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On Game-Based Learning Support for Early Childhood in Romania

Adriana-Mihaela Guran[1], Anamaria Moldovan[2], Grigoreta Sofia Cojocar[1]
[1] Babeş-Bolyai University, Cluj-Napoca
Str. M. Kogălniceanu, Nr.1, 400084, Cluj-Napoca
E-mail: adriana,grigo@cs.ubbcluj.ro
[2] Grădiniţa Albinuţa, Cluj-Napoca
Str. G. Alexandrescu, Nr. 27, 400529, Cluj-Napoca
E-mail: octombrie13@gmail.com

Abstract. There is growing evidence that more and more children are immersed in a digital landscape from birth. Young children use digital devices to play games, watch television and replay their favorite videos on YouTube. Through these activities, young children acquire digital competences. In Romania, the level of digital competencies on young children is smaller than in other countries from UE. This paper describes an initiative that has as main goal to explore the appropriateness of using interactive games, and to contribute to the improvement of game-based learning in formal early childhood education settings in Romania.

Keywords: human-computer interaction, serious gaming, user centered design, digital competences, digital literacy.

1. Introduction

Recently, many studies have been conducted on children and teenagers access to and use of various technologies, particularly with elder children. As Ofcom research shows (Ofcom, 2017), in UK children are spending more time online, with the estimated time spent online increasing for both groups of 3-4 years old and 5-15 years old. Children aged 3-4 years old and 5-15 years old are more likely to use a tablet to watch television programmes or films than in 2015, and children between 5-7 years old, 8-11 years old and 12-15 years old are all more likely to use a mobile phone for this. The number of children between 5 and 15 years old with their own tablet has increased since 2015, to 44%. Sixteen per cent of children aged 3-4 years old also have their own tablet. Parents' estimate of the amount of time spent gaming by children

between 3 and 4 years old is comparable to that of children between 5 and 7 years, which is around 7 hours per week.

However, Internet habits of different countries and age groups vary significantly, and 14 % of the EU population have never used the internet. Significant increases in the share of households connected to the internet were observed in Bulgaria and Romania between 2010 and 2016 (about 30 percentage points), but they still remain at the lower end of the scale (Eurostat, 2016). According to the study the highest proportion of the population with no experience of internet use (whether at home, at work or elsewhere) was registered in Bulgaria (33%) followed by Romania (30 %) (Eurostat, 2016).

The Digital Single Market (European Commission, 2017) strategy aims to open up digital opportunities for people and businesses and enhance Europe's position as a world leader in the digital economy. The Digital Agenda for Europe refers also to culture and media and intends to promote a coherent approach on media policies, covering legislation on audiovisual media services and preserving cultural heritage.

In a world that is increasingly reliant on computers, the integration of technology into school classrooms is on the rise. Children benefit from computers usage in the classroom by learning basic skills and keyboarding, as well as enjoying programs that enhance their curriculum. Computer skills are also essential for future generations entering the workforce. Most of the statistics on using the computers and other devices refer to people aged from 16 years and above, but the current trends show us that we have to move the focus on even younger children, even toddlers, because technology has already penetrated their environment. It makes no sense in trying to avoid the use of different digital devices by young children, but what we have to do is to focus on providing them digital content that will support them develop in the right direction.

Young children of our days grow up immersed in and surrounded by different digital devices and forms of communication right across Europe. The growth and spread of digital media technologies as well as their changing capabilities seriously enables (or disables) interpersonal, community and individual communication. It significantly affects what it means to be literate and to learn in the 21st-century. Sefton-Green et al. consider that it is of great importance to consider the changing nature of public education across the societies of Europe and to reflect on how expectations about the meaning,

nature, purpose and values of school are affecting young children of preschool age (Sefton-Green, 2016).

The Organisation for Economic Co-operation and Development launched the triennial survey of 15-year-old students around the world known as the Programme for International Students Assessment, or PISA (OECD, 2015). PISA assesses the extent to which 15-year-old students, near the end of their compulsory education, have acquired key knowledge and skills that are essential for full participation in modern societies. The evaluation performed in 2011 showed that Romania has the highest number of persons aged between 16 and 74 years old that do not possess digital competencies (around 61% of population). In order to improve the digital competences of Romanian population it is necessary to integrate the digital educational resources in early education.

Starting from the current situation, with our country having the lowest rates of internet household spread rate and looking to the future which will be a digitized one, we should focus our attention on how to prepare the young people from our country to integrate successfully in the future. This means that digital competences for Romanian young children should be enhanced.

2. Learning environments for young children

Froebel and Montessori considered freedom and choice to be fundamental to learning through play (Montessori, 1949). John Dewey considered that children learn best by experiencing by themselves, this way developing their instinct to investigate, express themselves and be creative (Dewey, 1938). Piaget considered children as "little scientists" that learn from their world by using their senses and movements to experiment with objects and ideas. He believed that children placed in a stimulating environment would develop deep learning, and the ability to think critically and creatively through exploration and experimentation (Piaget, 1952).

Piaget considered that children's cognitive development occurs in stages, such that they should have access to appropriate resources and opportunities. For the goal of this paper we are focusing only on the age range of 2 or 3 to 6 or 7 years old, called the pre-operational stage. During this stage, Piaget considers that, as children's language develops, they begin to engage in symbolic and make-believe play. Toddlers should be able to use replica technology and digital toys in self-directed, self-created, role-play activities

and they can use simple screen based media that allow symbolic play. The development of motor skills and cognitive abilities will allow the use of an increasing range of digital media within their play and the development of new links between ideas, digital media and non-digital resources and as a consequence the development of creative thinking. Creating new ideas requires space and time, and the use of various materials and media using different sensory modalities.

The use of technology by young children serves as a catalyst for social interaction in early education classrooms, studies showing that children have twice as many interactions while being in a front of a computer than when they are involved in other classroom activities (Svensson, 2000).

2.1 Literacy in the Digital Age

With the growing occurrence of technology in our lives, new concepts have been introduced such *technology literacy, digital literacy, ICT literacy, new literacy*, all of them describing the ability of people to use technology for various goals: learning, working, communicating, or fun.

Digital literacy has been defined initially by Paul Gilster (1997) as "the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers". The term is frequently used to refer to the digital skills and competences children and adults may acquire through the use of technology. Sefton Green defines the digital literacy as a social practice that involves reading, writing and multi-modal meaning making through the use of a range of digital technologies (Green, 2016). Other authors define digital literacy as a set of habits through which children use computer technology for learning, work, socializing and fun (Ba et al 2002).

Computer literacy, defined by researchers such as Luehrmann (1983, 2002), Hoffman and Blake (2003), and Livingstone (2004), is about developing instrumental skills to improve learning, productivity, and performance by mastering specific software applications for well-defined tasks, such as word processing and e-mail, and knowing the basic principles of how a computer works.

In 2006 the European Parliament and the European Council published a recommendation on key competences for lifelong learning in which eight key competences were identified and defined (Official Journal of the European Union, 2006). One of these eight key competences was digital competence,

defined as the confident and critical use of information society technology for work, leisure, learning and communication. The basic skills for digital competence are: the use of computers to retrieve, access, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet.

While all of the eight key competences were considered equally important and inter-related, competence in the fundamental basic skills of language, literacy, numeracy and information and communication technologies were described as an essential foundation for learning.

Positive Technological Development (PTD) is an initiative that tries to answer the questions about how can children use technology in positive ways to help themselves and the world, and how can educators and researchers develop programs that help children use technology to learn new things, to express themselves in creative ways, to communicate effectively, to take care of themselves and each other, and to contribute in positive ways to the self and the world (Bers, 2012). The early childhood is not the specific focus of the framework, but addresses themes that are relevant to early childhood (understanding symbols, creativity, collaboration, building a sense of community, social-emotional development). The author proposes a framework that advocates for the design of digital opportunities that promote positive youth development. Using the metaphor of landscape design, the author states that designers of digital programs should strive to provide young children with a digital playground, not a virtual playpen, to provide elementary youth a multimedia park, not a virtual mall (parks are places of creation while malls are venues of consumption), and provide high school adolescents with a palace in time, not simple wireless hangouts. Online environments should support purposeful explorations of identity, self-reflection, creativity, and community participation.

Digital games in education

Digital games attract children and young people with imaginary worlds, fascinating stories, and shared experiences with peers. They can also increase children's learning motivation and offer a variety of new affordances to explore and play with. The pedagogical use of digital games has been found to potentially intensify a more critical use and understanding of varied forms of media.

The potential of digital games for education is enhanced by the fact that

digital games are everywhere. Recent research (Douglas, 2017) shows the potential of digital games to support learning through conceptual understanding, process skills and practices. The study results showed that typical educational games, when carefully coordinated with learning goals, do support significant learning and increased engagement.

Rideout and Katz (2016) point out that most households today have an Internet connection but a new study finds that 23 percent of low-income families rely on mobile-only access with data limits, while 52 percent experience interruptions and poor service with their mobile plans. This "underconnectivity" has a big impact on economic and learning opportunities for those families. This is one of the reasons we have focused our research on kindergartens, trying to provide access to digital games to more children that attend kindergarten, even though they might not have access to technology at home.

4. Case study

This section describes our experience in improving the current situation related to the level of digital competencies on young children (3-6 years) from Romania. Understanding the fact that young children should not be isolated from technology, but supported in their efforts to interact with technology, we decided that the only way we could help is by providing "good content" to the children in an interactive format, such that they would improve their knowledge about the world and at the same time to improve their digital competences.

Currently, there exist multiple digital materials that theoretically are designed for children, but the main problems related to them are that they are not conceived in a manner that would bring learning benefits to the children or they are provided in a manner that requires technical skills of young children educators that make them avoid using the materials (CDs with long technical requirements on the cover, for example). The goal to provide educational interactive content for kindergarten environment is justified by the following arguments:

- the access of a large number of children to these applications, no matter the environment where they come from;
- the use of computers under the supervision of a qualified educator, thus assuring that the content presented to the children is adequate;

- the chance to involve kindergarten teachers in the design and development of the products, assuring that the content and the way it is delivered is adequate.

We considered that by creating interactive learning content we will contribute simultaneously on two directions: the children will access the content that will help them reach the learning goals for their age, and at the same time they will have the chance to start learning or to improve their digital competencies.

The study was performed during two semesters from the academic year 2016-2017. The goal of our project was to develop interactive learning applications for young children (between 3 and 6 years old) that will provide the appropriate content for the corresponding age. In this study bachelor and master students from Faculty of Mathematics and Computer Science from Babes-Bolyai University of Cluj-Napoca have participated. They were attending the Human Computer Interaction undergraduate study course or the Design of Interactive Software Systems graduate course.

A kindergarten teacher was involved in the study and she guided the students through the steps of the project. There was a total number of 105 students who were split into 26 teams, each team having three to five members. Each team had to choose a subject and a range of age for their application.

In order to provide useful and usable products the students were required to apply a User Centered Approach (UCD). The development of the project has started with an initial meeting between the client (the kindergarten teacher) and the students, where the client has briefly described her job, and the main challenges she encounters while trying to organize the learning activities with children from kindergarten using interactive content (applications on the computer). First of all, she mentioned her difficulties in using the interactive content that is distributed mainly on CDs that contain multiple technical specifications. She specified also the need to have access to interactive content that aligns to the curriculum for kindergarten (Curriculum, 2008).

The students' next step was to document on the subject and to understand the requirements. In this sense, the students had to study the curriculum for kindergarten and Bloom's taxonomy of educational objectives (Bloom et al., 1956). After this research step, each team had the chance to meet the client again, and gather the requirements for their project using a qualitative research method (structure/semi-structured interview, observation). After this

step the teams had to think of a solution to the client's problem (choose the domain of their application and the age range of children their solution addresses). The teams had to build alternative designs for their ideas and then to build an executable prototype that was evaluated with the client. Based on the feedback from the kindergarten teacher, the teams continued with the solution implementation followed by another evaluation session for the final product. The proposed solutions have taken the form of games, designed to support the learning goals of the curriculum. Each team had to specify the range of age of children their application addresses and the domains from curricula that the application applies to.

In Table 1 are shown the curriculum domains covered by the applications developed by the students and the number of applications for each domain.

Table 1 Curriculum domains and their frequency in our study

Curriculum Domain	Number of applications
Science (Mathematics and Natural Science)	22
Language and Communication	1
Human and Society	1
Aesthetics and creativity	2

The choices of domains were spread between the following curriculum domains: aesthetics and creativity, human and society, language and communication, sciences, and psycho-motor, in an integrated manner, but the dominant area is illustrated in Table 1. The proposed solutions cover all the above mentioned domains. Most of the solutions were focused on the mathematics domain and we can justify the choice by the fact that the students have a tight relation with this domain, but there were also surprising approaches to domains as human and society, and aesthetics and creativity. One characteristic of the proposed solutions is that they were not restricted to a single domain, such that they can be used in different learning contexts.

Table 2 Age range intended for applications

Age range	Number of applications for this age range
Elements for 4-5/6 years old	20
5-6/7 years old	26

Table 2 presents the age range covered by the developed applications. Most of the applications are designed for children of 5 to 6/7 year old, but some of them contain elements that are appropriate for children of 4 to 5 year old.

The major challenge in implementing their solutions was raised by the fact that the end users (kindergarten children) are unable to read. Interacting with the user without using written messages seemed very difficult to achieve, and students have chosen solutions like recording their own voice messages or using symbols (sometimes the chosen metaphors were ambiguous). Table 3 describes the interaction styles with the end users (children) chosen by the students for their solutions. Some applications have used more than one interaction style (voice messages for explaining the required tasks and written messages for possible answers).

Table 3 Interaction styles used in the developed applications

Interaction style	**Frequency**
Voice messages	24
Iconic	26
Written messages	2
Mixed	7

As a consequence of the client's requirement that she doesn't want to read technical details about installing and using the application, the students have provided their application in the form of executable files (.exe), web applications, and even mobile applications. Table 4 shows the frequency of the previously mentioned application types.

Table 4 Application types

Application type	**Frequency**
Desktop	19
Web	6
Mobile	1

During the development of their solutions, students encountered multiple challenges that they haven't faced during faculty. First of all, the existence of a real client for their project (that was not a technical personnel, having different background and vocabulary) was at the same time intimidating and challenging. The need to identify the requirements from real clients was also challenging, because during their studies, students are used to solve problems stated by very clear requirements. The requirement to follow UCD guidelines, and as a consequence applying qualitative research methods was a difficult step in project development, knowing that during their technical instruction, the communication skills of Mathematics and Computer Science students are

not very often elicited. Most of the students did not followed the recommendation to apply observation in the real environment of their client, such that many changes have been suggested after prototypes evaluation.

From the client's point of view, all the applications developed can be used in different activities organized with kindergarten children as following: a great amount of information can be integrated during a lesson (at the beginning, on-going or at the end of a lesson as evaluation of a certain content). There is a small number of applications (6) that can be used as a lesson itself- finding the proper face for an emotion, the garden, about seasons, animals from our country, learning musical instruments, learning about Europe.

In the following we present screenshots of some of the developed applications accompanied by a short description.

Figures 1 shows the interface of an application that presents the children the specific aspects (described in images and spoken explanations) of each season. After a short and comprehensive presentation of each season the children have to opportunity to practice. The required tasks (instructions) are specified in a vocal manner (read) and the children must answer by choosing the right image. The application was designed and developed for the Sciences domain, 5-6/7 age range, with elements for 4-5 years old children.

Figure 1 Interface for an application in the Sciences domain

Figure 2 presents the interface of My Garden application that proposes a game where the children are the gardeners and they have to solve tasks related to the objects found in a real garden (counting apples of a specified color and choosing the corresponding answer, finding specific objects in a particular region of a garden, gathering apples from a labyrinth without touching the grass areas). This game improves the problem solving capacities of children and improves their mouse-based interaction competencies. The instructions

for the tasks are given by vocal messages.

Figure 2 Interface for an application in the Science domain

Figure 3 shows the interface of an application that requires the children to select the color obtained by mixing the colors of the two moving squares (showed on the left and right areas of the screen) from three possible options (showed in the center of the screen). The application stores the time needed for a children to complete a set of tasks and generates a ranking of the results such that the progress can be monitored. The application is created for children of 5-6/7 age range.

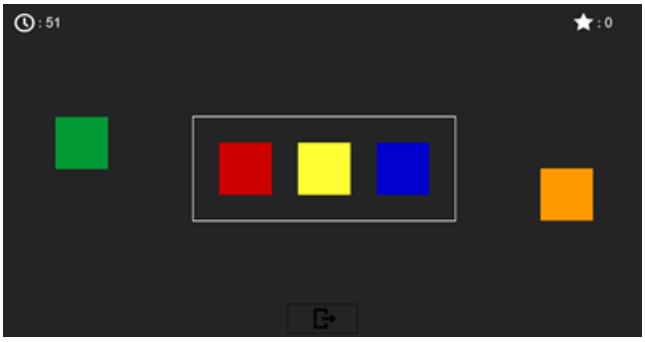

Figure 3 Interface for an application in the Aesthetics and creativity domain

Figure 4 presents the interface of an application having the goal to teach children how to recognize different human emotions. In the upper part of the interface a description of the emotion is presented. The children should build from three parts taken from pictures representing human emotions the image corresponding to the described emotions. The three parts of the pictures are changed by using the associated arrows.

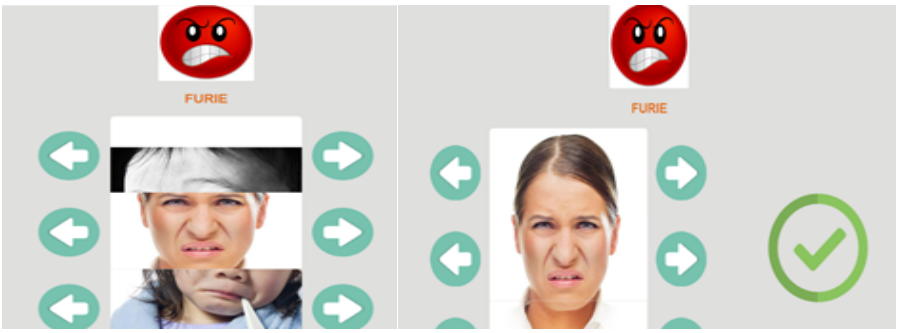

Figure 4 Screen captures from an application in the Human and Society domain

Figure 5 presents screen captures from an application that presents riddles to the children. The riddle is presented in written text, but it can be played by using the control that is positioned under the written text. The answer options are presented in different formats (sounds or images). To start the riddle games the authors have used the castle metaphor, where each door has a number and the children will access the riddles by opening the doors in ascending order of their number.

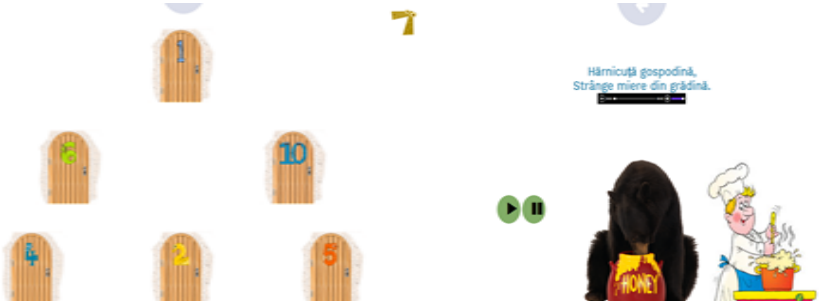

Figure 5 Interface for an application in Language and Communication domain

As it can be seen, all the applications address a specific knowledge domain, but they can be used to strengthen knowledge from other knowledge domain (counting, recognizing geometric forms, identifying colors, identifying decimal digits, recognizing seasons, identifying emotions, etc.). By using the above described applications, the children will learn the same content (or even an improved one) as before using the interactive applications, and at the same time they will improve their digital competencies. Another advantage of using technology in a learning context

is that the children will understand that technology may be used as a learning support, not only for fun activities.

4. Conclusions and further work

In a continuous developing digitally based society, young children should be supported in developing a correct and accurate model about technology and its use, and to gather the needed digital competences.

This paper discusses the motivation to provide digital content for children and explores the appropriateness of using interactive games to support game-based learning in formal early childhood education settings. The starting point in our initiative to support the development of digital, interactive content for young children was to develop interactive learning content adapted to kindergarten children, using a user centered approach.

The variety of the proposed solutions shows that there is room for improvement in the field of game-based learning for early childhood education. In the future we intend to test the effectiveness of the proposed solutions in real environment (with young children from kindergarten) and to disseminate the results of our work in multiple educational places, such that kindergarten teachers may access and integrate them in their regular activities with the children.

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