RE-O-POLY: A Game to Introduce Lightweight Requirements Engineering Good Practices

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Abstract

This paper reports on the design and educational use of a board game to introduce organizations to basic Requirements Engineering (RE) good practices. While this may seem intuitive, based on our experiences and empirical studies involving RE, our position is that small novice organizations can be assisted in the adoption and improvement of RE processes via simple, low-cost and creative game-play. We outline an initial game concept and the motivation for such, and summarize our ongoing work.

1. Introduction

Requirements Engineering (RE) deficiencies are considered one of the common causes of project failures in many classic studies of the state of the software industry [12]. While the literature is replete with new processes and techniques that can address these deficiencies in large organizations with requisite resources, much less attention has been paid to how to effectively introduce RE good practices into small novice organizations where RE experience and the resources (i.e., time and money) for developing this competence is limited [7].

This work draws upon the many RE practices described in the literature, and identifies a lightweight set that is anticipated to help small novice organizations in their requirements development and management efforts. The work also explores the use of traditional games and simulation as a pedagogical tool and proposes a game-based approach as a way of helping such organizations introduce these practices in a transparent manner. This paper describes a sample game, called RE-O-Poly, that is based on the popular game Monopoly. It is intended to teach RE good practices to novice requirements engineers by reinforcing a small set of lessons as players accumulate and discharge project responsibilities.

The structure of this paper is as follows: Section 2 discusses the RE challenges common to many software development projects within novice and mature organizations. It also identifies a lightweight set of RE good practices that can potentially assist organizations in improving their RE processes in a quick and playful manner. Section 3 discusses the pedagogical potential for games, describes how they can help organizations transfer and adapt new ideas or current good practices, and presents a number of challenges to creating them. Section 4 discusses an RE game design and its objectives, and initial trial sessions are reported on in Section 5. Section 6 summarizes our ongoing efforts and future plans.

2. The RE Problem Domain

The size, complexity and importance of developing some software systems stretch current development methods to their limits. It makes it difficult to introduce changes in the way in which RE is performed and managed. A panel of distinguished RE researchers identified a number of weaknesses in traditional approaches to engineering requirements for high assurance systems, which are also more general RE challenges [8]: (1) incomplete or ambiguous requirements; (2) insufficient rigor; (3) inadequate for development; (4) overemphasis on functional requirements; (5) requirements problem not recognized; (6) current practices lag best practices; (7) lack of maturity and guidance; (8) perceived impracticability; (9) lack of awareness; (10) admitting mistakes; (11) selling idea to management; (12) increased short-term cost; and (13) changing RE practices not in self interest.

Almost half of these challenges are related to the knowledge and use of suitable processes and activities, whereas the remaining challenges are more associated with creating an environment and culture for RE within an organization. This current work aims to examine alternative and simple ways to promote awareness of RE and to instruct about practices to address some of these challenges.

The Requirements Engineering Good Practice Guide (REGPG) provides a list of 66 good practices that cover RE processes and activities and are

applicable to novice organizations with little prior use and knowledge of RE [11]. We took the top ten practices from the REGPG list and distilled them into eight essential elements to create a lightweight set of RE practices that a novice organization can adopt to establish or improve its RE processes. Table 1 loosely shows how each element addresses one or more of the numbered RE challenges listed earlier.

Table 1. Good Practices that Target RE Challenges.

Good Practices	Description	Benefits	Challenge Addressed
Structure	Use a standard structure in requirements documents.	Higher quality lowers cost of requirements documents.	1,3,4
Versioning	Make the document easy to change.	Reduces costs of changing requirements.	2
Identifiers	Uniquely identify each requirement.	Provides unambiguous references to specific requirements.	2
Policy	Use policies for requirements management and conflict resolution.	Provides guidance for all involved in requirements management. Defined conflict resolution process facilitates faster requirements.	All
Templates	Use standard templates to represent individual requirements.	Requirements are presented in a consistent way so they are more understandable	1,3
Language	Use language simply, consistently and concisely.	Requirements are easier to read and understand.	1,7
Inspections	Organize formal requirements inspections.	Finds a high percentage of requirements problems.	1,2,3,5
Checklist	Use checklists for validation and analysis.	Helps to focus the validation process. Faster, more complete analysis of requirements.	2, 3,5

3. Learning Games

Games have the ability to provide entertainment and play while at the same time educating the players. This is commonly referred to as 'edutainment' [13]. When games draw from real life and modern culture, they can be a powerful tool for facilitating learning. For example, a role-playing computer game-based environment has been used to simulate everything from managing a football game (e.g., Madden NFL® 200X and NCAA Football®) to constructing entire civilizations (e.g., Sid Meier's Civilization® game). The military uses simulation games to evaluate strategies, explore scenarios and reveal unexpected weaknesses in battlefield positions. Recently, management consultants have been engaging with business leaders to use game-play to explore possible futures and trends in their industries [1, 10].

A significant amount of research has gone into using games as a learning tool. Since the players in a game are actively engaged as participants, they are more motivated and likely to learn and remember new information than they would from mere passive listening [9]. Figure 1 is an illustration of the effectiveness of various kinds of learning processes. The vertical axis represents the level of emotional engagement and the horizontal axis ranges from passive to active learning modes. Our position is that RE education and training can benefit from a spectrum of approaches, game-play being the closest approximation to real project experience.

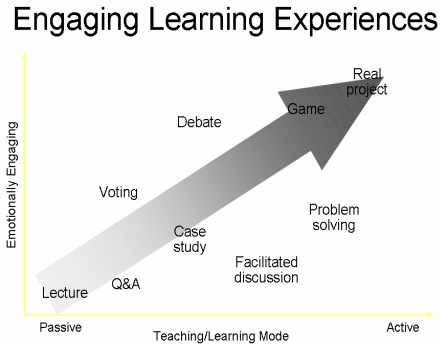

Figure 1. Learning Experience [9].

MIT developed an 'Education Arcade' to examine the effectiveness of games as a teaching method. This has served to demonstrate the social, cultural and educational potential of video games by initiating new game development projects, coordinating inter-disciplinary research efforts, and informing public conversations about the sometimes unexpected uses of this emerging art form in education [9].

3.1 Pedagogical Potential

Empirical evidence for improved learning via traditional teaching methods (e.g., lectures) is mixed and depends on other factors, such as a facilitator's skills or the students' background [2]. Games add additional dimensions to the learning process by supporting active, experiential and problem-based learning, and by providing immediate feedback [3].

Games have several advantages in a learning environment, relating not only to cognitive and effective learning, but to their ability to motivate, interest and effect change. Games can also be intrinsically motivating. The elements to enhance intrinsic motivation are individual balance between skills and challenge, goals whose attainment is uncertain, and surprises or other things that attract the users' attention to stimulate their curiosity [5]. Games have traditionally been a social experience where more than a single player commonly plays them. The competition or collaboration that is inherent in the game generally helps to stimulate the learning process.

Games are hence part of an effort to 'Re-engineer Education' [4] that supplement or replace traditional approaches to training.

One of the earlier studies on learning, motivation and the use of games was conducted by Thomas Malone [5]. As part of his dissertation, Malone used eight versions of a game called 'Darts' to teach fractions, and observed how different versions of the game were encouraging or discouraging the way children played with these games and learned with them. Malone's intrinsic motivation theory explained that the four key characteristics to create instructional games are challenge, fantasy, control and curiosity. Fantasy is used to challenge learners to imagine that they are completing the activity in a context in which they are really not present. Control is experienced when the player faces choices that produce consequences (good or bad). Challenge is created by having clear goals that are relevant for the learner. Curiosity is aroused by the intrigue of the game.

Some of the most common instructional games in use are: digital games, board games, card and dice games, role-play, energizers and icebreakers. For instance, board games such as 'The Mansion of Happiness', the first board game produced in the United States, taught children about good and bad [1]. XP War, a card game played with a specialized deck, is popular in teaching key principles behind agile software development and the use of patterns [6].

Simulation environments are also powerful learning tools that encourage exploration by allowing learners to manipulate their learning experience. Metaphorically, participants have a sandbox for learning -- a 'safe haven' in which to apply new ideas. In academia, simulations commonly enhance lectures, supplement labs and help engage students. In the workplace, simulations are often a cost-effective way to train personnel (e.g., in disaster planning).

3.2 Game Design Challenges

Games, in any form, can play a valuable role as a part of any learning process. However, they may have some drawbacks and present a number of challenges in their development. Will the game capture attention and encourage participants? Are there unintended consequences? Beyond the academic content, what other types of information might be conveyed by games? Will negative themes or undesirable perspectives be conveyed by educational games? How can domain specific principles (RE here) be adapted to educationally relevant contexts? How do you best achieve the pedagogical potential of the game and subsequently evaluate whether this has been achieved?

4. An RE Game

Small novice organizations need a fast, cost-effective and painless method to introduce and adopt RE, hence the idea for using simple and familiar games to teach RE good practices. Our contention is that simulation-based games can be effective tools for addressing the multiple dimensions of software engineering education and training. An RE game could be designed to encourage players to explore, negotiate and articulate certain requirements in order to win. Since requirements are often conflicting and unprioritized, players would have to learn to resolve conflicts and determine priorities in order to progress in the game. In the game, players would be living virtual lives in an environment that forces them to make constant decisions. Moreover, the game playing environment could be configured to encourage stakeholders to discuss and reach resolution on any conflicting priorities [1, 2]. They would then experience the consequences of those decisions in a way that simulates the actual project experience, except that consequences would be felt immediately (through loss of a turn, points or position on a board).

RE-O-Poly is a first-generation board-based and project-based simulation game that incorporates the lightweight set of eight RE practices mentioned in Section 2. It is designed to help learners:

- Get a broad overview of typical RE problems and challenges.
- Understand the value of RE, its processes and good practices, and learn how to apply some simple techniques.
- Make proactive decisions about projects that address business needs and requirements.
- Respond appropriately to unanticipated situations that impact projects that they are involved with.

The design goal behind the game is to engage the learner, without being overly pedantic. The game is based on the popular Monopoly game, which was developed in the public domain. Using the Monopoly interface as a model provided the dual benefit of shortening the game design time as well as offering players a proven and familiar interface. Also, the board game concept encourages face-to-face communication which is useful for learning about a discursive activity. Discussing and questioning experiences from the game fosters a natural and safe team building environment. Lastly, the game is supposed to be fun. Dramatic decision-making and competitive elements of the game raise interest, motivate repeated game sessions and make the game an enhanced pedagogical experience.

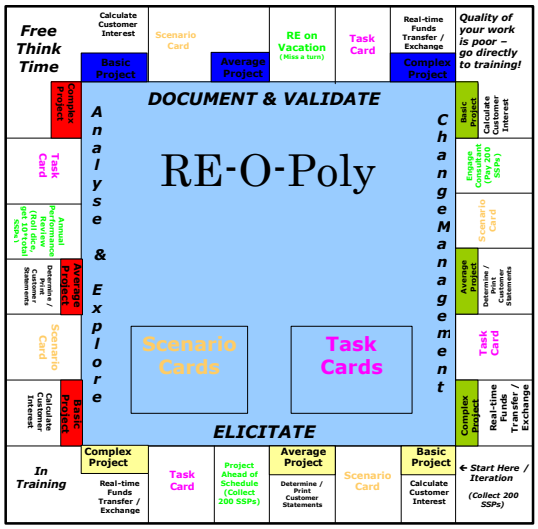

Figure 2. An Early Sample RE-O-Poly Interface.

RE-O-Poly is designed for novices -- players new to RE. It is meant to be used in conjunction with RE training or to reinforce lessons previously learned. It is intended to be facilitated and the projects used need to be tailored to the domain of the organization (e.g., defense, media, finance, telecoms, etc.) An early prototype of the game board is shown in Figure 2 and the key game concepts are as follows:

Stakeholder Satisfaction Points (SSPs), which players are allocated at the start of the game and then either earn or forfeit as the game progresses.

Projects for the players to own, run and buy resources for (e.g., tools), using SSPs and through undertaking and assessing tasks. For purposes of illustration, we have suggested three sample projects that may arise in a financial institution: basic (calculate customer interest), average (determine / print customer statements) and complex (real-time electronic funds transfer / exchange system).

Scenario Cards, which show what happens when RE good practices are implemented or not, such as the use of requirements templates or careful language to write atomic and unambiguous requirements. These are instructional and provide the opportunity for players to earn or lose SSPs according to the perceived importance of the practice.

Task Cards, which provide players with an opportunity to earn or lose SSPs by answering general RE questions based on one of the practices taught in the Scenario Cards, such as re-wording a problematic requirement. The facilitator can be the adjudicator.

The Game Board covers four basic stages in an RE process: Elicitation, Analysis and Exploration, Documentation and Validation, and Change Management. Like Monopoly, play is advanced by the roll of the dice. One circuit around the board represents one pass through a typical and basic RE process for the three projects under study. The intention is to convey the fact that multiple circuits (or iterations through RE activities) are required on any one project.

Players take **Ownership**, and hence responsibility for, the various stages of the RE process on the different projects using SSPs. To secure ownership of elicitation tasks on the simple project costs 100 SSPs, on the average project costs 150 SSPs and on the complex project costs 200 SSPs. Since more is at stake with the complexity of the project and with progress of RE activities, the number of SSPs required gradually increases with a circuit of the board. A player who lands on a project slot has the opportunity to buy ownership (if unowned) by paying the amount of SSPs shown and receives the corresponding **Project Card**.

If another player lands on a project slot that is already owned, the project owner gets to pose a **Specific RE Problem or Challenge** relating to the phase of the RE process where the project is located. For example, if it is the Complex Project in the Elicitation Phase, the problem posed might be: How would you go about determining the stakeholders for the electronic funds transfer system and / or list an initial set? If the project owner is not satisfied with the response, then the other player must pay the owner the amount of SSPs indicated as the 'quality control cost' on the back of the Project Card. If the owner is satisfied, then the other player pays nothing. Other players, guided by the facilitator, can act as **Quality Gatekeepers** to encourage discussion and decision making. The combination of Scenario and Task Cards provide for a teaching and assessment environment in general terms. The intention is to see how well the players transfer this learning to formulating and addressing project-specific problems and challenges.

5. Initial Experiences with Game-Play

During concept development of the game, the design and rules were volatile. Input was gathered from various sources: industry and academic literature, and Pace University faculty and students. Once the RE monopoly-based concept was agreed upon, early game ideas were created, and sessions were played with family members of the first author and with second year computer technology students at a local community college in New York City where the first author teaches. The game sessions consisted of three to four players, because with more than eight players the game was found to lose its effectiveness due to lower levels of participant interactivity.

Prior to playing the game with the student group, the facilitator gave a brief overview of basic RE principles. In a typical game session, the rules were explained and the game commenced without many problems. Players' familiarity with the Monopoly-like interface made it easy to understand. After the game was completed, the players were debriefed (verbal feedback) to obtain their reaction to the game and to gauge their learning experience. In most cases, the players with some preliminary software development knowledge seemed to understand and accept the RE good practice messages. The participants with no prior experience needed more time to accept or understand why the practices were meaningful. One more experienced participant liked the concepts and believed it formed the basis of something that could be useful with further refinement and development.

6. Conclusions and Future Work

Small novice organizations need a fast, cost-effective and painless way to introduce and adopt RE, hence the idea for the concept of the RE-O-Poly game as a potentially interesting way to teach RE good practices to an unsuspecting audience. Based on very preliminary results the game seems to be fun and captured the attention of the participants when played in a swift and time-boxed manner. Based on discussion after game-play, participants appeared more comfortable with basic RE concepts, so the pedagogical potential of using games to teach RE good practices is certainly worth exploring more fully.

Research into easy-to-adopt approaches to introducing RE concepts will benefit both academia and industry. In industry, if project stakeholders understand and practice RE, the results are likely to be quality software projects that meet the needs and expectations of stakeholders. In academia, if the next generation of software engineers understands the theory and practices behind RE, their transition to industry may be smoother. Also, these engineers can become agents of change for better RE in their respective organizations [14], which is essential to addressing the full set of challenges listed earlier.

Our ongoing work includes developing the game concept with concrete projects, scenarios and tasks, and expanding the study to a control environment where we can produce better data for statistical analysis. It is obviously essential to understand the impact of the game on people who have some training with RE practices versus those who do not, and also to assess the RE knowledge of the people who have been exposed to the game versus those who have not. We are designing such post game-play assessment instruments. Also, it would be useful to measure the training's impact on a participant's job skills.

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8. References

[1] El-Shamy, S. *Training Games: Everything You Need to Know About Using Games to Reinforce Learning.* Sterling VA: Stylus Publishing, 2001.

[2] Garris, R., Ahlers, R. and Diskell, J.E. Games, motivation and learning: a research and practice model. *Simulation and Gaming*, 33(4), 2002, pp.441-467.

[3] Kauppinen, M., Kujala, S., Aaltio, T. and Lehtola, L. Introducing Requirements Engineering: How to Make a Cultural Change Happen in Practice. *IEEE Intl. Conf. on Requirements Engineering*, Essen, Germany, IEEE Computer Society, 2002, pp.43-51.

[4] Lemke, J. Becoming the village: education across lives. In G. Wells and G. Claxton (editors), *Learning for Life in the 21st Century: Sociocultural Perspectives on the Future of Education.* London: Blackwell, 2002, pp.34-45.

[5] Malone, T.W. and Lepper, M.R. Making Learning Fun: A Taxonomy of Intrinsic Motivations for Learning. In R.E. Snow and M.J. Farr (editors), *Aptitude, Learning and Instruction: III. Conative and affective process analyses*. Hilsdale, NJ: Erlbaum, 1987, pp.223-253.

[6] Morales, A.W. XP - Extreme Programming trainer Joshua Kerievsky invents another card game. *Dr. Dobbs's Portal*, November 20, 2002 and June 19, 2007, *http://www.ddj.com/dept/architect/184415908*.

[7] Nikula, U. *Introducing Basic Systematic Requirements Engineering Practices in Small Organizations with an Easy to Adopt Method*. Doctoral Thesis, Dept. of Information Technology, Lappeenranta University of Technology, 2004.

[8] RHAS'05 Workshop Report. *Intl. Conf. on Requirements Engineering*, Paris, France, IEEE Computer Society, 2005.

[9] Sams, Bill. OLN where do games fit into education. *Ohio Learning Network's TeachU Online Seminars*, 2006, *www.teachuohio.org*.

[10] "Shall we play a game?" *The Economist*, June 2, 2007, pp.72-73.

[11] Sommerville, I. and Sawyer, P. *Requirements Engineering: A Good Practice Guide.* Chichester, England, John Wiley and Sons, 1997.

[12] Standish Group. *The CHAOS Report*, 1994 and 2003 versions, *www.standishgroup.com* (accessed Oct 15, 2006).

[13] Usrey, M.W. A Case for Engineering Edutainment in the 21st Century. In *Building on a Century of Progress in Engineering Education - Frontiers in Education 2000 Conference Proceedings*, D. Budny and G. Bjedov (editors), pp.S1A-20-S1A-24, Piscataway, NJ: IEEE, October 2000.

[14] Wieringa, R. and Ebert, C. Guest Editors' Introduction: RE'03 -- Practical Requirements Engineering Solutions. *IEEE Software,* 21(2), 2004, pp.16-18.