SKILL ME UP... AND UP!

AN ITERATIVE DESIGN METHODOLOGY TO IMPROVE STUDENT'S 21TH CENTURY SKILLS

J.Niewint-Gori[1], M.Naldini[1], A.Benassi[1]. L.Guasti[1], S.Mori[1]

[1]INDIRE (ITALY)

Abstract

Promoting the process of a deeper learning experience and help students to develop the skills required to face the challenges of the 21st century needs the activation of a series of resources, like the knowledge of concepts and procedures, cognitive strategies, personal skills and the appropriate attitudes [1]. The debate on what are the most effective strategies of teaching to stimulate these process gets more and more relevant. The very moment of the didactic planning becomes crucial for identifying the specific goals for every single stage of the learning path. Necessarily the attention shifts from the products of the learning to the learning process itself [2], and this evenmore when new technologies are used in classroom. Following the experiences of INDIRE in the use of 3D printers in the pre-primary and primary school [3,4,5] and the use of Minecraft game in primary school and considering the latest researches in the field of education at the international level (iTEC) [6] the need evolved to build a framework of reference to define a student-centered methodology which promotes an effective learning process and improves the skills of the 21st century [7]. Inspired by the Design Thinking [8] and by the model of Think Make Improve (TMI)[9],a methodology focused on the iterative design cycle able to enhance the mechanisms of cognitive activation of the students [10] is developed. This contribution illustrates the development of the framework and the peculiarities of the intervention in the classroom. During the 2018/2019 school year the methodology will be tested in a range of K-8 classes in order to optimize the methodology and to develop the evaluation tools to measure the effectiveness of the process.

Keywords: Innovation, ICT, 21st Century Skills, cognitive enhancement, evidence based teaching.

1 INTRODUCTION

> "We are competent when we decide our actions while we take them, we evaluate and correct them on the fly, we explore the implicit elements of such actions and take them into account for the following ones, we restructure meanings and purposes depending on the use of particular means, we discover, generate and share sense of what we do, and such sense fits and comes along with any system data modification and the relational dynamics that follow."
>
> (Bertagna, 2004, 37-38) [11]

In the last decades, competence-based learning has gained widespread attention in the ongoing process of rethinking the educational systems. The knowledge-based approach is called into question, as well as the discipline-based curriculum.

The competency paradigm is at the heart of an international process that aims at leading the national school systems towards common guidelines and goals. Beginning from OCSE-CERI DeSeCo project (Definition and Selection of Competencies) in 2002 [1] and the EU Council Recommendation on Key Competences for Lifelong Learning in 2006, policy plans started referring to the key competencies as a necessity for personal fulfilment and development, employability, social inclusion and active citizenship.

In recent years, the focus shifted on the so-called 21st century skills. The white paper "Assessment and Teaching of 21st Century Skills" outlines how - in this new century - "success lies in being able to communicate, share and use information to solve complex problems, in being able to adapt and innovate in response to new demands and changing circumstances, in being able to marshal and expand the power of technology to create new knowledge, and in expanding human capacity and productivity" [12]. The strong interest generated by initiatives such us the "Partnership for 21st skills" [7] and the "Assessment and teaching of 21st century skills" project [13] - which led to the definition of

specific frameworks of competencies - pointed out the relevance of this topic not only among teachers and researchers, but also policy makers and working world's representatives.

From 2011 to 2014 the European iTEC project (Innovative Technologies for an Engaging Classroom) [6] promoted the adoption (among 1000 classroom in 13 different European countries) of innovative, ICT enabled learning scenarios in support of 21st century skills. Here, as well in other similar initiatives, active learning methodologies are embraced as contexts for developing creativity, problem-solving, communication and team-working skills.

In Italy, the recent ministerial acts of 2015 about the adoption in schools of the Alternanza Scuola-Lavoro (dual-training system) and the Piano Nazionale Scuola Digitale (National Plan for the Digital School) gave the schools a strong push towards methodological approaches coming from the working world, such as FabLab and Design Thinking.

2 METHODOLOGY

To define a methodology that respects the ministerial recommendations some criteria for developing classroom activities supported by ICT and focused to improve skills for the 21th century have to kept in mind. The introduction of digital technologies in the classroom (especially tablets, mobile devices and personal computers)has been shown to have great potential in improving attentional capacity and memory and executive functions, as it can provide interesting learning opportunities, but does not automatically bring benefits on learning outcomes at school or gives a greater opportunity for educational success. However, the improvement due to the use of ICT is not a direct result: teachers and learners need to be involved in a meaningful application to take advantage of these possibilities with a view to improving cognitive activation. The ideas for a new methodology started from several approaches, all of these have the common purpose of developing deep learning and skills for the 21st century through the design of artifacts using new technologies.

Specifically they are:

2.1 Design Thinking

It refers to the "analytic and creative process that engages a person in opportunities to experiment, create and prototype models, gather feedback, and redesign" [14]. In learning environments, thinking as a designer means the empowering of the attitudes (eg. visualization, creativity) e the adoption of the techniques and tools that a good professional designer normally uses for solving problems, innovate, make change happen. D.School at Stanford University offers several labs and educational programs based on Design Thinking Process [Fig.1].

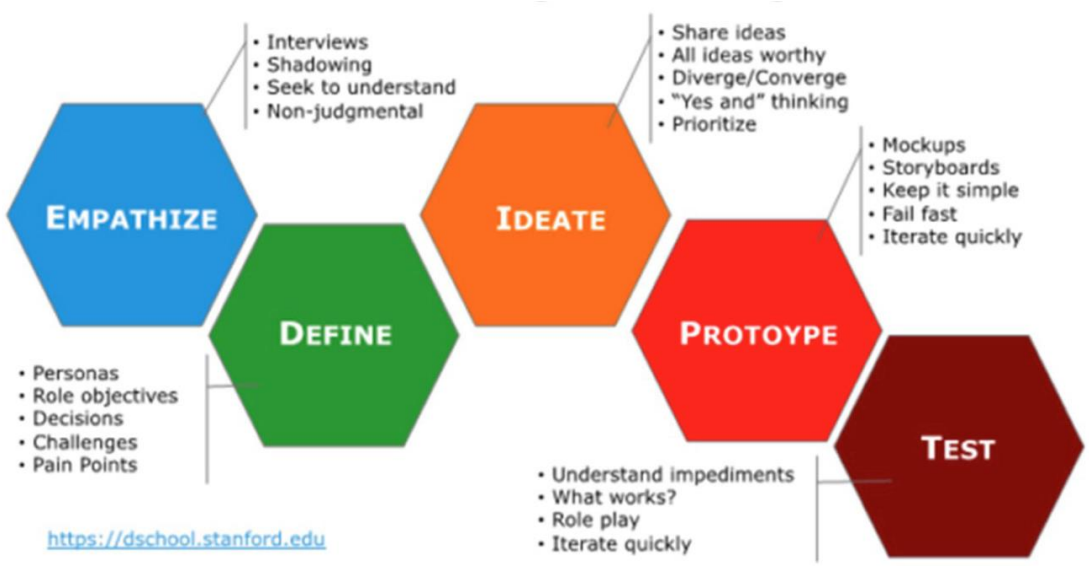

Figure 1. D.School's Design Thinking Process (https://dschool.stanford.edu)

2.2 Think-Make-Improve(TMI) cycle

The Think-Make-Improve(TMI) cycle is an Adaptive Decision Making process (ADM) optimized for a problem focused activity initially conceived by Martinez and Stager [9] in the book Invent to Learn. The cycle adds value in the process because lets the students works with a structured methodology that permitted to divide the design stage, from making and testing stages. The method helps to understand the process steps and works as well as a designing approach for teachers to define the lesson structure and at the same time for the students it is a way to organize their work. The TMI stages can be characterized in the following way (following the recommendations of the book):

- The “THINK” stage incorporates many of the problem-setting, brainstorming, and planning processes. The problem is described by the teacher who allows the students to come up with a design on paper or digital document and share his/her or their ideas. Students students are helped by the introductory stage where they can use various materials and techniques.
- MAKE: This is the part of the process where the most action occur. The project itself is created and become real. Here is where we see the challenge that comes out making the object in the way it was assigned in the previous stage.
- The IMPROVE is the stage where students focus on the object itself, they reflects on the object created, verifying if it relates to what was thought of during the previous stage.

This cycle, widely used also in the context of INDIRE research, has the merit of being simple to apply, consisting of only three stages. In some contexts, however, it was too reductive, too much compressing the initial design stage and the final stage of reflection on the product made.

2.3 The promotion of Deep Learning through cognitive activation

Deep learning refers to the development of critical and creative thinking in students, making inferences and transferring knowledge [15]. Digital technology can help the engagement of learners in deep learning promoting significant competences for the 21st century. ICT may support the use of innovative methods that make learning more efficient and more attractive to learners: the virtual reality, the artificial intelligence, and the 3D printers could be the support the development of deep learning in an educational setting. In our approach technology could enhance the learners’ metacognitive activities, like reflection and self-reflection [16]; moreover it could support Teachers’ procedural and technical play [17]. Supporting learners to develop their meta-cognitive skills and self-efficacy will help them to achieve learning outcomes [18]. The use of ICT can increase cognitive abilities of children and teenagers, in order to improve the learning and promote academic success [19]. Deep learning is promoted in cooperative processes where learners are building and expanding their notions, experiences and understanding in the process of discussion and sharing in a learner-centred setting [20].

3 RESULTS

In a previous research with the 3D printer in three different pre-primary schools the pupils were divided in experiment and control classes and given the WPPSI-III as a pre and post-test. The results of the test somministration show that the application of the TMI modell in class has improved the verbalization skills of the pupils[4]. A further research approach have to investigate if the findings of the growth of the verbal IQ can be attributed to the fact that the structuring of didactic paths based on the TMI model have stimulated the verbal skills, because the involved activities promote the sharing and communication of peers. The results of the improvement of verbal skills led the researchers to reflect on the need to define the specific processes activated in class in the single stages of the TMI model. This was the starting point of the definition of a methodology, that supports the process of a deeper learning and improves transversal skills. Since the previous researches applied new technologies like the 3D printer or the software Minecraft, in a didactic approach for competences, emerged also the need to define a methodology that not only promotes deeper learning but that could be used at school also with different kind of technologies and disciplines. Another important goal was to be able to measure the improvement. The need to measure the progress automatically led to the need to define indicators to evaluate the activation of cognitive processes and the core competences. To sum up everything: the use of the TMI model in the classroom got some limits for the future researches. A more detailed and defined approach in class is needed to be able to evaluate and

measure the impact of the use of new technologies with a specific didactical pathway to improve the transversal skills of the students. This evaluation follows an integrated perspective: assessment-as-learning. This form of evaluation integrates both: learning and evaluation activities. To do so a methodology is needed that includes models for the design of assessment as learning tasks, together with examples of protocols for debriefing and for monitoring the development of students' abilities.

4 CONCLUSIONS

The Iterative Design for Active Learning methodology (IDeAL) provides for five macro stages, each subdivided into micro stages [Fig.2]. The micro stages are accompanied by cards to plan, guide and evaluate the activity in the classroom [21,22,23]. In the first stage the activities consider the involvement of the whole class which is then divided into groups. Through the design and implementation stages the groups are stimulated to a constant peer evaluation on the ideas, the processes and the solutions developed with the aim of having a control on what they are doing and at the same time to evaluate and share the result obtained. With this in mind, the cycle ends with the evaluation by the class in its entirety of what has been achieved in a group; this stage makes it possible to consolidate an argument or concept and at the same time lays the groundwork for restarting the IDeAL cycle by setting new learning objectives. The subdivision of the cycle in micro stages is designed to give to the teacher involved in the use of this method the ability to calibrate the workload in consideration of the needs of the class and ensure students a constant control on the development of activities also developing communication skills. These competent are strengthened by the presence within the routine script whose use allows the student to consolidate analysis and evaluation processes put in place in the production of artefacts stimulating the acquisition of capacity for reflection on their work. Concluding the IDeAL cycle was designed for supporting teaching for skills and the teacher's performance; it also has the goal of stimulate metacognitive and self-regulation aspects improving the social climate in the classroom.

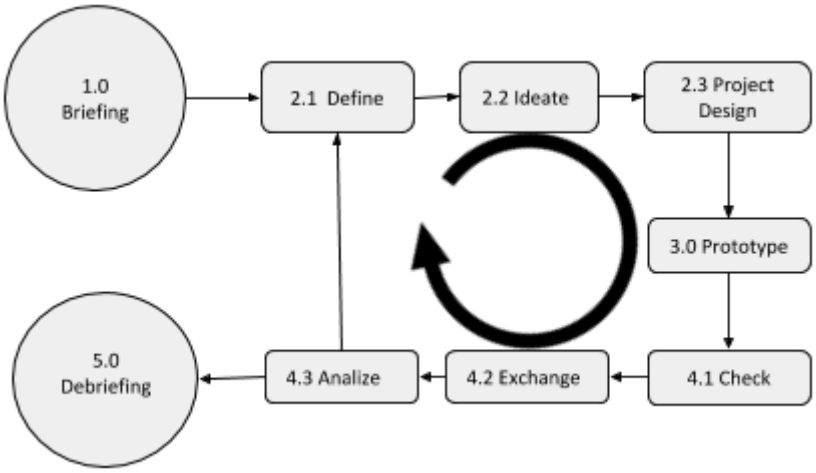

Figure 2: The IDeAL Methodology Cycle

4.1 "MineClass" Pilot Project

In December 2018, INDIRE, in collaboration with Microsoft, started a pilot project targeted at 200 primary and secondary Italian school's teacher and aimed at easing the adoption of Minecraft videogame within classroom learning activities. After a first stage of familiarization with the game, teachers are now (January 2019) designing their own IDeAL-based learning activities and then pilot them from February 2019 till the end of school year. Outcomes will be analyzed and discussed after the pilot stage (from June 2019).

4.2 3D Printer Pilot Project

The pilot research of the use of the IDeAL methodology with the 3D printer involves students of all school grades. The schools of grades K - 8 will use the methodology in a vertical project shared within

the comprehensive institute. For the secondary school (9-10) the methodology will be integrated into the disciplines chosen by the teachers. To evaluate the methodology, focus groups will be used for the teachers, and evaluation grids for the students. At the end of the pilot project a somministration of a cognitive test is scheduled.

REFERENCES

[1] DeSeCo, P. "*Definitions et sélection des compétences*.", Fondements théoriques et conceptuels, 2002.

[2] Anderson, L. W., & Krathwohl, D. R. "*A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*.", Complete Edition. New York: Longman, 2001.

[3] Di Stasio, M., Guasti, L., Niewint-Gori, J., & Nulli, G.."*Looking for Good Practices of Teaching and Learning with 3D Print in Primary School.*", In Conference Proceedings. The Future of Education. libreriauniversitaria.it Edizioni, 2017.

[4] S. Mori, J. Niewint, C. Beni. "*Cognitive enhancement and 3d printer in kindergarten: an exploratory study*", ICERI2018 Proceedings, pp. 2388-2392.doi: 10.21125/iceri.2018.1524 , 2018.

[5] L.Guasti, A.Benassi, G.Nulli, "*Costruire Giocattoli con la Stampante 3D nella Scuola dell'Infanzia. Spazi di utilizzo, sperimentazione e co-progettazione didattica*" - Conference Proceedings Learning digitals: which issues from Education 2.0? Università di Cagliari 2-3 luglio 2015.

[6] Ellis, W. J., Blamire, R., & Van Assche, F.."*Innovative technologies for an engaging classroom (iTEC)*.", In Re-engineering the Uptake of ICT in Schools (pp. 1-15). Springer, Cham, 2015.

[7] P21 - Partnership 21st century learning, Framework, Accessed 11 July, 2018. Retrieved from http://www.p21.org/our-work/p21-framework

[8] Meinel, C., Leifer, L., & Plattner, H. "Design Thinking: Understand-Improve-Apply.". Springer, 2010.

[9] Martinez, S. L., & Stager, G. "*Invent to learn: Making, tinkering, and engineering in the classroom*" (pp. 31-41). Torrance, CA: Constructing modern knowledge press. 2019

[10] Trinchero, R."*Il gioco computerizzato per il potenziamento cognitivo e la promozione del successo scolastico. Un approccio evidence based.*",Form@re, 3, 14, 7-24, 2014.

[11] Bertagna, G.. *Valutare tutti. Valutare ciascuno. Una prospettiva pedagogica.* La scuola.2004

[12] Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M.."*Defining twenty-first century skills. In Assessment and teaching of 21st century skills*" (pp. 17-66). Dordrecht, NL: Springer. doi:10.1007/978-94-007-2324-5_2,2012

[13] Assessment and teaching of 21st century skills, Accessed 16 January, 2019. Retrieved from http://www.atc21s.org/

[14] Razzouk, R., & Shute, V. "*What is design thinking and why is it important?*", Review of Educational Research, 82(3), 330-348, 2012.

[15] Zheng., R.. "*Strategies for Deep Learning with Digital Technology: Theories and Practices in Education*". Nova Editor. 2018

[16] Means, B., Toyama,Y., Murphy. R., Bakia, M., and Jones, K.. "*Evaluation of Evidence-based Practices in Online Learning: A Meta-analysis and Review of Online-learning Studies*." Washington, D.C.: U.S. Department of Education.2009

[17] Kirschner, P. A., Sweller, J., & Clark, R. E.. "*Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching*". Educational Psychologist, 41, 75–86, 2006

[18] Blanco, M.M, Van der Veer, G., Benvenuti, L. & Kirschner, P.A." *Design guidelines for self-assessment support for adult academic distance learning*". http://www.academia.edu/2722249/Design_guidelines_for_self-assessment_support_for_adult_academic_distance_learning Accessed 2013-11-05, 2011

[19] Roberto Trinchero. "Il gioco computerizzato per il potenziamento cognitivo e la promozione del successo scolastico. Un approccio evidence based". FORM@RE, n. 3, vol. 14, p.7-24 ISSN: 1825-7321, 2014.

[20] Trepule, Elena & Tereseviciene, Margarita & Rutkienė, Aušra.. *Didactic Approach of Introducing Technology Enhanced Learning (TEL)* Curriculum in Higher Education. Procedia - Social and Behavioral Sciences. 191. 848-852. 10.1016/j.sbspro.2015.04.340,2015.

[21] Boscolo, P.. "*La fatica e il piacere di imparare. Psicologia della motivazione scolastica*.", Torino: UTET, 2012.

[22] Ritchhart R., Church M., Morrison K. "*Making Thinking Visible: How to Promote Engagement, Understanding, and Independence for All Learners*.", Weley: Hoboken (NJ), 2011.

[23] Panzavolta, S., Mosa, E., Cinganotto, L., Guida M. & Laici, C.. "*MLTV, rendere l'apprendimento e il pensiero visibili nella scuola secondaria di secondo grado*." Exploring the Micro, Meso and Macro Proceedings of the European Distance and E-Learning Network (EDEN) 2018 Annual Conference Genova, 17-20 June, 2018 ISBN 978-615-5511-23-3, 2018.