

Dynamic Thinking Processes in Mathematics Learning: a Systematic Literature Review

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Abstract. Researchers in the field of mathematics education are also growing. This makes research on article reviews very important to do, because it can help researchers in determining the research to be carried out. In this study, a review of research articles on dynamic thinking in mathematics education was carried out. Researchers have investigated dynamic thinking, but what is being studied is diverse. The purpose of this article is to provide an overview of dynamic thinking discussed in mathematics education research. In this study, we analyzed 22 articles published from 1999-2020 with systematic review. We have searched for articles in the Web of Science database assisted by harzing's publish and perish software with a single keyword or keyword combination. Keywords or combinations of keywords used include dynamic thinking, dynamic of mind, a combination of dynamic thinking and mathematics. We have conducted a systematic review inductively finding dynamic thinking that is discussed in mathematics education. We found that there are still many things that have not been researched by researchers. Researchers are mostly from the United States and Canada. This article also provides an overview of the research of dynamic thought processes whose different focal points are cognitive processes (information processing, abstraction, restructuring, imagination, perceptual decision making), thinking, cognitive abilities, cognition, fMRI, environmental influences, and movement.

Key words: dynamic thinking; mathematics; systematic literature review

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INTRODUCTION

The history of mathematics reveals the dynamic way of thinking that underlies important concepts and their development (Moreno-Armella, Hegedus, & Kaput, 2008). The interpretation of dynamic ways of thinking is in line with the process of conceptualization in mathematics learning. Dynamic thinking or dynamic mindset is identifying the degree of freedom of the mental state. Dynamic thinking allows students to "put a magnifying glass" to "see" some necessary details, to change the view when emphasizing some specific situation or limiting the case, to change the position of the configuration that wants to be stable, or to decompose the whole into reorderable pieces (Pelczar, Singer, & Voica, 2014). Dynamic thinking is also an up-and-coming twenty-first century skill that requires test takers to solve dynamically changing problems. Based on the results of the article's analysis, there is still a little detailed discussion about the development of research trends regarding dynamic thinking in mathematics learning. In fact, dynamic thinking is a process in thinking that is very important in mathematics learning today, so it is necessary to do a lot of research on it. In addition, research to review articles in a particular field will be of great importance in the framework of the development

of research in related fields in the future (Chang et al, 2010).

Therefore, this research focuses on searching research articles on dynamic thinking in mathematics education. Tracking was done on articles published between 1999 and 2020. Specifically, this research was conducted with the aim of providing an overview of the dynamic thinking research that has been carried out. In addition, an analysis of the number of study distributions in several regions was also carried out, along with analysis of the topic or focal point of dynamic thinking research. His research questions are what is the number of research publications on dynamic thinking from 1999 – 2020?; which countries have contributed to the research of dynamic thought processes from 1999-2020?; what variables are the main focuses on deep dynamic thinking research from 1999-2020?. The purpose of this article is to provide an overview of dynamic thinking discussed in mathematics education research.

METHODS

In this study, it has conducted an article review and analyzed 22 articles published from 1999 - 2020 and indexed by the web of science. By using search engines, it is done by entering one keyword or a combination of several keywords. In this study, article tracking was carried out with

the following categories: (1) Journals are included in the social science citation index (SSCI) indexation category; (2) Journal entries in the Education & Psychology category; (3) Journals are written in English; (4) Journals have a high impact factor. Tracking is also done in science direct and Publish & Perish databases by limiting the search for keywords used.

Using search engines, we enter keywords or combinations of keywords. Then, we enter keywords in the search engines for the title category. Keywords or combinations of keywords used include dynamic thinking, dynamic of mind, a combination of dynamic thinking, dynamic of mind, and mathematics. The combination is carried out with the aim of making the article obtained more specific. Search results for journals and articles can be seen in Table 1.

Then from the 22 articles, researchers reviewed the title and abstract of the article. The activity is carried out with the aim of selecting selected articles according to and not in accordance with the scope of research carried out,

namely dynamic thinking in mathematics education. Based on the results of the study, the process resulted in 22 articles. In this study, the research stages were divided into four stages. The stages carried out in the 4 stages are identifying, screening, eligibility, and included. Next, the article is analyzed using a coding system. The collected articles are then coded according to the appropriate category. This coding is done with the aim that articles can be classified according to certain criteria. The coding used covers several topics related to dynamic thinking research. Other categories used are: the distribution of the number of articles when they were published (year) and the distribution of the researcher's home region.

RESULTS AND DISCUSSION

The focus of this research is articles that examine dynamic thinking processes published in the range of 1999 - 2020 and indexed by web of science. The article search results can be seen in Table 1 below.

Table 1. Article Tracking Results

Name of Journal	Tracking Results
Thinking and reasoning	2
Human brain mapping	2
Frontiers in Psychology	1
Technology, Knowledge and Learning	1
Procedia-Social and Behavioral Sciences	2
Perspectives on Psychological Science	1
Curriculum Inquiry	1
Quarterly Journal of Experimental Psychology	1
Educational Studies in Mathematics	2
Neuroimage	1
Visual Cognition	1
Journal of cognitive neuroscience	1
International Journal of Behavioral Development	1
Cognitive Systems Research	2
American Journal of Neuroscience	1
Journal of Science Education and technology	1
New Ideas in Psychology	1
Number of articles	22

Based on the results of the analysis of research articles that focus on dynamic thinking, in general, the number of studies on dynamic thinking always appears every year. This can be

seen in Table 2. From 1999 to 2020 there were always articles published about dynamic thinking.

Table 2. Distribution of the number of dt research publications from 1999 – 2020

Year	Tracking Results
1999	1
2008	2
2009	1
2010	1
2012	1
2013	3
2014	1
2015	1
2016	2
2017	3
2018	1
2019	4
2020	1
Number of articles	22

In Figure 1, research on dynamic thinking is mostly done by researchers from the USA. From 1999 - 2020, there were 11 articles published by researchers from the USA. The second largest country in research on dynamic thinking is Canada, a total of 3 articles. In general, the distribution of the number of researchers according to the country of origin who focus on

the field of study of dynamic thinking still does not extend to Asia, including Indonesia. Only a few researchers in countries around the world focus on researching about dynamic thinking. Many things can be unearthed in research studies on this topic, especially those related to the field of mathematics education.

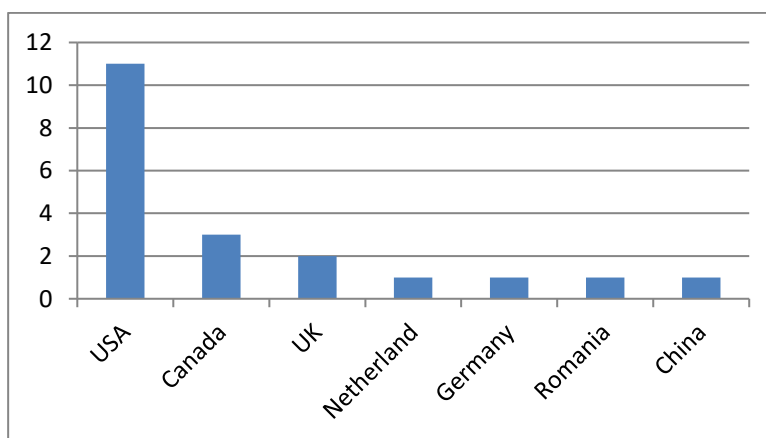


Figure 1. Distribution of The Researcher's Country of Origin with a focus on dynamic thinking research

Based on figure 2, the researcher's main focus on dynamic thinking is more on cognitive abilities. Based on the results of the analysis, 10 articles focused on cognitive abilities. The elaboration of topics that have been carried out by researchers, including information processing, abstraction (Reed & Vallacher, 2020), restructuring, imagination, perceptual decision making (Moher & Song, 2012)), thoughts (self-generated thoughts, changes of mind (Mooneyham et al, 2017), wandering thoughts (Denkova et al. 2019; Kucyi, 2018), dynamic mind infrastructure (Singer, 2009), systems

thinking (Wilensky & Resnick, 1999), static thinking, radiant thinking (Corona et al, 2010)), cognitive abilities (insight, problem solving, mental states (Hou et al, 2020), communication (Roth & Maheux, 2015), creativity (Beaty et al, 2017), complexity, imagery (Hartmann, Laubrock & Fischer, 2018)), cognition (Nastase, 2014), fMRI (Park & McDonough, 2013), environmental influences (Papera et al, 2019), movements (Tabaghi & Sinclair, 2013).

Dynamic thought processes are an interesting study by experts (Schoner, 2016. Dynamic ability is defined as the ability to sense and then grasp

opportunities quickly and proficiently so as to enable to support a sustainable competitive advantage (Schreyogg & Kliesch-Eberl, 2007; Teece, 2007). Dynamic thinking is the ability to integrate, build, and reconfigure internal and external competencies to cope with a rapidly changing environment (Teece et al,1997). Another definition of dynamic thinking put forward by Eisenhardt & Martin (2000) is organizing and preparing a routine strategy to achieve new resource configurations to emerge, collide, split, develop, and die. Dynamic thinking is also interpreted as a learned and stable pattern of collective activity in which the organization systematically generates and modifies its operating routines to achieve better effectiveness (Zollo & Winter, 2002).

CONCLUSION

Based on the research findings, there are still many things that have not been researched by researchers about dynamic thinking because it is in the field of education. Although the number of studies has been large, in terms of quantity, it is still very lacking, especially in the field of mathematics education, there are very few articles related to dynamic thinking. The most tracking in 2019 is 4 articles. Most researchers on dynamic thinking are still dominated by researchers from developed countries. In terms of the main focus, the variables studied are dominated by cognitive abilities developed from dynamic thinking. Based on the search, there are still many dynamic thought processes in mathematics education that have not been explored, only related to problem solving. Thus, there are still many aspects that can be explored in research activities in the field of mathematics education

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