

Holistic Approach to Teaching Mathematics in Secondary School as a Means of Improving Students' Comprehension of Study Material

Authors : Natalia Podkhodova, Olga Sheremeteva, Mariia Soldaeva

Abstract : Creating favorable conditions for students' comprehension of mathematical content is one of the primary problems in teaching mathematics in secondary school. Psychology research has demonstrated that positive comprehension becomes possible when new information becomes part of student's subjective experience and when linkages between the attributes of notions and various ways of their presentations can be established. The fact of comprehension includes the ability to build a working situational model and thus becomes an important means of solving mathematical problems. The article describes the implementation of a holistic approach to teaching mathematics designed to address the primary challenges of such teaching, specifically, the challenge of students' comprehension. This approach consists of (1) establishing links between the attributes of a notion: the sense, the meaning, and the term; (2) taking into account the components of student's subjective experience - emotional and value, contextual, procedural, communicative- during the educational process; (3) links between different ways to present mathematical information; (4) identifying and leveraging the relationships between real, perceptual and conceptual (scientific) mathematical spaces by applying real-life situational modeling. The article describes approaches to the practical use of these foundational concepts. Identifying how proposed methods and technology influence understanding of material used in teaching mathematics was the research's primary goal. The research included an experiment in which 256 secondary school students took part: 142 in the experimental group and 114 in the control group. All students in these groups had similar levels of achievement in math and studied math under the same curriculum. In the course of the experiment, comprehension of two topics - 'Derivative' and 'Trigonometric functions'- was evaluated. Control group participants were taught using traditional methods. Students in the experimental group were taught using the holistic method: under the teacher's guidance, they carried out problems designed to establish linkages between notion's characteristics, to convert information from one mode of presentation to another, as well as problems that required the ability to operate with all modes of presentation. The use of the technology that forms inter-subject notions based on linkages between perceptual, real, and conceptual mathematical spaces proved to be of special interest to the students. Results of the experiment were analyzed by presenting students in each of the groups with a final test in each of the studied topics. The test included problems that required building real situational models. Statistical analysis was used to aggregate test results. Pierson criterion was used to reveal the statistical significance of results (pass-fail the modeling test). A significant difference in results was revealed ($p < 0.001$), which allowed the authors to conclude that students in the study group showed better comprehension of mathematical information than those in the control group. Also, it was revealed (used Student's t-test) that the students of the experimental group performed reliably ($p = 0.0001$) more problems in comparison with those in the control group. The results obtained allow us to conclude that increasing comprehension and assimilation of study material took place as a result of applying implemented methods and techniques.

Keywords : comprehension of mathematical content, holistic approach to teaching mathematics in secondary school, subjective experience, technology of the formation of inter-subject notions

Conference Title : ICMET 2022 : International Conference on Mathematics Education and Technology

Conference Location : San Francisco, United States

Conference Dates : September 27-28, 2022