Incorporating Emotion Transition Pattern Graph in Metaphor-based Game Design related to Software Engineering

Grissa Vianney Maturana Gonzalez, M. Sc.

A Thesis Proposal for the degree of:
Doctor in Engineering, Systems and Informatics

Advisor

Carlos Mario Zapata Jaramillo, Ph.D.

Computer and Decision Science Department
Universidad Nacional de Colombia—Sede Medellín
October 2018

Abstract

Software engineering games are usually designed for teaching practical experiences to the students (*e.g.,* video games, board games, and card games). Metaphor-based game design is a process for creating games by using elements from other games. Emotion transition pattern graph (ETPG) is a visualization model of the player emotions. ETPG is only used in video games for evaluating emotions and showing the frequency of emotional changes. Game design models are developed for helping game designers to achieve well-done games. Some authors use such models and include emotional design. Emotion, emotion types, and emotion changes in video games are defined for evaluating user experience. Some metaphor-based games in software engineering are similar to Monopoly®, The Sims®, and others. However, such games lack an emotional design. Emotional design is imprecise in the method for including emotions in game design models. Also, software engineering players respond with low values in studies for evaluating games. We propose a method for incorporating emotion transition pattern graph in metaphor-based game design related to software engineering. Such a method allows for providing a visual representation of possible emotional responses of the players. Game designers can use such a method for increasing game potential success.

Keywords: Metaphor-based game design, software engineering games, emotions transition pattern graph.

Table of contents

1. Introduction

Software engineering games are usually designed in software engineering (SE) as a strategy for motivating and challenging the students and professionals to work in computer fields (Battistella & Wangenheim, 2016). SE topics are project management, software development process, software quality, and risk management, among others (Albayrak, 2015). Simulations, puzzles, and adventures are common genres in SE games (Battistella & Wangenheim, 2016). Such games are created for digital and non-digital platforms (Petri *et al*., 2017)

Metaphor-based game design is a term related to the use of game elements from existing abstract games for creating new non-abstract games by using a different metaphor. Rules and mechanics are game elements (Begy, 2010). SimSE, Project-o-poly (PoP), Project Risk, and other games in SE are accomplished by using elements from The Sims®, Monopoly®, and Risk®, respectively (Battistella & Wangenheim, 2016). Consequently, some games in SE are made by applying metaphor-based game design. Emotion transition pattern graph (ETPG) is a model for visualizing emotional responses of the players during a game. Such a model includes positive and negative emotions related to narrative events during the game (Kim & Doh, 2016). ETPG is used in successful and unsuccessful games for comparing distances on emotions types.

Some authors propose methods, frameworks, and models for designing games. Such methods, frameworks, and models are focused on serious games (Marfisi-Schottman, George, & Tarpin-Bernard, 2010), games based learning, educational games (Plass *et al.,* 2015; Zin *et al.*, 2009; Amory, 2007; Morales, 2015), understanding games (de Freitas & Javis, 2009; Hunicke, *et al.,* 2004), and others approaches (Gomez, 2010; de Lope *et al.,* 2017).

Commonly, game designs are related to some features as follows: mechanics, dynamics, rules, graphic environment, usability, challenge, goals, flow, users, scenario, characters, and plot, among others (Hunicke, *et al.,* 2004; de Lope *et al.,*2017; Padilla-Zea *et al.,* 2015; Ahmad, *et al.,* 2014).

Such game models are used for considering emotional and motivational attributes. Some authors define emotions in video games (Lazzaro, 2008), emotion categories, rule templates, and possible changes in game design (Bura, 2008), intensity, and variables for invoking emotions (Steunebrink *et al.,* 2009); also, emotions related to game elements are considered (Järvinen, 2008).

However, relationships among game elements and emotions are limited to classify emotion types (Järvinen, 2008). Some emotions are only defined for video games. Some authors record emotions of the players when the game is completed, but they ignore emotions during game design (Kim & Doh, 2016). Emotions in games are visualized from the human-computer interaction point of view (de Melo *et al.,* 2014). Emotions have few specifications from the perspective of game design (Plass *et al.,* 2015). Games made by using metaphor-based design are conditioned by using the elements of a base game and the subjectivity of the designer (Begy, 2013). Software engineering players express discomfort in evaluations about games related to user experiences (Petri *et al*., 2017).

In this Ph.D. Thesis proposal, we define a method for incorporating ETPG in metaphor-based game design related to software engineering. Such a method contributes for improving SE games by using game elements according to emotions generated on players.

This proposal is organized as follows: in Section 2 we present the main concepts related to games in software engineering, metaphor-based game design, and the emotion transition pattern graph; in Section 3 we relate the previous work oriented to experience evaluation of software engineering games, game design models, and emotions in games; in Section 4 we present the problem statement, research proposal; and finally, in Section 5 we present the methodology.

2. Theoretical Framework

2.1. Games in software engineering

Software engineering is a discipline focused on satisfying the customer and user requirements (Petri *et al*., 2017). SE includes fields like test, project management, software design, software development process, risk management, requirements management, software quality, project management, maintenance, and evolution (Albayrak, 2015). Such a discipline requires professionals trained in engineering and computer science knowledge, software development methods, and management and communication skills (Zapata, 2009). Software engineering games (SEG) provide an alternative instrument for gaining practical experience in a safe and controlled environment. SEGs are used in educational context for teaching about certain subject, expand and revising concepts, and learning skills; which improve non-technical issues like management, communication, and teamwork (Petri *et al*., 2017). SEGs are reported as educational games, simulation games, educational video games, digital game-based learning (DGBL), game-based learning (GBL), and serious games (Albayrak, 2015).

2.2. Metaphor-based game design

Begy (2010) proposes the term Metaphor-based game design for consciously designing abstract games by using an experiential metaphor. Abstract games have signs outside the game fiction; In addition, abstract games are games unrelated to any type of source system. Game objects-fiction-signs are pieces manipulated by players (*e.g.,* cards, tokens, and coins). Such games are abstract because are unrelated and non-represented anything else. Fictional elements are related to characters, plot and narrative elements, and objects operating as iconic fiction-signs. *Tetris, Tipping Point, Checkers*, and *Go* are abstract games. Non-abstract games are games with metaphorical meaning; which refer to themes and messages of game (*e.g.,* monopoly is related to a financial system, clue is related to a criminal research, chess is related to a war).

2.3. Emotion transition pattern graph

Emotion transition pattern Graph (ETPG) is a visualization of emotional changes of players. Such a pattern graph is used for representing numerical data related to dispersion of emotional types evoked in a player. Emotional types are based on the Ortony, Clore, and Collins (OCC) model of emotion they can be compared with story events related to narrative structure of the game. In Figure 1 we show the ETPG of a player during two gameplays *Tomb Raider (TR) and The Matrix (TM)*. TM is considered a successful game and TR is considered an unsuccessful game related to number of sales. Both games have similar game elements and narrative events.

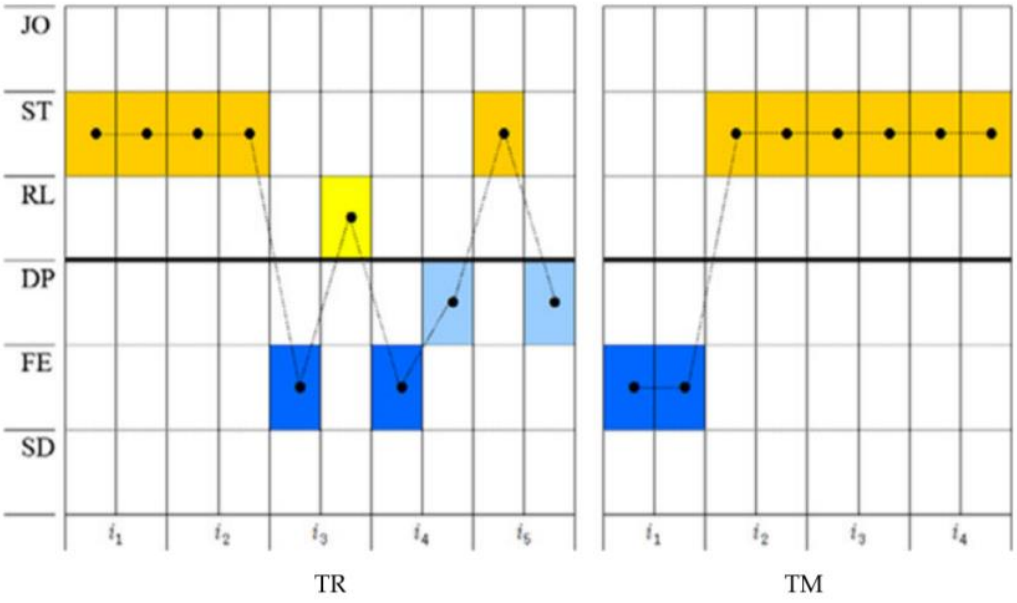


Figure 1. Example of the ETPG (JO: Joy, ST: Satisfaction, RL: Relief, DP: Disappointment, FE: Fear, SD: Sadness; Kim & Doh, 2016)

3. Background

Software engineering games are reported in some work related to games for computer science. Battistella and Wangenheim (2016) register 41 games related to software engineering out of 107 games for teaching computing in higher education by using a systematic review. Petri *et al.* (2017) create a model for evaluating games for teaching software engineering; such a model include some games previously reported by Battistella & Wangenheim (2016). Souza, *et al.* (2018) perform a systematic mapping study on game-related methods for software engineering education; thus, they include games-related to serious games, gamification, and GBL. Such a study report 156 unique primary studies. SimSE, Simsoft, SlimjavaSP, SESAM, and others are games commonly known by SE instructors (Albayrak, 2015).

Game metaphor is related to the game theme. According to OCC model, game elements are based on game metaphor. Such game elements are events, which include a rule set (game mechanics, game system procedures), agents (players, game system agencies), and objects (components, environments, information, goals. Järvinen, 2008).

Begy (2013) defines a process for including a metaphor in abstract games: isolating the key game elements, analyzing such elements linked to a common sequence of states within the game, and identifying emotion arosing during such games states. Such abstract games are the *source domain* and the new game with another metaphor is the *target domain*.

Gomez (2010) defines a method for designing games based on templates from a game. Such templates include game goals, number of players, game purposes, instructional objectives, game keywords, materials, rule set, and winner selection criteria. This method includes some activities: selecting the purpose of the game; responding questionnaires related to game elements and selecting a game; keeping the game elements and rule sets; and incorporating the new metaphor into the game.

SEGs are designed for considering a metaphor of the real world like a software development office (Peixoto *et al*., 2012). Some SE games can be classified as metaphor-based games (see Table 1). In such games are used the same elements of game-based by implementing a metaphor of SE.

Some authors propose methods, frameworks, and models for designing games.

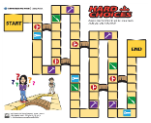
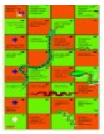
Marfisi-Schottman *et al*. (2010) propose a method for efficiently designing serious games by using seven steps based on engineering process. MDA framework (standing for Mechanics, Dynamics, and Aesthetics) allows for a formal understanding of games. Mechanics refers to game components; dynamics refers to run-time behavior of the mechanics related to players. Aesthetics describes the desirable emotional responses evoked in the players (Hunicke *et al*., 2004). Padilla-Zea *et al.* (2015) design a process for balancing educational video games with collaborative activities. Such a process is based on software engineering principles for allowing educational and recreational goals.

De Lope *et al.* (2017) describe a method for designing educational games based on graphical notations. Such method comprises three phases: designing educational challenges, designing game type, and designing story and main characters. Also, the method includes emotional design by using labels with a desire emotion for dialogues and actions. De Freitas and Javis (2009) propose a framework related to serious games. Such a framework explain four game dimensions: context, learner specific action, representation, and pedagogic model.

History education game design approach is created like a means for conveying learning contents on digital games. Such a game design approach is based on understanding pedagogy elements and GBL (Zin *et al.,* 2009). Educational game design model combines game design, pedagogy, and learning content for modeling. Such a model emphasizes in motivation theory importance (Ibrahim & Jaafar, 2009). Staalduinen and Freitas present a framework for categorize 25 game elements into four dimensions: context, learner specifics, representation, and pedagogy. Such a framework is developed for mapping games and obtaining feedback (Staalduinen & Freitas, 2011). Amory (2007) proposes a theoretical framework for educational game development focused on computer games and video games. Such a framework is based on the object-oriented programming system paradigm in which game elements are described like objects.

Experiential gaming model depends the players for studying the individual experience during a gameplay. Such a model is a loop for finding and solving problems by using feedback of players (Kiili, 2005). Morales (2015) defines a process for creating serious games with social an educational purpose. Such a process includes the game world, system rules, interaction, and learning system.

Table 1. Software engineering metaphor-based games

No	Name	Metaphor-based game	Screendshot/photo	Reference
1	Mission to mars - Release or iteration planning	Monopoly		(Battistella & Wangenheim, 2016)
2	Project-o-polu (PoP)	Monopoly		(Battistella & Wangenheim, 2016)
3	SimSE	The sims		(Navarro & van der Hoek, 2004)
4	The hard choices	Snakes and Ladders		(Battistella & Wangenheim, 2016)
5	The waterfall game	Snakes and Ladders		(Battistella & Wangenheim, 2016)
6	Rividoc	Clue		(Maturana *et al.* , 2015).
7	Metricc	Mille Bornes		(Zapata *et al.*, 2013a)
8	RISKWARE	Risk		(Zapata *et al.*, 2013b)

Source: The authors

Plass *et al.* (2015) include emotional design into GBL. Such an emotional design refers to use features, which induce emotions for learning knowledge. Such emotions are related to game mechanics and game representations. Frustration (anger), fear, surprise, sadness, amusement (happiness), disgust, and curiosity are emotions for a serious fun in video games (Lazzaro, 2008). In

the OCC model 22 emotions types are defined (Steunebrink *et al.*, 2009) *e.g.*, joy, distress, pity, and hope, among others. De Lope *et al.,* (2017) select the psycho-pedagogical classification of the emotions. Such emotions are negative (*e.g.,* fear, anger, sadness, disgust, anxiety, and shame), positive (*e.g.,* pleasure, love, and happiness), and ambiguous (*e.g.,* surprise).

Bura (2008) describes game states by using a set of gameplay variables, which induce emotions into games. Emotions influence interactions between the player and the game. Such interactions change gameplay variables. Consequently, variations and stability of gameplay variables induce emotions. Also, Bura (2008) describes abstract categories of variables into orthogonal families (action, system, self, social, freedom, mastery, and data). Such variable categories (see Figure 2) change with actions from the game and the player. Changes are temporary or persistent. In addition, game variables and emotions are linked to values and variations of one or several variables. Too low, low, high, and too high are states of emotional changes. Such states are compared with variables categories for evoking emotions and feeling into players. Fear, shock, claustrophobia, disorientations, and paralysis, among others are possible emotions or feelings defined by Bura.

	Freedom	Mastery	Data
Action	Opportunities, Tools and Abilities	Trained reflexes, Tactics	Game world resources and collectibles, Operational rules
System	Exploration, Experimentation, Purpose	Learning skills and using them to gain more control	Preparation, Constitutive rules
Self	Strategy, Creativity	Exploiting skills, knowledge and metagame data	Mementos, Achievements, Memories
Social	Community support, Shared experience	Competition, Cooperation, Teaching skills	Status, Metagame, Implicit rules

Figure 2. Categories of gameplay variables (Bura, 2008)

Consequences of events, actions of agents, and aspects of objects from the OCC model are analyzed by comparing emotion types and game elements. Game elements are divided into three categories: systemic, compound, and behavioral. Game elements for s*ystemic category* are components and environments. Game elements for *compound category* are rule set, game mechanics, theme, interface, and information. Game elements for *behavioral category* are players and contexts (Järvinen, 2008).

4. Research Proposal

4.1. Problem statement

Computer science games are scarcely reported with information related to developing process. Information on the instructional context, game design elements, mechanics, narratives, and descriptions about the way games should be developed (Battistella & Wangenheim, 2016). Some authors create SE games by using game elements from existing games. However, they ignore the use of metaphor-based game design into their developments.

Software engineering players evaluate SE games by using questionnaires. Such questionnaires are made for digital and non-digital games. Petri *et al*. (2017) show (see Figure 3) low values for user experience related to fun.

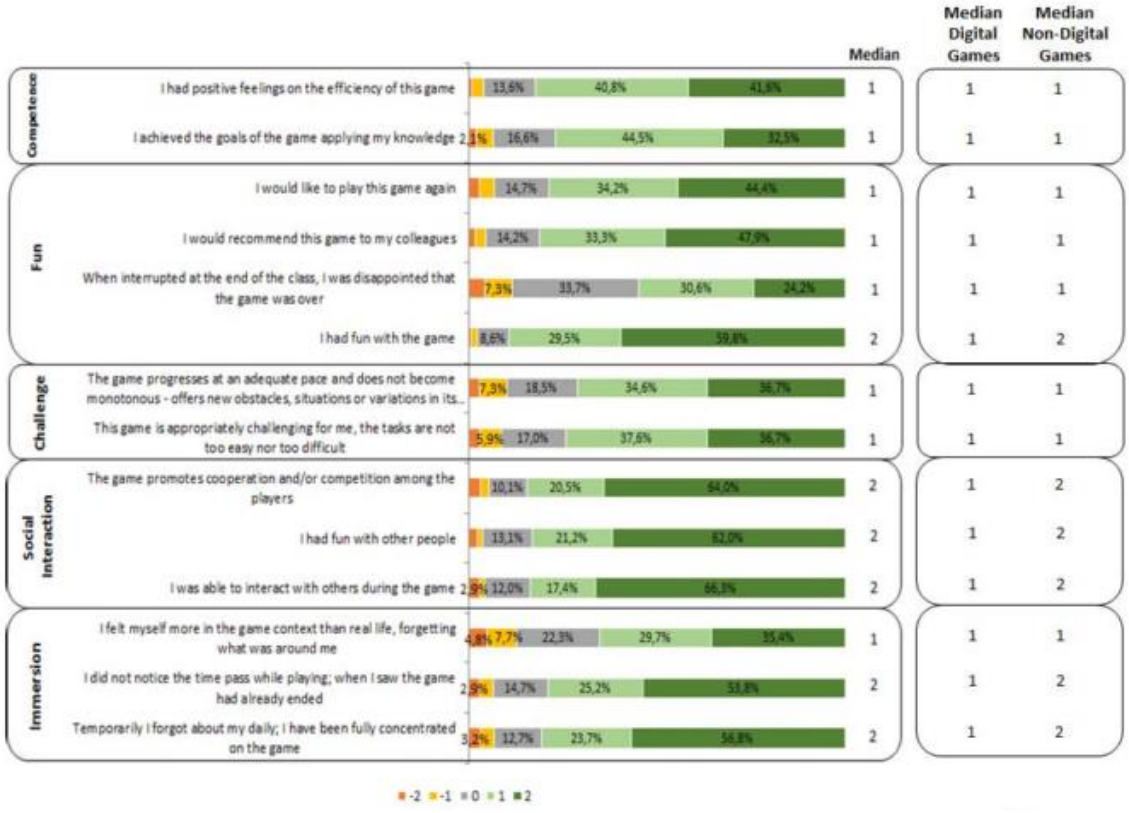


Figure 3. Motivation for any kind of game related to computer science (Petri *et al*., 2017)

Metaphor-based game design use an experimental metaphor as a projection of emotional process or mental states in gameplay; such a process is used for identifying emotions arising from those states in a mental process of the game designer without a physical representation (Begy, 2013). Selecting game elements for applying using a metaphor-based design is an unknown process (Gomez, 2010).

Some authors dismiss emotional states in their game design models (Gomez, 2010; Marfisi-Schottman *et al.*, 2010; Ahmad *et al.*, 2014; Zin *et al*., 2009; Morales, 2015). MDA includes the importance of emotions evoked in the players during gameplay (Hunicke *et al*. 2004). Some authors mention motivational attributes as important element for games; but they lack a description for modeling such attributes in a game design (Padilla-Zea *et al*., 2015; Ibrahim & Jaafar, 2009; Staalduinen and Freitas, 2011; Kiili, 2005). In Table 2 we show a game design models review related to emotional inclusion in game design.

Emotional changes are only visualized on gameplays for video game (Kim & Doh, 2016). Such emotional changes are isolated from game elements and each author consider their own emotions.

Table 2. Game design models review

Models/Framework	Emotional inclusion	Description
The 7 steps for designing Serious Games (Marfisi-Schottman *et al.,* 2010)		Only mention game motivation like a general element of serious games.
MDA framework (Hunicke *et al.* , 2004)	x	Description of the emotions. importance of the emotions related to game mechanics and dynamics
A design process for balancing educational video games with collaborative activities (Padilla-Zea *et al* ., 2015)	x	Motivation of the player by level o game stages and challenges.
Method based on graphical notations (de Lope, 2017)	x	Emotions labels on nodes (dialogues and actions)
Four-Dimensional Framework (de Freitas & Javis, 2008)		Considerer motivation of learning
Model for History Educational Games Design (Zin, Yue, & Jaafar, 2009)		Mention the importance of enjoyment in the games
Educational Game Design Model (Ibrahim & Jaafar, 2009)	x	Mention motivational theory such a important element of the game
Staalduinen and Freitas Framework (Staalduinen and Freitas, 2011)	x	Multimedia components improve user satisfaction
Game Object Model 2 (Amory 2007)	x	Fun and emotive are considered as interface characteristics user experience
Experiential Gaming Model (Kiili, 2005)	x	Include feedback of players related emotions attributes during gameplay
Serious games: Design videogames with social and educational agenda (Morales, 2015)		Include motivational attributes
Metaphor-based Game Design (Begy, 2013)		Mention emotion states
Gomez method design (Gomez, 2010)		Not mentioned

Source: The authors

4.2. Research Hypothesis

Incorporating ETPG in metaphor-based game design related to software engineering is possible by defining a method.

4.3. General Objective

Defining a method for incorporating emotion transition pattern graph in metaphor-based game design related to software engineering

4.4. Specific Objectives

- Identifying the main emotions in game design by performing a state-of-the-art review.
- Characterizing game elements coming from metaphor-based game design related to software engineering.
- Formulating a general emotion transition pattern graph matching emotions and game elements.
- Proposing a method for incorporating the emotion transition pattern graph in metaphor-based game design.
- Evaluating the proposed method by using the validation square method.

4.5. Scope

This Ph.D Thesis proposal is aimed to contribute to the SE game design by improving the knowledge of game designer related to player emotional states. Emotional transitions of the player can be tracked from game design conception for digital and non-digital games. Game designer can use such method for adjusting game elements.

The method allows for a graphical visualization of player emotions in metaphor game-based design. Also the values in evaluation of the SE games can be increased by using this method.

5. Methodology

The methodology to be used in this Ph.D. Thesis proposal is adapted from Wohlin *et al.,* (2012) and comprises four phases:

1. Exploration: we select primary studies related to software engineering games, metaphor-based game design, and emotion transition pattern graph. Then, we perform data synthesis and map the aforementioned studies.

2. Problem formulation: we specify problem statement, formulate the research hypothesis and research objectives of the Thesis proposal.

3. Solution: we characterize game elements, study game elements, study game elements in metaphor games, formulate an emotion transition pattern graph, and propose a method for incorporating ETPG to metaphor-based game design related to software engineering.

4. Validation: we validate the game design method by using the square validation. Such a validation method is based on usefulness respect to a purpose; also we consider a qualitative and quantitative evaluation. In Figure 3 we show a synthesis of the validation process (Seepersad *et al*., 2006).

   Activities associated to structural validation and related to a qualitative process are:

   a. Accepting the method validity by performing a critical evaluation of the literature.
   b. Accepting the method consistency by using flow-chart representation focused on information flow.
   c. Accepting the example problems by documenting example problems, thus the actual problems are represented and documented by using the method.

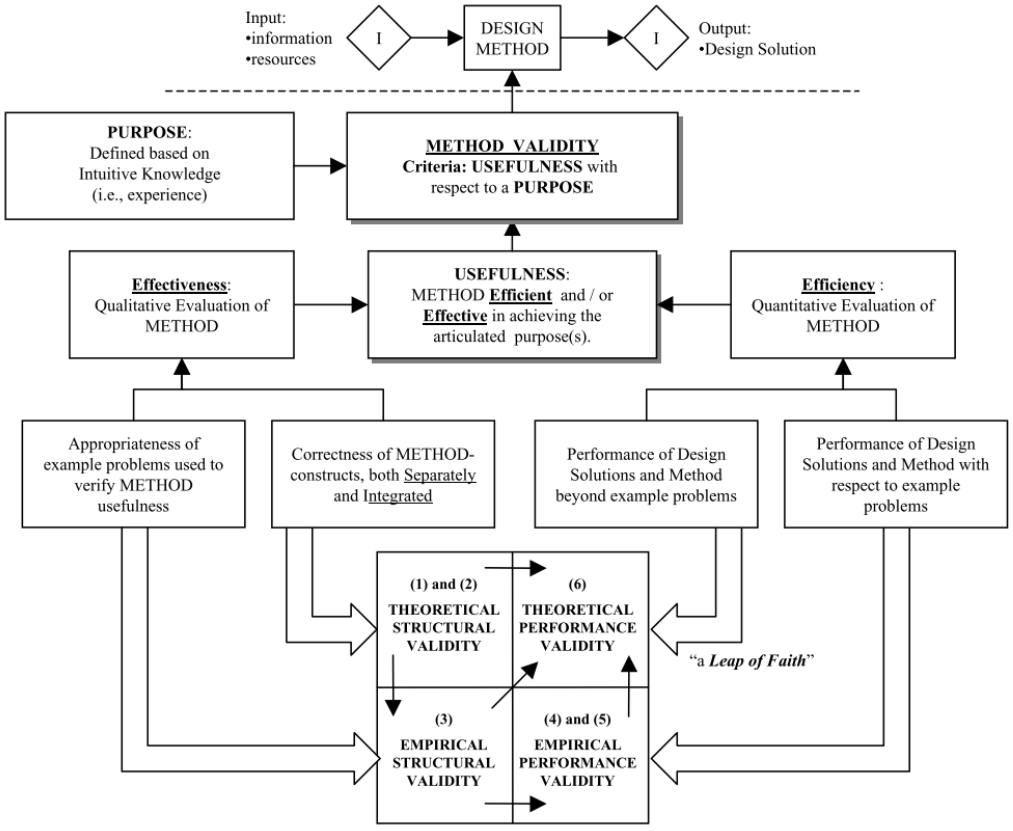


Figure 3. Design method validation: a process of building confidence in usefulness with respect to a purpose (Seepersad et al., 2006)

Activities associated to structural validation and related to a quantitative process are:

a. Accepting the method usefulness from some example problems by evaluating usefulness game metrics.
b. Accepting the usefulness linked to applying the method by a quantitative evaluation for comparing the solutions with and without a construct.
c. Accepting the method usefulness from beyond example problems. Whether a method is deemed useful for some example problems evaluated in activity a) and b), we denote this empirical performance valid.

5.1. Tentative Schedule

Table 3. Proposed timeline

Phase	Activities	2017				2018				2019				2020			
		Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec	Jun- Mar	Apr - Jun	Jul - Sep	Oct - Dec	Jun- Mar	Apr - Jun	Jul - Sep	Oct - Dec
Exploration	Selection of primary studies																
	Data synthesis																
	Mapping Studies																
Problem Formulation	Specifying problem statement																
	Formulating hypothesis																
	Formulating research question																
presentation Solutio	Characterizing game elements																
	Studying game elements in metaphor games																
	Formulating a general emotion transition pattern graph																
	Proposing a method																
Validating	Accepting the construct validity																
	Accepting method consistency																
	Accepting the example problems																
	Accepting usefulness of method for some example problems																
	Accepting that usefulness is linked to applying the method																
	Accepting usefulness of method beyond example problems																

Source: The authors

6. References

Ahmad, M., Rahim, L. A., & Arshad, N. I. (2014). A review of educational games design frameworks: An analysis from software engineering. *2014 International Conference on Computer and Information*

Sciences, ICCOINS 2014 - A Conference of World Engineering, Science and Technology Congress, *ESTCON 2014* – Proceedings, Kuala Lumpur.

Albayrak, O. (2015). Instructor's Acceptance of Games Utilization in Undergraduate Software Engineering Education: A Pilot Study in Turkey. *Proceedings - 4th International Workshop on Games and Software Engineering, GAS 2015*, 43–49, Florence.

Amory, A. (2007). Game object model version II: A theoretical framework for educational game development. *Educational Technology Research and Development*, *55*, 51–77.

Battistella, P., & Wangenheim, C. (2016). Games for teaching computing in higher education–a systematic review. *Technology and Engineering Education,* 1(3), 8-30.

Begy, J. (2010). *Interpreting abstract games: the metaphorical potential of formal game elements.* (Master thesis). Massachusetts institute of technology. Cambridge, Massachusetts.

Begy, J. (2013). Experiential Metaphors in Abstract Games. *Transactions of the Digital Games Research Association*, *1*(1), 2328–9422.

Bura, S. (2008). Emotion engineering: A scientific approach for understanding game appeal. Gamasutra. [Online]. Available: http://www.stephanebura.com/emotion/

de Freitas, S., & Jarvis, S. (2009). Towards a development approach for serious games. In T. M. Connolly, M. Stansfield, & E. Boyle (Eds.), *Games-based learning advancements for multi-sensory human-computer interfaces: techniques and effective practices* (pp. 215-231). Information Science Reference.

de Lope, R. P., López Arcos, J. R., Medina-Medina, N., Paderewski, P., & Gutiérrez-Vela, F. L. (2017). Design methodology for educational games based on graphical notations: Designing Urano. *Entertainment Computing*, 18, 1–14.

de Melo, C., Paiva, A., & Gratch, J. (2014). Game Design and Development . In M. C. Agius & H. Angelides (Eds.), *Handbook of Digital Games* (pp. 3–6). Hoboken, New Jersey. IEEE Press Wiley

Gomez, M.C., (2010). *Definición de un método para el diseño de juegos orientados al desarrollo de habilidades gerenciales como estrategia de entrenamiento empresarial.* (Master thesis). Universidad Nacional de Colombia. Medellín, Antioquia, Colombia.

Hunicke, R., Leblanc, M., & Zubek, R. (2004). MDA : A Formal Approach to Game Design and Game Research. [Online]. Available: https://www.researchgate.net/publication/228884866_MDA_A_Formal_Approach_to_Game_Design_and_Game_Research

Ibrahim, R., & Jaafar, A. (2009). Educational Games (EG) Design Framework: Combination of Game Design, Pedagogy and Content Modeling. *2009 International Conference on Electrical Engineering and Informatics ICEEI '09*, 1, 293-298, Selangor.

Järvinen, A. (2008). *Games without Frontiers: Theories and Methods for Game Studies and Design*. *Game Studies* (Ph.D. thesis). University of Tampere. Finland.

Kiili, K. (2005). Digital game-based learning: Towards an experiential gaming model. *Internet and Higher Education*, 8(1), 13–24.

Kim, M., & Doh, Y. (2016). Computational Modeling of Players's Emotional Response Patterns to the Story Events of Video Games. *IEEE Transactions on Affective Computing*, *PP* (99), 216-227.

Lazzaro, N. (2008). The four fun keys. In K. Isbister, N. Schaffer (Eds.) *Game usability (pp.* 317 – 343). CRC Press Taylor & Francis Group.

Marfisi-Schottman, I., George, S., & Tarpin-Bernard, F. (2010). Tools and Methods for Efficiently Designing Serious Games. 4t*h European Conference on Games Based Learning ECGBL2010*, (October), 226–234, Copenhagen.

Maturana, G., Zapata, C., Rojas M. (2015). A Game For Simulating the Extraction Of Relevant Information From Documentary Videos. *Developments in Business Simulation and Experiential Learning.* 42. 145 – 150.

Morales, I. M. J. (2015). Serious games: diseño de videojuegos con una agenda educativa y social. Madrid, Editorial UOC.

Navarro, E. O., van der Hoek, A. (2004). SIMSE: An Interactive Simulation Game for Software Engineering Education. *Proc. of the 7th Int. Conf. on Computers and Advanced Technology in Education.* Kauai, HI. 2004, Lisbon.

Padilla-Zea, N., Medina-Medina, N., Gutiérrez-Vela, F. L., López-Arcos, J. R., Paderewski, P., González-González, C. S. (2015). A design process for balanced educational video games with collaborative activities. *DYNA*, 82(193), 223–232.

Petri, G., Von Wangenheim, C. G., & Borgatto, A. F. (2017). Quality of games for teaching software engineering: An analysis of empirical evidences of digital and non-digital games. *Proceedings - 2017 IEEE/ACM 39th International Conference on Software Engineering: Software Engineering and Education Track, ICSE-SEET* 2017, 150–159, Buenos Aires.

Peixoto, D. C. C., Possa, R. M., Resende, R. F., & Padua, C. I. P. S. (2012). Challenges and issues in the development of a Software Engineering simulation game. *2012 Frontiers in Education Conference Proceedings*, 1–6. Seattle, WA, USA.

Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of Game-Based Learning. *Educational Psychologist*, *50*(4), 258–283.

Seepersad, C., Pedersen, K., Emblemsvåg, J., Bailey, R., Allen, J., & Mistree, F. (2006). The Validation Square: How Does One Verify and Validate a Design Method? *Decision Making in Engineering Design*, 303–313.

Steunebrink, B. R., Dastani, M., & Meyer, J.-J. C. (2009). The OCC Model Revisited. *4th Workshop on Emotion and Computing*, 1–8, Baden-Württemberg.

Souza, M. R. D. A., Veado, L., Teles, R., Figueiredo, E., & Costa, H. (2018). A systematic mapping study on game-related methods for software engineering education. *Information and Software Technology*, *95*(October 2017), 201–218.

van Staalduinen J. P., de Freitas, S. (2011). A game-based learning framework: Linking game design and learning outcomes. In K. MyintSwe(ed.), *Learning to Play: Exploring the Future of Education with Video Games.* Peter Lang Publishers New York.

Wohlin, C., Runeson, P., Höst, M., Ohlsson, M. C., Regnell, B., & Wesslén, A. (2012). Experimentation in software engineering. New York: Springer Science & Business Media.

Zapata Jaramillo, C. M. (2009). Teaching Software Development by Means of A Classroom Game: The Software Development Game. *Developments in Business Simulation and Experiential Learning*, *36*, 156–164.

Zapata C. M., Maturana G., Castro L. (2013)a. Tutorial sobre la iniciativa SEMAT y el juego MetricC, en Congreso Colombiano de Computación, Armenia, Colombia.

Zapata C. M., Gomez M. C., Gonzalez-Calderon. G. (2013)b. Riskware: A Game for Teaching Software Project Risk Management. *Developments in Business Simulation and Experiential Learning.* 40. 237 – 243.

Zin, N. A. M., Yue, W. S., & Jaafar, A. (2009). Digital Game-based Learning (DGBL) Model and Development Methodology for Teaching History. *WSEAS Transactions on Computers*, 8(2), 322–333.