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# Similarities and differences in problem solving: case of “exhibition grounds”

Radka Havlíčková, [David Janda](#), Derek Pilous and Veronika Tůmová

Charles University, Faculty of Education, Prague, Czech Republic; [derek.pilous@seznam.cz](mailto:derek.pilous@seznam.cz)

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## Introduction

Problem solving strategies play one of the major roles in mathematics education research in the last decades (Schoenfeld, 1992). Its importance naturally arose from teaching practice in which teachers work with solving strategies intuitively, on the basis of their own experience, without any particular theoretical framework. One of the authors made an interesting observation in his teaching: there are problems with no simple algorithmic solution and more than one solution in which both mathematically less experienced solvers and more experienced solvers find the first solution in comparable time, but the more experienced solvers are more successful and faster when finding all the solutions of the problem. Therefore, measuring of reaction time when solving such problems might capture the difference between the above groups of respondents. If it is the case, this connection could be used as a further source of information about particular heuristic strategies with implications for teaching practice and teacher preparation.

## Theoretical background

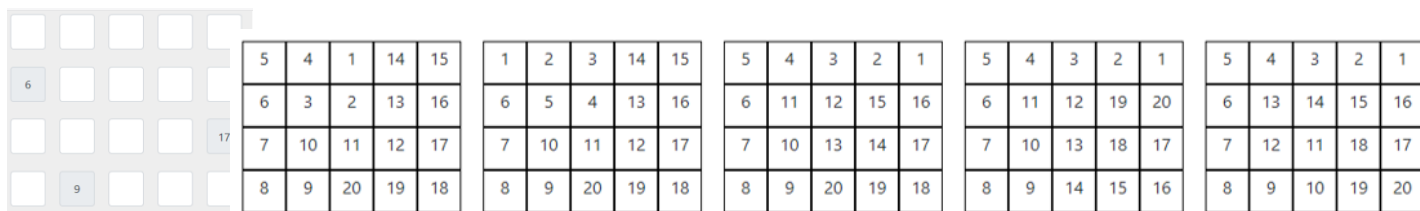
Since Polya (1957) introduced the modern conception of heuristics in mathematics education, a lot of research effort has been put into the exploration and description of possible connections between the level of mathematical knowledge and the ability to solve non-procedural problems. Problem solving process, and especially differences between more and less experienced solvers, have been examined by many authors. Lester (1994) summarized main findings in this domain when characterizing a good problem solver by five basic characteristics. We follow these findings when formulating our research questions:

1. What relationship is there between the time of finding the first solution and the time of finding all the solutions for different groups of solvers?
2. What relationship is there between parameters of the solutions such as the number of solutions, their order and multiplicity of submission, and the solver's knowledge?

## Methodology

The learning environment called *exhibition grounds* is in accordance with our motivation as it provides problems to solve with several solving strategies and more than one solution. The task is to go through all the rooms of the exhibition center. A solver records his/her way by filling numbers into the squares (see Figure 1). Each room can be passed only once. Some rooms are filled by numbers from the start which means that these rooms must be visited in a prescribed order. The start and end rooms must be on the border of the grid and one can go only left, right, up or down from one room to another. It is forbidden to jump rooms, go diagonally, go through the same room twice or leave empty rooms behind. The solution is correct when each square is numbered with

different numbers from 1 to  $m \times n$  for an exhibition ground with  $m$  rows and  $n$  columns. The exhibition ground used in the study and all correct solutions are shown in Figure 1.



**Figure 1: Exhibition ground used in the study with all the correct solutions**

The research sample consists of two groups of respondents, 49 students of general high school of age 16–17 and 28 future mathematics teachers in 1<sup>st</sup>–3<sup>rd</sup> year of their study. The sample is an opportunity one as our study was exploratory. The exhibition ground from Figure 1 was used in the study. There was no time constraint and students received no information that their reaction time is measured due to our previous findings that this kind of information can significantly influence a solver’s behavior (Pilous & Janda 2017). In total, 77 respondents submitted 305 correct solutions.

## Results and conclusions

Each respondent found at least one solution, only 15 respondents in total found all five solutions, 12 from the high school and 3 from the university. Due to the small number of solvers who found all the solutions, direct comparison as described in RQ 1 (first solution vs. all solutions) is not significant here. However, several relationships between the time of finding the first solution and the time of finding all the solutions for both groups of solvers was found. The university respondents found the first solution as well as all solutions approximately twice as fast in average as the high school respondents, but they spent less time overall on the task and found less unique solutions in average. Both groups shared a dominant order of submitted solutions, especially for the first two. We also observed similarity between series of average solving times of both groups. The significance and interpretation of this observations will be subject of a forthcoming study.

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