Cognitive flexibility abilities in learning: A systematic review of the literature

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ABSTRACT
Cognitive flexibility is the ability to adapt a person’s cognitive processes to face new conditions in the environment. The main aim of this research is to find out information about the research design, subject and findings about cognitive flexibility that have been published. This research study uses 5 indexed journal articles throughout 2017-2021. The method used is a systematic review referring to the Kitchenham guidelines. The results of this research show that correlational research is the most commonly used design with students as the most popular subject. Overall, cognitive flexibility abilities have a positive influence. More empirical research is needed to see the extent of cognitive flexibility in the learning process at various levels of education.

KEYWORDS
Cognitive flexibility; educational; educational; student; adaptive thinking; Systematic review

Introduction
Practicing skills and gaining knowledge that will later be used and useful for life is one part of the learning objectives. Acquiring knowledge and practicing skills are usually carried out simultaneously during the learning process. These skills include all skills that can be trained, such as thinking, speaking, writing, calculating and so on. This ability will always be used, but sometimes there are problems that arise in a new environment and adaptation skills are needed to solve them. This ability often refers to the ability of cognitive flexibility (Oktaviani et al., 2021). Cognitive Flexibility is a person’s ability to adapt to situations Cañ et al., (2005) revealed that the ability to adapt a person’s cognitive processes to face new conditions in the environment can be said to be cognitive flexibility. And it can be interpreted as the ability to respond adaptively between thoughts (Yu & Tatia M. C. Lee., 2016). A person’s ability to select, generalize and apply various solutions to a problem that are appropriate and creative to complex learning tasks and involves the ability to provide unexpected responses is referred to as cognitive flexibility (Human - Vogel, 2004). The ability to remember and the ability to adapt cognitive behavior are influenced by cognitive flexibility (Taconnat et al., 2009). So individual thinking abilities are related to cognitive flexibility abilities.

The learning process often presents problems in order to train students’ problem-solving abilities. The problem solving process certainly needs to involve a lot of information to be processed so that it can be used as a solution. So cognitive flexibility is needed to help construct knowledge and adapt information to the problems faced. The many benefits of cognitive flexibility in learning make it imperative for the world of education to hone these abilities. On the other hand, research on cognitive flexibility has been reported, such as research on cognitive flexibility in anagram problem solving among native English speaker students (Walker et al., 2002). Then, research conducted by Esen–aygun (2018) regarding the relationship between pre-service teachers' cognitive flexibility and interpersonal problem-solving skills. Furthermore, Oktaviani et al., (2021) who conducted research on the relationship between cognitive flexibility and problem solving skills in biology subjects.

Based on the research above, no researchers have been found who have conducted systematic reviews of articles with the aim of finding out information about research design, subjects and findings about cognitive flexibility that have been published. This research has several aspects that differentiate it from several previous studies. Firstly, this research focuses on all articles that have been published throughout 2017-2021 in all educational journals, all of which are indexed. Second, this research is devoted to investigating a number of articles regarding cognitive flexibility.
**Literature review**

The ability to send information and explain things again and make new adaptations to new methods is called flexibility. In line with this, flexibility can be interpreted as the ability to use something general in special ways (Moore & Malinowski, 2009). Flexibility can also be interpreted as an individual’s ability to adapt cognitive processing strategies to deal with new and unexpected conditions in the environment (Cañas et al., 2003). Another definition related to cognitive flexibility is the ability to change thoughts in terms of environmental conditions that allow change (Dennis & Vander Wal, 2010). From the definition of cognitive flexibility itself, cognitive flexibility is seen as the ability to use information when problem solving skills are being used and trained. The ability to think from various points of view in order to use knowledge in the future and what is most likely to be faced by an individual is defined as cognitive flexibility (Spiro et al., 1991). Examples of case studies of cognitive flexibility include:

1. Switching between tasks: A person who has good cognitive flexibility can quickly switch from one task to another without difficulty, such as switching from working on a work task to dealing with a personal problem.
2. Changing strategies: When someone faces obstacles or difficulties in completing a task, they can change the strategy or approach used to achieve the desired results. For example, in problem solving, if one approach does not work, cognitively flexible individuals may try another approach.
3. Adapt to change: Cognitive flexibility also includes the ability to adapt to changing situations or changing policies. For example, in a work environment, an employee who is able to quickly adapt to changes in company rules or policies will be more effective.
4. Think out-of-the-box: Individuals who have cognitive flexibility tend to be able to think creatively and see various points of view in solving problems. They are not fixated on one particular way of thinking or understanding, but are willing to look at possible alternatives.
5. Adjusting plans: When initial plans do not fit the situation, cognitively flexible individuals can easily redesign their plans to achieve their goals.
6. Cognitive flexibility is a mental skill that is valuable in various aspects of life, including education, work, and social relationships. The ability to think and adapt quickly can help a person better overcome challenges and achieve their goals.

Based on the description above, it can be concluded that cognitive flexibility is the ability to adapt individual patterns and ways of thinking in responding, understanding and solving problems.

**Methods**

The research focuses on research results related to cognitive flexibility from various journal articles. This research uses a systematic review analysis of cognitive flexibility in learning based on a guideline framework Kitchenham (2004). The development of research on a theme can be mapped clearly through a systematic review (Kitchenham et al., 2009; Angarita & Chiappe, 2019; Chan, 2013). This systematic review analysis combines several activities separately (van Laar et al., 2017). The systematic review stage consists of three main phases, namely, planning the review, conducting the review and reporting the review (Kitchenham, 2004). These stages can be seen in Figure 1 below.

**Planning a Review**

- Identify needs
- Protocol development

**do a review**

- Identification of research
- Selection of primary studies
- Study quality assessment
- Data extraction & monitoring
- Data synthesis

**Report**

**Figure 1.** Systematic review stages based on Kitchenham guidelines

**Planning a Review**

The first stage focuses on planning the research which is carried out by conducting literature analysis studies on other studies. Next, plan the selection of appropriate keywords to find out more about cognitive flexibility. The
planned keyword selection is "cognitive flexibility in learning" in order to improve the quality of studies, certain software is used.

**Conducting Reviews**

The second stage is carried out by starting to determine the type of research that will be carried out. This type of research is a systematic review of literature. The aim of this method is that this research is able to provide an overview of the results of a comprehensive literature review based on the research theme so that it is hoped that it will be able to provide an overview for future researchers. The articles used in this research study are a collection of national and international journal articles that are relevant to the chosen theme. Database searches were carried out using publish or perish software. Next, the researcher conducted a preliminary search using various search patterns. The researcher intended to systematically identify reviews and examine the number of studies related to the research theme. Then the researcher reviewed the research results by reviewing the abstract to ensure the alignment of the article with the research questions. The search results for publications or articles related to outcomes regarding cognitive flexibility were 110. This article data was then read and sorted one by one and then selected based on keywords and abstracts, resulting in 5 articles. Selected articles are then assessed at the quality assessment stage to correct whether the articles meet the researchers' criteria. Then the articles that pass this hold are then reviewed at the data extraction and synthesis stage. The article selection and sorting stages can be seen in Figure 2 below.

**Data Extraction and Synthesis**

In the final stage of this research, the researcher extracted data based on articles that met the criteria by reading the article title and abstract and examining the paper more thoroughly from the 5 articles that had been determined. Extraction was carried out with the aim of finding out in general and looking at the content components in articles about cognitive flexibility. Based on the components that have been identified from existing literature, researchers carry out data synthesis.

**Results**

In this section we will present the results of a systematic review of cognitive flexibility articles. Systematic reviews in various publications can provide a general overview of research subjects, research methods and research results obtained. Based on 26 reviews and abstract reviews of articles, there were 5 articles that met the criteria for this research. Overall, it can be seen in Table 1 below.

![](Figure_2_Implementation_of_selection_and_sorting.png)

**Table 1. Komponen kemampuan fleksibilitas kognitif dalam artikel yang dikaji**

<table>
<thead>
<tr>
<th>No</th>
<th>Authors</th>
<th>Title</th>
<th>Research design</th>
<th>Subject</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Oktaviani et al., 2021)</td>
<td>The Relationship between Cognitive Flexibility and Problem Solving Skills in Biology Subjects at MAN Tasikmalaya City</td>
<td>Correlational research</td>
<td>86 Class X students</td>
<td>There is a relationship between cognitive flexibility and problem solving skills</td>
</tr>
<tr>
<td>2</td>
<td>(Soylu &amp; Özkan, 2021)</td>
<td>The Relationship Between Preschool Teachers’ Attitudes Towards Science Education and Cognitive Flexibility Levels.</td>
<td>Correlational research</td>
<td>207 207 Early Childhood Education Students</td>
<td>There is a positive and significant relationship between PAUD students’ attitudes towards science</td>
</tr>
</tbody>
</table>
Discussion

Based on Table 1, the researcher synthesized three components in the article regarding cognitive flexibility, namely research methods, research subjects and research results. It can be seen that the systematic review study provides information that the correlational research design is the design used by researchers in their research on cognitive flexibility and is included in descriptive research. This is in line with Fraenkel & Wallen (2008) that one of the designs in descriptive research is correlational research. This research design is an attempt to describe conditions that have occurred. A researcher will describe a condition of the subject and object in the research. So throughout research activities, a researcher will collect data from two variables and then determine the relationship between the two. Next, it will be known whether this relationship tends to be strong or not. It is important to know the level of relationship between several variables in research. Because knowing how strong a relationship is between variables will increasingly help a researcher in preparing further research. It is hoped that the research can be developed and then adapted to the initial objectives of the research (Curtis et al., 2016).

Regarding the research subject components used in the systematic review of the five selected articles, it can be seen that overall students are the research subjects chosen by researchers in their research related to flexible cognitive skills. The researchers assume that at this level students have a more open level of thinking. Apart from that, at the student level, of course, they more often encounter complex problems in the lecture context. So researchers are interested in conducting research related to cognitive flexibility abilities in students. The number of students who are often used as research subjects is in line with Goktas et al., (2012) which said that students are the most widely used subjects in educational research articles in Turkey. As well as Choi, S. H., Seo, H. J., & Kim (2016) that the research subjects most often chosen in educational research are students.

Furthermore, the research results components in the five articles show that overall cognitive flexibility shows positive results. It can be seen that cognitive flexibility has a significant role in problem solving skills and a positive relationship with student attitudes (Oktaviani et al., 2021; Soylu & Özkan, 2021; Esen-aygun, 2018). Furthermore Tikhonova & Rezepova (2017) The results of his research showed that there had been a remarkable increase in the level of cognitive flexibility of students. Then cognitive flexibility is able to contribute to the development and use of techno-pedagogical content knowledge which has an important role in teacher education (ÖZTÜRK et al., 2020). Based on the overall results of this research, it can be said that someone who cognitively has high flexibility will be aware of cognitive alternatives and be able to experience difficult conditions in a controlled manner, change maladaptive thoughts with adaptive thoughts and face challenges in a successful way (Dennis & Vander Wal, 2010; Gabrys et al., 2018). In this process, cognitive flexibility plays a quite big role, according to (Lin, 2013) The results of research conducted on 770 students showed that cognitive flexibility had a positive impact on change and openness.

Conclusion

This research presents a systematic review of cognitive flexibility abilities. This study shows that publications regarding cognitive flexibility abilities were mostly carried out at the tertiary level using a correlational research design. Meanwhile, the overall research results show that cognitive flexibility abilities have a positive influence. The implication of this research is that more empirical research is needed to see the extent of cognitive flexibility in the learning process at various levels of education. Then technology-based cognitive flexibility needs to be explored further regarding effectiveness, usefulness and influence relationships.
References


http://gateway.webofknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=ORCID&SrcApp=OrcidOrg&DestLinkType =FullRecord&DestApp=WOS_CPL&KeyUT=WOS:000405070400025&KeyUID=WOS:000405070400025

