

TRENDS AND RESEARCH IN NEUROCOGNITIVE ENHANCEMENT

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Abstract: The cognitive enhancement of students and adults has always been a desideratum of formal and informal education. In this context, cognitive enhancement focuses on the improvement or strengthening of cognitive functions such as attention, memory, processing speed and problem solving. For cognitive enhancement to be achieved, different interventions are attempted and a variety of strategies are chosen, some of them generally acknowledged and documented in publications and others described as quite promising but not yet widely acknowledged. The present study focuses on neurocognitive enhancement methods approach. Authors main objective is to evaluate and analyze current trends and research approaches of neurocognitive enhancement in the field of algorithmic thinking and computer (generally digital devices) programming. Experimental results are discussed and the enhancement of cognitive performance is suggested.

Keywords: Algorithmic thinking, textual programming, visual programming, neurocognitive enhancement.

Introduction: In recent years, human cognition, learning difficulties, problem solving and reasoning, are mainly evaluated within the special educator's perspective. Moreover, the current research, primary focuses in learning outcomes which are mainly pursued in educational practice. Nevertheless, a higher level of reasoning is not directly or inevitably related to the way a solution is expressed or with the difficulty of following prior specified procedures. This level of reasoning is related to the ability of a person to create new methodologies and strategies and to apply decision making abilities efficiently in order to deal with a given problem and create a new algorithm. However, research within reasoning difficulties seems to have failed till now to shed light on the field of algorithmic thinking and programming abilities enhancement. The main objective of authors approach is to explore the different way of enhancing human cognition. On the one hand, within the frame of neuroscience, developing appropriate learning paths during the educational procedure may be helpful in order to reach an enhanced educational approach. On the other hand, the use of neurofeedback enhancement and the interaction elements between the educator and the respectively used technology may be essential in order to achieve neurocognitive enhancement.

Methodology: Algorithmic problem solving are suggested as higher-order cognitive processes that require the modulation and control of more routines or fundamental skills and are considered as the most complex of all intellectual functions (Lewis & Smith, 1993). In this study, the neurocognitive approach focus in a proposed neurocognitive enhance model. This model is based on several scientific criteria and methods in order to contribute to algorithmic thinking augmentation. Specifically, the proposed model is mainly based on cognitive science, brain imaging, human computer interaction (HCI) (Carroll, 2003) and neurofeedback techniques (Vernon et al., 2003). Problem solving, reasoning enhancement and cognitive science principles were strongly involved in the proposed model. In addition, education in digital device programming is another step which can take place after the development of students' algorithmic thinking. Digital device programming can be realized using two types of programming, namely the textual and visual programming. The two types are likely to have a different impact on the trainee/student. As the algorithmic thinking, the cognitive processes taking place during programming are assessed on the general cognitive theories of problem solving, which includes processing of structural and semantic information, acquisition of knowledge in fragments, construction of information in schemata and solving problems (Shneiderman & Mayer, 1979). The above approaches indicate the significance of studying different mental states through observation of possible changes in brain activity, brain rhythms in particular, with criteria of electrophysiology, as trainees and students are learning or working in algorithmic or/and computer programming tasks. Research shows that understanding cerebral processes during training can greatly contribute to the enhancement and attainment of learning (Dresler et al., 2013). The model was applied with the use of ten algorithmic task selected according to the above criteria and results suggest an enhanced cognitive performance. Brain imaging like Electroencephalography (EEG), brain signal recording and neuro-feedback techniques were essential for the proposed model outline. The effect of the Alpha-theta and SMR-Low Beta neuro-feedback training protocol is taken into consideration within the frame of attention, cognitive and therefore reasoning and algorithmic thinking ability enhancement (Boeck, 2016). Considering educational neuroscience aspects within the frame of algorithmic thinking and programming abilities enhancement, author's main objective are to:

1. Provide a conceptual framework for developing a higher-order cognitive process like critical thinking, problem-solving skills and programming abilities within the practice.
2. Identify potential different brain patterns during algorithmic thinking and programming procedure using brain imaging techniques.
3. Develop a conceptual framework for assessing algorithmic problem solving and programming procedures within the frame and brain EEG signal behavior.

Findings: The model for algorithmic thinking enhancement was evaluated with the use of a statistically significant number of participants who were gathered and their algorithmic thinking ability was evaluated in order to check the proposed model efficiency. Algorithmic tasks evaluation results suggest participant's statistically significant enhanced performance while using the proposed model. EEG recording analysis suggests the significant variation in terms of EEG brain signal ratios signifying the potential relation between enhanced algorithmic thinking performances with the intensively alternating brain electrical activity. Concerning digital devices programming the research takes place this time, and the results are expecting to contribute to the exploration of specific ways aimed at reinforcing the trainees' learning of digital device programming.

Conclusions: In recent years, cognition enhancement has become increasingly popular as a topic of scientific research in order to enhance effects on brain and cognition mostly within the special educators perceptive that focus in a primary reasoning stage. Educational aspects are blended with brain imaging techniques and neuro-feedback training perspectives. The basic aim is to propose an algorithmic thinking and programming abilities enhancement model in order to promote adaptability, decision making, intelligence, and learning. Future directions lean towards an overall implementation of the proposed methodology within neuro-educational terms in order to confirm the effectiveness of the neurocognitive algorithmic thinking and programming abilities enhancement model.

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