UNIVERSITÀ DEGLI STUDI DI SALERNO

DIPARTIMENTO DI MATEMATICA

Corso di Dottorato in Matematica, Fisica ed Applicazioni

XXXIV Ciclo

TESI DI DOTTORATO IN MATEMATICA

The use of technologies in Mathematics Education

research paths in the "Mathematical High School" Project

RELAZIONE DI SINTESI

Relatore

Ch.mo Prof. Francesco Saverio Tortoriello

Candidata

Dott. Ilaria Veronesi

Anno Accademico 2021/2022

Abstract

In the last twenty years the school has been hit by a succession of disruptive and unknown innovations. In particular, there is institutional talk for the first time of ascertaining competences in DPR 323-98 (reform of the state examinations of secondary school). Leaving aside the various indications that have followed one another very quickly, in the Regulations for the Reorganization of Higher Institutes (DPR 87, 88 and 89 of 2010) a disciplinary system centered on competences is envisaged, followed by the relative ministerial indications. Finally, we come to the much-discussed Law 107 of 2015 in which it is provided that the activity of School-Work Alternation is extended to all three-year courses of high schools.

The PNSD states that "digital technologies intervene to support all dimensions of transversal skills. But they also fit vertically, as part of the literacy of our time and fundamental skills for a full, active and informed citizenship", as anticipated by the Recommendation of the European Parliament and the Council of Europe and as even better emphasized by frameworks such as the 21st Century Skills, promoted by the "World Economic Forum" (Bellanca 2010).

In fact, the S.T.E.M. curriculum incorporates the "four C's" of 21st-century skills: creativity, critical thinking, collaboration and communication. Students work together to create innovative solutions to real-world problems and communicate their solutions with others. As they carry out their investigations and projects, they must access, analyze, and use the information they need to complete the learning tasks. While working through the task, students build important life and career skills by learning to manage their time, to become self-directed workers and to collaborate effectively with others. Using appropriate technology tools to complete their task, students discover the most effective and efficient ways to access and manage the world of digital information that is available to them (Beers 2011).

The importance of new skills not included in the traditional school curricula was highlighted in numerous teaching conferences where it was emphasized that "Exemplary science education can offer a rich context for developing many 21st-century skills, such as critical thinking, problem-solving, and information literacy. These skills not only contribute to a well-prepared workforce of the future but also give all individuals life skills that help them succeed." (NSTA 2011)

The choice of the research group in mathematics education of the Department of Mathematics of the University of Salerno to develop educational paths that exploit the potential of technological tools for the training of teachers and laboratory activities for students of upper secondary school, is the natural

evolution of an educational Didactic Design aimed at developing models and paths that can be proposed in the classroom thanks to the help of new technologies.

The research group has been involved for years in updating the teaching of mathematics by bringing to the center of educational choices the close interconnection between the various disciplines and in particular the role of mathematics as a bridge between the two cultures, the scientific and the humanistic. In this interdisciplinary key that aims to become transdisciplinary, new technologies have the important task of allowing the reworking of in-depth paths on the various curricular themes through a laboratory activity and in particular experimental research.
This vision of mathematics as a link between the various cultural areas and new technologies as the key to activating these interconnections, led the didactic research group in mathematics of Salerno to develop numerous training proposals at various levels.
My research project in mathematics teaching aimed to

- deepen the interrelationships of mathematics with other disciplinary areas,
- prepare both informative and technical teaching material, both in the traditional format of dossiers and handouts
- organize and structure educational paths for skills that provide for the presence of "mathematics with...", or not monothematic paths where mathematics is linked to physics and chemistry, but transdisciplinar paths that tie mathematics to all the disciplines of the curriculum. In particular, the importance of mathematics in various historical contexts, in philosophical processes, interconnections with literature, art, music, religions, sport...
- implement the use of new technologies and new learning processes also thanks to dedicated hardware and software. Young people are commonly called "digital natives", they are used to living with computer technology much more than previous generations and it is appropriate that they also find it in study paths, in order to learn that even non-"dedicated" tools can be portable laboratories (exactly as twenty years ago scientific calculators supplanted logarithmic and trigonometric tables ...). Inevitably the future will lead to an increasingly pushed and exasperated use. It therefore becomes essential that the world of education uses and makes its own the available tools and transforms them into an "accelerator of interest": only if teachers and students speak the same language, they can communicate.

The extraordinary upheaval that the school world has undergone in the last two years in light of the effects of the Covid-19 pandemic and the consequent lockdowns, has strengthened and accelerated the affirmation of an unprecedented level of distance learning. The lockdowns have further pushed my research in a direction of predisposition to design a series of activities developed on-line for

teaching implemented with the use of technologies, also thanks to the aid of e-learning platforms for distance learning.

During my PhD I have been involved in many activities carried out by the research group in mathematics teaching of the DIPMAT of UNISA. The paths that I have developed in my doctoral course have been inserted curricularly into the activities that are carried out in the Mathematical High School, implement the activities already structured with new paths strongly based on the use of technologies in teaching and are currently in the teaching calendar of schools. With a view to sharing good practices to develop a collaborative network, some aspects of the activities that will be described and analyzed in depth in this thesis have been presented in national and international mathematics education conferences and are published in the proceedings.

I mainly dealt with three research subjects:

- mathematics with graphic calculators, a path of heuristic exploration of mathematical concepts through different learning channels, the numerical, graphic, analytical, tabular approach developed in the classes of the Mathematical High Schools with observations on the impact on students' learning levels thanks to an active teachers' training model in a research project DIPMAT UNISA-CASIO ITALIA (chapter 3)
- mathematics and economics as a language to understand and explain a real-life problem, in a collaboration DIPMAT-DISES UNISA. In particular, the research deal with the issue of solving an economic problem using not only real analysis instruments but also geometrical topics concerning in particular Euclidean geometry and topology implemented by the use of online platforms and dedicated mathematical software such as dynamic geometry software and computer simulations (chapter 4)
- the role of semiotic mediators of mathematical knowledge played by the tools in the astroparticles physics research, and the preparation of paths dedicated to teachers in the OCRA project of INFN which was followed by a path dedicated to the analysis of cosmic rays in the classes of "Mathematical High School" Project with the use of the CRC (cosmic Ray Cube) in collaboration INFN Naples-DIPMAT UNISA (chapter 5)