

CONVEYING CONCEPTS THROUGH CARTOONS: PRELIMINARY RESULTS FROM SOFTWARE ENGINEERS IN AN INDUSTRIAL ORGANIZATION THEORY CLASS

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ABSTRACT

Cartoons have been used to improve learning in several disciplines such as linguistics, politics, and sociology, but they have seldom been used to teach in engineering programs. The authors produced and used a cartoon book to introduce some basic concepts associated with software engineering to a heterogeneous group of students enrolled in an industrial organization theory class. There is preliminary support for this approach since students exhibited the ability to more quickly employ challenging software engineering concepts after using this method.

INTRODUCTION

Since cartoons usually aim to amuse or entertain, the extensive use of cartoons as part of traditional teaching methodologies is uncommon. Despite that, some evidence suggests that the use of cartoons has improved learning in linguistics (Mains, 1945), politics (Hess & Kaplan, 1975), sociology (Scanlan & Feinberg, 2000), physics (Perales & Vilchez, 2002), soil management (Hyun, 2006), and the general sciences (Naylor & Keogh, 2000). Also, Hall (2008) has used cartoons (as sequences of pictures with text) in order to understand the relationships between models and learning interactions.

Some cartoons, such as *The Simpsons* or *Pokemon* take place within a unique context and specific issues of importance are staged within that context in order to communicate the intended messages. In contrast, cartoons used to address subjects like politics are often specifically designed to convey a particular message. Regardless of

format, the aforementioned studies advocate the use of cartoons in studying concepts, as well as conveying issues.

In previous ABSEL conferences, some work has been devoted to explain the need for involving students as active subjects in the teaching-learning process (Hoover, 2007; Anitsal & Cadotte, 2007; Gentry & McGinnis, 2008). Teaching software engineering can be challenging because it involves highly abstract concepts and thinking. To enhance software engineering teaching methods, Zapata & Olaya (2007) authored a cartoon-based book entitled *Software Engineering for Analysts*. They have subsequently used the book to advance the understanding of basic concepts in software engineering among a heterogeneous group of students from several different engineering programs. This paper reports the preliminary results of that experience, highlighting improvements in students' capabilities to use challenging software engineering concepts as a result of their experience with and exposure to subject-specific cartoons in an industrial organization theory class.

THE ROLE OF CARTOONS IN TEACHING

Previous ABSEL conferences have shown the importance of simulation in the teaching-learning process. In this line of thought, Hoover (2007) examined the influence of spirituality in the design of learning systems, and the importance of this kind of tools in experiential learning. Anitsal & Cadotte (2007) explored the application of means-end theory as a mental model to demonstrate the usefulness of participating in a simulation experience. Gentry & McGinnis (2008) suggested several ways to motivate students as opposed to the traditional focus on a one-way flow of information from teachers to students.

Cartoons, as tools for the teaching and learning process, can benefit from these approaches, as reviewed this section.

The use of cartoons is an effective learning and teaching strategy for two main reasons: (a) the immediateness of the visual impact generated by cartoons, and (b) the nature of this impact upon people regardless of age (Lochrie, 1992). In addition to the amusement stimulated by cartoons, the instructive response among viewers is noteworthy. One final reason for using cartoons in learning is the reinforcement of learning cycles, as presented by Reyes (2008).

Mains (1945) first reported the effectiveness of cartoons in teaching grammar. Cartoons were used as a means to reflect upon students' learning of grammar. Students were tasked to create cartoons in order to exhibit their understanding and then the cartoons were assessed to determine the extent to which they conveyed an image of the students' assimilation of targeted concepts.

Cartoons are useful sources of historical data because cartoons reflect social attitudes and this is especially true of opinion-based cartoons (Kemnitz, 1973). In subsequent work, Hess & Kaplan (1975) conducted an extensive review of the use of cartoons in American politics and revealed their effectiveness in conveying particular political ideas. They collected numerous cartoons from newspapers and explained how the cartoons could be used in teaching political science. Some of this work advocates the use of cartoons as a multi-sensory approach for learning.

In a more contemporary and novel approach, teachers

have employed popular cartoons to address the subject of sociology. In particular, *The Simpsons* is studied to promote critical thinking about various significant social issues (Scanlan & Feinberg, 2000). In this case, a representation of contemporary American culture in the form of a cartoon is used in an attempt to convey social realities to students.

In a similar strategy, Perales and Vilchez (2002) employ not only *The Simpsons*, but *Pokemon* in order to generate critical thinking about both real and impossible situations in the context of physics. Their method includes the analysis of particular situations in the cartoons through teacher-student discussions about the observed phenomena. It is then extended through interviews with students as they search for meaning in the situations, as well as interviews with parents to determine the extent to which students have gained insights from the process. In this case, animated and well-known cartoons are suggested to be the most effective cartoons to enhance the teaching and learning process.

Similar to Mains (1945), Hyun (2006) used the process of creating of cartoons as a class exercise to generate evidence of the extent of understanding in matters of soil management. In an effort to motivate effective student participation, the cartoons were published in a weekly farming newspaper.

Among the ABSEL community, Hall (2008) explored the relationships between models and their interactions with learners. For completing this task, Hall used the sequence revealed by pictures in a cartoon and he compared it to simulation by means of models.

Front and rear covers of the book

Figure 1



La enseñanza tradicional en Ingeniería de Software se suele realizar con Clases expositivas y proyectos prácticos. Sin embargo, las estrategias tradicionales de enseñanza, en ocasiones, no suscitan la motivación requerida por los estudiantes, puesto que la seriedad de los temas genera verdaderos mitos al respecto. En este libro, se aborda la Ingeniería de Software con una propuesta humorística, que busca desmitificar estos temas y complementar, de esta forma, su enseñanza.

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Cartoons are also being used as vehicles to teach the fundamental subjects of science, math and English. *Concept Cartoons*TM (see <http://www.conceptcartoons.com>) is an initiative designed to examine intriguing ideas, promote discussion, and stimulate scientific thinking (Naylor & Keogh, 2000). The basic features of this approach include the visual representation of scientific ideas, minimal use of text when representing dialogue in cartoons, the presentation of alternative views, and the application of scientific ideas to daily or routine life situations. This and the aforementioned approaches have been adopted, adapted and employed by the authors of this paper to enhance the teaching and learning of concepts related to software engineering.

SOFTWARE ENGINEERING FOR ANALYSTS: APPLICATION IN TEACHING SOFTWARE CONCEPTS

PRODUCTION OF THE BOOK

Software Engineering for Analysts (In Spanish, “*Ingeniería de Software para Analistas*”, Zapata & Olaya, 2007) was written as part of a research project to assess the effectiveness of a new teaching method in a software engineering program. The strategy adopted was similar to that proposed by *Concept Cartoons*TM because the objective was to use cartoons in order to promote critical and scientific thinking in the process of software engineering. With that purpose in mind, Zapata and Olaya produced and published *Software Engineering for Analysts*. Figure 1 shows the front and the rear covers of the book.

The rear cover explains the underlying philosophy of the book, which is to supplement traditional teaching strategies with humorous and motivating cartoons. Though not a direct translation, the Spanish text in Figure 1 is best

interpreted as follows: the teaching of software engineering is usually done through lectures and little “toy” projects. However, these strategies are sometimes ineffective and discouraging for students because engineering has an inherently serious theme. This book uses humor as a means to complement the traditional approach to teaching software engineering by helping the student to think freely in order to enhance and clarify the challenging processes associated with software development. An example of the humor appears in Figure 2, which shows two of the main characters of the book: the stakeholder and the software vendor.

The book illustrates the concepts used to explain the software development lifecycle and other organization issues related to software engineering. In drawing the cartoons, the authors employ humorous situations about the software development process accompanied by graphical representations of software engineering concepts. Figure 3 shows a description of the waterfall model for developing software. Note that the authors do not use pre-existing or published cartoons because their intent is to explain particular engineering concepts through the use of cartoons that are effectively matched to the idea they want to convey. This approach also allows the authors to create a small group of reusable, and thus familiar characters appropriate to the software engineering context, such as analysts, developers, and stakeholders.

The cartoons are accompanied by some explanatory text in order to ensure sufficient understanding of the concepts; however, there is no exhaustive written discussion of the concepts. Instead, the text serves to amplify the cartoons. The book serves as an introductory text for guiding the students’ initial view of software engineering concepts. It is currently 48 pages which can be reviewed and its contents assimilated in about an hour. This stands in sharp contrast to the greater and more uncertain time needed to read and comprehend a traditional software engineering book.

**The vampire (software vendor) says
“Come with me... our engineers will show you the payroll software...”**

Figure 2



USING A SOFTWARE-RELATED BOOK IN AN EXPERIENTIAL WAY

After the book was produced, the authors employed the book in a course appropriate to test its usefulness. The course was chosen to ensure it had the following desired features:

1. A group of heterogeneous students from several semesters and with different levels of software engineering knowledge.
2. The potential to address a non-technical software issue in the context of software development, such as management or control.
3. Sufficient motivation to seriously engage in the task, which was attained by ensuring that the task was a graded event in the course.
4. A syllabus meaningfully different from the topics covered by software engineering.

The course chosen was “Industrial Organization Theory;” a course belonging to several engineering programs of the Mines Faculty in the Universidad Nacional de Colombia. This course is similar to other courses in several universities in the world. It covers topics about marketing, microeconomics, strategy, modeling, simulations, and game theory. This course was selected

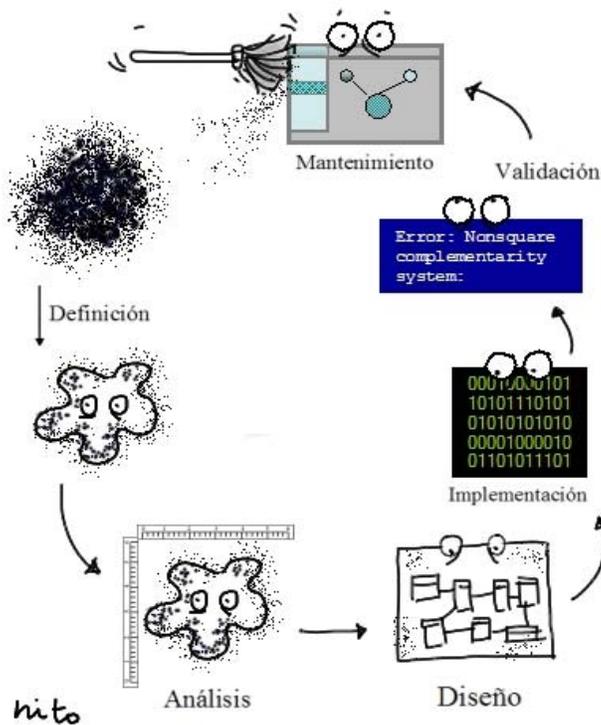
because the topics covered are far from traditional software engineering topics. Among the class members 28.7% of the students had previous experience in software engineering courses, which contributed to the heterogeneity of group experience levels, as well as the number of semesters completed. During the course, students were given the subtask of engaging in a workshop on game theory because this is where students are taught to analyze strategic situations using game theory concepts. They were tasked to read *Software Engineering for Analysts*, identify a strategic issue and represent it in a strategy game using relevant topics addressed in the book. Finally, they were to solve the game and discuss the results.

ANALYSIS OF THE EXPERIENCE

The task assigned to students in “Industrial Organization Theory” was accomplished by 21 students. We analyzed the results in terms of the following criteria: (a) adequate use of terminology, (b) the choice of strategic issue to be addressed in the game, and (c) the effective use of strategies in the game. By assessing their use of terminology, we indirectly evaluated the students’ comprehension of software engineering topics, as a result of reading the book. The themes selected for the game reflected the students’ interests. Finally, we reviewed the

Phases of software development lifecycle: definition, analysis, design, implementation, validation, and maintenance.

Figure 3



effective use strategy in the game as a way to evaluate the application of the concepts in a real problem outside the usual and more technical aspects of software engineering. We summarize the results in Tables 1, 2, and 3, and employ these tables in discussing the results.

Table 1 explores the behavior of only the expert students in accomplishing the assignment. In this case, expert students are defined as having experience in software engineering through previous courses. It makes sense that 67% of these students exhibited a good conceptualization of software engineering since they have had experience in managing such terminology in previous courses. Also, prior work in software engineering-related projects gave them the expertise for defining communication as one of the main issues in the software development lifecycle. Most of the expert students recognized external communication as the most important issue in software engineering, followed next by internal communication.

The use of methodology and the need for good quality are the other issues that the expert students (17%) used in their decision game. In the final criteria assessed, 33% of the students employed a good strategy in the decision game. This leads us to suggest that the cartoon approach at least complemented the learning process for the more advanced software engineering students.

Table 2 shows the results of the non-expert students used in this study. Without prior experience and by reading only the book, 53% of these students achieved good use of the terminology in this field. This is one of the important results of our examination. It suggests that the use of cartoons in our book had some positive impact upon the ability of inexperienced students to quickly assimilate the information and be able to appropriately use the terminology related to the concepts in the book. The most common themes used in the creation of the decision game were external communication (40%), internal

Summary of Expert Student Performance in the Experience

Table 1

Criteria	Amount	Percentage
Good terminology usage	4	67%
Themes		
Communication		
External communication: analyst-stakeholder	4	67%
Internal communication: inside the development team	2	33%
Quality		
Methodology usage	1	17%
Need for quality	1	17%
Good strategy in the game	2	33%

Summary of Non-Expert Student Performance in the Experience

Table 2

Criteria	Amount	Percentage
Good terminology usage	8	53%
Themes		
Communication		
External communication: analyst-stakeholder	6	40%
Internal communication: inside the development team	3	20%
Quality		
Methodology usage	1	7%
Maintenance	1	7%
Agile vs. Plan-driven Methodologies	1	7%
Need for good quality	3	20%
Competence among enterprises	3	20%
Good strategy in the game	12	80%

communication (20%), need for good quality (20%), and competence among enterprises (20%). These categories align with the previous results for the expert students for communication and two of the quality categories. This result is also important because it suggests that non-expert students could identify important themes after having been exposed only to the concise cartoon coverage approach. In addition, non-expert students were also able to recognize the additional themes of maintenance, agile versus plan-driven methodologies, and competence among enterprises as important themes in software engineering. All of these identified themes are presented in the book through cartoons and brief supplementary text. The final outcome associated with this group reveals that 80% of these non-expert students employed a good strategy in solving the game. This indicates that the cartoon approach also had a positive impact on the non-experts' ability to employ an effective strategy even though their traditional education was not as extensive as the experts.

Table 3 shows consolidated results for the two groups of students. In total, 57% of the students employed good terminology relative to software engineering. This is a remarkable result because our experience suggests that traditional software engineering teaching methods would require more time to achieve a similar result. A possible explanation for this result is the thesis of this paper: that students could quickly assimilate information conveyed by cartoons and are more motivated to read through cartoon-based material as a more interesting and concise medium than traditional textbooks. The students' abilities to identify communication and quality themes are also significant because these themes are emphasized by the cartoons.

CONCLUSIONS

This paper reported the process of producing a cartoon book on the subject of software engineering and subsequently using it as a learning tool. The results of the experience are promising because they show some evidence that a group of non-expert students exhibited good usage of software engineering terminology and identified important disciplinary themes after only a brief exposure to the ideas through the use of the cartoon methodology. The visual impact of cartoons accompanied by accurate, but bounded textual explanations is the main factor that is likely to have influenced the outcome of this experience. On a percentage basis, expert students still fared slightly better in using terminology and identifying some important themes, but non-expert students did well and achieved their results in less time. The results suggest that the cartoon approach can be effective.

LIMITATIONS

This study was the first attempt to explore the effectiveness of the cartoon method in the context of software engineering with only a very limited sample size. The percentages represent only a few people, so should not be misconstrued as significant. The effect of having prior coursework and/or excellent academic capability in software engineering is also unclear since the sample was not controlled for things like the number of prior courses and prior academic performance. Finally, learning styles and student motivation were not measured or accounted for in this process.

Summary of Consolidated Student Performance in the Experience

Table 3

Criteria	Amount	Percentage
Good terminology usage	12	57%
Themes		
Communication		
External communication: analyst-stakeholder	10	48%
Internal communication: inside the development team	5	24%
Quality		
Methodology usage	2	10%
Maintenance	1	5%
Agile vs. Plan-driven Methodologies	1	5%
Need for good quality	4	19%
Management		
Competence among enterprises	3	14%
Good strategy in the game	14	67%

FUTURE WORK

This experiential usage of software-related cartoon books has suggested some lines for future work, like the following:

1. Creating new kinds of experiences for promoting the reading of educational cartoons and the analysis of these experiences.
2. Developing more specialized books and trying to explore other important themes in software engineering.
3. Designing experiments for measuring the real impact of cartoon books as a learning and teaching strategy for complementing well-known teaching methods.
4. Developing new strategies based upon the same principles of cartoon books for improving the teaching of software engineering. For example, we suggest the creation of animated movies or video games, because such strategies can exploit visual impact and motivation in software engineering students.

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