

HEEG: Heuristic Evaluation for Educational Games

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Abstract

Educational games are a fun and interactive alternative to the education process, and may bring a brand new perspective to that context. This paper presents a heuristic for evaluating educational games in terms of usability and game experience. The methodology presented is based in a study on a series of existing heuristics such as *HEP*, *PLAY* and *GameFlow*, and also the *Criteria for Designing Educational Computer Games* from Nicola Whitton. The heuristic developed is currently being applied in the development process of educational games at an academic project held in a local university. This project is engaged in developing educational games for schools as teaching tools. Therefore, we seek to develop a best-adapted heuristic for our environment. The proposed heuristic, *HEEG*: Heuristic Evaluation for Educational Games, is a mechanism that can be applied to quickly identify problems and improve general quality in games. Results obtained at the academic project points out that *HEEG* provides a starting point for game's evaluation, identifying qualities and specific problems of usability, immersion, design, and gameplay

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1. Introduction

Computer games have been commonly used as a multipurpose digital tool due to its great potential of incorporating knowledge within its foundations and expose it in an entertaining form. Educational games are studying tools that are meant to stimulate learning and transform it into a more joyful method [Allery 2014]. An academic project held in a local university had the initiative to produce digital educational games with the goal to enhance the learning process in secondary schools. Through the usage of Educational games as a didactic mechanism, the traditional models for sharing knowledge become more adjusted with the real learning needs of the students. The games produced by this project shall act as catalysts for motivating and encouraging education.

As noted by educational games shall offer equivalent entertainment level as commercial games. To increase their overall quality, a heuristic evaluation was created and entitled *HEEG*: Heuristic Evaluation for Educational Games. It was applied on the academic

project previously mentioned. The *HEEG* was constructed based on the studies of other heuristics that are often used in the digital games industry.

According to Brown [2008], heuristic is a guide to assist in the design process. The heuristics may be applied in two ways: to inform design decision and as an evaluation tool called heuristic evaluation. From a heuristic list, it is possible to create an evaluation report about a software product. The evaluation generates a result that shows if the application features are following the proposed heuristic measures. A professional tester or quality analyst usually applies a heuristic evaluation. Additionally, it helps to reduce costs, since it does not involve experiments with final users. It also it increase the chances to identify problems on the initial stages of development. A heuristic evaluation is an adaptable and flexible technique. With that in mind, it is plausible to say that it may be applied in a diverse variety of games. If by increasing usability in a product we manage to increase its overall quality, it is necessary to invest on a usable game product instead of focusing solely on its effectiveness.

After examining a variety of heuristics, it was perceived that none of them incorporated all requirements of an educational game. Malone [1981] points that most of the studies address the problem to be the fault of characteristics that make it fun, and forget about what makes it educational. The *HEEG* is based on the *HEP*, *PLAY*, and *GameFlow* heuristics. All of the mentioned heuristics focus essentially on the gameplay evaluation. To appraise a different side, Whitton [2007] creates a guide to develop educational games and listed the *Criteria for Designing Educational Computer Games*. Whitton's research was used as a transformer factor for the heuristic evaluation proposed, as it places a necessary educational aspect into the evaluation.

This paper presents a heuristic evaluation that could reduce the time of game production, allow the detection of early problems and make sure that the games produced can entertain and educate at the same time. As a consequence, it will help the project where it's currently being applied to generate quality educational games, cut production costs and reduce game refactoring.

2. Related Work

The Heuristic Evaluation for Playability (*HEP*) is based in other relevant studies and revised by

professionals of the game industry. *HEP* is grouped in four categories: game story, gameplay, game mechanics and game usability. Although *HEP* evaluation is proven to be a useful tool, it presents some restrictions such as several categories that can be analyzed during a game evaluation, and *HEP* addresses only specific characteristics [Desurvire & Wiberg 2009]. On that matter, the *PLAY* heuristic came subsequently as an improvement of *HEP*. The name stands for Principles of Game Playability. According to Desurvire and Wiberg [2009], *PLAY* gives support to every phase in a game development process. The *PLAY* set of heuristics was created with information from the most estimated game designer professionals.

In order to compose a new heuristic we started the process by choosing the categories that best fit our premise. Studies were performed on the *HEP* and *PLAY* heuristics in order to establish a detailed comparison between them. The *HEP*'s categories are very similar to the ones described by *PLAY*. The categories chosen for our heuristic model were derived from the *PLAY* evaluation alone since it is an evolution from *HEP*. Three categories were extracted for composing the first part of our heuristic evaluation, they are: *Game Play*, *Coolness / Entertainment / Humor / Emotional Immersion* and *Usability & Game Mechanics*.

Unlike *HEP* and *PLAY*, the *GameFlow* heuristic evaluation was created with the intention of improving the game enjoyment experience. *GameFlow* has eight categories: concentration, challenge, skills, control, clear goals, feedback, immersion and social. For measure the enjoyment of a game it is important to see if it demands attention from the player. Games need to quickly make the player concentrate on a task. The more absorption is required, more the player will be immersed in the game [Sweetser & Wyeth 2005].

By analyzing the *GameFlow* model, we perceived that enjoyment is a necessary factor to maintain the quality of the game. For that reason, we decided to incorporate it into the planned evaluation. For that reason, we added some rules that can measure the entertainment of the players. The category named *Coolness / Entertainment / Humor / Emotional Immersion* from the *PLAY* method was transformed into the *Enjoyment* category.

Whitton [2007] formulated the *Criteria for designing educational computer games* and according to her, a good instructional game adds pedagogic principles to the subjects taught. It is also important to merge the goal of the game with the subject matter, so the student does not realize what is being taught. Malone [1981] adds that most children loses interest over time in playing the educational game outside of classroom. To solve this, the game must have sufficient stimulation for students to become more eager about using it out of the school environment. From Whitton's set of criteria, the following five heuristics were taken:

Supports active learning, Engenders engagement, Appropriateness, Supports reflection and Provides equitable experience. Those heuristics were appended to our new heuristic evaluation. With this addition, we pretended to give the model a pedagogical and educational direction.

Although the studied methods are distinct, it is important to note that they can be perceived as complementary to each other. As result of this research, we did compile all the relevant aspects of the game elements into a list, which is further used as a basis to our heuristic evaluation model.

3. HEEG

The Heuristic Evaluation for Education Games: *HEEG* is the result of a study made upon the heuristics mentioned in the previous section, and it is intended to be applied in an academic project held in a local university. It is an important project that counted with the participation of a group of scholars. The members were engaged in three major areas: the development of educational games, development of a learning platform and research on educational games. Most of them are involved in the development process of the games used as subjects. This characteristic was the primal motivational factor to create an evaluation system with the purpose of checking the proficiency of the games produced in the project. *HEEG* was conceived with the main responsibility to standardize created games.

The development process involved a comparison of all the rules in each heuristic evaluation. During this analysis, it was noticed equivalent rules and rules that do not concern to the environment under study. Between *HEP* and *PLAY*, for instance, since one is originated from another, some cases presented similar rules. Those matching rules were compressed into a single new rule. Furthermore, the *HEP* holds a category called Game Story that is designed to evaluate a story inside a game. The studied academic project creates casual games only and the games developed there do not require a complex story or manage a story telling process. For this reason, the rules in this category were not included in *HEEG*. A similar case occurred with the Social Interaction category in the *GameFlow* heuristic evaluation, since the project does not work with network or multiplayer games. The last category mentioned was discarded.

The *HEEG* seeks to fill various needs for game usability evaluation. It allows an earlier detection of real problems, while reducing the production time, cutting costs and generating a minimum efficient game. The advantages of the *HEEG* structure, compared to traditional methods of evaluation in qualitative research, are the focus on educational games structured upon efficiently proven techniques and its practice application. The main objective of this evaluation is to assess the quality of interactions and

take into account the results of these tests to build new versions of the games on which interfaces and activities are improved.

In total, sixteen heuristics were listed. They were sorted by categories and subdivided into a set of rules, which are called *Criteria*. The model has thirty-six rules altogether. These heuristics and criteria were grouped in four categories: Game Play, Enjoyment, Usability & Game Mechanics, and Educational Design. **Game Play:** Originated from Heuristic *PLAY*. This section contains rules related to how a player experiences the game. **Enjoyment:** This category

summarizes the main function of a game: being enjoyable and fun. **Usability & Game Mechanics:** This category role is to verify if the game offers enough information to assist the player during its gameplay experience. **Educational Design:** This section of heuristics permit to check if the game promotes learning in an appropriate way. An educational game is a pedagogical tool that teachers can use in the classroom as methodological techniques.

The following table shows the complete *HEEG* heuristic, taken from the best characteristics observed in each studied heuristic.

Category	Heuristic	Criteria	Source
Game Play	Enduring Play	The players find the game fun, with no repetitive or boring tasks.	PLAY
		Player should not experience being penalized repetitively for the same failure.	HEP
	Challenge, Strategy and Pace	Player's fatigue is minimized by varying activities and pacing during game play.	HEP
Enjoyment	Goals	The game goals are clear. The game provides clear goals, presents overriding goals early as well as short term goals throughout game play.	PLAY
		Game should react in a consistent, challenging, and exciting way to the player's actions (e.g., appropriate music with music with the action).	HEP
	Immersion	The game utilizes visceral, audio and visual content to further the players' immersion in the game.	PLAY
		Games should provide a lot of stimuli from different sources.	GameFlow
		Games must provide stimuli that are worth attending to.	GameFlow
Concentration	Games should quickly grab the players' attention and maintain their focus throughout the game.	GameFlow	
	Players shouldn't be burdened with tasks that don't feel important.	GameFlow	
	Players should not be distracted from tasks that they want or need to concentrate on.	GameFlow	
	Documentation/Tutorial	Player does not need to read the manual, tutorial, or documentation to play. Player is given controls that are basic enough to learn quickly, yet expandable as player attain for new goals and challenges. Learning the game should not be boring, but be part of the fun.	HEP HEP/ Play GameFlow
Usability & Game Mechanics	Game Provides Feedback	A player should always be able to identify their score/status and goal in the game.	HEP
		Game provides feedback and reacts in a consistent, immediate, challenging and exciting way to the players' actions. Providing appropriate audio/visual/visceral feedback (music, sound effects).	PLAY
	Screen Layout	Screen layout is visually pleasing (in controller, color, typographic, dialogue and user interface design).	HEP
		Player experiences the user interface as consistent, efficient and integrated (menu as a part of the game).	PLAY
	Navigation	Player experiences the user interface/HUD navigation as logical and minimalist.	PLAY
		Player error is avoided.	PLAY
		Upon turning on the game, the player has enough information to begin.	PLAY
Error Prevention	Players should be given context sensitive help while playing so that they are not stuck and need to rely on a manual for help.	PLAY	
	All levels of players are able to play and get involved quickly and easily with tutorials, and/or progressive or adjustable difficulty levels.	PLAY	
Control	Players should feel a sense of control over the game interface and input devices.	GameFlow	
	Game controls are consistent within the game and follow standard conventions.	PLAY	
Educational Design	Supports active learning	Encourages exploration, problem solving, and enquiry.	N J Whitton
		Game goals align with learning goals.	N J Whitton
	Engenders engagement	Stimulates curiosity.	N J Whitton
		Appropriate challenge.	N J Whitton
		Provides control over the learning environment.	N J Whitton
	Appropriateness	Fits with curriculum and assessment.	N J Whitton
		Personally relevant for students.	N J Whitton
	Supports reflection	Opportunities for reflection and debriefing on learning.	N J Whitton
		Highlights process of learning.	N J Whitton
	Provides equitable experience	Accounts for differing prior knowledge.	N J Whitton
Provides equal opportunities to participate.		N J Whitton	

4. Evaluations conducted

The evaluation was made with the intention to investigate the test coverage range of the game as well as its efficiency and effectiveness. The testing of these characteristics was made necessary to establish the run-time of a test. Additionally, it does not delay the production period. The evaluations require that a project developer interpret the assessments safely and without doubtful thoughts.

Five games were randomly chosen from the academic project in which we were engaged. *HEEG* was applied in those games. Two researchers and a game developer that makes part of the project carried out the test. The final report of each game was based on a consensual opinion of the three evaluators. The test procedure is simple: the tester takes the list of standards of the *HEEG* model and checks if the game meets or not the heuristics disposed. The score given to the games after the evaluation are based on how many criteria the game applies to, compared with the total number of rules exposed in the criteria section of the model. For example, if a game passes on 10 points of the model criteria, the final score of the evaluation is 10 out of 36 (total number of criteria).

There are two moments that the heuristic evaluation may be applied. First, during the development of the games, when it is essential to make sure that the games are generally correct and if they met the criteria of being instructional. Second, when a game is complete, it must be checked if the final product meets the requirements before being released. The tests were executed according to the second situation.

4.1 Results

HEEG was implemented efficiently and proved itself to be a valuable tool that produces a comprehensive review of educational games. An average of the individual score from every game was made and it was possible to see which aspects from the games are in urgent need to be repaired. Three evaluators applied the heuristic to five games selected from the targeted project and obtained a medium score of: 15 out of 36; 21 out of 36; 01 out of 36; 31 out of 36; and 18 out of 36. The test time for each evaluator did vary from ten to fifteen minutes depending on the game. The evaluation can also point a recurring problem common to all games subjected to tests, for example, a navigation menu and the documentation is incomplete, among others.

6. Conclusion

This paper presents *HEEG*, usability heuristic for educational games. *HEEG* is based on a group of researched heuristic evaluation models and diverge from other heuristic by focusing on the assessment of educational games. From the collection of items

researched, a new heuristic perception arose aiming to detail the problems of the educational games developed in an academic project held at a local university. The heuristic evaluation model developed has the important function of reducing the risks and conceptual flaws in the creation of instructional games. *HEEG* also ensures that each production cycle will provide more robust products with higher quality. By applying it correctly, we shall be able to reach the expectations and needs of students. *HEEG's* practical application was possible by verifying its usefulness as a means of evaluation on real educational games. Most games flaws could be identified by the proposed heuristic and referrals were conducted to the development team.

As future work, we plan to re-conduct the evaluation tests after *refactoring* the games in accordance with the problems pointed out by *HEEG*. Further, we aim at improving *HEEG* heuristic evaluation by applying the evaluated games at school's real context in order to obtain experience from final users. Additionally, apply *HEEG* to all the educational games developed at the academic project surveyed. At last, we intend to generate a comparative statistic of the results based on the performance of the games for each category in the heuristic.

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