

COGNITIVE THEORIES OF LEARNING AS THE BASIS FOR DIDACTIC METAPROGRAMMING

KOGNITIVNE TEORIJE UČENJA KAO OSNOVA ZA DIDAKTIČKO METAPROGRAMIRANJE

Wojciech Walat

University of Rzeszow, Rzeszow, Poland

Sveučilište u Rzeszowu, Rzeszow, Poljska

Abstract

I have introduced the notion of *didactic metaprogramming* on account of the need to "go beyond" stiff and formed by the behaviouristic tradition ways of educational programming. In accordance to notional understanding of the prefix *meta-* which means: beyond, after, above, including, among, according to, indicates sequence or variability of something. It is accepted in informatics that *metaprogramming* – is a technique which allows a program to create or modify the codes of other programs (or their own) during their operation. Hence a didactic metaprogram is one that includes functions of all student and teacher programs, creating a consistent hypermedia educational space. It is possible thanks to the use of hypermedia.

Sažetak

Uveo sam pojam didaktičkog metaprogramiranja na račun potrebe da "se ide dalje" od krute i formirane behaviorističke tradicije načina obrazovnih programa. U skladu sa razumijevanjem prefiksa *meta* što znači: iznad, nakon, gore, uključujući, među prema ukazuje se slijed ili varijabilnost nečega. Prihvaćeno je u informatici da je metaprogramiranje tehnika koja omogućuje program za izradu ili izmjenu kodova drugih programa (ili vlastitih) tijekom njihovog djelovanja. Stoga je didaktičko metaprogramiranje ono koje uključuje funkcije svih studenata i nastavnika programa, stvarajući dosljedan hipermedijalni obrazovni prostor. To je moguće zahvaljujući korištenju hipermedija.

1. Place of hypermedia in didactic processes

Carried out analyses, regarding an evolution course of psychoeducational learning theories in relation to the development of information theories from the behaviourism through humanistic theories up to cognitive theories (cognitive-constructivist), indicate the need to comprehensively (complementary) encompass learning and teaching theories during the modelling of hypermedia educational programs /1/. Nowadays, there are no evaluative questions asked regarding any theory, since the search for a homogeneous theory, without taking into a consideration multidimensionality of human psyche is recognised as failure. Individual human psychological concepts accept one or some of dimensions of its essence. The search for optimal solutions in the scope of hypermedia educational programs modelling and optimization should be based on educational and methodological complementarities of individual

conceptions and forms regarding the pedagogic conduct. It is justified by a variety of education aims and content as well as diversity of students' characteristics and experience.

Having analysed the conceptions which were the basis of educational systems reconstruction, it can be stated that behaviourism determined the range and possibilities of learning automation while humanism attributed a superior part to the conscious orientation of those processes towards the values believed in and aspired to by man (orientation to individual maturity), finally cognitivism brought in activeness and constructivism independence into processes of reality cognition.

The basic teacher's role is to control educational processes (in a didactic literature it is described as management). Describing a teacher's role as a subject that manages a student is not aimed, from the information theories point of view, at determining the possibilities of their

physical elimination from the system and replacing by a machine (computer), but it serves a purpose of better explaining those process mechanisms and a considerable broadening teacher's possibilities that is, those situations, events (and their parameters), which can be influenced in some ways. The point is, to recognize possibilities of educational processes optimization from the point of view of information theories and practical use of computers in specific educational situations.

Hypermedia didactic programs (HDP) is a new group of educational studies which, thanks to including messages based on different media, create a homogenous educational message, and their implementation has an interactive character. That is why a necessity arises to explain the *difference between hypermedia educational compilation and traditional compilation published in form of book?* The basic difference is that in hypermedia didactic systems every part of it is performed by a hyper-text program, apart from that thanks to its interactivity, the emphasis is put on student's independent work. Those programs have many functions in educational processes which can be reduced to three main ones: cognitive-educational, emotional-motivating, operation-interactive

2. Cognitive and constructivist theories perspective of meta-programming learning

Few years after the end of the Second World War, in 1950s, there were many significant works on psychological concepts of a human based on the assumptions of cybernetics as the science of control. The accomplishments of Wiener (1950), Bartalanffy (1984) and Ashby (1963) resulted in including such notions as: *information, feedback, black box, control system* as well as other information and control theories into psychology. However, the basic notion remained was information comprehended in a quantitative form – as the measure to reduce uncertainty as well as qualitative - as the content with a specific meaning i.e. representation of a certain fragment of reality. The scope of works and studies performed by cybernetics theoreticians were processes of control i.e. processing information into operations modifying states of a given system. The effect relied on paying special attention at information processes of an individual, self-regulation, control and correcting measures mechanisms with regard to certain

standards as the indispensable conditions for regulating processes. The turning point in thinking on mechanisms of human behaviour was the work of Neisser: *Cognitive psychology* /2/. The author proposed the conceptions of the active mind of an individual in the scope of cognitive processes (e.g. memory, attention, selection of information, processing information, solving problems), being contrary to the binding passive conceptions (associating). Cognitive psychology was treated as the science on functioning of the mind /3/.

Kelly /4/ may include the following assumptions of cognitive psychology as a range of specific applications /5/:

- 1) People anticipate events, thanks to which, construct the replicas of the events, their images or reflections (assumptions of constructing); these replicas have been called personal constructs;
- 2) People differ in possessed constructs of events (assumption on individual differences);
- 3) Each individual shapes anticipating processes, however, the cognitive system includes ordered relations between constructs (organisation assumptions);
- 4) Cognitive system of an individual is composed of a limited number of dichotomous constructs (assumption of dichotomy);
- 5) Among dichotomous constructs, people choose this possibility which has a greater usability of the entire cognitive system (assumption of selection);
- 6) Personal construct is needed for anticipating only a given scope of events (assumption of the application scope);
- 7) Cognitive system is changing as people gradually create other images of events (experience assumption);
- 8) Variability in the cognitive system is limited, what results from the limited capability of creating constructs to accept discrepancies (modulation assumption);
- 9) People may use many constructs which are not agreed to each other (fragmentation assumption);
- 10) If two persons refer to a similar system of experiences, it may be anticipated that their behaviour will be similar (dividing assumption);
- 11) If a person influences creating a cognitive system of another people, it may cause emerging

social behaviours in this other person (socialisation assumption).

The common feature of the aforementioned assumptions formulated by various directions in cognitive psychology, is that gaining experience relies on creating dichotomous (white and black, small and big, light and dark) representations of the reality. These representations have a dynamic character (experience is gained and internal compliance is greater). The content of these representations (constructs) results in human's behaviour. Generally, it may be useful to observe psychological assumptions of cognitivism:

- 1) An individual is not a reactive system, to the contrary – is an active system, independently and actively seeking information, collecting experience, building experience in their cognitive system. It may be claimed that an individual is not an active player who formulates hypotheses, collecting information, confirming or rejecting their expectations. This is a concept of a naive theoretician, naive researcher and thinker.
- 2) Experience does not constitute stable data but also undergoes constant process of integration, generalisations; significance of particular elements is modified by the context in which they function.
- 3) Human experience is a tool for a cognitive control over the environment and over themselves and used for anticipation, constructing expectations, action plans, formulating aspirations, causal explanation of events, understanding own behaviours and others .
- 4) The experience system is not a strictly logical structure. It is constructed on many ways and the loftiness of described occurrences, their repeatability, order etc. may decide on the content of the cognitive system and the manner of its organisation.
- 5) The system of experiences is not only a complex representation of reality. It undergoes constant changes, as a result of which there are images of other states of things: projects, visions, aims, ideals etc.
- 6) In the cognitive system, there is an internal affective and motivating mechanism that triggers a given behaviour. This mechanism is – generally speaking – desire to avoid discrepancies and aiming at compliance within a cognitive system /6/.

- 7) Human actions have a rational character, however, the notion of rationalism has changed many times. It has evolved from the conviction that human actions and decisions meet formal requirements, normative models based on classical logics, to convictions on the individual character of human rationalism, referring to an individual and group criterion of sufficiency in actions.
- 8) A normal (typical) state in each human is desire for constant enriching the structure of experience as well as aiming at eliminating unnecessary (excessive) diversity. Aiming at equilibrium between diversity and extending information resources is a basic determinant of a schematic structure of human experience.

In cognitive theories of learning, the basic thesis that any element may be remembered, if it has been included in a much greater, existing entirety – human is a separate and creative subject, who is capable of creating themselves (their competences, motivations and emotional maturity). Koziellecki /7/ writes that a human being is a system processing information and his behaviour, i.e. learning depends on the information flowing from the external world and internal information i.e. subjective cognitive structures. As the time of learning and manipulation of strengths in form of awards and punishments played a basic role in association theories, in cognitive theories, the basic meaning has a structure being a program regulating behaviour of a human, determining his cognitive, creative and action-based activity. The example of the classical cognitive theory – structural – is the theory of assimilation and accommodation by Piaget /8/.

The significance of knowledge and cognitive processes was emphasised in the works by Bruner (1964): a learner is capable to generate new knowledge and go beyond obtained information. Koziellecki /9/ defined the human mind as the reproductive and generative medium, a human being not only assimilates external information but can also create new ones.

On the basis of cognitive psychology the concept of constructivism has emerged, by means of excluding the results of research by Piaget, Wygotski and Brunera, achievements of artificial intelligence including: neuron networks, expert

systems and databases. In constructivism, it is assumed that knowledge is a construction of human mind, which comes into being as a result of own and diversified activity. A human being not only acquires fixed knowledge (as a product) provided by others, but also constructs their own system of knowledge by undertaking various kinds of activity:

- Verbal (asking questions and formulating answers),
- Practical (conducting experiences and formulating conclusions and hypotheses),
- Intellectual (starting the processes and analysis and synthesis),
- Sensory (directed at noticing and remembering imaginary schemes),
- Receptive (listening and selection of acquired messages),
- Emotional (experiencing and dealing with stress).

In these situations, teachers play a role of a “mediator” – agent helping students to choose proper strategies of learning, manners of solving problems and self-acquiring of knowledge. In the role, the teacher and students may be supported by didactic (hypermedia) computer programmes which shall include the best didactic strategy of learning in a given situation, assisting a learner in his research approach to the world: observing phenomena, formulating hypotheses, conducting experiments and simulations and drawing conclusions. These actions are very often named constructionism relying on creating new structures of knowledge which may help others (students) not only remember a given fragment of reality but also provide their own subjective meaning. To a great extent, it is a natural desire of a human being: participants take notes during lectures, speeches. Even if they do not use the notes any more – only during the lecture – by means of taking notes, there is processing of provided information in a notion construct.

While creating notion constructs it is necessary to self-organise didactic programmes created on the basis of didactic meta-programming, according to individual psycho-physical properties of students. It is possible thanks to dynamic development of IT in the scope of hardware and software (including AI).

Conclusion

The didactic programming in the previous approach was limited to a creation of more or less developed „stiff” didactic programs: linear, branched and mixed. Only block programming (block-problem) and semi-programming have shown some possibilities to move away from education automation. At present, a new impulse for didactic programming comes from the research on artificial intelligence and neuronal webs. I think that there are two ways to use AI. One of them is a creation of computer educational programs with, so called, friendly interface that is, orientated to user’s needs and capabilities, where the knowledge of a complicated code is not required. The other way to use AI, is the education individualisation. Multilevel didactic programs (including many „paths of learning”) adapt „themselves” to the user’s level of knowledge and abilities directing him from one educational level to another. The scope of knowledge a student already has is then avoided in favour of things he/she still has to learn. After an initial control and evaluation of the candidate’s knowledge level he/she is directed on the right (individual) “path of learning”. During this time the system tests student’s knowledge and abilities in order to improve his/her individual learning model, determines the improvement and chooses the next learning path. In order to achieve that there can be established a *set of fuzzy rules*, which will combine tests results from a suitable decision determining and modelling student’s individual learning path.

I would like to emphasize here a crucial role of the teacher as a „guide standing by”, often directing a student and constantly modifying the program, giving to a student a sense of achievement (subjectivity and responsibility for actions).

Notes

- /1/ Walat W., *Introduction to didactic meta-programming*. „Informatologia” Vol. 42, no 2, June 2009, Croatian Communication Association, Zagreb. s. 126 – 129.
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