Available online at www.sciencedirect.com
ScienceDirect
Procedia
Social and Behavioral Sciences
Procedia - Social and Behavioral Sciences 128 (2014) 217 – 222

EPC-TKS 2013

Dynamic thinking and static thinking in problem solving: do they explain different patterns of students' answers?

Ildikó Pelczer [a], Florence Mihaela Singer [b], Cristian Voica [c]*

[a] *Concordia University, 1455 De Maisonneuve Blvd. W., Montreal, Canada*
[b] *Ploiesti University, 39 Bucuresti Bv., 100680, Ploiesti, Romania*
[c] *Bucharest University, 14 Academiei Str., 010014 Bucharest, Romania*

Abstract

We look at dynamic thinking and static thinking in relation to mathematical problem solving. We examine the distribution of answers chosen by large samples of students to multiple-choice problems. Our empirical data suggest that static thinking activated by students in problem solving is likely to be responsible for a certain pattern of students' responses, which is characterized by a uniform distribution among the choices. This finding has implications for curriculum development, as well as for the teaching practice in school.

Selection and peer-review under responsibility of Petroleum-Gas University of Ploiesti, Education Sciences Department.

Keywords: problem solving; static thinking; dynamic thinking; multiple choice problems; patterns of answers.

1. Introduction

In this paper we present empirical data regarding students' problem-solving behavior. The idea of this study started from the statistical analysis of students' responses to multiple choice problems contained in a large database. We have noticed the existence of some patterns in the distribution of students' responses. Specifically, we noticed an intriguing fact: for most problems, the correct answer or one of the distractors was chosen in a much larger proportion than the rest of the distractors, while for some few problems, the students' responses were almost evenly distributed among the distractors (the correct answer included). This latter situation led us to the question: what

* Corresponding author. Tel.: +40-021 3142863; fax: +40-021 3156990.
E-mail address: voica@gta.math.unibuc.ro

Selection and peer-review under responsibility of Petroleum-Gas University of Ploiesti, Education Sciences Department.
doi:10.1016/j.sbspro.2014.03.146

could cause this homogeneous distribution? To answer this question, we looked more carefully to both the text of those problems, and the skills required from a solver for finding the right answer. Since the correct answer option was relatively rare among students' responses, these problems seem to pose serious difficulty. As a result, a source of analysis for this category of problems can be the expert-solver, i.e. the mathematician able to develop concepts, and that led us to see this phenomenon from a historical perspective. While trying to relate the targeted problems and solutions to elements of the history of mathematics, some seemingly relevant factors emerged from kinematics. Further, these elements have highlighted differences between two specific ways of thinking: static and dynamic, which will be characterized in the next paragraph.

Static thinking or static mindset refers to a mental state that has reached certain equilibrium so that no changes are taking place. It supposes automatism of thought and action. In mathematical problem solving, such automatism of thought becomes visible when a person frequently uses standard algorithms and procedures without taking the context into account. *Dynamic thinking* or dynamic mindset involves identifying degrees of freedom in mental states. These degrees of freedom allow changes in perspective, changes in context, changes in content, etc. Dynamic thinking allows a student to "put a magnifying glass" in order to "see" some details otherwise negligible, to change the view in order to emphasize some particular situations or limit cases, to change positions of configurations that were looking to be stable, or to decompose the whole into pieces that can be rearranged. All these actions might lead to both a better understanding of the problem, and an effective way to discover the correct answer or solution strategies.

In the present paper we analyze several cases in which the percentages of students' responses are evenly distributed among all the distractors. We argue that in solving these problems, it is likely that most students have enabled static ways of thinking. This finding has implications for curriculum development, as well as for the teaching practice in school.

2. Background

Elements inherently related to the kinematics of concepts represented a boost in the discovery and development of new fields of mathematics. Thus, for example, vectors and vector spaces emerged from the study of motion in physics; calculus developed from dynamic processes of successive approximations; limits were conceptualized through imagining the variation of sequences, series, functions, etc. In this respect, the history of mathematics reveals dynamic modes of thinking that underlie important concepts (e.g. Moreno-Armella, Hegedus, & Kaput, 2008) and their development.

In the literature on mathematics teaching, static thinking and dynamic thinking are mentioned in various contexts. For example, in the construction of a concept map, functional interdependence between two concepts reveals dynamic thinking, while the relative position of concepts shows static thinking (Safayeni, Derbentseva, & Cañas, 2007). On the side of problem solving and mathematics teaching, the dynamic versus static thinking can be related to research on visualization, with particular focus on the role of imagery in problem solving (e.g. Presmeg 1997). Research on imagery in mathematics education goes back to late 70's and gained a new impetus with the rise of new theoretical frameworks and dynamic software environments. Based on a qualitative analysis of the problem solving of 54 high school students, Presmeg (1986) proposed 5 different categories of mathematical imagery: concrete, pattern, kinesthetic, dynamic and memory images of formulas. From these, we focus on dynamic imagery that is defined as the mental or physical transformation of images during the problem solving process. As Presmeg (1986) mentioned this is a powerful tool, though rarely employed naturally by students. In their study regarding proof schemes, Harel and Sowder (1998) propose three categories, each with several subcategories. One of these subcategories is termed "transformational proof scheme", and involves operating on objects along with foreseeing the results of the transformation.

We consider that our interpretation of dynamic thinking is in line with the above-mentioned conceptualizations. The above studies build on individual analysis of detailed solutions or interviews given by students. In this context, we pose the question: in situations where no detailed work is available, could the pattern of students' answers contain hints of the usage of dynamic versus static thinking?