POLITECNICO DI MILANO

PhD in MODELLI E METODI MATEMATICI PER L'INGEGNERIA / MATHEMATICAL MODELS AND METHODS IN ENGINEERING - 40th cycle

PNRR 629 PA Research Field: ENHANCE TEACHING AND LEARNING STEM TOPICS WITH EMERGING TECHNOLOGIES

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The school system is one of the most delicate ones. Last years have witnessed that the huge majority of schools are not ready to respond properly and promptly to the changes, despite a lot of effort the managers, the teachers, the staff and the students put in.After the pandemic, schools were pushed to renovate their structures and facilities to boost the digital transition. However, as happened at the beginning of the century, the schools are not yet ready to exploit and resort emerging technologies to improve and innovate education. The main risk today is that schools will renovate their laboratories without the proper tools and competencies to work with and within those. As an example, many schools have been equipped with VR and even immersive rooms, but teachers are still looking for a way they exploit these emerging technologies for teaching STEM effectively, in particular mathematics and physics. This research aims at addressing such a need, developing processes and practices which enhance the management of the class and the resources as well as the wider competence of interpreting the continuous variation of the local and global variables, such as emerging technologies and students' needs.
Methods and techniques that will be developed and used to carry out the research	To deal with such a challenge, the main idea is to consider the school as a complex system composed of

three different kinds of agents: the students, the teachers and instructors, and the administration and the stakeholders, characterized by their own cognitive and not-cognitive variables (e.g., goals and orientations). The candidate will model the interaction between and among the three agents combining the Instrumental genesis and the Practice-Belief-Knowledge model within the thinking classroom perspective. Moreover, the candidate will integrate such a model within the Student Opinion Dynamics model. More precisely, this research focuses on the characterization of the Thinking Classroom and the understanding of the dynamics that arise within groups, which depend on both cognitive and affective factors, through the lens of IG and PBK. Then, the extension to the whole domain (i.e., the school) is required. To that end, this research project wants to develop and experimentally verify a model that can quantify the impact of cooperation on designing, teaching and learning STEM disciplines with emerging technologies. The research unfolds according to the Design-Based Research:

- Model the agents' interactions resorting to both cognitive and affective.
- Quantify the proprieties of a Thinking School with respect to the previous model
- Analyze the condition that can bring a school towards a Thinking School
- Enrich the model for Student Opinion Dynamics with the evolution of non-cognitive factors (such as perceived self-efficacy)
- Set up a quasi-experiment with small classes (e.g., school classes) to collect data for validating the two models
- Design mathematical and physical practices and carry out group work activities within the quasi-experiment
- Identify the practices and the process which foster and stuck the evolution towards the Thinking School
- Validate and tune the model
- Carry out a training session for teachers and stakeholders

The research is characterized by a quasi-experiment methodological approach which can be employed using either qualitative or quantitative and mixed methods.

	Moreover, the candidate will work also with the Department of Physics as concerns the practices related to such a discipline, and will spent 6 months within an Italian school (Istituto di Istruzione Superiore "Taramelli - Foscolo" Pavia)
Educational objectives	This research focuses on innovative models and methods in education facing interdisciplinary challenges in the context of mathematics and physics education, and school managing.
Job opportunities	The research activity addresses innovative topics at thefrontier of education and applied mathematics. The PhD candidate will develop mathematical, managing, and teaching skills which can be used both in academic research and education field.
Composition of the research group	0 Full Professors 2 Associated Professors 1 Assistant Professors 0 PhD Students
Name of the research directors	Proff. Domenico Savio Brunetto, Maurizio Zani

Contacts
domenico.brunetto@polimi.it

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	
By number of months abroad	6

POLITECNICO DI MILANO

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): financial aid per PhD student per year   1st year: max 1.902,40 euros   2nd year: max 1.902,40euros   3rd year: max 1.902,40 euros.   The PhD students are encouraged to take part in activities related to teaching, within the limits allowed by the regulations.1 individual PC per student +several shared PC. Access to one cluster with 32 processors and 384 GB RAM, and to several multi-processor servers.