audience, preferences and age group.
6. Provide a clear match between the game settings and the learning goals.

GG3: Game Rules

1. Limit player actions using game rules.
2. Make game rules explicit and unambiguous.
3. Fix, bind, and repeat the game rules.
4. Make game rules and playing instruction clear and easily accessible from any stage in the game.

GG4: Game Challenge

1. Design challenging, achievable game objectives with interesting rewards.
2. Provide new challenges at an appropriate pace.
3. Design challenges that provide positive game experiences leading to continued play of the game rather than negative experiences leading to players quitting the game.
4. Provide rewards that increase the players' capabilities and expand their ability to be engaged in the game.

5. Create memorable meaning and engage emotions at significant moments.
6. Design a game with expected outcomes.
7. Allow the players to discover the game storyline

GG5: Game Mechanics and Movements

1. Design game mechanics and movements that are natural and have correct weight and momentum.
2. Match basic mechanics with the situation faced by the player.
3. Use the minimum amount of mechanics that the player needs to simplify the game.
4. Create clear and visible effects that are consistent with the player's reasonable expectations.
5. Implement mechanics and controller actions that are consistently mapped to the learning objectives.
6. Use input mappings that are easy to learn, intuitive, and follow the standard conventions of similar games.
7. Ensure that controls are clear and visible at all times and are easy to use.

GG6: Game Resources

1. Ensure that resources have both utility and scarcity in the game system.
2. Provide sufficient information to allow players to make appropriate choices regarding resource use.
3. Allow players to earn points or rewards for successfully completing a phase.

GG7: Game Help and Support

1. Provide an easily accessed and searchable game help section.
2. Highlight the default choices when players are required to make selections in the game.
3. Provide additional online help within the application to guide the player.
4. Focus the game help around the player's tasks.

Game design requires not only the inclusion of basic software requirements but also the assessment of additional properties of the game experience, including game play, game resources, game support, game objects, and mechanics.

C. User Interface Requirements

User interface (UI) design is the design of computers, applications, mobile communication devices and web sites with the focus on user interaction and experience. The high percentage of unusable e-learning systems demonstrates that users are often unable to use existing systems due to their difficult and complex user interfaces (Sulaiman et al., 2009). Various guidelines exist for assisting in the design, preparation, and development of easy-to-use e-learning systems. E-learning systems should hide complexity, thereby providing simple, engaging, satisfying, and flexible interaction (Li, 2010).

Usability ensures students' satisfaction when using a system (Sulaiman et al., 2009). Many heuristics have been proposed to enhance the usability of a system, and many user interface design guidelines have been outlined by various researchers (Polson & Lewis, 1990, Nielsen, 1994, Schneiderman & Plaisant, 2005). The UI of a system should be well designed to realize the usability goal (Sajedi et al. 2008, Brown 2008, Ayob et al., 2009).

The proposed guidelines should also give sufficient consideration to the accessibility of systems for individuals with moderate disabilities. E-learning accessibility involves the removal of any obstacle that may prevent the learner from either using the game or understanding the intended learning content (Li, 2010, Ben et al., 2013).

We elaborated on previous guidelines (Federoff, 2002, Sajedi et al., 2008, Ayob et al., 2009, Junqi et al., 2009) to propose a more comprehensive set of Aesthetic UI guidelines (AG) as discussed next.

AG1: Accessibility

1. Design a usable UI for any environment relevant to target players.
2. Include text for all elements that are not text based.
3. Use audio as well as text. Include natural cadence and nuances such as voice acting.
4. Accommodate the needs of slower learners who need to separately decode each word.
5. Implement hardware and software requirements that are suitable for the target players.
6. Design customizable interface options and shortcuts to accommodate high-skill users.
7. Allow players to save games in different states.
8. Use boxes for emphasis or to highlight important text.
9. Design the interface to accommodate the needs of color blind children.

AG2: Visual Representation, Metaphors and Objects

1. Provide visual representations, such as maps, icons, and avatars, to illustrate information about the current status of the game.
2. Support the game with audio-visual representations.
3. Use visual representations that are easy to interpret, thereby helping the players to differentiate important elements from irrelevant elements.
4. Provide clear and familiar scenes that are appropriate to the player's current actions.
5. Spread the use of metaphors.
6. Use metaphors such as avatars, objects, and scenes within the expected imagination of the students.
7. Use identifiable game objects that "speak their function" and provide clues as to their identity and purpose.
8. Ensure that game objects are simply abstractions of real-life objects and that their functions are follow the rules.

AG3: Adaptive UI

1. Use a variety of equipment and platforms such as laptops, PDAs, and mobile phones.
2. Ensure that the system is accessible even when older technologies are not supported or are disabled.

AG4: Consistency

1. Design an internally consistent game, with the same conventions and rules applied throughout all UI content.
2. Design an externally consistent game that follows existing platforms and cultural conventions.
3. Design a consistent game with the real-world experiences, observations and perceptions of the user, i.e., consistent with general practice.

AG5: Video and Audio Settings

1. Accommodate players' needs by providing a range of changeable settings.
2. Allow the player to control any audio or video.

AG6: Usability

1. Design an efficient and flexible UI for the player.
2. Help students prevent errors.
3. Provide clear and understandable error messages.
4. Use features that facilitate the interface elements via different input devices.

To design an effective and complete UI, we proposed a set of guidelines regarding consistency, color use, UI settings and other factors that will be applied directly on Cloud Computing.

D. Child Guidelines and Requirements

Designing an e-learning system for children requires careful investigation. The user interface design guidelines explained in the previous subsections and guidelines regarding designing an effective e-learning system, especially for children, must be carefully developed, tested and evaluated. To this end, we elaborated on the guidelines of Alsumait and Al-Osaimi (2009), Lai et al. (2013), and Simões et al. (2013). The child-related guidelines with their explanations are presented next.

CG1: Child Learning Content

1. Illustrate abstract concepts with concrete, specific examples.
2. Use suitable learning objects to achieve the primary goals and objectives of the e-learning program.
3. Use simple words and commands throughout the system, bringing it to the child's level.
4. Mirror the language of the target players, ensuring that vocabulary and sentence structure are age appropriate.
5. Include instructors with recognized qualifications in the subject area and appropriate skills for online teaching.

CG2: Child Motivation

1. Design an enjoyable and interesting system, using e-stories, games, role playing, and activities to gain the attention and maintain the motivation of the students.
2. Provide the students with both ordinary and unique learning activities that increase learning success.
3. Reward the students with expressive audio, video, text, or animations.

CG3: Immediate Feedback

1. Provide immediate feedback on the child's interaction.
2. Continuously display the player and game status.
3. Provide text/audio/video feedback to guide the child.
4. Allow players to see and compare their progress.

CG4: Social Interaction

1. Use the characteristics of social network games so that children can interact with peers while engaging in GBL.
2. Help the child to communicate, collaborate, share and socialize with instructors, friends, and parents.
3. Provide intuitive, simple-to-learn, and engaging social environments such as forums and social network applications.
4. Improve the child's skills with social rewards such as "like" buttons and other incentives.
5. Provide tools for parents to observe their children's progress.
6. Provide notifications of peers' achievements.
7. Encourage the instructor to be an active participant in online chats and/or discussions and to articulate performance expectations for students.

Designing a game-based learning system for children that is fun to play and has educational goals is not an easy task. Guidelines for building this type of system should be tested and evaluated with the goal of creating an innovative means of learning.

III. CONCLUSIONS AND FUTURE WORK

Despite progress in GBL guideline and heuristic development, game guidelines and heuristics have yet to be compiled into a comprehensive list or verified in any manner. In this paper, we have developed a comprehensive set of GBL guidelines and heuristics along with a detailed explanation of each guideline. The set of GBL guidelines will be later tested in real classroom scenarios to obtain empirical data on the actual effects of the guidelines. These guidelines will be comparatively tested against traditional user study methodologies during the critique of a new game design. The proposed set of guidelines is observed as a subset of the wider concept of using cloud computing for GBL. The results will be examined to evaluate the apparent validity of the individual guidelines and heuristics as well as to identify the strengths, weaknesses, and qualitative differences with other methodologies.

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