Analyzing Collaboration in the Gamification Process of Childprogramming

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Abstract: According to Jeannette Wing computational thinking involves problem solving, system design and understanding of human behavior, making use of the fundamental concepts of informatics, thus, it means that boys and girls acquire skills to solve problems in different contexts through informatics and software programming in different devices. For the purpose of supporting the initiatives to strengthen the development of computational thinking, the Software engineering research and development group (IDIS) of the University of Cauca, in 2012 formalized the Childprogramming model to support the development of software oriented to children, based on strategies of collaborative learning, agile software development, and ludic learning. Since then, this model has been improved, such as, the Childprogramming-G model that looks for the improvement of the ludic learning, offering gamification strategies for the software development process carried out by children. This article presents an exploratory case study where the ChildProgramming-G version was applied, taking some dynamics and game mechanics combined with the previous sensitization of the importance of collaborative work in children's work teams. From this case study it was possible to obtain more information about the collaborative processes involved in the teaching-learning process of the software development carried out by children.

1 INTRODUCTION

The case study presented in this article is part of the research "Childprogramming-C: Extending Childprogramming from Collaborative Engineering", proposed by the IDIS Research Group, as an improvement of the collaborative dimension of the current ChildProgramming model (Hurtado et al., 2012). This work is framed within the research lines of Collaboration Engineering and Software Engineering, and seeks to contribute in the design of collaborative processes, contributing significantly in the teaching of software development at an early age, and encouraging the resolution of problems Complex and the development of computational thinking.

Since 2013 improvements have been made to the Childprogramming model, such as the version of the Childprogramming-G model (Garcia and Orejuela, 2014), which offers a more dynamic process for teaching software programming for children in different de-vices, with the help of techniques and dynamics of gamification. In the search to improve the collaborative component of the model, the Childprogrammig - C project has developed case studies to identify aspects that allow improving the collaborative component from the Collaborative Engineering approach from case studies. This article analyses the collaboration of the software development process from three fundamental aspects, which are: positive interdependence, equal participation, and individual responsibility as essential elements that must be presented in the collaboration, so that the Learning takes place effectively (Collazos et al., 2007), also takes into account the definition of team strategies and the work of the leader.

Next, section two describes some conceptual elements of the Collaborative Collaboration and Engineering that guide the development of the proposed work. In section three, a brief presentation of the methodology is made; then, section four analyses the results of the case study, and finally section five shows the conclusions and future work.

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2 THEORETICAL REFERENCES

This section describes some concepts necessary for the contextualization of the article. The first of these is Collaboration Engineering, attached to Software Engineering as an area that promotes an organizational philosophy of the development process and that fosters teamwork, based on the recognition of the individual skills and abilities of the group Work (Jurado and Collazos, 2013), later gamification is presented as a process of incorporation of game elements in non-play processes (Deterding, 2011), and finally the ChildProgramming model and its version is presented.

2.1 Engineering Collaboration

The field of Collaboration Engineering has emerged as a focal point for research on the design and implementation of collaborative processes that are recurrent in nature and executed by professionals in organizations, rather than collaborative professionals(De Vreede *et al*, 2009). By collaborating, individuals achieve greater results than they could individually, however, achieving effective team collaboration remains a challenge (Vreede and Briggs, 2005).

From the need to design, execute and structure collaborative processes within different groups, Collaboration Engineering arises (Kolfschoten et al., 2006), which is "a systematic approach to the design of repeatable collaboration processes, which can be used to Increase human efficiency and effectiveness in organizations " (Kolfschoten et al., 2006). Collaboration Engineering is an approach to the design of reusable collaborative processes, therefore, collaborative processes need to be explicitly designed, structured and managed, in order to be transferable to groups, using collaborative techniques and technologies (Vreede and Briggs, 2005).

2.2 Collaborative Work

Collaborative work offers an option to overcome limitations of traditional learning, under this scheme the presence of different actors and their coordination must be taken into account, since situations require collaboration, communication and exchange of information (Mendoza and Galvis, 1998), integrating aspects of collaborative work into a given process, the goal is not only to improve communication, but also to achieve greater participation and commitment among the members of a group working on a common activity, leading to better quality Of the processed product (Collazos and Mendoza, 2006).

Johnson and Johnson have developed several statistical analyzes with students of different ages, educational and social levels, and have demonstrated the positive effect that collaborative learning has had on their academic success and their social achievements (Johnson and Johnson, 1994), thus defining work Collaborative as (Johnson and Johnson, 1994): "the set of methods of instruction or training for use in small groups, as well as strategies to foster the development of mixed skills (learning and personal and social development), where each group member is responsible both of their learning as of the rest of the group".

Turban defines that group work has a number of advantages over individual work, among them one has: a group understands a problem better than a single person, there is a shared responsibility, it facilitates the detection of errors, a group presents A greater knowledge than a single person, which offers better alternatives for solving problems, presents effectiveness and quality of production, the effectiveness and quality of production of a group is greater than the sum of what each member can produce in Individual form, since this individual knowledge is strengthened with the group obtaining better results; In this way collaboration is one of the main components of the Childprogramming Model that seeks to be improved (Turban, 1995).

2.3 Gamification

Gamification is defined as the application of basic elements that make fun and attractive to things that are not normally considered a game (Sridharan *et al.*, 2012). Similarly refers to "the adoption of gaming technology and methods of game design outside the video game industry" (Deterding e*t al.*, 2011). "The process of using game thinking and game mechanics to solve problems and attract users" (Hagglund, 2012).

ChildPrograming in its gamified version has taken into account gamification oriented in an educational and collaborative environment, incorporating elements of play in a classroom context with the objective of engaging students with learning through activities that provide fun experiences of their own Games for children (Lee and Hammer., 2011). Within gamification the following concepts play a very important role:

- Game mechanics: rules that aim to increase the motivation and the commitment of the players through the achievement of objectives and with the purpose of obtaining recognition (Beza, 2011).
- Game dynamics: are the human needs and concerns that motivate people and are the result of using the game mechanics (Beza, 2011).

2.4 ChildProgrammig Model

Some discussions in the area of software programming in children have focused on different topics such as: identify how to create programming languages with children, or whether children can learn particular topics in software programming (Sheingold, 1987); however, other issues have been addressed in finding a strategy for small children to create their own programs, this is the case of the ChildProgramming model, which is born as a project idea in the IDIS group, and formalizes a model to support the development of software oriented to children.

Considering that collaborative learning is a set of methods of instruction or training for use in small groups, as well as strategies to promote the development of personal and social skills (Gomez, and Izuzquiza, 2015), the ChildProgramming model also proposes the collaborative dimension, which attempts to increase The quality of learning and favors the acquisition of students knowledge through interaction between them, through software development (Cruz and Rojas, 2013).

Figure 1: Early Child Programming Process Life Cycle.

ChildProgramming consists of three dimensions (Cruz and Rojas, 2013): the cognitive dimension, considered as the effort that a child will make to understand, analyze and appropriate situations present in the tasks defined by ChildProgramming, contributing to the process the main concepts for the development of the same. The Agile dimension: based on the promulgation of the manifesto values of agile software development methodologies, the agile dimension provides ChildProgramming with an agreed form of work to achieve the objectives where a team work is evidenced that allows the members of the same stay together throughout the activity. ChildPrograming defines three phases: pre-game, game and post-game as shown in figure 1, and proposes the following roles: teacher, team guide, team and researcher.

The model has been evolving and its latest version has incorporated improvements related to gamification, obtaining the model ChildPrograming - G (Garcia and Orejuela, 2014), presented in the figure 2, where it can be appreciated a significant improvement regarding tasks and the tutor role.

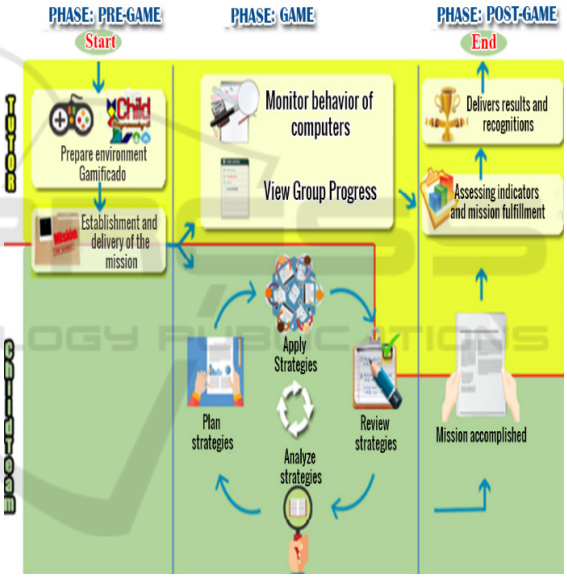

Figure 2: Childprogramming-G process lifecycle (Garcia and Orejuela, 2014).

Currently working on Childprogramming-C to strengthen the collaborative component from the Collaborative Engineering approach.

3 METHODOLOGY

3.1 CSACE (Case Study based Analysis in Collaboration Engineering)

For the development of the ChildProgramming - C project, the CSACE method has been followed,

which is based on case studies to establish the needs of collaborative processes from the team interactions, as well as the empirical evaluation of the effectiveness of the resulting collaborative process, see figure 3. It integrates the need to study the phenome-none of collaboration in software development teams and the case study as a methodology to conduct such a study (Hurtado and Collazos, 2014). The case studies are a research methodology that has proven to be useful for Software Engineering in the analysis of study subjects that are easier to observe in group than in isolation (Runeson and Höst, 2009), so they are a viable approach to The analysis and evaluation of collaborative pro-cesses (Hurtado and Collazos, 2014).

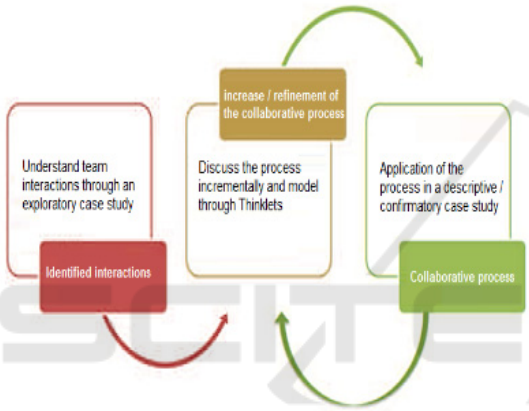

Figure 3: Fundamental structure of the CSACE method (Hurtado and Collazos, 2014).

Following the CSACE method, exploratory case studies have been performed to identify and understand the interactions of children's teams while developing software oriented with the Childprogramming and ChildProgramming model, using the Scratch 2.0 programming tool and the process tracking tool Gamitool.

During the development of the case studies applying the initial Childprogramming model, several failures of the team work and the collaboration of the members of the same one, for which, an activity of sensitization was proposed on the importance of the collaborative work in the phase Pre-game model, where children are taught the importance of collaboration before starting a software development process.

In the figure 4 and 5, you can see some of the dynamics made for children in the process of awareness raising, the importance of positive interdependence, individual responsibility and equal participation in work teams to achieve goals.

Figure 4: Collaborative dynamics one.

Figure 5: Collaborative dynamics two.

Subsequently, a case study was carried out to validate if there is an impact on the work teams by raising awareness in children about the importance of collaboration, combined with the structuring and planning of mechanics and game dynamics applicable in the pro-cess of software development.

3.2 Applying the ChildProgramming-G Model

3.2.1 Pre-game Phase

Once the process of raising awareness about the importance of Collaborative work was carried out, the children organized the software development teams, assigning a name and choosing a leader. The teacher gave the team the mission that included a set of programming challenges in laptops and mobile devices. Initially in this phase the teacher and the researcher chose the dynamics and game mechanics that would be used, taking into account the characteristics of the children and the environment where the case study was developed, between the eight game mechanics and five dynamics of Game

revised by Childprogramming-G, those presented in table 1 and table 2 were selected.

Table 1: Selected game Mechanics.

Mechanics.	Description (Garcia and Orejuela, 2014)
Classification tables	Seeks to provide desire for aspiration and provide a comparison between groups of children that leads to an overview of the development of activities and states of groups of children.
Benefits	Mechanics that will give the user motivation through a prize for their positive participation in the development of the activity, can be tangible or virtual.
Levels	These are the indicators that contribute to recognition once objectives previously defined by the instructor have been met. They serve so that the children are motivated to conquer each proposed level and can see a clearer picture of how they are located in the activity since there is a finite series of levels

Table 2: Selected game Dynamics.

Dynamics	Description (Garcia and Orejuela, 2014)
Reward	It is one of the dynamics of gamification important to keep children motivated and committed. Depending on the behavior or the points it offers the rewards.
Achievements	Commitment and enthusiasm for participating in activities. The achievements can be given at the end of the activities and can be points, medals.
Competition	Competition generates an increase in the enthusiasm to finish tasks before others, to earn points, other recognitions to be in first places.

3.2.2 Phase Game

In this phase of the rounds, which includes the cycle of the strategy of the plan, the strategy of the game, the budget and the strategy of the examination. During this phase the children designed and developed their task tables, in the same way they defined the strategy to execute the challenges and develop the applications. For each achievement of a task received points, which are positioned in the classification table of the gamitool. See figure 5.

Figure 6: Task boards.

The task board was very important for the control and evaluation of the strategy of the work teams.

On the other hand, teams received benefits and points for helping other teams, which allowed the collaboration that was intended to be achieved internally in a team, transcending achieving a collaboration in the classroom.

3.2.3 Post-game Phase

During this phase the children delivered their mission and the teacher evaluated the software products, and the points and benefits gained as a team were analyzed, to later collect the information that motivated the following programming challenges. See figure 6 and 7.

Figure 7: Children Programming.

Figure 8: Challenge programming.

4 RESULTS

Table 3 presents the preliminary assessment of the work teams that was carried out at the beginning of the research in the first case study applying the model Childprogramming, Table 4, shows the assessment of work teams performed in one of the last study of case using the model Childprogramming - G, and giving greater relevance to the dynamics and mechanical of game. Comparing the tables can be seen a significant improvement in the evaluation of the characteristics of the collaboration, being the individual responsibility and the work of the leader the valuations that have varied significantly.

Table 3: Preliminary evaluation of the work teams - First case study.

Characteristics of the collaboration					
Teams	Positive Interdependence	Equal participation	Individual responsibility	Definition of strategy	Work of the leader
E1	3	2	3	1	2
E2	3	2	1	1	3
E3	4	2	3	2	4
E4	3	3	2	2	3
E5	2	2	2	2	1

Table 4: Final evaluation of the work teams - Case study with dynamics and game mechanics.

Characteristics of the collaboration					
Teams	Positive Interdependence	Equal participation	Individual responsibility	Definition of strategy	Work of the leader
E1	5	4	4	3	4
E2	4	4	5	3	5
E3	4	3	5	2	5
E4	5	5	5	5	5
E5	3	4	5	3	3

The leaders of the teams said that the dynamics and game mechanics were a great tool to motivate their work teams to stay united, and concentrated during the development of the challenges.

It is worth noting that the motivation for self-learning was also evidenced, because the desire to win the challenges to the children to see the teacher busy answering doubts of other groups, seek help in video tutorials, forums and other pages of Scratch, not to depend so much of the teacher and to be able to advance in the search of its objectives.

5 CONCLUSIONS

The dynamics and game mechanics were fundamental for children's teams to see the software development process as a game. Gamification improved the performance of the equipment and the collaboration between its members.

One of the key elements to improve the characteristics of collaborative work during the software in different devices, was the task board that allowed the follow-up and evaluation of tasks to be performed, tasks in progress and Tasks done. In the same way, gamification through the allocation of points motivated students throughout the development of their programming challenges.

For this type of activities, it is fundamental that teachers and researchers make a correct definition and planning of the dynamics and mechanics of play, because the learning process is accelerated when a team starts to earn points and others are motivated not to stay behind.

Working in the strengthening of the collaborative component of the Childprogramming model, it is possible to consolidate a software development model that, in addition to contributing to the development of children's computational thinking,

improves communication, self-learning, participation, and commitment among members of the teams.

As future work in Childprogramming - C, we will continue in the design and mode-ling of the process from the collaboration engineering, in the same way we will follow the collaborative processes generated when the children program in different devices such as laptop, mobile devices and smart boards.

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