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The MathE Project: Effective Teaching of Mathematics

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Abstract

The article is a study based on MathE (Improve Math Skills in Higher Education) project coordinated by Pixel (Italy) in cooperation with technical universities and educational centres from Ireland, Lithuania, Portugal and Romania. The project is funded by the European Commission under the Erasmus+ Programme, KA2 - Strategic Partnerships for Higher Education. The project's idea stems from the fact that university students studying science and economics often lack the basic maths skills to effectively follow their lectures. The partnership has collaborated in this respect to find the most effective solutions and to prepare students for a world where mathematics is of central importance and extensively applied to diverse fields. The project aims to help teachers identify their students' gaps and to provide mathematics teachers with the necessary teaching sources so that they can help their students to overcome existing gaps. The article presents the project's main objectives, activities and outputs. It gives insights into the project's research and focuses on the effective instructional approaches used by teachers of mathematics to meet the diverse learning needs of their students.

Keywords: *mathematics, students, research, collaboration, teaching methods;*

1. Context

At the dawn of the fourth industrial revolution characterised by an unprecedented development of science and technology Europe is facing a paradoxical challenge: students, even higher education students studying scientific and economics subjects such as engineering and Economics, often lack the basic maths skills to effectively follow their lectures. It is imperative to find the most effective solutions and to prepare students for a world where mathematics is of central importance and extensively applied to diverse fields. The MathE (Improve Math Skills in Higher Education) project aims to help teachers to identify their students' gaps and to provide mathematics teachers with the necessary teaching resources so that they can help their students to overcome existing gaps.

2. The MathE project: its objectives, target groups and activities

The main goal of the MathE project is to enhance the quality of teaching mathematics by encouraging the use of digital technologies as well setting up transnational teacher training courses and strengthening cooperation between teacher training universities.
The specific objectives are:

- To identify students' gaps in the knowledge of maths so that they effectively attend their courses
- To provide Math teachers with the necessary teaching resources so that they can help their students to overcome existing gaps
- To enhance a transnational sharing of teaching resources, tools and strategies in the field of Mathematics teaching and learning at higher education level

The MathE project addresses the following target groups: higher education students and mathematics teachers. From the student's point of view, the MathE project will stimulate students' motivation to study mathematics and make the best use of digital educational resources to increase their mathematical knowledge.
From the teacher's point of view, the MathE project promotes digital educational tools for the classroom, provides teachers with resources for the evaluation of students' progress in learning mathematics and also offers them evaluation and assessment tools; the platform enables discussion among teachers and researchers about good practices in teaching/learning mathematics.

3. The MathE project's research in Romania and its findings

The MathE project's research used interviews and data collection questionnaires, carried out on the people (academics and teachers) participating in the project. The interviews and questionnaires were administered at the beginning of the MathE project: 25 persons from the mathematics and engineering departments of the "Gheorghe Asachi" Technical University of Iasi and teachers from several high schools in Iasi. The group was treated as a whole and the answers were interpreted qualitatively. The focus was on the main methods teachers used in their work with their students. The teachers were encouraged to highlight the benefits and drawbacks of their teaching approaches.

All teachers participating in the interviews and questionnaire agree that traditional methods are still widely used in teaching mathematics in higher education; those methods are non-interactive: the student is the receiver of what the teacher lectures. Traditional approaches are rooted in theory and do not meet most students' needs. Teaching mathematics is abstract and decontextualized based on memorization and drills. Thus, the teacher explains an abstract concept, writes exercises on the blackboard and asks the students to copy them down. After that the students solve exercises. The students are rarely taught how to apply their knowledge into practice [1]. However, respondents also state that new tendencies have emerged recently which demand the introduction of innovative pedagogical approaches which encourage students' conceptual understanding. The new approaches follow the main principles of constructivist theory: learning is a student-centred process; students' autonomy is fostered; learning should be contextualised and connected with the real-world; social interaction and discourse is part of learning; the new knowledge should be made relevant to the learner and linked with the learners' previous knowledge. Learning becomes an active process in which the learner is deeply involved; learning becomes a process of constructing knowledge by students themselves [2]. According to constructivist learning theory, knowledge is constructed as students integrate new information into their previous knowledge base.

The research has identified the following teaching methods: lecture method, inductive-deductive method, heuristic method (discovery/inquiry method), analytical-synthetic method, project method, brain storming and Think-Pair-Share method. Most teachers use all methods depending on the content, context or students.

Ten academics state that the lecture method is the most widely used form of presentation. They agree that this method addresses small and large groups and can be used to introduce new topics, summarize ideas, show relationships between theory and practice, highlight main points, etc. However, they all draw attention towards its limitations: students have a passive role as it encourages one-way of communication: teacher's lecture; therefore, the lecturer may find it difficult to perceive students'problems and realize how much students have understood from the lecture.

Nine interviewees stress that the inductive-deductive methods they use stir students' interest by resorting toexperiences and discoveries. This method develops independence and self-confidence in the students who discover the solution themselves.

The majority of respondents note that the heuristic method (discovery/inquiry method) allows students to lead and control their own learning experiences. The teacher acts like a facilitator and a guide. He/she is a resource person facilitating learning by stimulating or motivating students, clarifying and explaining. The learning atmosphere is relaxing and non-threatening.Students become active participants who solve problems they understand bystructuring their own learningexperiences. Respondents also agree that it is a time-consuming method.

Fifteen respondents consider that the problem-based method is one of the most popular methods among students. Learning relies on organizing problem situations, defining problems, helping and guiding students to solve the problems, checking solutions and managing the process of systematizing and reinforcing the required knowledge. The problem-solving method enhances critical thinking.

The project method is another popular method as it promotes interaction among the students. It gives students an opportunity to work in a team and apply theoretical knowledge they learned in the classroom to meaningful contexts.

Analysis and synthesis methods complement each other and in the teaching of mathematics, the two should always go together. Generally, analysis is the procedure by which we break down an intellectual or substantial entity into its main components, parts or elements. Synthesis is the opposite procedure: we combine separate parts, elements or components in order to form or to reconstruct a coherent entity.

Educational games are by far the most popular. They centre around a problematic situation, which can offer students pleasant learning opportunities by engaging them in panel discussion, simulation, drama, etc. Games prepare students for life by ascribing different social roles to them and by exposing

them to environmental phenomena which require deep analysis of various situations. A few teachers use analogies as teaching and learning strategies because they create nice atmosphere, are flexible, memorable and ease of use. An analogy is a comparison between two things. Academic analogies are useful for teaching and learning because they require students to examine and analyze things and thenthey have to transfer that analysis to another thing. This kind of transfer requires conceptual understanding [3].

Think-Pair-Share, the technique encourages students to think about a question or an issue (Think) on their own, and then discuss their work with their deskmate (Pair). Finally they have to report to class their findings (Share). Students appreciate the opportunity to test out ideas in a safe nonjudgemental environment. The last stage stimulates discussions: students share their variety of opinions and ideas in a relaxing an dstimulating atmosphere.

The learning by doing method enables students to see science, engineering 'in action'. Math is often thought of as reying on memorization of formulas and practicing skills. However, the test comes when students do not remember these formulas and have to reconstruct them. Students often use manipulatives to solve problems. All teachers agree that they systematically integrate the use of concrete and digital manipulatives into their classes because they help students to make connections between concrete manipulatives and abstract mathematical ideas. Manipulatives can support student learning by helping students create links between theory and practice, abstract and real things.

All respondents state that there is no specific teaching method that leads to successful teaching of mathematics; they agree that there is a variety of methods of teaching which can be used in different classes depending on several factors such as: the sizes of the classes, students' ages needs and interests. All the above mentioned methods may not be equally appropriate and suitable for all levels of mathematics teaching. The teacher should feel comfortable with all these methods, their advantages and drawbacks and should adopt methods which ensure maximum participation of students [4].

4. Conclusions

The teacher and the student are partners in the teaching/learning process and are both equally responsible for the results of joint work and effort [2]. The teacher facilitates students' comprehension of the new material. To this end s/he connects the new knowledge to what students know and helps students to relate and apply it to their context (personal, family and community experiences). Contextualization of a course's content and concepts can improve student motivation and learning. Students understand the new knowledge as it is relevant to their context. These connections consolidate and make newly acquired knowledge meaningful and increase student engagement with learning activities. Effective teaching demonstrates that abstractions are rooted in and applied to the everyday world. Relating abstract knowledge to daily life helps students to retain information better. In the new teaching approaches the teacher and the student take on new roles. Thus, students become active participants, responsible for their learning process. The teacher is no longer the only knowledgeable authority; s/he is a guide, a facilitator, an advisor and an organizer. S/he is versatile with all teaching and learning methods but s/he knows that s/he has to embrace and adapt those methods which stimulate his/ her students' participation in his classes [5].

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