INVESTIGATING THE "MAGICAL" EFFECTS OF GAME BUILDING ON THE DEVELOPMENT OF 21ST CENTURY SKILLS

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Abstract

This paper tackles the issue of ICT-enhanced development of so-called 21st Century skills. In doing so, it draws on the experience gained in the framework of MAGICAL (MAking Games In CollAboration for Learning), an EU project funded in 2011 under the LLP transversal ICT Programme. The core mission of MAGICAL is to exploit the potential of collaborative game building as an innovative learning approach for primary school students. The paper first analyses the concept of 21st Century skills and goes on to propose and explore the idea that game building activities can contribute to the development of a variety of such abilities. The paper also offers some reflections on the key role of teachers in guiding and monitoring the entailed learning processes, and briefly discusses some ideas on the new competences demanded of teachers.

Keywords: game-based learning, 21st Century skills, game building, creativity, collaborative learning.

1 INTRODUCTION

The new skills required for taking an active part in the Knowledge Society are commonly referred to as "21st Century skills". Given the obvious need for contemporary education to contribute towards the development of such skills [1, 2, 3, 4], it necessarily follows that educational research has a central role to play in supporting that role, especially in establishing the most suitable educational methods and tools for pursuing this aim. Following [5], we can say that "*21st century skills are different than 20th century skills primarily due to the emergence of very sophisticated information and communications technologies*". Actually, Information and Communication Technologies (ICT) play a major role here: as agents of innovation shaping the Knowledge Society, as means entailing and requiring the acquisition of new skills, and also as powerful tools for sustaining the development of key abilities across the board [6].

In the following, we tackle the issue of ICT-enhanced development of 21st Century skills by referring to the use of a specific subset of ICT educational technologies, namely Serious Games - digital games designed for purposes other than entertainment [7].

Serious Games (SG) are widely perceived and recognized as effective learning/teaching tools mainly because of their intrinsic potential to motivate learners [8, 9,]. This is acknowledged both within formal [10] and non-formal educational environments [11. SG have the key advantages of providing immediate feedback and allowing for personalised learning [12]. They also stimulate learners' critical thinking [13] by offering them the chance to try out alternatives and personally experience the consequences without high-stakes risk-taking. SG also lend themselves to collective and social use [14]. As will be explored further in this paper, some specific types of SG also place the learner in genuine "learning by doing" environments, where learning is the direct outcome of personal decisions and concrete actions. This is particularly true for those games offering an immersive experience in which learners have margins for performing self-directed and constructive activities [15]; it also applies to those environments in which game creation and not only game playing is the main objective. To date, game construction as a learning activity has been relatively small and largely limited to pilot experiences run in the US [16, 17,]. Nevertheless, some significant studies have shown that "game building" activities not only trigger and support the development of the procedural abilities required to complete a game, but also have strong potential for supporting some transversal skills [18, 19] considered key to personal, intellectual development and to academic achievement [20, 21].

Along these lines, the paper explores the connection between game building practices and the development of so-called 21st Century skills. It first investigates what exactly we mean by the term "21st Century skills" and then explores which of these skills are engaged and required in game building processes. The basis for this study is MAGICAL (MAking Games In CollAboration for Learning), an EU

project funded in 2011 under the LLP transversal ICT Programme, whose core mission is to exploit the potential of collaborative game building as a learning tool for primary school students [22].

2   THE SO-CALLED 21ST CENTURY SKILLS

What do we exactly mean, then, by the term 21st century skills (21CS) ? The question has attracted considerable attention in the literature, with different definitions and classifications proposed by researchers who have considered the matter from different perspectives. For example, Binkley and colleagues [23] considered 21CS as "ways of thinking, working, living, and as tools for working in connected, media-rich worlds". Redecker et al [24] have identified three general categories: 1) personal skills (initiative, resilience, responsibility, risk-taking, creativity); 2) social skills (team-, networking, empathy, compassion, co-constructing); 3) learning skills (managing, organizing, metacognitive skills, failing forward). In any case there is a general agreement that 21CS "*bring together skills considered necessary in the knowledge society*" [25]. Among these, digital competence is widely considered a vital component, although certainly not the only one or even the most important. Dede [26] nevertheless argues that a set of fully new competences is required "*because of*" the ubiquity of ICT; thus among the new, required abilities he includes in the stack we find "information problem solving" or "*the ability to rapidly filter huge amounts of incoming data, extracting information valuable for decision making*" plus "*the ability to separate signal from noise in a potentially overwhelming flood of incoming data*".

As highlighted by Kickmeier-Rust & Dietrich [27], the major obstacle to reaching a shared definition arises from "the unclear, probably vague, and highly informal nature of these 21st century skills". The concept is, then, an overarching term for many kinds of meta-abilities, soft skills, communication and collaboration skills, of attitudes, self-awareness, strengths in non-linear thinking, and innovative problem solving, as well as the ability to reflect about one's own thinking and being. That said, a number of serious attempts have been made both by individual researchers and by institutions in the field not just to define 21CS but to arrive at a systematic 21CS framework or structured classification.

While a universally recognized and shared definition of 21CS has yet to be reached, the efforts made by groups working on conceptualizations of such skills have at least built sufficiently on each other's ideas so as to avoid a "Tower of Babel" situation [26]. So the main frameworks that have been proposed are largely consistent; as a general rule, they focus on skills such as innovative thinking, creative problem solving, meta-cognitive abilities, communication and collaboration.

As an example, the P21 - Partnership for 21st Century Skills [28] has defined the following (fig.1) Framework for 21st Century Learning, which focuses on mastery of four categories of skills regarded as the most important:
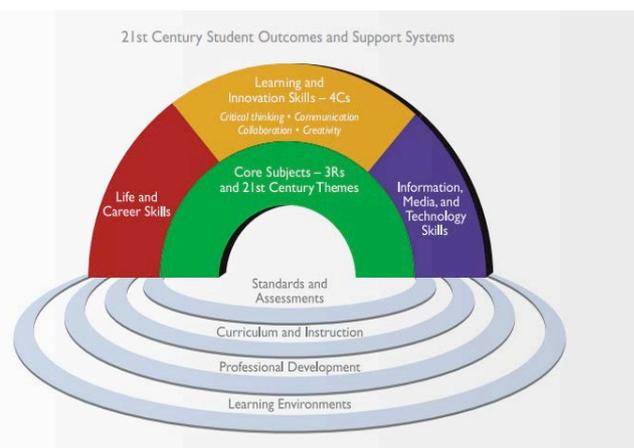

Fig 1 Exemplar framework by P21.

1. ***Core subjects and 21st century themes*** including: English, reading or language arts, world languages, arts, mathematics, economics, science, geography, history, government and civics and also interdisciplinary themes such as: Global Awareness, Financial, Economic, Business and Entrepreneurial Literacy, Civic Literacy, Health Literacy, Environmental Literacy

2. ***Learning and Innovation Skills*** including: Creativity and Innovation, Critical Thinking and Problem Solving, Communication and Collaboration, Information, Media and Technology Skills

3. **Information, Media and Technology skills** such as: Information Literacy, Media Literacy, ICT (Information, Communications and Technology) Literacy

4. **Life and Career Skills** encompassing Flexibility and Adaptability, Initiative and Self-Direction, Social and Cross-Cultural Skills, Productivity and Accountability, Leadership and Responsibility.

A research group at the University of Twente [29] recently carried out a meta-analysis of six 21CS frameworks, namely P21 [28], ENGAUGE [30], ATCS [31], ISTE [32], OECD [33], CASE [34]. The result is a comprehensive list of 21CS that accounts for the "frequency" with which each skill appears in the various frameworks considered. Hereunder in Fig 2, following [29] we report the list of skills mentioned in all or at least most of the mentioned frameworks.

Mentioned in *all* frameworks	Mentioned in *most* frameworks (i.e., P21, EnGauge, ATCS and NETS/ISTE)
- Collaboration - Communication - ICT literacy - Social and/or cultural skills; citizenship	- Creativity - Critical thinking - Problem solving - Develop quality products / Productivity (except in ATCS)

Fig.2 List of skills mentioned in all/most of the six 21CS frameworks considered in Voogt et al, 2010.

3   THE MAGICAL PROJECT

The MAGICAL project is mainly aimed at investigating the educational potential of learning activities based on game building and at defining a suitable and effective methodology for adopting game construction in formal educational contexts at primary school level.

Despite the increasing possibilities and popularity of games for learning:

- most educational experiments devoted to game-based learning involve game play on an individual basis;
- in the vast majority of cases games are used as closed environments in which learners rarely have margins for self-directed and creative activities;
- the practice of incorporating game development into regular classroom activities is still relatively unexplored even though technological development has now opened up new possibilities for utilizing game-making for learning: game authoring tools have been developed that rely on visual programming (e.g. Kodu and GameMaker) and some commercial entertainment games allow generation of user-defined versions (moding) and addition of user-generated content. Both these possibilities have made game development more accessible to young students and have opened the door to further in-depth curricular experiments.

For game construction to be considered an effective educational strategy, well-conceived educational methods and pedagogical strategies need to be defined to maximize the effectiveness of "game building" in support of learning (and development of transversal skills in particular): this is exactly MAGICAL's vision and scope.

The project has developed a gaming environment that embeds game authoring features [35]. The aim is to engage school students in an innovative "learning by doing" process by allowing them to build/create their own games in a collaborative manner (fig.4). Among other things, this approach will introduce them to the basics of designing and iteratively developing an interactive digital artefact (though obviously within the limits of the target age group). One possible fallout from this is activation of students' systems thinking, namely their awareness and understanding of how individual things influence one another within a whole; it will also provide the opportunity for exercising a wealth of other relevant competences.

Besides the adoption of the "learning by doing" approach, other significant innovative aspects of the MAGICAL project are:

- the shift from the traditional individual dimension of gaming (even adopted in many Massive Multiplayer Online Role-Playing Games) to a collaborative one, thus engaging groups of students in a collaborative game building experience;

- the adoption of the "design for all" principle [36], which implies addressing all students in a classroom without exclusion (e-inclusion of students with disabilities);

- the development of parallel courses targeting student teachers and professional health authority staff in charge of introducing game building activities in their daily practice, with the ultimate aim of developing students' transversal skills.

In this light, MAGICAL is a response to a strong need felt within the field of game based learning to clarify whether and how digital games can be used to trigger and sustain the acquisition of key transversal skills. The primary focus is on identifying which pedagogical approaches are applicable in the field of game-based learning and could be best suited for the purpose, starting from those learning/teaching approaches that are well established in the TEL domain (discovery learning, social and collaborative learning, learning by doing etc.). Drawing on these key ideas, the project also aims to verify if game building can actually contribute to develop children's abilities, which exactly and how.

4 MAGICAL, GAME BUILDING AND THE DEVELOPMENT OF THE 21ST CENTURY SKILLS

The MAGICAL project offers food for thought on the theme "game building activities and the development of 21CS". First of all it suggests that, when considering learning environments and objectives, both the learners' and the teachers'/educators' viewpoints need to be considered. As a matter of fact, the endeavour of triggering and fostering students' new skills also calls for careful design and deployment of learning interventions and this may require significant shifts in everyday teaching practices. So the role and competences of teachers also change, and this aspect needs to be considered with special attention.

4.1 Learners' 21st Century skills addressed by game building activities

If we look at the development of 21CS in the light of the MAGICAL project [22] we see that it (and, as a consequence, the game building educational activities that are at the core of the project) explicitly addresses most of the skills mentioned in Fig.2 namely:

- *ICT literacy* or rather in a wider sense "digital competence" [36] since building new games entails much more than simply "playing" - it means mastering basic conceptual know-how/capabilities typical of the information technology field;

- *Critical thinking and problem solving* or, in particular, reasoning and logical abilities at large; designing and building games means possessing the abilities required to play a game (such as problem solving) plus the capacity to comprehend - and to manage - how these abilities will be engaged through a specific game format (critical thinking);

- *Creativity*, which is to be considered not as an innate attitude but a potential skill that can be supported and enhanced by means of appropriate educational interventions mainly based on the learning by doing approach. Creativity is mainly involved in the phase of the design of the game structure and features and in the implementation of some significant interface features.

- *Productivity* since game building is grounded on the learning by doing approach and is to be regarded as an activity that *per se* is oriented towards the production of real and tangible objects.

In addition, if we consider the methodology underpinning the MAGICAL project we see that it strongly relies on collaboration and cooperation among students. Actually game building is the outcome of cooperative group work which is, in turn, strongly dependent on the students' abilities to communicate fruitfully. We can therefore say that, among the identified 21CS, collaboration and communication also figure strongly.

The one exception is that the MAGICAL project doesn't explicitly address the social/cultural skills entailed in the framework proposed by Voogt and al [29]. Nevertheless, this key aspects could easily be introduced in future work by stressing that, when creating games, students (at high school levels) should take into account the usability and adaptability of their games for the cultural context and setting they are to be used in.
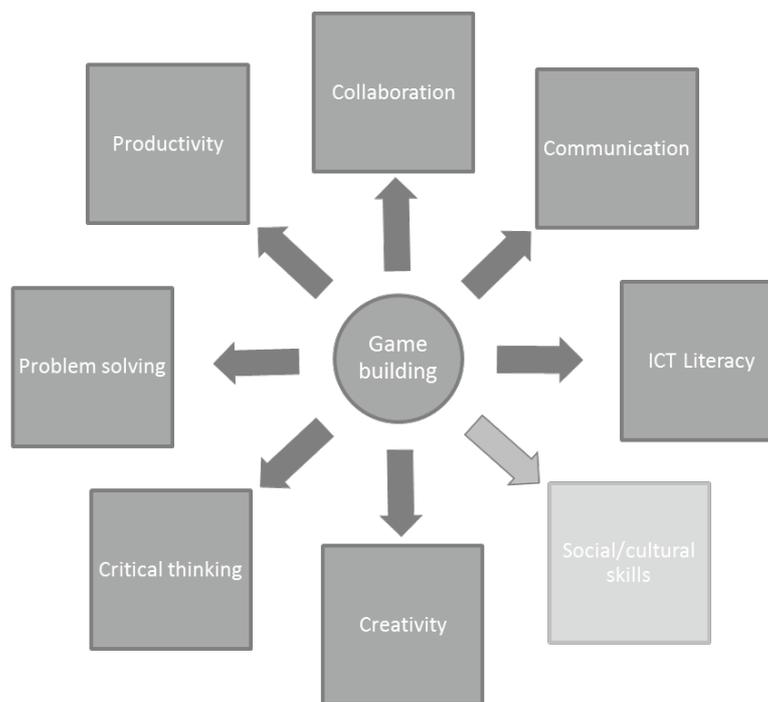

Fig.3 Relevant students' 21st Century skills potentially addressed by game building activities

As shown in Fig.3, game building can, then, be considered an activity that potentially addresses the development of almost all the most relevant 21CS. Further confirmation will hopefully come from analysis of the results from MAGICAL field testing, which is still in progress.

In the meantime there is a further (related) key issue that ought to be addressed, namely that if the above-mentioned objectives are to be seriously pursued, game building activities need to be carefully planned and guided; in this context the role of educators/teachers is a key one. In the following, we briefly discuss this issue from the standpoint that educators also need new skills in order to design and conduct effective educational interventions of this kind.

4.2 The 21st Century skills educators require

Following UNESCO [37], in today's society the "*roles of teachers have changed and continue to change from that of instructors to that of constructors, facilitators, coaches, and creators of learning environments. It is no longer sufficient for teachers to impart content knowledge… They must encourage higher levels of cognitive skills, promote information literacy, and nurture collaborative working practices*". If, on the one hand, these new responsibilities are greatly facilitated by the use of ICT in teaching, on the other ICT also call for significant changes in teaching practices in order to address the new, enlarged objectives that education systems are being expected to meet.

The central figure of teachers and educators and the need for adequate teacher training programmes that take in board the development of students' 21CS is clearly highlighted by several authors, although from a thorough survey conducted by the OECD [25] it emerges that, presently, the type of training on offer varies considerably from country to country.

What also appears (Fig. 4) is that:

- the teachers'/educators' areas of competence should be enlarged so as to include both new educational methods and approaches (e.g. game construction; new assessment methods) and new educational tools (e.g. digital tools, such as digital games).

- the standards associated to professional practice should be, to some extent, altered and adjusted in conformity with the new requirements (e.g. shifting from information giver to guide and working companion) and the allocation of personal resources (e.g. in terms of time and preparation; attitude towards learning and testing new tools) should be increased.
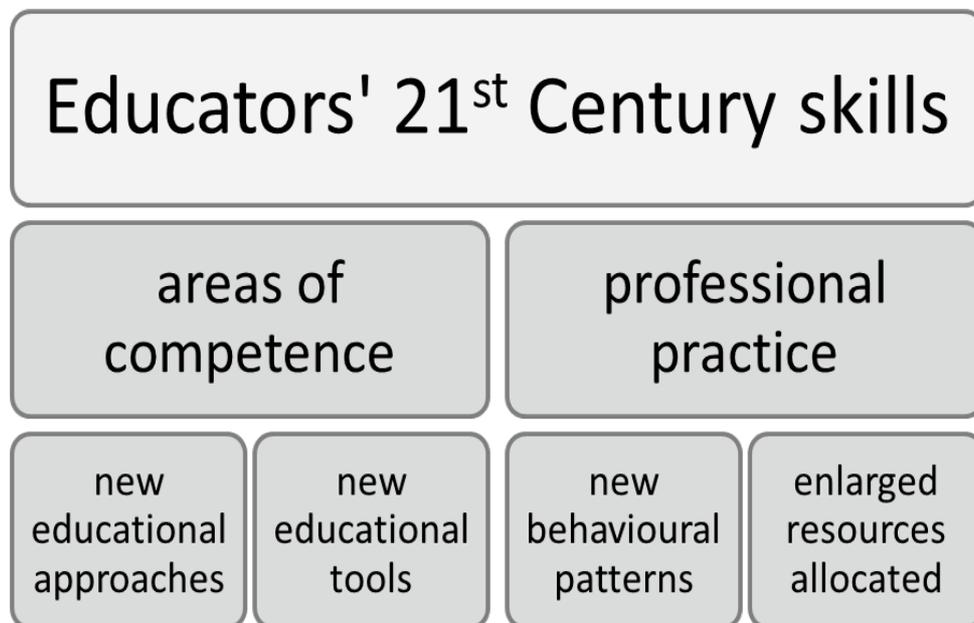

Fig.4 An overview of new abilities required of educators in order to foster students' 21st Century skills

5   CONCLUSIONS AND FUTURE WORKS

In this paper some reflections and ideas have been proposed concerning the educational potential of game building practices for the development of so-called 21st Century skills. The still on-going MAGICAL project has offered some cues for investigating *how* game construction can be integrated in the curriculum with the specific aim of supporting the development of such skills. Analysis of the MAGICAL approach and objectives has revealed that game construction can be seen as a means to practice and sustain the development of the most relevant skills to be mastered in the Knowledge Society: Collaboration, Communication, ICT literacy, Creativity, Critical thinking, Problem Solving and Productivity. This is a "vision" that needs to be confirmed by practice, and analysis of MAGICAL project results will offer food for thought to this end.

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