Structural Learning Theory

General

Structural learning theory is one of the cognitivist perspectives on instructional design proposed by Joseph Scandura in 1970s. Scandura's theory suggests human **knowledge is** consisted of **rules** which are to be learned. Those rules are determined by parameters of **domain**, **procedure**, and **range**.

What is structural learning theory?

Structural learning theory suggests that structures (problems) that a learner must learn, need to be formed as **rules** performed on a **domain**.

A domain here is defined as a set of characterizing **inputs** and **outputs**. Inputs and outputs can be anything, even a process, an idea or a concept. For example:

- list of verbs (input) → present participles (output).

Operations performed on given inputs are called rules, and they generate unique outputs. Rules can contain different levels of abstraction and are always defined with three parameters:

- **domain** - its allowed **inputs**,
- **range** - its expected outputs, and
- **procedure** - the sequence of **operations** to perform **on the inputs**.

For example: a rule *form present participle* has the domain of all English verbs, the range of present participles and the procedure of adding “-ing” ending to the verb.

Rules can be simplified into **lower-order rules** (*atomic components*) which represent most basic concepts learner needs to know when dealing with a problem from given domain. By combining these atomic components and application of more complicated to lower order rules new **higher-order rules** are derived. Higher-order rules are rules which can have other rules as inputs or outputs (for example mathematical theorems) and they can be used to solve complex problems in the whole domain.

Structural learning theory further attempts to identify components crucial for solving the given problem and is based on the procedure called *structural analysis*. Structural analysis is performed in the following steps:

1. The first step is to identify problem domain inputs and outputs, or even only outputs (representative problems).
2. Rules should be defined and explained on each representative problem. Problem domain can be both well- and ill-defined[1]. In case of an ill-defined domain, it should be divided into well-defined sub-domains which can generate at least one solution rule.
3. Each solution rule should be converted into a new higher-order problem and new higher-order rules for solving them.

4. Redundant rules should be eliminated and the whole process repeated until simple enough rules are reached.

An important part of the theory is also **prior knowledge (rules)** of the learner, that will **enable construction of new rules**. This knowledge can be examined by instructor, that can be both human or artificial.

What is the practical meaning of structural learning theory?

An example of application of structural learning on learning how to subtract:[2)]

1. Select a representative sample of subtraction problems such as 9-5, 248-13, or 801-302.
2. Identify the minimal capabilities of the learners: be able to recognize the digits 0-9, minus sign, column and rows. Then identify rules for solving each of the subtraction problems. For example, one of the rules can be that if the last digit of the minuend is smaller than a corresponding digit of the subtrahend, the next left digit in minuend is decremented by one.
3. Identify higher-order rules and eliminate other rules they subsume. For subtraction this means the rule mentioned under (2) should be generalized for any digit of the minuend and corresponding digit of the subtrahend, not just the last one.
4. Reconsider the resulting rules from (3) and generalize them to account for all problems within the domain. In the case of subtraction we could generalize the problem to subtraction of numbers in different bases.

Structural learning theory's applications have been made in **mathematics** and **language learning**.

Criticisms

Keywords and most important names

- **Structural learning theory**, **rules**, **domain**, **range**, **procedures**
- Joseph Scandura

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Read more

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1)
An ill-defined domain is one in which rules are quite simple, yet there is no direct complete solution like chess, or poetry writing.

2)
Suggested by Scandura in Scandura, J.M. Problem Solving: A Structural/Process Approach with Instructional Applications. NY: Academic Press. 1977.. Cited in TIP: Structural Learning Theory (J. Scandura). Retrieved March 16, 2011.