AIEd Theory Macro Model Foundations

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The AIEd Theory Macro Model helps to insure a metacognitive and ethical role of the use of AI in education. Embracing a new age yet celebrating traditional instructional design principles through casting learning theories and mixed methodologies. The macro model consists of three simple overlapping discourse communities of applied learning theory, computer system analysis, and effective student learning. Learning theories and methodologies cast across the communities that best support given learning designs. The model roughly defines computer systems analysis as all hardware and programmatic solutions to teaching (from hardware devices – through the cloud). Effective student learning states that this model is learner-centric. This space in the evolution of AIEd where types of artificial intelligence and the impact on learning is not always recognized. Where interaction with big data and complex multimodal systems demand an ethical approach by way of metacognition.

Keywords: AIEd, Casting Requirements, Formative Evaluation, Learning Theories, Metacognition

Introduction

What is AIEd

Before we begin, let's agree on a few terms and perspectives. Artificial intelligence in education (AIEd) comes in various forms see Appendix A: Uses of AIEd. But at its core, the AIEd Theory Macro Model views artificial intelligence as a set of algorithms, systems and subsystems, and interfaces with the explicit intention of helping to facilitate knowledge acquisition for the purpose of effective student learning in a pedagogical setting.

Architecturally, the algorithms, systems, and interfaces can be assembled in ways limited only by the human imagination. The field of AIEd is not without skepticism. But it must be pointed out that algorithms and system models are the basis of a determinately human endeavor (Luckin et al., 2016). The field of AIEd is both trite and ingeniously innovative. It beckons continued research in computer science, behavioral psychology, epistemology, and learning theories among other disciplines (Holmes et al., 2019; EDUCAUSE, 2013).

Ethics in a Metacognitive Approach

It is warranted to have a degree of skepticism to AIEd. And to champion the fact that every human being learns differently. In instructional technology, there is an obligation to cross examine every permutation of AIEd for potential bias particularly of multimodal content delivery systems. Yet to observe an apparent yearning as a human endeavor to search for less didactic and potentially more motivating approaches to learning. Fostered in the overwhelming importance and simple contentment of learning (Bstan-dzin-rgya-mtsho, 1999).

Core Theory Model

Albert Einstein is quoted as saying, "It's the theory that decides what we observe." For the purpose of this paper, AIEd Theory Macro Model Foundations, the focus of AIEd technologies is to facilitate knowledge acquisition for the purpose of effective student learning in a pedagogical setting. This theory is designed in the spirit of promoting further research and development of new systems and testing technologies. The theory model is designed to help bridge the gap of well-designed formative assessment processes and emerging technologies (Jamenez, 2021).

The analysis, design, development, implementation, and evaluation (ADDIE) modal is an existing system with an outcome-based approach. It allows for the "analysis of the interlocking connection between components, especially the relationships between strategy and desired learning outcomes" (Dick et al., 2015). However, a typical ADDIE formative evaluation process may not be iterative enough for some types of AIEd systems where evaluations happen literally at the blink of an eye with learning agents supported by computer vision and proprioception.

We must recognize that the complexity and ubiquitous nature of AI adds significant demands on the definition of technical strategies and how those strategies impact learning outcomes in a pedagogical setting. For example, there are aspects of AI that contribute to learning either directly or indirectly. There are uses of AI that we no longer label as AI like grammar check, spellcheck, and voice assistance. What's more, some AI educational systems are so massive and rely on subsystems to the point the original objective is lost. These are some of the issues to take into account when considering AIEd theory. For some examples, please see Appendix A: Uses of AIEd.

The AIEd theory macro model has three overlapping domains of discourse that encompasses a larger scheme of the traditional ADDIE model. An integrated system includes: applied learning theories (learner analysis), computer systems analysis (strategies), effective student learning (instruction goals).

Learning Theories and Methodology

To maintain a metacognitive approach of AIEd it is necessary to identify learning theories and methodologies for any given scenario. We must ponder the larger research questions of epistemology and folksonomy. What is the nature of knowledge and how is it represented? How may we best help the learner?

One methodology in the emerging technology of AIEd offers three paradigms: 1) AI-directed *learner-as-recipients*, 2) AI-supported *learner-as-collaborator*, 3) AI-empowered *learner-as-leader* (Ouyang et al,. 2021).

Casting Requirements

An AI-driven multimodal interactive learning must supplicate learning theories such as behaviorism, cognitivism, constructivism, connectivism, experientialism, among others.

Artificial intelligence has been in use for so long that its everyday use is cooped with labels like grammar check, spellcheck, and voice assistance. With the ubiquitous nature of AI, attention needs to be paid to what AI is impacting student learning and how it impacts your lesson or system. To maintain metacognition, we must observe what roles the theories and methodologies play in a given curriculum plan. What is the extent of both planned and unplanned application of AI technologies that influence learning and instruction (Hwang et al., 2020).

The educational software development process begins with requirements. Please see figure 1. Casting is a way to establish the requirements for a pedagogical setting by articulating what is needed. What is the gap as we see in an ADDIE model? The requirements contain arguments that state what learning theories are the most appropriate for the desired learning outcome and given strategies.
If an educational design team were to put forward requirements for voice assistance skills. They might want to observe and expand on theories as provided by (https://www.educationcorner.com/learning-theories-in-education/), for example.

One example of casting the requirements for educational software development focused on voice assistance custom skills as a learning strategy might be to choose a blend of theories or maybe focus on theories such as Gagne's 5 categories of learning where some of this information was pulled from (https://educationaltechnology.net/robert-gagnes-taxonomy-of-learning/). In so focusing on the cognitive domain that contains intellectual skills, cognitive strategies, and verbal information. The cognitive strategy requires learning and thinking. Learning requires rehearsing, elaboration, and organization. Thinking is more meta cognitive by setting goals, tracking progress, and modifying strategies (Kurt, 2020). Verbal information is key to rehearsal which in turn promotes higher learning efficacy (Effective Student Learning. Please see figure 2.) Verbal information is full of facts. Verbal information with

use of memory aid techniques is at the core of voice AIED to achieve declarative knowledge. Easy partner to rehearse and social learning.

Computer Systems Analysis

In the past, education portrayed a lack of necessity towards AIEd as a viable learning and teaching tool. Rightly so. Traditionally, computer science has been the driving force behind AIEd. However, as this technology has emerged and better tools come available, pedagogy has been disposed to better understand the importance of providing requirements to educational technology based on a host of learning theories and methodologies (Cumming et al., 1999).

The field is so vast that it's best for the AIEd Theory Macro Model to place all computer systems analysis as having the potential of AI in a discourse domain with overlapping amenable work of applied learning theories, and effective student learning. We are in new territory in light of emerging technical strategies supporting systematic design of instruction.

The baseline is no artificial intelligence in education. In fact, no tech at all. Imagine rows of wooden benches in a meadow. No internet or cellular access. There's an instructor with an old-timey chalkboard and books. For millennium societies modeled educational settings as such.

Now as you begin to plan instructional design based on user analysis and learning outcomes, what can computer's offer? Are you allowing grammar check, spell check, voice assistance, or voice-to-text in your design? Do you have a narrow objective that can be supported by an intelligent tutoring system (ITS)? Or do you require modeling supported by deep learning?

An ITS is a computer system that aims to provide immediate and customized instruction or feedback to the learner, usually without requiring intervention from a human teacher according to wikipedia.org. Deep learning can create rules on hidden patterns needed for natural language processing and image classification. Classical machine learning for straightforward tasks and is not best suited for unstructured data (Clarusway, 2021).

Effective Student Learning

The AIEd Theory Macro Model is learner-centered. All of the carefully crafted AI and appropriately casted learning theories molds something. This is the outcome; therefore making this section a succinct conclusion.

According to the website keydifferences (https://keydifferences.com/), the term "learning" refers to an intellectual process of acquiring new skills and knowledge, through experience, study or teaching. The term "education" is an enlightening process of receiving and providing knowledge, through systematic instruction. As a means to regulate future actions and development of new knowledge.

Goals in education for K-12 provide core concepts and essential content that set the context for the skills, character, meta learning. Adult learning, post K-12, can be seen for economic, civic, and personal reasons (Holmes et al., 2019).

It can be argued that the idea of education is a value system guided by principles and ethics. That humans approach learning as both a societal and personal endeavor. Societal needs have evolved from creating laborers with basic skills of literacy and numeracy to state sponsored schools seen as the way to higher education, status, and financial independence (Holmes et al., 2019).

As we engage this existential era of artificial intelligence in education let me quote Dr. Martin Luther King as saying, "Intelligence plus character, that is the goal of true education."

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Figures

Figure 1

Casted Requirements Feed AI Software Development

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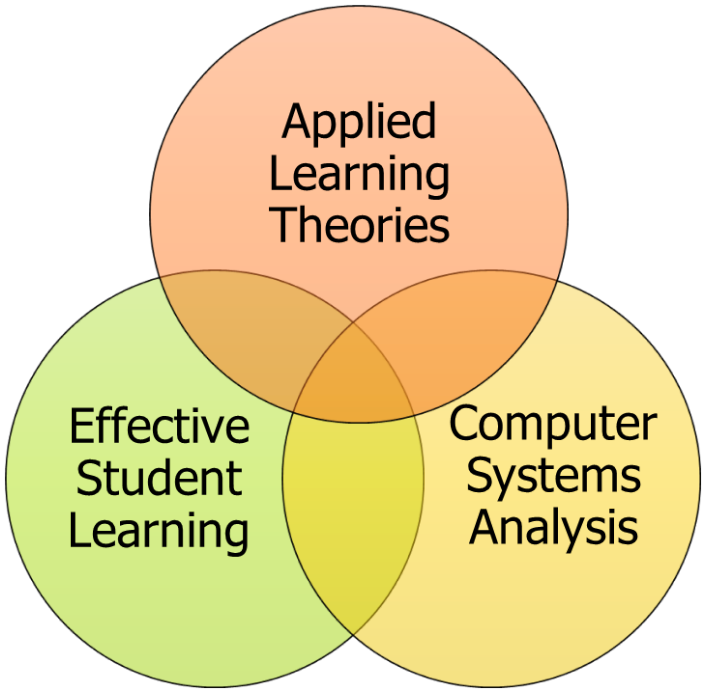
Figure 2

The AIEd Theory Macro Model



Appendix A: Uses of AIEd

The scope of AIEd is broad and can include supportive roles. Some long established uses of AIEd include domains of health, safety and finance. The following table is based on some examples of AIEd uses provided by the University of San Diego (https://onlinedegrees.sandiego.edu/artificial-intelligence-education/) with supplemented citation.

Table 1

Examples of Applied AIEd Uses

AIEd Use	Description
Adaptive Learning	"Used to teach students basic and advanced skills by assessing their prescient skill level and creating a guided instructional experience that helps them become proficient."
Assistive Technology	AI can help special needs students access a more equitable education, for example by presenting "reading passages to a visually imparied student."
Assessment	Also includes data and learning analytics to help instructors and administrators analyze and interpret data, enabling them to make better-informed decisions.
Chatbots	A chatbot is designed to simulate human-to-human conversion. However, with the help of big data new modalities between learners, instructors, and supporting technology are being explored (Timms, 2016).
Classroom Behavior Management	Machine learning enables prediction of student behavior (Rasheed et al,. 2021).
Cybersecurity	To intelligently solve today's various cybersecurity issues, popular AI techniques involving Machine Learning (ML) and Deep Learning (DL) methods, the concept of Natural Language Processing (NLP), Knowledge Representation and Reasoning (KRR), as well as the concept of knowledge or rule-based Expert Systems (ES) modeling can be used. (Sarker et al,. 2021)
Early Childhood Education	"AI is currently being used to power interactive games that teach children basic academic skills and more."
Gamification	Digital game concepts with educational design elements of elements of action (interaction), social, mastery, achievement, immersion, creativity (Blankman, 2022). With potential game analytics providing an adaptive learning environment (Tenório et al,. 2020).
Language Learning	AI-driven platforms for language learning allow users to learn at their own pace and emphasize trouble areas. It is engaging and appealing to to learner interests. That is to say that AI-driven language learning applications have elements of adaptive learning. (Rohalevych, 2020)
Learning Management Systems (LMS)	Machine learning data analysis and chatbots are the most common uses in the AIEd LMS paradigm (Teslenko, 2021).
Students Success Analysis	Improving student engagement and graduation rates by way of the following AIEd solutions: student-supported AI tools, AI designed group work, customized class improvement recommendations (Weir, 2021).

Writing	Students regularly use AI to improve writing skills. Without a thought, I'm using AI components to write this paper, AIEd Theory Macro Model Foundations.