

# Review of: "Artificial Intelligence and Digital Technologies in the Future Education"

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**Potential competing interests:** No potential competing interests to declare.

The following peer review is based on the following criteria:

Relevance of the subject and explication of the problem; Explication of the thesis; Clarity and validity of argumentation; Acquaintance with contemporary research of the subject; Conclusions – do they make any contribution to the field; Language, style; Relevance of Keywords and Summary to the title.

## **Relevance of the subject and explication of the problem** Good

The paper provides a clear explanation of the role of Artificial Intelligence (AI) and digital technologies in future education. It discusses the benefits and limitations of introducing AI techniques in learning and sets the context for the Fourth Industrial Revolution.

## **Explication of the thesis:** Good

The thesis is clearly stated in the introduction and is consistently addressed throughout the paper. The author discusses the role of AI in education and its potential impact on teaching and learning processes.

## **Clarity and validity of argumentation:** Good / Medium

The argumentation in the paper is generally clear, but some points could be further elaborated to strengthen the validity of the arguments. More supporting evidence and examples could enhance the overall clarity and validity of the argumentation.

## **Acquaintance with contemporary research of the subject:** Good

The author demonstrates familiarity with contemporary research on the subject of AI in education. They cite relevant sources to support their claims and discuss different perspectives on the topic.

## **Conclusions – do they make any contribution to the field?** Medium

The paper provides some conclusions regarding the role of AI in education, but they could be more explicit in discussing the contributions and implications of the findings. A stronger emphasis on the potential impact and future directions of AI in education would enhance the contribution to the field.

## **Language, style:** Good

The language and style of the paper are clear and appropriate for an academic work. The author effectively communicates their ideas and concepts related to AI in education. -

### **Relevance of Keywords and Summary to the title** Good

The keywords and summary accurately reflect the main topic of the paper, which is Artificial Intelligence and Digital Technologies in Future Education. They provide a concise overview of the key concepts discussed in the paper.

The most of the authors mentioned in the text are directly cited or referenced.

### **Summarization:**

The text is well-written, structured and informative. It presents an interdisciplinary approach to developing an AI-based education concept that draws on various theories, methods, and technologies from philosophy, psychology, mathematics, and computer science. It shows how different aspects of human and machine learning can be related, compared, and integrated into a coherent framework. It also provides some examples, diagrams, and references to support its arguments.

### **Some strengths of article are:**

- It deals with traditional theories such as behaviorism, cognitivism, constructivism, and connectivism, and shows their influence on computer-based learning approaches.
- It traces back the historical development of computer theories such as fuzzy logic, probabilistic thinking, artificial neural networks, and genetic algorithms, and shows their connections with traditional logic such as Aristotle's bivalent logic or Lukasiewicz's multivalent logic.
- It defines soft computing as a method that mimics or complements the functioning of human mind to think and learn in an environment of uncertainty and imprecision.
- It introduces computational thinking as a necessary skill for solving complex problems that arise from new technologies.
- It shows how knowledge, critical thinking, and computational thinking can be combined to create a learning AI that helps with problem solving.

### **Some weaknesses** of the article are:

- It does not explain how or why 4IR will lead humanity into an era of near-free energy, goods, and services, or how an AI-based education will be an integral part of 4IR.
- It does not provide enough evidence or sources to support some claims such as how fuzzy logic imitates human learning or how social robots can enhance e-learning.
- It does not discuss potential challenges or limitations of applying AI-based education such as ethical issues, privacy concerns, or social implications.

Overall, the text is academically interesting, deep, original, and comprehensive, but it could be improved by providing more justification or citation for some statements or assumptions, or by addressing some possible criticisms or questions that might arise from its proposal.

### **A more detailed analysis of the text:**

#### **1. Interdisciplinary approach to the development of AI-based education**

The author has succeeded in creating an interdisciplinary approach for an AI-based learning concept and showing how there are analogies between human learning and machine learning that form a natural basis for human-machine learning interaction.

He first orientates himself to Turing's questions about the properties of AI and shows at many points in the text how different learning methods and thinking styles can be combined to model, interpret and explain human behavior data-based. He shows analogies between computer thinking and human thinking. This is done under the premise that humans bring the computer closer to their human nature, adapt it more and more to their needs and integrate it into the basic human processes such as learning.

He creates an overview *of the connections between learning approaches, theories and methods of philosophy, learning, AI, machine learning, in which he marks the building blocks for the underlying integrative framework of an extended AI learning concept*. AI-based technologies (Artificial Intelligence), Turing test (a test for assessing the intelligence of machines), behaviorism (a psychological theory that understands learning as a response to stimuli), cognitivism (a psychological theory that understands learning as an active process of information processing), constructivism (an educational theory that understands learning as an active construction of knowledge by the learner), connectivism (an educational theory that understands learning as a networking of sources of knowledge through digital media), chaos theory (a mathematical theory that describes the behavior of dynamic systems that can be strongly influenced by small changes), self-organization (a process in which a structure or pattern forms without central control or planning), knowledge-based systems (computer systems that can store and use knowledge from various sources), ontologies (formal descriptions of concepts and their relationships in a specific domain), social robots (robots that can interact with humans or other robots), e-learning (electronic learning with the help of digital media and technologies), soft computing (an approach of artificial intelligence that tolerates uncertainty and imprecision and is based on the human way of thinking), fuzzy logic (a form of logic that allows more than two truth values), probabilistic thinking (a form of thinking that takes into account probabilities and uncertainties), artificial neural networks (computer systems that mimic the human brain and consist of interconnected units), computational thinking (a form of thinking that analyzes and solves problems in a way that is suitable for computers).

#### **2. Strengths:**

The author visualizes his approach by a graphical representation.

The approach deals parallel as well with trends as with traditional theories. It shows e.g. the influence of Piaget's

psychology on the learning approaches and paradigms of computer-based learning (e.g. APOS). It also shows concrete examples of how certain approaches have been incorporated into learning models.

### 3. Connection between traditional philosophy and computer theories

The author develops a roadmap with the development of individual applications of computerized solutions and searches for and discovers connections with the functions of the human mind. He defines soft computing as a method that "mimics the functioning of the human mind to think and learn in an environment of uncertainty and imprecision". He models in this way a new framework for understanding the technologies and their closeness to humans, from whose mind they have sprung. He explains why and how soft computing with the "topics fuzzy logic (FL), probabilistic thinking, artificial neural networks (AANs) and genetic algorithms (GAs)" relates to the mind and offers an original synthesis.

*He traces back the historical development of the approaches of computer theories, compares them, looks for conformity, relationships, influences and finds them in the traditional approaches of philosophy, with their exploration of the mind.*

Thus, the computer theories appear as a legacy and embodiment of **traditional theories**, which are extended with **new language models**. He takes a look at the connections between traditional logic of Aristotle, newer logic of "middle truth values" by Lukasiewicz and Tarski, Zadeh (fuzzy logic, 1970) and describes how these schools of thought have received a further development in soft computing. Thus, for example, fuzzy logic from his point of view represents the extension of **Aristotle's traditional bivalent logic**. He examines these schools of thought from tradition from the perspective of a breeding ground for computational thinking and shows that these logics have played a key role in the development of intelligent technologies, that are also suitable for human learning from this logical basis.

He refers to other own studies on this topic from 2019 and emphasizes the important role of fuzzy logic. The emphasis on the importance of fuzzy systems, KNNs, Bayesian Reasoning and Neuro-Fuzzy Systems is explained in terms of how they link and use data from the real world, which is similar to how the brain links data when learning. He sees a comparability between fuzzy logic, learning and brain and describes fuzzy logic as an imitation of human learning. Their greatest similarity lies in their use for problem solving in situations of uncertainty. That's why:

- they are integrated together in learning algorithms to solve problems by quickly and adaptively identifying patterns.
- they mimic or complement the functioning of the human mind to think and learn in an environment of uncertainty and imprecision.
- they are based on different theories and logics that have influenced the development of intelligent technologies and human learning.

The author shows how from combining three components - knowledge, critical thinking, and computational thinking – emerges the learning AI, which helps with problem solving. He addresses the aspect of enslavement of humans by "intelligent machines" and how to avoid it - by constantly working with symbols and numbers, and by critically searching for and rediscovering new evidence in them.

### 4. Computational Thinking as Problem Solving Approach in Learning

The key role of computers and soft computing is addressed, analyzed and highlighted in sections 2 and 3. Section 4 deals with comparing traditional and digital learning. He **compares in particular behaviorist, cognitivist-constructivist and connectivist learning approaches**. He shows the interactions, influence of theories and new elements that are integrated into learning.

The author shows how computers and AI-based tools can support and promote human mental activity by moving him from one mental state to another. This process is influenced by sociological constructivists and based on internalization of actions and experiences. He refers to his own writings in this context, which is relevant.

He rightly emphasizes very current that critical thinking alone is not enough to solve many problems that have arisen through the development of new technologies. He introduces computational thinking, supported by AI as a necessity for problem solving and consequence of complexity.