


# Chapter 3

## Cognitive Structures and Their Place in Science Education

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### **ABSTRACT**

*Cognitive structures have attracted the attention of science education researchers because they affect students' learning of new scientific knowledge and play an important role in subsequent learning. According to the researchers, in order to realise meaningful learning in education and training, students' cognitive structures should be determined correctly. Researchers have used techniques such as word association test, flow maps, concept maps, drawing and writing technique, and concept cartoons to determine students' cognitive structures. They analysed the data with methods such as cut-off point technique, coefficient of relatedness formula, response frequencies mapping method, and qualitative analysis. In this study, a) what cognitive structure is; b) the methods, techniques, and tools used to determine cognitive structures; and c) how the data collected was used to determine cognitive structures are analysed and explained with examples of articles. In addition, the results of previous studies on cognitive constructs, especially in the field of science education, are presented.*

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## INTRODUCTION

Ausubel (1968) stated that prior knowledge affects learning and that the teaching process should be designed according to students' prior knowledge in order to achieve meaningful learning (Derman & Ebenezer, 2020). The act of learning occurs as a result of the interaction between the taught concept and the pre-existing concepts in the human mind. For this reason, revealing the concepts in the cognitive structures of students' minds is essential for learning (Kurt & Ekici, 2013).

Cognitive structure is a theoretical structure that shows the relationships between concepts in students' long-term memory (Shavelson, 1974). According to White (1979), cognitive structure is the relationship level of the connections related to the subject in the learner's memory according to his/her performance before and after the lesson. Ausubel (1963) considers a person's existing cognitive structure as the most important factor that determines whether new information will be meaningful or not and the correct association of new information with old information (Ausubel, 1968; as cited in Khurshid & Iqbal, 2009).

In educational research (especially in science education), it is very important to try to determine the cognitive structure of the learner (Tsai, 1999) and to develop teaching methods in this regard (Tsai & Huang, 2002). Determining the cognitive structures will contribute to the determination of learners' misconceptions, learning difficulties and the development of learning processes (Jonassen, 1987; as cited in Varoglu et al., 2020). Cognitive structures support students' understanding and learning processes in science. Students who are unable to relate concepts correctly and are unaware of the incorrect information they have in their minds may have misconceptions (Sen & Nakiboglu, 2021) because these students have poorly structured cognitive structures. It is seen that research on cognitive structure is compatible with the constructivist learning approach (Temel & Ozcan, 2016). In the constructivist learning approach, learning is a process that occurs in the student's mind, and in this process, the student tries to associate his/her previous knowledge with the new phenomena he/she sees. If they are compatible with each other, he/she accepts, i.e. learns; if they contradict each other, he/she either rejects them completely, i.e. does not learn and remains with his/her old knowledge, or interprets the new information in a way that is consistent with his/her old knowledge and configures it in his/her mind (Cakıcı et al., 2006). For meaningful learning to take place (Ausubel, 1968);

- New concepts, knowledge and principles to be learnt become meaningful when they are associated with previously learnt ones. If the student cannot establish these relationships in his/her mind, he/she cannot comprehend the subject.

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