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Technology-enhanced learning: Cloud Computing to implement cooperation among schools

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Abstract

In this article we describe an interdisciplinary laboratory implemented thanks to the technology designed as part of the activities elaborated in the Mathematical High School Project by the research group of the Department of Mathematics of the University of Salerno. Four classes of different schools, led by their teachers and coordinated by university researchers, have produced an educational computer game by sharing the various statuses of the work in the cloud. The teaching activity was aimed at deepening literary texts concerning mathematics transformed into a game thanks to the skills acquired by the students in computer science in which the advancement in the various levels required the resolution of enigmas and mathematical riddles. In this work, we will also present the topics that lead us to evaluate in an extremely positive way the use of cloud computing in curricular teaching in a wide vision of knowledge.

Keywords: *Interdisciplinarity; cloud computing; education; technology; mathematical language.*

1. Introduction

Contemporary society is defined as "global" because every action, every cultural, economic, social, and political choice has repercussions that are independent of the context in which it took place and determine effects and interrelationships in much broader contexts. The school must therefore encourage students to carry out collaborative activities both in the form of group work also through the structuring of paths that involve wider networks, for example between geographically distant schools. In this way, in addition to broadening the cultural horizon of the participants, a sharing of good educational practices is developed. Technology is certainly an extremely effective tool to encourage these interactions even at a distance because, in economic terms, it allows the meeting, exchange and share processing through computer tools and programs. This has therefore led to the design of experimental laboratory paths oriented in this educational direction. The use of technology is natural to high school students who are part of that category called "digital natives", therefore the choice to exploit tools close to the daily life of youngers leads them to feel like main actors, the protagonists of the formation of their knowledge with an active role in the construction of their skills. Consequently, it is important to observe and analyze the educational effects of activities that are developed in collaboration among different schools and research institutes, sometimes very far both for the distance and for the educational paths, thanks to virtual platforms.

In the “Sustainable Development Goal 4 - Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” of the 2030 Agenda for Sustainable Development, that is guided by the purposes and principles of the Charter of the United Nations, we read: “The spread of information and communications technology and global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies… By 2030, substantially increase the number of youth and adults who have relevant skills, …substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries,…” (Agenda 2030).

Sharing and collaboration become more difficult to manage when institutions are placed in distant locations. In these cases, the technologies are powerful and effective tools for cooperative work and the Cloud is a widespread methodology for managing the administration of educational institutions: the electronic register, which is also accessible to students and parents, database files and material sharing in the various departments are all in cloud mode. The use of these powerful tools for sharing in educational activities is much less widespread even if it could become extremely powerful. In fact, with Cloud Computing, teachers and students may implement collaborative learning thanks to the use of archiving, exchange, and online document editing (Alabbadi,2011), (Dmitriev et al., 2012), (Sultan, 2010). Generic software, like Google Apps for Education or Microsoft Office, offers online productivity applications such as word processing, spreadsheets and functions that can be

used in the classroom (Bennett, Pence, 2011), (Bonham, 2011), (Nevin, 2009) (Rienzo, Han, 2009). This provides to work and share progresses or results in real-time. Cloud services become a powerful architecture for performing complex large-scale computing tasks and a wide range of IT functions, from archiving to computing, database and application services. The cloud is also convenient for teachers as it does not require complex software operations, it is enough to connect to a web browser and learn simple instructions to access shared platforms. It is even economical because last-generation software is used without having to buy it. The schools are very sensitive to this theme because of the scarce economic resources available, so the business model of sharing through the cloud may offer excellent insights into the world of school and, even if it has only been talked about for a few years, it is not a recent idea (Baldassarre, 2018), (Katiyar, 2018).

In our research-work, we choose the Cloud platform as a privileged tool for the development of a teaching model that is oriented to a cooperative-metacognitive approach that encourages students to improve study and learning strategies, the management of variables involved in the construction of their knowledge, the social mediation and positive interdependence. The elaboration of students' responses to the experiential stimuli favored by teachers, highlights the production of skills in individual cognitive potentialities that are particularly enriched by the exchange in different school contexts. As Vygotskij (Vygotskij, 1934) argues, cognitive development theory focuses on the important contributions made by society to individual development. This theory emphasizes the interaction between developing individuals and the culture in which they live and considers human learning as a social process. Therefore, social interaction between students is effective for developing skills and strategies and the interaction between students and teachers is fundamental for cognitive development since teachers are more competent people in different contexts.

The choice of the theme for the laboratory activities is linked to the desire to develop the entire relationship between language and thought in the various areas of knowledge and with different communication channels. The narrative book with mathematical content has been deepened, analyzed in the various literary and scientific fields, dissected and subsequently reconstructed to be reproduced in the context of a video game (with various narrative moments in the form of a short cartoon). The whole process was developed through a careful analysis of the different languages to be used in different contexts. The contents of the book, as cultural mediators, have also been developed through the use of various languages and this led students to enhance critical thinking through processes of analysis and synthesis at a high level of skills.

The decision to remotely share the materials on the platform led students to improve digital skills with a specific language; the need to discuss via the web about the choices to be implemented for the activities, required the commitment of the students to pay particular attention to reciprocal communications to avoid misunderstandings in the activities to be

carried out. The development of computer works close to the habits and lifestyles of youths led them to acquire transversal skills and experiences without a specific added effort.

2. Cloud Computing, a powerful didactical tool to develop transversal skills

2.1. The background: the project "Mathematical High School"

The "Mathematical High School Project" (MHS) is a project developed by the Department of Mathematics of the University of Salerno in 2015 in collaboration with several Departments of the same University. Currently, the project has expanded nationwide and involves 26 universities and over 160 high schools. The activities are developed during extracurricular hours and are presented in collaboration between university researchers and teachers of the schools involved. The MHS activities aim at building interdisciplinary skills that go beyond the fragmentation of knowledge into the various school subjects and make use of the full potential of technology in the educational domain by exploring innovative experimental paths (Tortoriello, Veronesi, 2021), (Bimonte et al., 2022). Mathematics becomes the universal language that is declined in various areas and is the link between the two cultures, the humanistic and the scientific ones (Rogora, Tortoriello, 2021). The digital platforms that facilitate the sharing of materials have opened up new avenues for fostering collaborative networks between universities and schools, thereby enabling a more comprehensive and inclusive approach to collaboration. This has resulted in the creation of diverse pathways in MHS schools that emphasize the use of innovative technologies to promote an interdisciplinary approach underpinned by constructivist pedagogy.

2.2. Our research – a "digital storytelling" experience

In this paragraph, we report the experience of an activity developed within the MHS project starting from the school year 2017/18. In that year the project envisaged the participation of university researchers, school teachers of Italian literature, Math and Computer Science and four 10th-grade classes from MHS schools located in different cities in South Italy. About eighty students participated in the activities.

The aim of the Laboratory was to develop an interdisciplinary path between literature and mathematics through the reading of famous books that dealt with mathematical ideas and contents in narrative form, to transform the plots into a serious game with enigmas and mathematical riddles to overcome the levels and continue the narration of the stories. In this way, mathematical literary contents and computer skills become both the object of the study and the development tool of a path that is certainly fascinating and captivating for students. The researchers divided the activities to be carried out among schools to develop the video game with the Skretch software, choosing for each school the best area in which to produce materials consistent with what has been done in the activities of the MHS. In particular, a

group of students choose within the plot of the book which moments to develop in the activity, another group of students developed the backgrounds and the play environments, and the last group of students built the actions on the characters designed by students from other groups. Upstream of computer programming activities, students with their Italian literature professors read books that had become a curricular subject of teaching activities. In the various passages with references to geometry and mathematics, mathematics teachers joined colleagues realizing activities in didactic cooperation designed by the teaching team through online meetings and sharing of material and exchange of ideas on Cloud platforms.

The books, in the form of a fictionalized adventure, deal with many maths topics that students face in their school curriculum of the upper two-year course and which have been the starting point for developing collaborative didactic laboratory activities and for designing skills tests to advance in the educational game path. In a meeting on an online platform, the researchers and teachers of the schools shared a development plan for the entire course. Firstly, the cultural moments of the educational path were outlined: the reading of the book in class, the discussion of the mathematical themes addressed and the use of the language used by the authors, the synthesis of the contents of the book reworked as the plot of a video game. Subsequently, the scanning of the contents to be developed for each group of students and the realization times of the various components of the videogame were defined.

Students worked under the supervision of their teachers, who provided them with help and support following the schema:

Step 1: brainstorming - The first phase of the activity was dedicated to reading books in Italian, including "What is the name of this book?" (Raymond Smullyan), "The Parrot Theorem" (Denis Guedj), "A Tangled Tale" (Lewis Carroll). During the teaching activity in the classroom, the teachers created working groups in which the students deepened the analysis of the texts, focusing on the characterizing passages and subsequently the reduction of the plot in the form of video game levels

Step 2: creating scenes - In this step, whose duration is 2 weeks, the students worked on the direction and screenplay: they wrote the storyboard, built the sequences and described the contents and scenarios of the various levels. The activities have been organized as follows: during the curricular time, in the classes, teachers helped their students to arrange their ideas, write the storyboard and organize the story sequences; at home, students collaborated in writing scenes using cloud resourcing and storing them in a repository on a shared drive. Periodically teachers organized online briefings with students to verify the work in progress.

The skills that the students had to put in place in this didactic moment consisted precisely of the use of language. They had to read books and narrative texts with numerous mathematical references recalled with rigorous sectorial vocabulary. They then had to synthesize the plot, break it down into sequences and define the main ones to be selected. For the design and

development of the video game, they had to rework the texts transforming them into short dialogues in a theatrical readjustment. All this had to happen without losing the plot of the book, thus keeping the product rich in content but fluid in its playability to stimulate interest in the mathematical contents of the game. Obviously, the answers to questions, riddles and route choices can be found right in the book mentioned so players are encouraged to read or re-read the book in the various steps to look for key clues that allow progress in the game levels. We chose to use narrative text because it is widely used in literature as a powerful tool to implement the achievement of mathematical objectives, now it is common practice to contextualize mathematical problems in contexts of reality that are perceived as less "abstract" and closer to the fields experience and knowledge of the students and thus diminishes the fear of trial and evaluation. Students also demonstrate that coordinated logical-mathematical thinking and narrative thinking cooperate more effectively through the narrative tool because intuition and creativity make it possible to convey arguments that are subsequently structured with the formal rigor of the scientific sphere through a rational analytical development.

Step 3: creating the digital story - In this phase, lasting about a month, under the guidance of teachers and researchers developed the video game with the Scratch software using the materials that had been produced in advance and saved in Drive, then created the scripts of the various phases and the various levels of the game, processed the backgrounds with the scenes, built the characters adding the music and videos. They developed the activity so that the player is the protagonist that advances in the game through challenges to be solved with different skills: cultural and scientific skills, mathematical logical skills, speed and dexterity, visual and spatial memory exercises and logical reasoning.

Figure 1. Two scenes from the digital story

Step 4: presentation - The presentation of the work took place at two different times. First, in each school involved in the project, the teachers of the classes organized a seminar in which the students presented the video game they had produced to other boys and girls of their Institute. Subsequently, during the National Seminar of Mathematical High Schools at the University of Salerno a workshop was organized in which students presented to their peers (with a “Peer-to-peer” education model) and subsequently to the teachers who attended the conference (with a “flipped classroom” approach) the activities they had carried out and the result they had obtained, that is the videogame.

3. Conclusions

In our educational path, we have chosen to develop a constructivist learning model which through the use of technologies has intended to develop interdisciplinary paths with close interconnections between the mathematical area and the humanistic area in which students have been made protagonists of their process of learning both as videogame directors and developers and as gamers. We also wanted to develop a collaboration path between students from different schools and cities through cloud computing platforms to create virtuous connections and circuits for sharing good educational practices. since this path was started two years before the covid forced us to carry out distance learning, we believe that it was a far-sighted starting point for the development of the mathematical high school.

In this paper, after a careful examination of the various definitions of cloud computing and an introduction to the implementation of cloud computing in education, the digital storytelling activity carried out with crowdsourcing and cloud techniques is presented. the use of a constructivist approach enhanced with technologies has shown that the participation of students and the quality of the video game as the final product of the course were qualitatively excellent thanks to the use of the cloud and the sharing of results step by step, above all, the students' skills on the topics addressed are superior to those obtainable with traditional teaching. According to teachers' support, we can conclude that this model allows students to learn by doing, enriching the path with active participation.

The experimental laboratory offered teachers and researchers the opportunity to observe the didactic impact on students. Various aspects emerged that deserve emphasis:

- The path develops in the literary, mathematical and computer fields and allowed each participant to deepen the topics covered by choosing the cultural environment most congenial to their study preferences, so each student has always felt involved and interested having been able to evaluate how to work in the project;
- The students worked in groups within their class and compared with other classes interacting thanks to the cloud for sharing materials and remote online meetings. This allowed them to develop soft skills such as communication, respect for other points of view, team collaboration, designing with teamwork through the sharing of skills and expertise;
- The choice to center the entire project around the construction of a Scratch videogame allowed to convey information and knowledge of less attractive disciplines such as mathematics and literature through the semiotic mediation of the artifact in the interaction of tools, methods and languages that enabled the strengthening of students' skills in an interdisciplinary key.

The activities did not include a formalized assessment mechanism to stimulate students' participation. The reports generated by the students at the completion of the project indicate

a profound sense of contentment with the activities undertaken, evincing a strong inclination towards future participation in similar ventures.

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