

## **OPENNESS OF PROBLEM SOLVING IN THE 21ST CENTURY: MATHEMATICAL OR SOCIAL?**

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Mathematics is one of the oldest disciplines for the human beings. Bishop (1988) expressed its value regarding human relationship and social institution as Openness. It means that mathematical constructs such as propositions and ideas are open to human consideration. Even before such systematization, many problems have been solved and simultaneously been created since the earliest civilizations. This effort provides us with foundation for further endeavor.

Here, what is the “Problem” in the problem-solving? The problem can be Greek construction problem, real-life problem, word problem, non-routine problem, open-ended problem, trans-scientific problem, and so on. They show such characteristics as difficulty, solution methods, and its origin. Especially in mathematics education, the open-ended approach (Shimada 1977) has been developed in Japan as a method to evaluate and grow mathematical thinking. Further, problem posing can be an extension of the problem solving. While varying problems systematically, we may be able to pose as many problems as possible, and realize the patterns among problem variations. In this sense, asking for problem posing itself can be a problem.

And what is “Solving” in the problem-solving? As there are different types and characteristics of problems, the meaning of “solving” also depends on them. In fact, the open-ended problems provide not only one solution. Socially open-ended problems provide solutions with various values. The solution can be extended to the solution process such as Kadai-gakushu (Learning through problem solving), mathematical modelling, model eliciting activities, and so on. Further, problem posing requires developing a problem and such development can be a solution. An important point here is that the meaning of solving a problem is extended beyond traditional problem solving.

This lecture explores the idea of problem-solving in mathematics to appreciate the value of openness under open science movement (OSF 2021). Open science includes openness in methodology, source, data, access, peer-reviewing, and educational resource so that not only experts but also non-experts have an access to the outputs of scientific research and participate in the research activities in various ways. This is essential for future citizen and is related to ethnical dimension of mathematics education (Ernest 2012).

### **References**

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*Last names of the authors in the order as on the paper*

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