Short Serious Games Creation under the Paradigm of Software Process and Competencies as Software Requirements. Case Study: Elementary Math Competencies

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ABSTRACT
Development of digital resources is difficult due to their particular complexity relying on pedagogical aspects. Another aspect is the lack of well-defined development processes, experiences documented, and standard methodologies to guide and organize game development. Added to this, there is no documented technique to ensure correct implementation of a competency in a videogame. This research proposes a Short Serious Game Development Process founded in Software Engineering paradigms and complemented by previous efforts on large scale development of digital learning resources. This paper focuses in a technique called Competency-Based Decomposition that achieves implementing a formal competency into a short serious game, with which the formal learning process will be complemented to improve the way students learn. Through a case study will be demonstrated its utility by implementing the process and the technique in the whole of mathematics competencies for sixth grade of elementary school in Mexico. The result of applying the proposed process for study case is a collection of video games that satisfactorily implements the competencies and its contents, its expected learning and its knowledge areas specified for sixth grade of elementary school in Mexico by the Ministry of Public Education.

INTRODUCTION
Through the experience gained by the different entities of software developers has identified the need to manage a software project for it to be successful.

To manage a project, four desirable characteristics of a software development team are identified (Reyes Delgado, 2005): the creation of a set of defined processes, the quality of products and, efficacy and efficiency efforts. To achieve the proper management of a software project should be performed, in the first instance, the creation of the defined processes of the organization through the use of best practices and formal software engineering methods and matured to match to the actual process of the organization.

Defined software development processes receive much attention in research, but are rarely used in industry for the development of software systems. One of the main reasons is that very little is known about the integration, interpretation, definition and adoption of software process and the precise role of processes in the lifecycle of software remains very diffuse (Plat & J. Toetenel, 1992).

Despite all the stresses generated in research centers, as mentioned in (Plat & J. Toetenel, 1992), globally there is a significant percentage of software development companies that do not use software processes for the development of projects. This problem can also be attributed to the fact that many entrepreneurs and software developers ignore the potential benefits of using software processes and their definitions for both quality of product and the quality of the process, and therefore the project (Chatzoglou, 1997).

When thinking about a large scale resource production you should think in a production that involves the creation of a set of software products through a development process based on standards, methodologies, process guidance and best practices of software engineering (Oktaba & Ibargüengoitia González, 1998). At this point, the Software Engineering provides a mechanism for the development of affordable software systems, and through organizations such as the SEI (Software Engineering Institute) and ISO (International Standardization Organization), have generated international standards for assurance of quality in software development processes and the management of resources and models to measure the maturity of software development processes, such as CMMI (Capability maturity Model Integration), Rational Unified Process (RUP), Software process Improvement and Capability Determination (SPICE), Process Model for Software Industry (MoProSoft, internationally known as ISO 29100), Personal Software Process (PSP) and Team Software Process (TSP). (Sommerville, 2005) (Pressman, 2006) (Kulpa & Johnson, 2003)

But when talking about digital educational resources, "*A large scale development of digital learning resources involves the creation of a large number of these educational resources with a time limit, usually with the aim of supporting one or more educational courses.*" (Velázquez Amador et al., 2011)

PROBLEMS OF THE LARGE SCALE DEVELOPMENT

As mentioned in (Barajas Saavedra, Muñoz Arteaga, Álvarez Rodríguez, & García Gaona, 2009) and (Velázquez Amador, et al., 2011), a large scale development of digital learning resources involves the creation of a large number of these educational resources with a time limit, usually with the aim of supporting one or more educational courses.

Some of the reasons why it is not often the large scale development of digital resources are (Barajas Saavedra, Muñoz Arteaga, Álvarez Rodríguez, & García Gaona, 2009), (Velázquez Amador, et al., 2011), (Vidani & Chittaro, 2009), (Masuch & Rueger, 2005):

1. The difficulty of developing these resources, as they are resources with particular complexity by relying on pedagogical aspects.
2. Lack of well-defined development processes and experiences documented.
3. Lack of standard methodologies to guide and organize game development.
4. Game development in an educational environment have to face some severe restrictions in the development process compared to professional game development. This implies manpower, development time, and budget.
5. Lack of mechanism to guarantee the correct implementation of pedagogical aspects into the games, like for example a "Serious Game Requirements Management" or "Serious Game Quality Assurance".

However, despite the existing difficulties, in video games lies a viable means to solve the current problems of education, creating materials that support the knowledge acquired in the classroom, extending the classroom beyond the physical limits of the educational institution and allowing students to have an improvement in the way of learning through the use of these resources.

This research is providing solution to the lack of well-defined development processes for large scale production of serious video games, presenting a proposal for a development process with fundamentals in software engineering practices (Barajas Saavedra, Álvarez Rodríguez, Muñoz Arteaga, Santaolaya Delgado, & Collazos Ordóñez, 2014), the results of using this process for the production of various video games (Álvarez Rodríguez, Barajas Saavedra, & Muñoz Arteaga, 2014), and the results of usability testing of video games with students (Barajas Saavedra, Álvarez Rodríguez, Muñoz Arteaga, Santaolaya Delgado, & Collazos Ordóñez, 2014). Solving, in this way, the problems identified within this subject of investigation (Barajas Saavedra, 2009), that is to say: (1) the experts in contents have not been provided with simple and intuitive tools that automate the large scale production; (2) the game producers do not have the rationale that supports the structuring or design of the serious game, or the experience in the competencies in which the videogame applies; (3) for the production of a serious game neither a structured nor based on software engineering process exists that guarantees the consistency and standardization of the production to increase and to guarantee the quality of products.

This paper will present in detail the mechanism to guarantee that the pedagogical aspects (competencies, knowledge areas, contents and expected learning) are correctly implemented into the short serious games through a technique called **Competency-Based Decomposition**.

SHORT SERIOUS GAMES (SSG) DEVELOPMENT PROCESS

A Short Serious Game is a serious game that must have the following elements, regardless of their purpose (training, education, etc.) and its competencies:

1) **Pedagogic aspects**, which include the next elements:
   a) Learning needs of the individual or group of individuals.
   b) The social and cultural context of the individual or group of individuals.
   c) Learning methodology (includes consideration of the learning model and learning styles). This aspect covers the elements "Pedagogic considerations", "Learner specification" and "Context" proposed by

deFreitas and Oliver in (de Freitas & Jarvis, 2006) and (de Freitas & Oliver, 2006).

2) **Technical aspects** including:
   a) Considerations for game-play and story (Zyda, 2005).
   b) Level of fidelity, interactivity, immersion, fun, etc.

3) **Integration aspects** that include:
   a) Considerations for game-based learning (Martens, Diener, & Steffen, 2008).
   b) Considerations for inclusion of materials in formal classes.
   c) Considerations of context for the implementation of digital educational resources (de Freitas & Jarvis, 2006).

In **Figure 1** can be seen the SSG Development Process proposed by this research, which has the next features:

1. is founded in the traditional Software Engineering paradigms;
2. provides developers and game designers with a process that will lead them clearly through the production of an educational video game;
3. provides a framework for the integration of experts from different disciplines to develop an short serious game;
4. allows to implement the process in a transparent way because the game is considered as a software product;
5. provides, at the stage of requirements, the ability to develop products that tell teachers how to integrate the game with their classes.

Besides, this process enables SSG Developers to correctly manage SSG Requirements with Software Engineering best practices. Also, this process provides a new technique called Competency-Based Decomposition that transforms a competency and its components (contents, expected learnings, and knowledge areas) into a manageable and measureable software requirement so developers can successfully implement or develop at large scale those requirements (competencies) in the SSG.

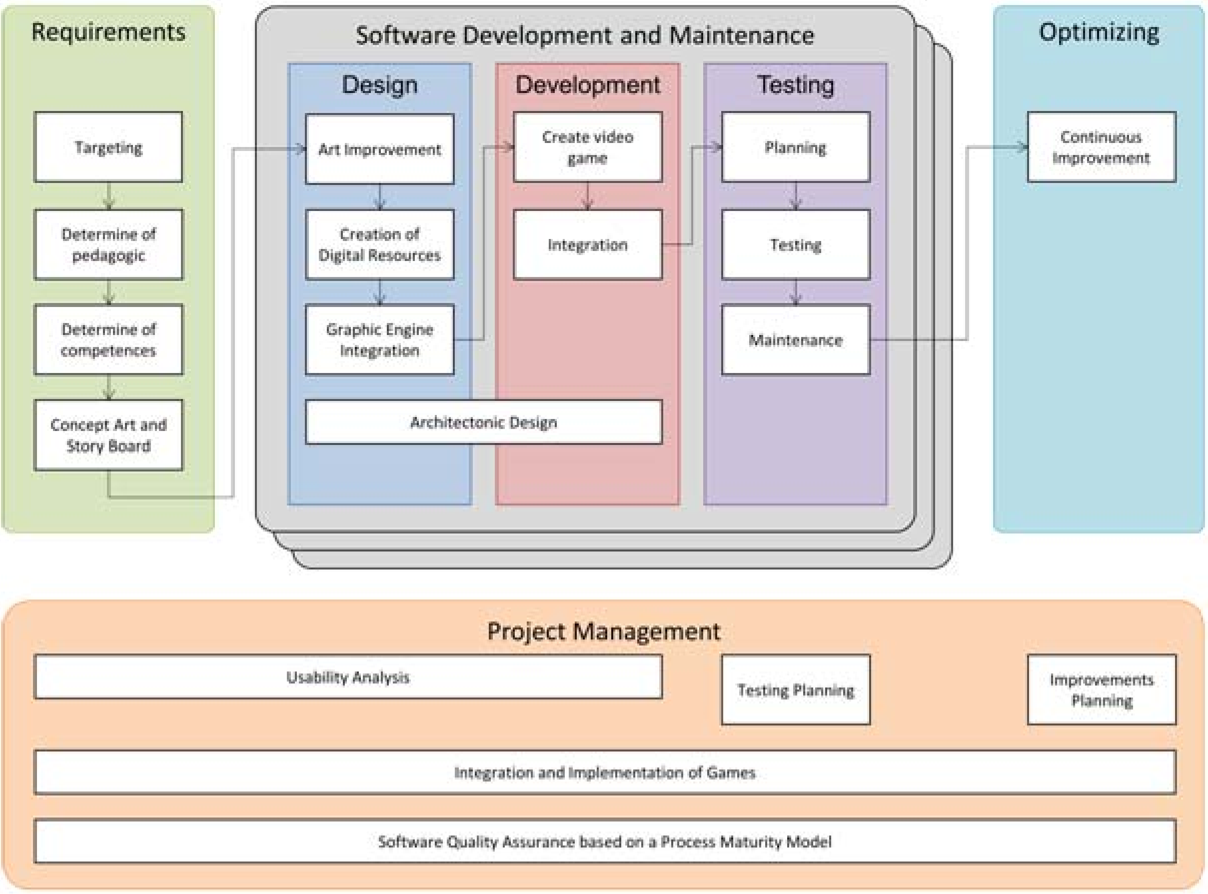


Figure 1. Short Serious Game Development Process.

Then, the fulfilment of the requirements must be ensured in order to guarantee product quality. The compliance with requirements must be seen from the views: pedagogical, educational and ludic.

Next section presents a review of the quality aspects for digital educational resources and serious games, and presents a set of characteristics a short serious game must meet in order to have a good grade of quality.

QUALITY OF THE SHORT SERIOUS GAMES

In the particular case of educational resources studied in this research, (Velázquez Amador, et al., 2011) mentions that the quality of a digital educational resource covers various aspects of software development using an object-oriented paradigm, and issues related to pedagogy. Therefore, is identified the existence of technical and pedagogical aspects, and usability and content components, which are considered as aspects that determine the quality.

1. Technical aspects include reuse and adaptability, as well as those established by the software engineering as utility, reliability, among others.
2. Pedagogical aspects contemplate everything that facilitates the teaching-learning process, as we have examples, assessments, self-assessments, feedback, and a pedagogical objective expressed under any taxonomy, to mention some, Bloom's Taxonomy. The relationship between teaching methods and quality of the resource depends on the learning style of the user, so that John recommends that the modalities of digital resources include auditory, visual and kinesthetic recommendation that videogames cover perfectly.
3. In the content items are those that give information about the complexity of the subject and the level of detail that addresses the content.
4. The aspects of usability of a digital resource concern the presentation of information (fonts, colors, sizes, etc.) and the disposition thereof (symmetrically, asymmetrically, using positive and negative space, etc.). From the point of view of software engineering usability it means ease of use and learning of an object created by humans.

Bearing in mind the quality aspects for serious games, and the analyzed literature on video games and learning objects, a non-exhaustive set of basic features that represent a good starting point to achieve a usable product with a good grade of quality were identified:

1. Short and focused on a single knowledge area to guarantee portability of the video game. In case of a Game Scenario can implement all the knowledge areas of a competency through a set of mini-games or in a single game.
2. Graphical user interface with aesthetic and minimalist design, friendly, and pedagogically evaluated;
3. Cases with formal reasoning;
4. Cases randomly generated to prevent the student memorize the answers to problems;
5. Challenging content and generating competition among students using the game, i.e., cases with different levels of difficulty.

COMPETENCY-BASED DECOMPOSITION: A REQUIREMENTS IDENTIFICATION TECHNIQUE

This “Short Serious Game Requirements Management” was not found in the literature review done, so this paper will present a mechanism to match a formal competency with a non-formal content, identifying the aspects (contents and expected learnings) and factors that should be implemented in the production of the game so that satisfactorily cover the expectation of the competency within a scholar grade and guarantee the quality of the serious game through the fulfilment of the requirements. This process is called **Competency-based decomposition** (**CBD**), which is a proven successful way to accomplish the production of a digital educational resources that was applied for the development of the project “Business-Academia-Government Linkage Model for the Development of IT Capabilities of Human Resources” (Known in Spanish as “Modelo de Vinculación Empresa-Academia-Gobierno para el Desarrollo en Capacidades de Capital Humano en Tecnologías de la Información”) (Velázquez Amador, et al., 2011).

Before continuing, the definition (based upon the review of the work in (Mulder, Weigel, & Collins, 2007) and (Díaz Barriga, 2006)) used in this research for competency is as follows: “Competencies are all mental resources of individuals that are used to master tasks, acquire knowledge and achieve a good performance in some specified abilities with a certain skill level.”

With this procedure it is proposed to completely cover the contents and learnings that accompany a subject in a syllabus, thus ensuring the appropriation of knowledge and learning outcomes for a particular competency.

To perform the CBD is necessary to complete the following steps for each subject to analyze.

1. To identify the standards, goals and graduate profiles (SGGP) of the subject analyzed. This step is very important as the products of the subsequent steps must be aligned to these elements.
2. To identify the contents and expected learning of the syllabus.
3. To group, in knowledge areas, the contents and expected learnings in accordance with SGGP.
4. To organize knowledge areas in accordance with SGGP.
5. To identify competencies from the knowledge areas grouping.
6. To organize competencies and their knowledge areas in accordance with SGGP.

It is very important to stress that every competency and its knowledge areas must be attainable from the point of view of the Software Engineering, since, for example, the Study Program for Sixth Grade Mathematics published by the Ministry of Education, provides a set of math competencies, namely:

1. Solve problems independently.
2. Communicate mathematical information.
3. Validate procedures and results.
4. Efficiently handling techniques.

Where all of them are “Competencies for life”, which, from the point of view of the Software Engineering, are very complex to manage and measure due to their multifactor nature.

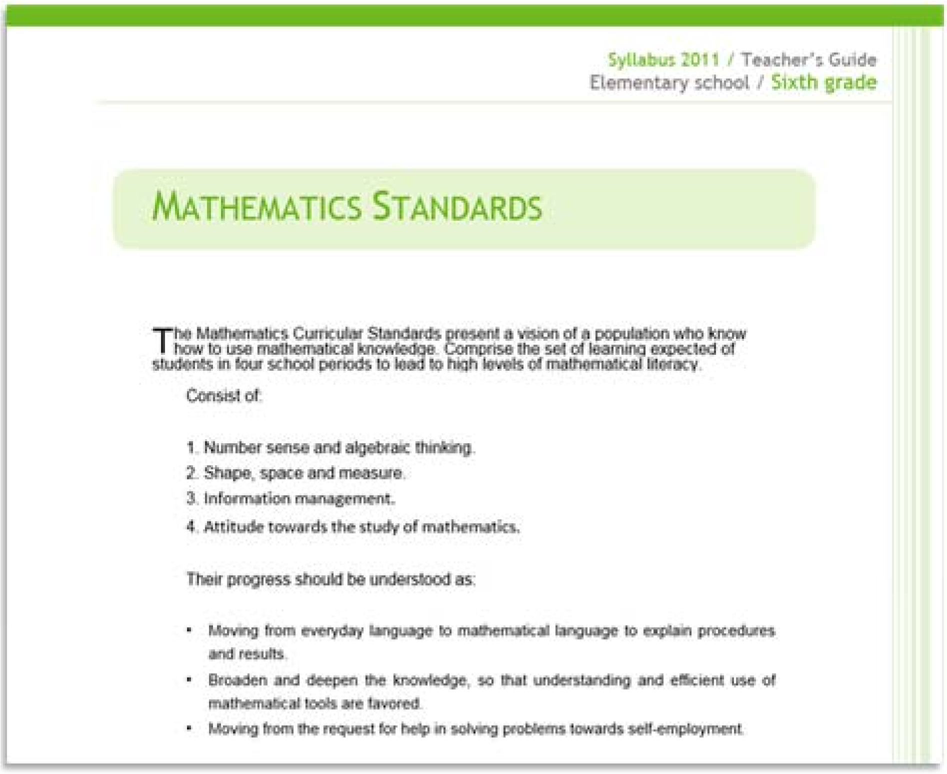
In the next paragraphs is shown the application of this CBD process which was applied in this research to identify all the competencies for sixth grade mathematics to carry out the production of video games.

USING CBD TO IDENTIFY SOFTWARE REQUIREMENTS

This section will show the process to apply the CBD step by step using the Sixth grade math of Elementary school in México.

Step 1. To identify the standards, goals and graduate profiles.

In the next figures is shown the standards (**Figure 2**), goals (**Figure 3**) and graduate profiles (**Figure 4**) from the syllabus analyzed.



Syllabus 2011 / Teacher's Guide
Elementary school / Sixth grade

MATHEMATICS STANDARDS

The Mathematics Curricular Standards present a vision of a population who know how to use mathematical knowledge. Comprise the set of learning expected of students in four school periods to lead to high levels of mathematical literacy.

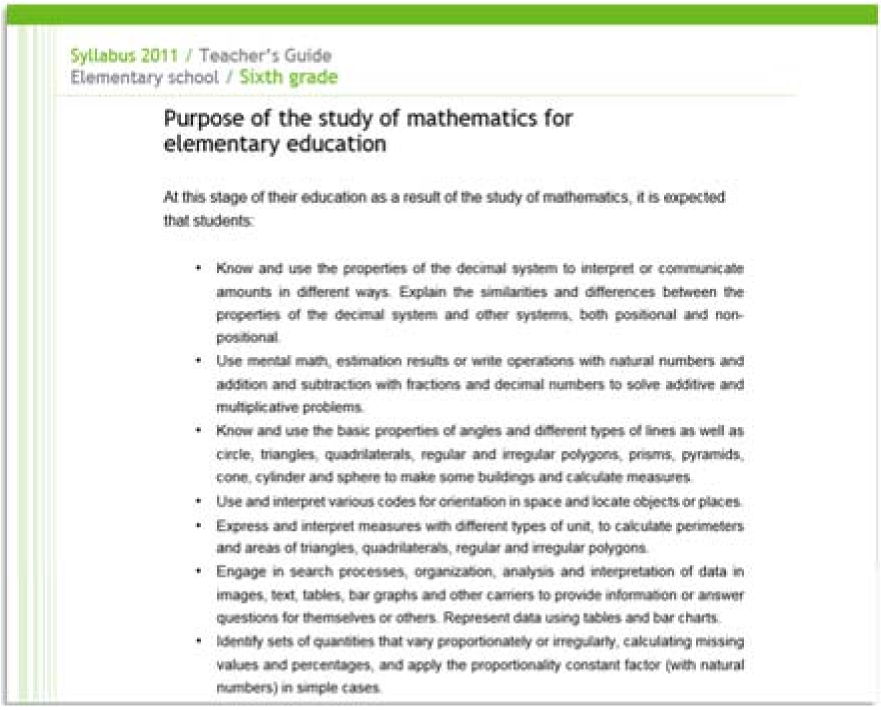
Consist of:

1. Number sense and algebraic thinking.
2. Shape, space and measure.
3. Information management.
4. Attitude towards the study of mathematics.

Their progress should be understood as:

- Moving from everyday language to mathematical language to explain procedures and results.
- Broaden and deepen the knowledge, so that understanding and efficient use of mathematical tools are favored.
- Moving from the request for help in solving problems towards self-employment

Figure 2. Standards of the study of mathematics for elementary education established in the Syllabus 2011 published by the Mexican Ministry of Education. (Secretaría de Educación Pública, 2011)



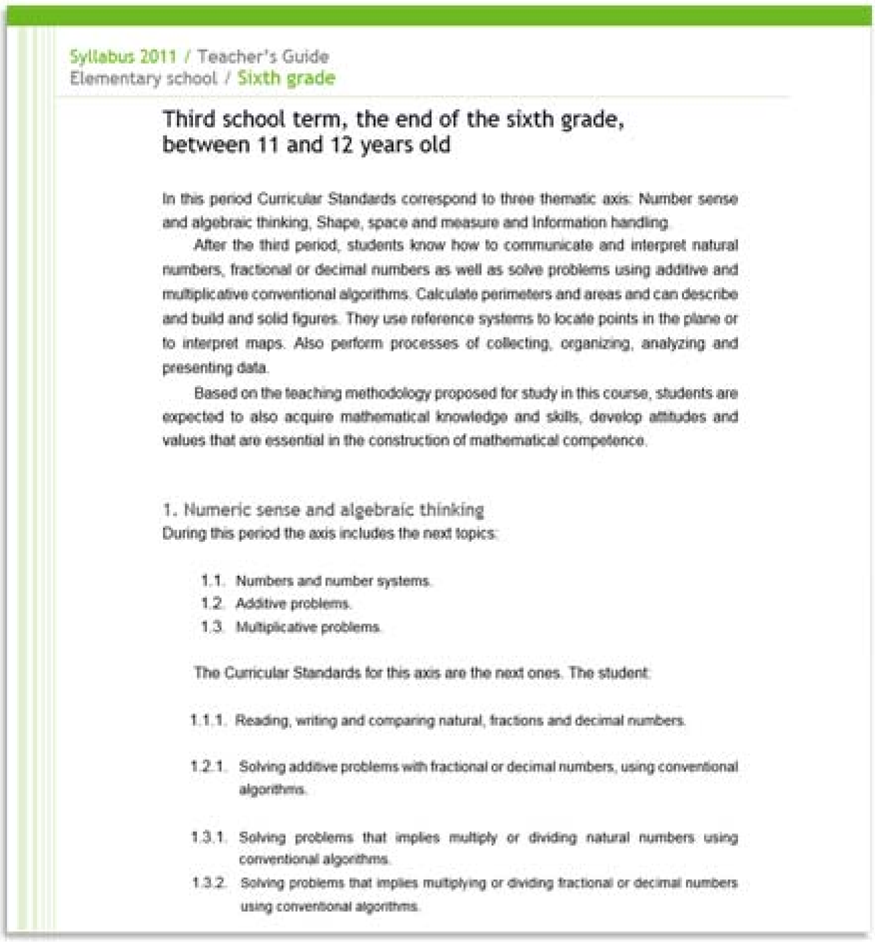
Syllabus 2011 / Teacher's Guide
Elementary school / Sixth grade

Purpose of the study of mathematics for elementary education

At this stage of their education as a result of the study of mathematics, it is expected that students:

- Know and use the properties of the decimal system to interpret or communicate amounts in different ways. Explain the similarities and differences between the properties of the decimal system and other systems, both positional and non-positional.
- Use mental math, estimation results or write operations with natural numbers and addition and subtraction with fractions and decimal numbers to solve additive and multiplicative problems.
- Know and use the basic properties of angles and different types of lines as well as circle, triangles, quadrilaterals, regular and irregular polygons, prisms, pyramids, cone, cylinder and sphere to make some buildings and calculate measures.
- Use and interpret various codes for orientation in space and locate objects or places.
- Express and interpret measures with different types of unit, to calculate perimeters and areas of triangles, quadrilaterals, regular and irregular polygons.
- Engage in search processes, organization, analysis and interpretation of data in images, text, tables, bar graphs and other carriers to provide information or answer questions for themselves or others. Represent data using tables and bar charts.
- Identify sets of quantities that vary proportionately or irregularly, calculating missing values and percentages, and apply the proportionality constant factor (with natural numbers) in simple cases.

Figure 3. Purposes or goals of the study of mathematics for elementary education established in the Syllabus 2011 published by the Mexican Ministry of Education. (Secretaría de Educación Pública, 2011)



Syllabus 2011 / Teacher's Guide
Elementary school / Sixth grade

Third school term, the end of the sixth grade, between 11 and 12 years old

In this period Curricular Standards correspond to three thematic axis: Number sense and algebraic thinking, Shape, space and measure and Information handling.

After the third period, students know how to communicate and interpret natural numbers, fractional or decimal numbers as well as solve problems using additive and multiplicative conventional algorithms. Calculate perimeters and areas and can describe and build and solid figures. They use reference systems to locate points in the plane or to interpret maps. Also perform processes of collecting, organizing, analyzing and presenting data.

Based on the teaching methodology proposed for study in this course, students are expected to also acquire mathematical knowledge and skills, develop attitudes and values that are essential in the construction of mathematical competence.

1. Numeric sense and algebraic thinking
During this period the axis includes the next topics:

1.1. Numbers and number systems.
1.2. Additive problems.
1.3. Multiplicative problems.

The Curricular Standards for this axis are the next ones. The student:

1.1.1. Reading, writing and comparing natural, fractions and decimal numbers.

1.2.1. Solving additive problems with fractional or decimal numbers, using conventional algorithms.

1.3.1. Solving problems that implies multiply or dividing natural numbers using conventional algorithms.
1.3.2. Solving problems that implies multiplying or dividing fractional or decimal numbers using conventional algorithms.

Figure 4. Graduate profile of mathematics for elementary education established in the Syllabus 2011 published by the Mexican Ministry of Education. (Secretaría de Educación Pública, 2011).

Step 2. To identify the contents and expected learning of the syllabus.
In the Syllabus 2011 can be found all the subjects that integrate a scholar grade, and each grade is divided into blocks.

Each block is integrated in its first level by the central axis, in its second level by the topics, and in its third level by the contents. This can be seen in **Figure 5**. As you can see there are only three axes in the figure, this is due to that the fourth axis "Attitude towards the study of mathematics" is implicitly evaluated by the other three axes.

Block I

COMPETENCIES TO ENHANCE: Solve problems independently • Communicate mathematical information • Validate procedures and results • Efficiently handling techniques

EXPECTED LEARNING	CENTRAL AXES		
	NUMBER SENSE AND ALGEBRAIC THINKING	FORM, SPACE AND MEASURE	INFORMATION MANAGEMENT
• Solve problems involving read, write and compare natural, fractional and decimal numbers, specifying the comparison criteria. • Solve additive problems with natural, decimal and fractional numbers involving two or more transformations. • Describes routes and calculates the real distance from one point to another on maps.	NUMBERS AND NUMBER SYSTEMS • Reading, writing and comparing natural, fractions and decimal numbers. Explanation of comparison criteria. ADDITIVE PROBLEMS • Solving additive problems with natural, decimal and fractional numbers, varying the structure of problems. Study or reaffirmation of conventional algorithms. MULTIPLICATIVE PROBLEMS • Solving multiplicative problems with fractional or decimal values through informal procedures.	FIGURES AND BODIES • Identifying the symmetry axes of a figure (polygonal or not polygonal) and mutually symmetrical shapes, through different resources. SPATIAL LOCATION • Choosing a code to communicate the location of objects in a grid. Establishing of common codes for locating objects. MEASURE • Calculating real distances though rough measurement from one point to another or a map.	PROPORTIONALITY AND FUNCTIONS • Calculation of percentage amounts by various methods (application of correspondence "per 100, n", implementing a common or decimal fraction, using 10% as base). ANALYSIS AND DATA REPRESENTATION • Reading data in tables and circle graphs to answer diverse questioning.

Figure 5. Extract of the syllabus for sixth grade math of elementary school. This figure shows the competencies to enhance, the expected learning, the central axes, the topics and the contents for the Block I. The syllabus is integrated by five blocks. Note that the fourth axis is not shown due to is evaluated implicitly in the other three. (Secretaría de Educación Pública, 2011)

Step 3. To group, in knowledge areas, the contents and expected learnings.
After identifying the contents and expected learning, the grouping resulted in the next knowledge areas:

1. Areas
2. Cartesian plane
3. Combinations
4. Cross product
5. Decimal system
6. Fractions
7. Graphic representation of results
8. Handling of solid figures
9. Lengths
10. Odds
11. Operations
12. Patterns
13. Percentages
14. Perimeters
15. Shapes and polygons
16. Time
17. Values of unity
18. Volume
19. Weight/Mass

Step 4. To organize knowledge areas.
The process of organizing the knowledge areas resulted in the creation of "groups" that later will be competencies.

1. Competency 1
   a. Operations
   b. Decimal system
   c. Fractions
2. Competency 2
   a. Shapes and polygons
   b. Handling of solid figures
   c. Cartesian plane
3. Competency 3
   a. Lengths
   b. Volume
   c. Weight/Mass
   d. Perimeters
   e. Areas
   f. Time
4. Competency 4

a. Graphic representation of results

5. Competency 5
   a. Patterns
   b. Values of unity

c. Cross product
d. Percentages

6. Competency 9
   a. Combinations
   b. Odds

Step 5. To identify competencies from the knowledge areas.
The identified competencies are:

1. The numbers, relationships and operations
2. Geometry
3. Measures and Conversions
4. Information processing
5. Processes of change
6. The prediction and chance

Step 6. To organize competencies and their knowledge areas.
The Competency-Based Decomposition process is graphically shown in the following figure (see **Figure 6**). The final result of this process, is shown in **Figure 7**.

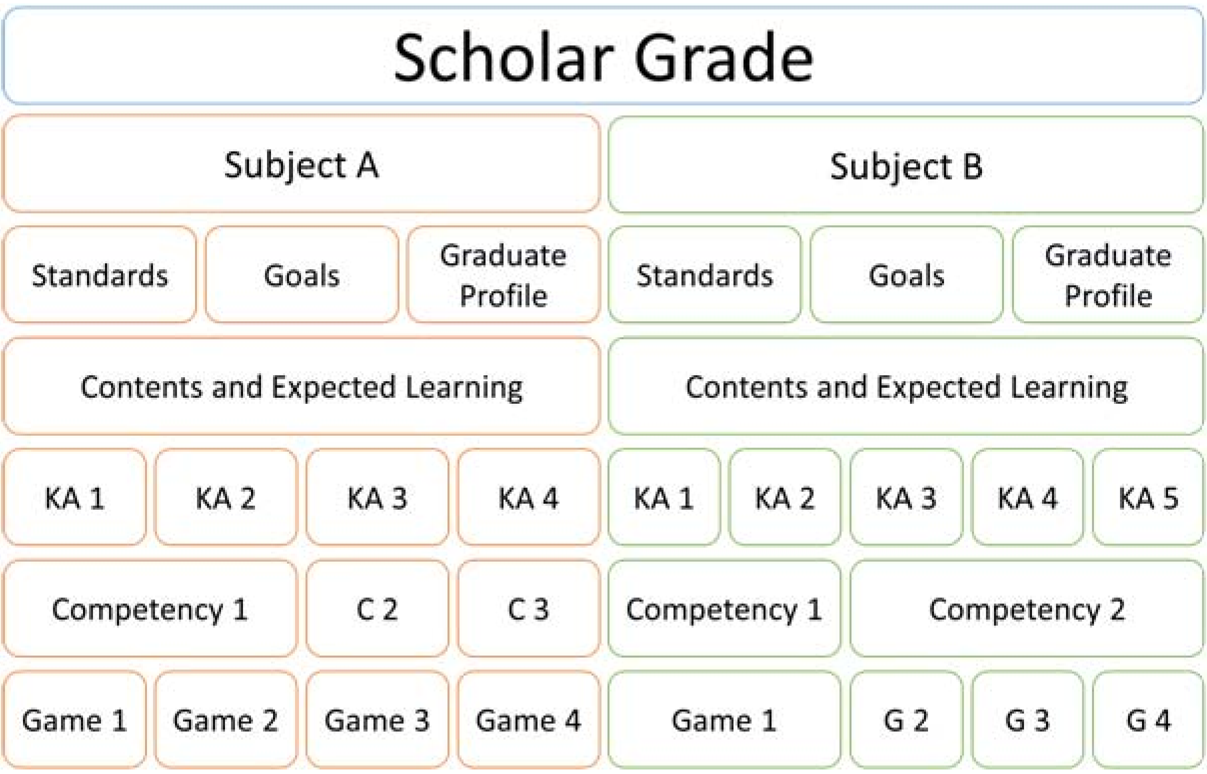


Figure 6. This approach allows to match a formal competency with a non-formal content, identifying the aspects and factors that should be implemented in the production of the game so that satisfactorily cover the expectation of the competency within a scholar grade.

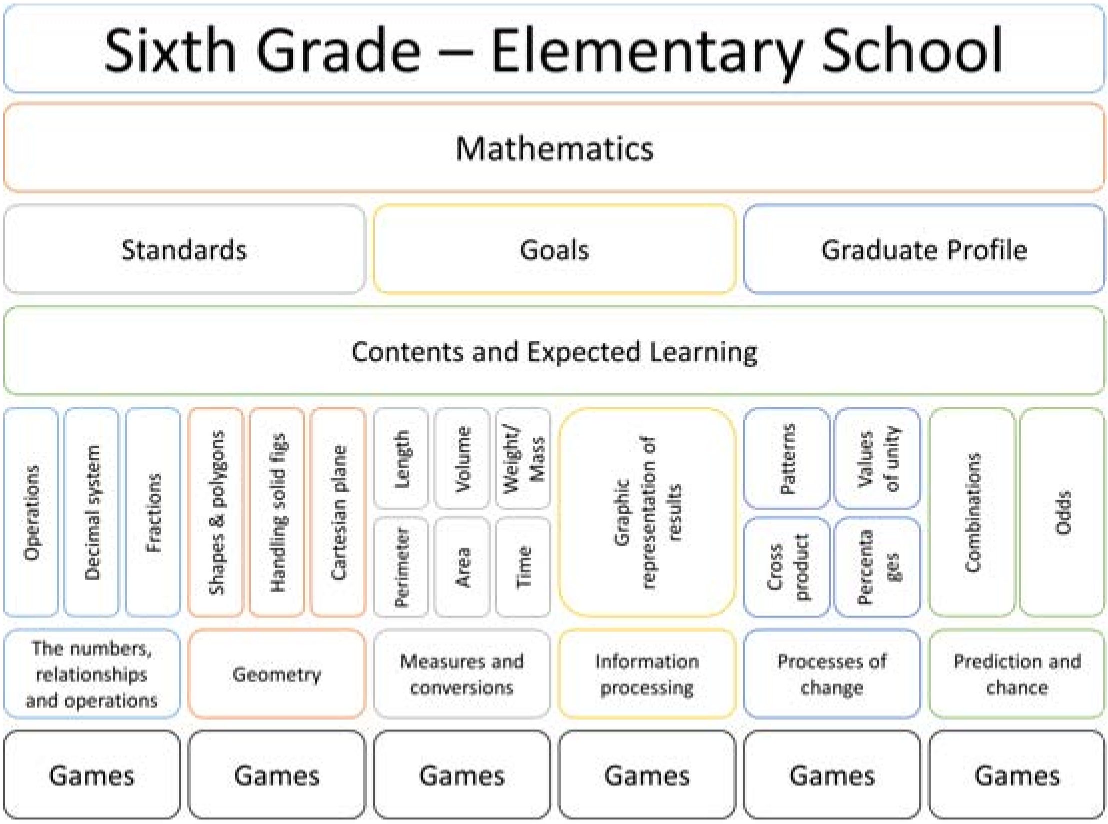


Figure 7. Result of the Competency-Based Decomposition applied to the subject Mathematics of sixth grade of elementary school.

CASE STUDY: SIXTH GRADE VIDEO GAMES

As a proof of concept of our approach the research conducted a case study using as scenario "the development of educational games to cover all the official competencies for sixth grade for elementary school in Mexico". Competencies shown in **Figure 7** lead us to create a collection of fifty educational videogames oriented to increase learning encouraging appropriation of specific math-competencies. A summary of this list is presented in **Table 1**.

Table 1. Extract of developed video games.

Video games	***Knowledge areas***	***Language***
pokeMath	Operations	JavaME
MathChallenge	Operations	.NET
	Weight/mass	.NET
DS3A	Operations	JavaME
SpaceMath	Operations	Flash
Fracciones	Fractions	JavaME
GeoBodies	Shapes and polygons	JavaME
CubeLand	Handling of solid figures	OpenGL
Submarino	Cartesian plane	JavaME
GolfMeter	Lengths	JavaME
miHuerta	Volume	JavaME
Áreas	Areas	JavaME
Ubicación	Values of unity	JavaME
Regla de Tres	Cross product	JavaME
Kaxan	Percentages	JavaME
WWE	Odds	JavaME
Marcianos	Shapes and polygons	Android
Time Rider	Time	JavaME/Android
Time Champ	Time	JavaME/Android
Jinete Solitario	Lengths	JavaME/Android

Perimeters	Perimeters	JavaME/Android
Softy	Combinations	JavaME/Android
MathFractions	Fractions	JavaME/Android

TESTING THE VIDEO GAMES
After the initial production phase of educational video games, the team proceeded to test them in order to study the impact on the learning level of students exposed to this learning strategy. Participants consisted in a group of 29 students from sixth grade of elementary school from the "Federal Rural Cuauhtémoc Elementary School" located in La Paz, Ojuelos, Jalisco. Children studying in this school come from families just as scarce resources. This community has many needs, and to increase the use of IT access to information technology helps to alleviate some of them.

The process performed for the test was as follows(Hernández Sampieri, Fernández Collado, & Baptista Lucio, 2010): (1) Identify potential schools. (2) Tests were designed for initial and control evaluations. The tests were designed to evaluate knowledge level of students in the next knowledge areas: Areas, Handling of solid figures, Fractions, Shapes and polygons, and Crossed product. (3) School was selected. (4) Students group was selected. The group was divided into two parts; taking into account that in both groups, students' average grade must be equally distributed, i.e., the group was divided according to the average grades of the students. (5) Initial evaluation was applied to all students. (6) The test group used video games in one-hour sessions twice a week for four weeks. (7) At the end of eight sessions, a control test was applied to identify the impact of video games use. (8) The collected data were analyzed with SPSS software.

RESULTS OF KNOWLEDGE EVALUATION
The team applied linear regression to the results obtained during testing for each knowledge area. The information allow to determine trends in student's scores before and after use short serious games. The overall findings are graphically depicted in **Figure 8** where diamonds-line displays the results obtained during initial examination. Squares-line displays the results of the evaluation performed after short serious games use.

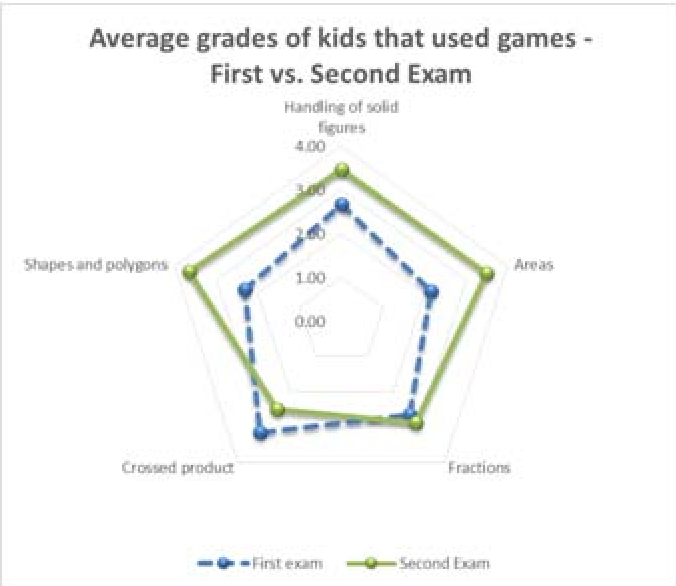


Figure 8. Overall result of the students in different areas of knowledge tested.

As the reader can see, there are improvements in four knowledge areas, this is due to the students achieved a higher level of adoption of the competencies implemented in the short serious games they used.

The "Crossed Product" game, which shows a decrease in the adoption of the competency, was developed with a question bank instead of randomly-generated problems, so the students memorized suck question bank and did not achieve the intended adoption of the competency.

DISCUSSION
The correct implementation of the competencies and the characteristics of the short serious games is extremely important because this is the only way to guarantee that the students of users will achieve a higher level of adoption of the competencies implemented in the games.

As the reader can see, the "Crossed Product" game did not achieve its purpose: transfer the competency into the students due to a deviation in its development.

CONCLUSIONS AND FUTURES WORK

This research proposes a short serious game development process that includes an explicit requirements management which allows the identification and modeling of the software requiremets from a set of implicit educative competencies of an official syllabus.

This process makes available to research or (independent) development groups, universities and companies a clear guide to the development of a short serious game. It also eases the implementation of the process itself because it has a documental support that guides the team through the development of the products. This process also allows managing the product quality through checkpoints in the provided documentation, achieving in this way develop a high quality product with a high level of fulfilment of the competencies (requirements).

The CBD process allows clearly identify the competencies to implement in the short serious games, since in many cases this aspect is not taken into account during the development process (if a development process exists). The CBD process takes as inputs common elements in the syllabus and turns them into short serious game programmable and measurable competencies (requirements).

Once identified the competencies, the short serious game development process is capable of building software products, from those requirements (which include learning activities and learning contents), with a high quality level and meeting the correct implementation of the competencies.

This research has created and tested (with real world students) a big set of short serious games, achieving an improvement in the competency adoption due to the correct implementation of requirements (competencies, learning activities and learning contents) into the games.

The short serious game process is being translated into SPEM and ISPW-6 with a variability model and will be published online once it is finished. In this way it will be turned into a Serious Game Development Framework that will be accessible to anyone interested in developing short serious games.

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