A Didactical Analysis of Math Online Games for Primary Education

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Abstract

Digital learning games belong to the types of software that almost all European countries promote, Romania not being a part of them (EACEA P9 Eurydice, 2011). Because of this, Romanian teachers do not have validated digital learning games for training. Yet the need for such games is felt not only by the teachers, but also by students or parents. In this article we make an analysis of existing online math games for primary education in Romanian language. General finding which was spun off in the analysis is that many of the online math games do not meet the pedagogical requests and even if the topics addressed arouse children's interest, they only rarely develop certain skills. On the other hand, in most cases, we cannot have such claims because the sites do not maintain that the games they promote have an educational purpose. There are, however, some examples of good practices that are presented in the article and can be the starting point in the development of truly valuable online math games. This includes games made for CDs that are well designed in terms of items you need to find in a teaching game.

Keywords: On-line games, mathematics, primary education

1. Introduction

According to Vlada, Albeanu & Adâscăliței (2015) the term of “virtual learning/education” is not replacing traditional education forms and ways to eliminate the role of teachers in the teaching process, but the contrary should represent forms and modern ways to achieve a higher level the teaching-learning-assessment through ICT. In the European Union almost twice as many students browse the Internet for fun than for schoolwork at least once a week (83 % and 46 % respectively) (EACEA P9 Eurydice, 2011. Key Data on Learning and Innovation through ICT at School in Europe). This is only one reason for what the great majority of European countries recommends or suggests several innovative pedagogical approaches that may be effectively enhanced through the use of ICT with the aim to increase students’ engagement and improve their results. One of these pedagogical approaches is the online learning (see figure C1, p. 43, EACEA P9 Eurydice, 2011). According to the same sources, the official documents from Romania do not provide recommendations, suggestions or support for teachers in this direction. Digital learning games belong to the types of software which almost all European countries promote (see figure C2 p. 45 EACEA P9 Eurydice, 2011). Based on these general observations, in this article we make an analysis of online math games for primary education in Romanian language, a subset of digital learning games, in order to see on what extent they can be integrated in the teaching-learning-assessment of mathematics.
2. Pedagogical considerations on online games

Educational offers’ diversity and significance of the new technologies of information and communication increasingly bring in the spectrum of the playful activities digital games. These games have the advantage of being able to be accessed at any time and through any means (PC, laptop, tablet, phone, etc.). They represent a category that came from the need of release of certain mental energies, the need to relate to each other, regardless of the limitations of a geographic area. Educationally, M. Prensky (2001) coined the term Digital Game-Based Learning (DGBL). Online games are a subset of digital learning games “that is either partially or primarily played through the Internet or another computer network” (Rollings & Adams, 2006). The interest in online games is because of the easy access to them and also for the purpose of the electronic teaching communication finalities which properly complete written and oral teaching finalities.

At the level of electronic teaching practice existing in the school there were already identified some advantages and limitations (R. Răduţ-Taciuc, M.-D. Bocoș, O. Chiș (eds.), 2015, p. 415). A. Adăscăliţei (2007, p. 57) shows the basic structure of the games for computer training.

At the level of electronic communication management, we identified the following pragmatic landmarks, which can be explained by reference to online games (see table 1).

<table>
<thead>
<tr>
<th>Pragmatic highlights in the management of electronic communication</th>
<th>Explanation:</th>
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<tbody>
<tr>
<td>- using phrases, sentences - with limited extension - in the transmitted instructing</td>
<td>- using short phrases, to coordinate as accurately the player’s action</td>
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<tr>
<td>- ensuring accessibility and message comprehension</td>
<td>- using adequate words and semantic fields accessible to the receptor, in his/her native language</td>
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<td></td>
<td>- avoiding specialised computer terminology</td>
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<td>- rational limiting of the individual symbolism field</td>
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<td>- avoiding exaggerated abbreviations</td>
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<td>- dozing the use of emoticons; correlating them properly with the written message which strengthens and nuances them</td>
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<td>- ensuring the clarity and accuracy of message</td>
<td>- respecting scientific accuracy</td>
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<td>- careful building of messages using clear and unambiguous words and phrases</td>
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<td>- avoiding confusing information, redundant or unnecessary words, expressions of oral language, elements of slang / familiar language (they can generate language barriers)</td>
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<td>- using affirmative expressions, preferably</td>
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<td>- using messages appropriated to the context and recipients</td>
<td>- taking into account the characteristics of the communication context, the velocity of information, the handset psycho-individual features of the receiver and reporting them to the finalities proposed in the communication process</td>
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<td>- taking into account the psychosocial particularities of the partner micro group in communication</td>
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<td>- using relevant and effective messages</td>
<td>- respecting the linguistic correctness</td>
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<td>- practicing critical attitude in message design</td>
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<td>- encouraging critical attitude in the receiving and decoding of messages</td>
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<td>- harnessing the formative and informative valences of the message</td>
<td>- using words loaded with affection</td>
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<td>- exploiting the possibility of building playful connotations which increases the involvement of the preschooler / pupil in the game</td>
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<td>- enabling the creation of a perceptive multi-modality, by coherently articulating the image, word, color, sound and dynamics in composite representations</td>
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- stimulating cognitive interest and desire for knowledge
- developing the capacity for abstraction and synthesis of information
- enabling the student to become a real producer of documentary resources

- using an attractive design in the writing of a message
- font size and text spacing must be adequate to the peculiarities of players
- using an attractive font and background
- the adequacy of the content of the message and iconic register to the peculiarities of the players

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<td>C. Cucoș (2006) presents the evaluation criteria of a digital curriculum product, namely: relevance of content and methodology; transparency with respect to clarity; of the goals, of the formulation of the results the student will obtain, of the presentation, of the methodological principles; validity; attractiveness; flexibility; openness; participation and socialization.</td>
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### Table 1. Pragmatic highlights in the management of electronic communication


3. Analysis of math online games for primary education

For our study were analyzed for free online math games for the primary education. Only numeracy games, mathematical calculations with the four operations (addition, subtraction, multiplication and division) to integers and fractions games were studied. Games were to be searched only on Romanian language sites in order to analyze the variety existing on the local market and to what measure they correspond to the Romanian curriculum. A first observation is that there are no specific sites with mathematical games in Romanian, but sites with various games, unlike the English language for which there are many such sites. Some sites have subpages with mathematical games like: http://www.xjocuri.com/jocuri-cu-matematica.html; www.jocuri-friv.ro/jocuri-cu-matematica.html, and on others maths games can be selected only by search like: www.ejocuri.ro, but there are also sites that math games appear inserted in the other categories, for example: http://jocuri.itbox.ro/jocuri-indemanare/. A special case is the publishers’ sites that produce educational CDs (which can be purchased for a fee), and which post in addition other materials and educational math games online in order to promote their CDs. Among these sites are: eduteca.ro, edituraedu.ro, http://www.didactic.ro/jocuri (promoting Intuitext products). We have not found Romanian official sites (of the Ministry of National Education or other institutions) fostering/promoting mathematical post content online, not just games, but also educational animations or films, Power Point presentations, etc.

Didactic analysis of online games was made analysing the following aspects:

- **Ease of access to the game and of using the game.**
  
  Many games have advertisements inserted in their opening that support the free access to them. Some games need a long time of waiting to open due to the commercials, while others cannot even be opened. Often must be sought carefully on the screen the area that opens the game, because sometimes the games open in marginal areas of the screen and cannot be intensified the full screen. Sometimes when you want to open a game, another tab appears that does not always direct you to the desired game, but for other games.

- **Suggestivity in the naming the game.**

  Most often, the name of a game suggests the theme, the interface or the game characters and less the mathematical content covered, e.g. "Rapunzel exam in mathematics" (http://www.jocuri-friv.ro/joc/13972/clopotica-scoala-de-zane.html); "To decorate the forest" (edituraedu.ro) is a solitaire-type game in charge with tasks like finding neighbors of the numbers 1-10. A suggestive name would have been: "Let us decorate the forest playing with neighbors numbers from 1 to 10". On some sites the name of the game presented at first (in Romanian) does not correspond with the game name's presentation after opening it (in English), e.g. the game "Ecuați joc de matematică" (in translation "Math Equations game") after opening appears as "The Equador" (http://www.xjocuri.com/jocuri-cu-matematica.html).
The themes and math games online interface are varied, including elements from:

- **school life** (hall of the classroom, blackboard: green, black, white; chalk, calculator etc.) - e.g. http://www.mathgame5-10.com/ro/#audience, http://www.xjocuri.com/-by-matematica.html (the games "Exercises at the blackboard," "Calculation games", "Mathematical general culture", "Learning math with Julia games" etc.);
- **everyday life** - e.g. "At the grocery store" (eduteca.ro), nature - e.g. "Adventure on the lake" (edituraedu.ro);
- **sports games** - e.g. "Mathematics in Baseball" (http://www.xjocuri.com/jocuri-cu-matematica.html);
- **known films and animations games** - e.g. "Mathematics with Dora," "Help the descending numbers" (www.jocuri-friv.ro/jocuri-cu-matematica.html);
- **known games adapted for mathematics** (bingo, pairing, puzzle, Zuma etc.) - e.g. "Mathematical Lines" (http://www.xjocuri.com/jocuri-cu-matematica.html) or the same game with a different name "Zuma mathematics" (http://jocuri.itbox.ro/jocuri-indemanare/zuma-matematica/), "Let's decorate the forest" (edituraedu.ro) - solitaire-type game;
- **abstract or imaginary themes** - e.g. "The giraffe on diet" (http://www.didactic.ro/jocuri), "Conquer territories" (editura.edu).

Our finding here is that on Romanian sites is not found a wide variety of mathematical games compared to other foreign websites. For example, we have never found a game of bingo with mathematical calculations, but just one ordinary game of bingo in the English language, while on sites in the English language there are such games.

The characters found in games are varied: cartoon characters loved by children, characters from films for children, ordinary people and / or children, monsters, animals, plants or various animated objects. There are also online math games without characters. Choosing a particular game, perseverance in the playful task proposed by it, child's desire to complete and even to repeat the game, including to recommend it to friends, all relates to the game's characters. While sorts of games that induce the idea of aggression, of violence, of failure or other negative connotations should not be agreed with, we have found that they are contained in online games, even if not so aggressive as in other types of games. We encounter therefore monsters, shootings, battles etc. Most often the result of genuine involvement of children in the game is an empathic ability derived by relating to his fictitious characters. It's enough to be a cheerful girl to empathize with Tinkerbell or a boy running through a difficult maze to find a treasure alongside Ben Ten.

Didactical communication management.

Unlike traditional didactic games, in the case of online games communication is unidirectional from the computer to the user and must be consistent with the marks presented in Table 1. The information presented should be: the game description, purpose, target age group, explaining tasks (rules) of the game, presenting feedback (feedback, rewards, punishments). All games analyzed have a description in Romanian. There a brief description and information can be found on the game tasks and rewards, but rarely on the targeted age group. Description has mostly the purpose to spark the child's interest to play. For games on websites that promote educational CDs, the items listed above are mostly present: e.g. game "The ducks to bed" (http://www.didactic.ro/jocuri) has the following description - "This is a free online game where you can be a reliable aid for ducks who must call their ducklings back from play time. This is an educational game suitable for those who want to test their knowledge fast and fun"; explanation of the game - "Put in the right of every duck as many ducklings of the same color as indicated in the number above them. Only after you have completed correctly the columns, you can move to the next number "; targeted age group – 3rd grade; assessment at the end of the game - "Unfortunately, time is up and there are still ducklings who have not returned from play time. Their mothers are worried and ask you to help them again." On the other hand, many of the games have descriptions in Romanian, but the game
itself is in English. The description is written without diacritics, with spelling and writing errors. We can not establish if they were created in such manner or if they were downloaded from foreign sites and translated using translation tool, such as Google translate. Certainly some games can be found on multiple websites. Explanation of game tasks is not always clear, counting on the fact that users will figure things out on the way or through repetition of the game. Regarding the feedback given to players, the games end with a score display and / or verbal or written feedback. Sometimes assessments are not suitable; such as "The giraffe can eat sweets because of you" in the game "The giraffe on diet" (http://www.didactic.ro/jocuri) as it induces in children the desire to eat sweets, although the intention of the game (as shown by the title) is a good one. The reward offered most often is passing to a higher level.

- **The types of game elements** met are based on the most widely used following: choice from several possible ones, sometimes the choice being a multiple one, completion response - for example, the result of a calculation, moving parts, pairing, finding several numbers that have a particular property - e.g. finding three numbers from adjacent houses of which the last selected which is the result of a calculation of the first two.

- **The number of people involved in game.**

  We have found only individual games that do not allow other competition than by improving the score obtained, or by switching to a higher level of play. We have identified only one game, "Duel of spring" (http://www.didactic.ro/jocuri), in which the player character duels with Mordeus.

- **Game time** is often limited. However, considering that the game can be repeated as many times as you want, time spent in the game is not monitored. The question of time spent online by children remains a problem unsolved at the level of specialists. This temporary sequence should be placed correctly under what we now call school time, in the teaching community of leisure pedagogy.

- **Mathematical contents and their accuracy.**

  We have identified games addressing: numeration from 0-1000000, mathematical operations with natural numbers (addition, subtraction, multiplication and division), order of operations, finding the unknown number and fractions. In general, mathematical contents are correct, with small exceptions. For example, some games use signs like * for multiplication and / for division, signs that we do not routinely use in written mathematical calculations. Some games offer the same exercises replay, which makes that game to be played only one, maximum two times.

- **Consistency of the entertaining content with the school curriculum.**

  We have found that only a few games, especially those on CDs specify the age or class at which the games can be used. Therefore, the consistency was checked only in those games. Due to the changes in the syllabus for primary education, many games could not be revised, so some games that are proposed for the 1st grade can now be used in the pre-school class too, such as the game "Ladybugs" (edituraedu.ro).

- **The skills analyzed that games form, in addition to the cognitive ones, mind-different aspects of thinking such as: analytical mind, ability of synthesis, decision making, speed, sense of observation, attention, fine motor function. However, these skills are often only partially communicated to the users.**

- **The existence of game use suggestions.**

  We have not found such suggestions, except for that one game, which is presented in paragraph 4.
4. Examples of good practice of online math games

An example of good practice is Math Game 5-10 (http://www.mathgame5-10.com/ro/#audience). The website assumes promoting a game "very effective for any child who is learning elementary math." The target age group is stated as being "children between 5 to 10 years". The game interface is similar to that of the school board (Figure 1). This game has information addressed to parents on what kind of expectations the children can have after practising the game. In the section "How" of the game there are shown information for parents on setting the parameters: the number of tries for each session; thresholds for the prize I and II. Also, the parent / adult can choose what prizes to grant the child (the default is to award a package of wafers for the First Prize and a candy for the Second Prize). The mathematical content of the game are the four basic mathematical operations with natural numbers and comparing numbers up to 100. The game allows you to select an operation and customize it. The user must enter the result on keyboard (in the case of calculations) and select one of the options <, > or = to compare numbers. The feedback is instant, the score appears during the process and time is not limited. What we appreciate about this game is that it can be used both in the classroom and at home, both for practice and for assessing students' ability to conduct operations with natural numbers. Even in the case of the existence of a single computer in class, students can take turns playing, the teacher receiving an immediate feedback of the student performance after which he can think of differentiated approach strategies.

5. Conclusions

According to the document entitled *Key Data on Learning and Innovation through ICT at School in Europe* (EACEA P9 Eurydice, 2011) digital learning games belong to the types of software that almost all European countries promote, Romania not being a part of them. For this reason we have not found the existence of Romanian official sites (of the Ministry of National Education or other institutions) fostering / promoting mathematical post content online, not just games, but also educational videos, animations, Power Point presentations etc. Thus, Romanian
teachers do not have online validated materials for training. Yet the need for such online material is felt both by teachers and students or parents. Starting from the fact that in the primary education, especially, didactic game is a beneficial training method, it outlines the need to introduce online math games in the training. Therefore, we considered that an analysis of existing online math games in the Romanian language is welcomed. The general result which was spun off from the analysis is that much of the online math games do not meet the pedagogical requests and even if the topics addressed spark children's interest, they only rarely develop certain skills. On the other hand, in most cases, we cannot even have such claims as sites do not say that the games they promote have an educational purpose. There are, however, some examples of good practice (one being shown above) that can be the starting point in developing really valuable online math games. In this category are includes games made for CDs that are well designed in terms of items you need to find in a teaching game. Also, they are much easier to access and play. Unfortunately, they are fewer games like this. We believe that practicing online math games must be in the teacher's attention as an alternative to traditional didactic games.

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