A NEW MODEL DESIGN TO IMPROVE MATHEMATICAL LITERACY: A DUAL FOCUS TEACHING MODEL

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In this study, a new teaching model for mathematics teaching, called Dual Focused Teaching Model, is introduced. This teaching model aims to educate individuals who have high mathematical literacy in accordance with learning theories in mathematics teaching. In the first focus of the model, there are activities in which concepts and generalizations are acquired, skills are developed, and students share their responsibilities in their own learning. The second focus is the stage in which the acquired concepts and generalizations are reinforced and applications are made. At this focus, there are mathematical literacy questions and practices in which knowledge is transformed into skills. The common point of both focuses is that the studies are carried out with the active participation of the students through activities. The dual-focused teaching model was introduced to middle school mathematics teachers within the scope of a project supported by TUBITAK (The Scientific and Technological Research Council of Turkey), lesson modules suitable for the model were prepared and applications continue with students.

INTRODUCTION

The fact that many countries, while revising their curricula, take the results of PISA assessments to measure mathematics and science literacy and native language skills (Breakspear, 2012) reveals the importance of the development of mathematical literacy skills in mathematics teaching. As a reflection of this situation, the first of the special objectives of the Primary Education Mathematics Curriculum, which was put into practice in Turkey, in 2018, is "The student will be able to develop and effectively use mathematical literacy skills." (MoNE, 2018). Mathematical literacy competencies were widely embedded in other items among the objectives.

This situation led to the need to consider mathematics teaching with all its components (content, teaching methods and techniques, measurement and evaluation activities) as a whole and make it suitable for developing Mathematical Literacy. The project "Increasing Mathematical Literacy through Dual Focused Instruction" is based on this need. The subject of the project is to develop, apply and evaluate the results of the "Dual Focused Teaching Model" designed to consider and develop Mathematical Literacy with its competencies, knowledge and skills.

Although the learning process in mathematics teaching is divided into many steps, especially two points seems critical. One is the acquisition of the concept or generalization and the other is its reinforcement and application.

Both constructivist learning theory and RME are both based on starting the teaching of concepts or generalizations with a chosen problem or activity. The solution of this problem or the elimination of mental confusion in the activity takes place in the exploratory step in constructivist learning, and in the mathematical process in accordance with the principle of "guided reinvention" in RME (Gravemeijer, 1994). After that, it consists of explaining the result reached. We can realize the concepts or generalizations that we aim to teach by selecting the appropriate one of these two ways. So the first critical point is discovery. The elimination of the fragility and reinforcement of the learned knowledge takes place in the deepening step in constructivist learning, and in the vertical mathematization process in RME. So the second critical point is the implementation. The other detail consists of an evaluation and explanation of the result obtained. Teaching can be considered as a process that takes these two critical points as a focus and gain detail. Due to the emergence and teaching of these two critical points, this teaching model has been named as dual focused teaching model. The functions and different aspects of the foci can be summarized as follows.

Mathematics lessons have two main objectives on a subject basis. These are;

- Creating a concept or generalization and gaining skills
- Elimination and deepening of the fragility of the concept or generalization, the reinforcement of skills and the inclusion of vital practices.

The dual-focused teaching model is a model that highlights these two points in line with learning theories and is based on developing teaching around these two focal points, and the functions of focuses and the differences between them can be explained as follows.

The first focus

The first focus consists of studies in which the students have the learning process, the concept or generalization is gained through the teaching activities in which their own learning is shared with the responsibilities, and skills are developed (Altun, 2020). The activity here, unlike some operations performed one after the other in the lesson, are applied exercises that contain a mental confusion and include flexible thinking, expressing one's thoughts, defending and discussing in order to remove this confusion. The selection of activities is made in accordance with the nature of the concept and generalization being taught. The biggest difference between traditional teaching and teaching in the first focus is that Realistic Mathematics Education (RME) is based on constructivist teaching in teaching design related to the acquisition of concepts and generalizations. In addition, the RBC + C model, which consists of the steps of Recognizing, Building-with, Constructing and Consolidation in the abstraction of mathematical knowledge, is taken into account as a basic reference in teaching (Dreyfus et al., 2001). It is expected that activities at this stage, whether suitable for RME or in accordance with the constructivist theory, will naturally lead to the emergence of Mathematical Literacy competencies, with their characteristics that allow students to produce ideas and discuss each other's thoughts. Either in accordance with RME or with a constructivist approach, the activities at this stage provide a suitable environment for the natural emergence of mathematical competencies with the features that allow students to produce ideas and discuss each other's thoughts. In the activities, it is essential that the students freely work and choose the ways and methods themselves in order to deal with the determined tasks. The term semi-structured finds its full meaning in the realization of these

activities. Here, the risk arises when students are not interested in the activity, and this risk can be reduced by qualified design of teaching activities and planning alternative activities. At this stage, there are also questions that will require reflection on concepts and will enable "deepening of conceptual understanding".

Second focus

The second focus is the stage in which the acquired concepts and generalizations are reinforced and deepened. When mathematical concepts and generalizations are introduced, they become fragile (Dreyfus et al., 2001). In traditional teaching, the dominant behavior for this stage is solving exercises in the textbooks. In this focus, real life problems and practices that require the use of learned knowledge and skills are included in addition to exercises. Questions that require *using mathematics in making vital decisions or making a suggestion for a decision to be made* are included, which are hardly included in the national textbooks. The intention of using mathematics in decision making is to include questions that require modeling in social areas in this focus. In summary, this stage consists of exercises, mathematical literacy problems and practices. The first of these three actions is performed in traditional teaching. In the proposed model, by including mathematical literacy problems and vital practices in the second focus, the integration of knowledge with skills, and accordingly, the strengthening of belief in the necessity of knowledge and the internalization of knowledge are guaranteed. Using the knowledge gained in the production of another knowledge is a valuable work in terms of meeting reinforcement expectations. For example, similarity relations are used in triangles to acquire Euclidean relations in right triangle and this study reinforces and deepens the similarity relations (Altun, 2020).

This stage, which requires intensive preparation in course design, leads to the acquisition of competences explained in Niss (2003) (representing mathematical entities; handling mathematical symbols and formalisms; communicating in, with, and about mathematics and making use of aids and tools) with the implementation of the applications. In addition, since these studies will reveal the benefits of the learned knowledge in life, they develop the sense of value against mathematics and it causes the question "why do we learn this?" to disappear spontaneously. It is important to conduct semi-structured studies that will allow students to explain their own thoughts easily in the teaching conducted in both focal points. Once a discussion begins, the time allocated to the discussion should not be limited, and the discussion should be waited for fading in order to summarize the issue.

Studies in both focuses on a subject can fit into the same lesson hour, sometimes studies in one focus can fill one lesson hour, and studies in the other focus may require for another lesson hour / hours.

Framework for Lesson Plan Flow Suitable for Dual Focused Instruction

Subject Title (Duration)

Benefits

Focus I

- Gaining concepts or generalizations (Constructivist Theory, RME, work on problems or activity)

- Questions to improve conceptual understanding

Focus II

- Reinforcement and deepening of the concept and generalization
- Math literacy questions
- Applications
- Assignments defined outside of the course
- Exercises and questions in textbooks

The dual-focused teaching model introduced in this study has been implemented within the scope of a project supported by The Scientific and Technological Research Council of Turkey (TUBITAK). In the first step of the project, the model was introduced to 32 middle school mathematics teachers with in-service training. Under the leadership of the researchers, teaching modules suitable for the model were developed. The project is currently in the process of implementing teachers' modules in their classrooms and is expected to be completed at the end of one year.

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