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From Automation to Educational Value: A Conceptual Framework for Human–AI Co-Learning in Education

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Abstract

The rapid expansion of artificial intelligence (AI) in education has increased the availability of personalized learning, intelligent tutoring, generative feedback, and automated instructional support. However, technological capability does not necessarily translate into educational value. This conceptual study addresses the question: Under what pedagogical, human, and institutional conditions does AI capability translate into educational value? A critical conceptual synthesis of research on AI-supported personalization, intelligent tutoring, generative AI, cognitive engagement, learner and teacher agency, reliability, equity, and learning authenticity was undertaken. The analysis distinguishes AI capability from educational value and identifies five dimensions through which AI-supported education can be evaluated: personalization, reliability, human agency, equity, and learning authenticity. Based on these dimensions, the study develops a Human–AI Co-Learning Framework (HACLF) comprising six interconnected layers- learner, AI assistant, teacher, learning environment, governance, and society- and proposes the AI Education Value Index (AEVI) as a conceptual evaluation framework. The conceptual synthesis indicates that the educational consequences of AI are conditional on how technological capabilities are pedagogically integrated and mediated by human judgment, verification practices, equitable access, and authentic learner participation. The study contributes an education-centred perspective that shifts evaluation from what AI can automate to the conditions under which AI can support meaningful learning. HACLF and AEVI provide a basis for future empirical research and validation of AI-supported educational practices.

Keywords: *Artificial intelligence in education; Generative AI; Human–AI co-learning; Educational value; Learner agency; Teacher agency; Learning authenticity; AI literacy; Educational equity.*

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1. Introduction

Artificial intelligence (AI) has become an important part of modern teaching methods. AI tools are now used for custom learning help, automatic comments learning data analysis, content creation, test support, and talking with students. New changes in AI that create things have created more possibilities by letting students and teachers talk to systems that can make explanations, examples, summaries, questions, and other teaching materials in regular language. Because of this, the conversation about AI in school has moved from whether AI can be used for teaching and learning to how its growing abilities should be put into teaching in ways that're good for learning and responsible (Luckin et al., 2016; Holmes et al., 2019; Williamson & Eynon, 2020; Kasneci et al., 2023).

The growing power of AI does not always mean more learning value. An AI system may give information fast, make content personal, give comments, or do an instructional task without improving understanding, thinking, student choice, or real learning. For example, making things personal may make teaching seem faster but also take away chances for students to make their choices. Also, AI that creates things may give explanations and solutions, but if the system gives answers instead of helping with thinking, the student may not have to work as hard (Baidoo-Anu & Ansah, 2023; Kasneci et al., 2023; Deng et al., 2024). These problems show that the value of AI in education can't be about what the AI can do (Zawacki-Richter et al., 2019; Yogesh and Dwivedi et al., 2023; Yusuf et al., 2024).

This difference is very important because studies have shown both the opportunities and limits of AI in education. Studies on teaching systems have found good results for learning. Reviews of AI in education have found uses from testing to adapting and teaching (Ma et al., 2014; Zawacki-Richter et al., 2019). More recent studies on AI that creates things also show benefits for learning, motivation, comments, and grades, but also problems with overreliance, depending too much on it, honesty, thinking, and what teachers and students should do (Deng et al., 2024; Chen & Cheung, 2025; Qian, 2025). So, the evidence doesn't support saying that more AI use improves learning.

The main issue here is not if AI is good or bad on its own. Under what conditions does its power become learning value? This means going beyond looking at AI's abilities to looking at how tech, teaching, people, trust, fairness, and real learning work together. From this view, AI power is what the AI can do technically. Learning value is how much that helps real, fair, and human-centered learning. The connection between the two is not automatic. Depends on situations.

1.1 Research Problem

A lot of the writing on AI in education has looked at uses, possible benefits, problems, or certain learning results. This work is important for seeing how much AI is

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used. It doesn't fully explain why similar AI skills can have different learning results in different teaching and school situations. An AI tutor can help when students ask questions, check information, and use the comments. The same system may take away thinking if students just take the answers. Also, AI that creates things may help teachers by doing tasks but also create new needs for checking, changing tests, and teaching decisions.

The research problem in this study is that there's no clear difference between AI skills and learning value. Without these technical skills may be seen as learning, and more automation may be seen as better learning. A better way is to look at the situations where AI skills are affected by teachers, students, learning places, rules, and bigger social conditions.

1.2 Research Gap

Three gaps drive this study.

First, there's a lot of evidence on AI uses but less on a full way to explain when technical AI skills become good for learning. Reviews of AI in education have listed uses and research trends, while new studies on AI that creates things have looked at learning results, teaching chances, and risks. These are often looked at separately instead of being part of a single model that links AI skills with learning results (Zawacki-Richter et al. 2019; Deng et al., 2024; Liu & Zhong 2025).

Second, writing is more and more aware of the importance of people's choice, teacher help, trust, ethics, and fairness. These are not always seen as connected parts of learning. Human-focused AI approaches say people need to be in control, have choice, be clear, fair, private, and have teachers. This shows that learning value comes from how tech and people work, not just from the tech. This study builds on this by seeing these parts as parts of learning value, not separate ethics issues.

Third, there's a need for ways to guide tests. Existing studies often look at one result or use case, while schools need a basis to see if AI uses are personally trustworthy, keep people's choice, fair and real. This study fills that gap by providing two ways: the Human–AI Co-Learning Framework (HACLF), which explains how learners, AI, teachers, places, rules, and society work together; and the AI Education Value Index (AEVI), which organizes five parts for checking learning value.

1.3 Research Question and Objectives

The study is guided by this question:

RQ: Under what teaching people and school situations do AI skills turn into learning value?

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To answer this, the study has three goals:

1. To look closely at how AI skills and learning value are connected by looking at teaching quality, people's choice, trust, fairness, and real learning.

2. To develop the Human–AI Co-Learning Framework (HACLF) that explains the roles and interactions of learners, AI help, teachers, learning places, rules, and society.

3. To introduce the AI Education Value Index (AEVI) as a way to check AI uses across five parts: personalization, trust, people's choice, fairness, and real learning.

These goals make the study a way to think about things, not an experiment to see if AI works. The ideas and parts are meant to give a base for tests.

1.4 Conceptual Orientation

The study looks at the education of tech. Its main idea is that AI skills are needed but not enough for learning value. How AI is used in teaching and how students and teachers use the tech effects the value.

So, the way of thinking in this study can be shown as:

AI Skills → Teaching Use → People and AI Use → Learning Value

In this path, learning value is seen as depending on AI skills, teaching quality, people's choice, trust, fairness, and real learning:

$$EV = f(AC, PQ, HA, R, EQ, LA)$$

where EV is learning value; AC is AI skills; PQ is teaching quality; HA is people's choice; R is trust; EQ is fairness; LA is real learning.

This is a way of thinking, not a math formula; it doesn't say there's a link. Instead, it shows the parts to look at when checking if AI uses make value.

The model also sees learning value is different in places. The same AI skills can have different results because of how teachers help students take part, how schools support tech use, rules are made, and society is. This matches human-focused AI in education, which says people's choice, ethics, clear use, and fair involvement are important (UNESCO, 2021; Miao & Cukurova, 2024; UNESCO, 2025).

1.5 Contribution of the Study

The study adds three ideas. First, it separates AI skills from learning value, so the idea that tech's better means better learning is questioned. Second, it introduces the Human–AI Co-Learning Framework (HACLF) as a way to see how AI, students, teachers, schools, rules, and society work together. Third, it introduces AEVI as a way to check AI uses around personalization, trust, people's choice, fairness, and real learning.

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Together these ideas move the focus from how much AI can do to how AI can be part of learning without taking away the thinking parts that make learning real. The model doesn't say AI should take over teaching; it looks at the situations where AI can help people support students and make learning fair and real.

The rest of the article shows this by looking at the study, using a way of thinking to form HACLF and AEVI, and talking about ideas for tests.

2. Theoretical Framework: From AI Capability to Educational Value

2.1 Theoretical Orientation

The rapid development of artificial intelligence (AI) has brought new technical possibilities to education. These include feedback, intelligent tutoring, automated content creation, learner analytics, and conversational support. Having the technology does not mean it will lead to better learning. The same AI capability can support learning in one setting, while in another it may lead to shallow engagement, overdependence, unfair outcomes, or unreliable learning. The main idea of this study is that AI capability and educational value are not the same thing. They are related. They are separate and should be understood differently.

This study builds a framework focused on education. It brings together four viewpoints: Social Cognitive Theory and human agency, Self-Determination Theory, the ICAP framework for cognitive engagement, and the human-centred view of AI in education. These perspectives help us understand how learners, teachers, AI systems, institutions, and governance structures work together. They help determine whether AI in education leads to learning. This framework draws from research by Holmes et al. (2019), Luckin et al. (2016), Ma et al. (2014), and Zawacki-Richter et al. (2019).

The framework changes how we think about AI in education. Instead of asking "What can AI do in education?" we should ask "Under what teaching, human, and institutional conditions does what AI can do become educationally valuable?”

2.2 AI Capability and Educational Value

AI capability refers to what an AI system can do in an educational setting. This includes generating explanations, adapting learning materials, giving feedback, helping solve problems, analyzing learner data, and supporting assessment. These are the things an AI system's able to do, not necessarily the learning outcomes it produces.

Educational value, on the other hand, refers to how well AI-supported practices support deep, reliable, fair, and human-centred learning. Educational value depends on more than the technology. It also depends on the quality of teaching, how learners are involved, teacher judgment, accuracy of information access for all students, and the truthfulness of the learning process.

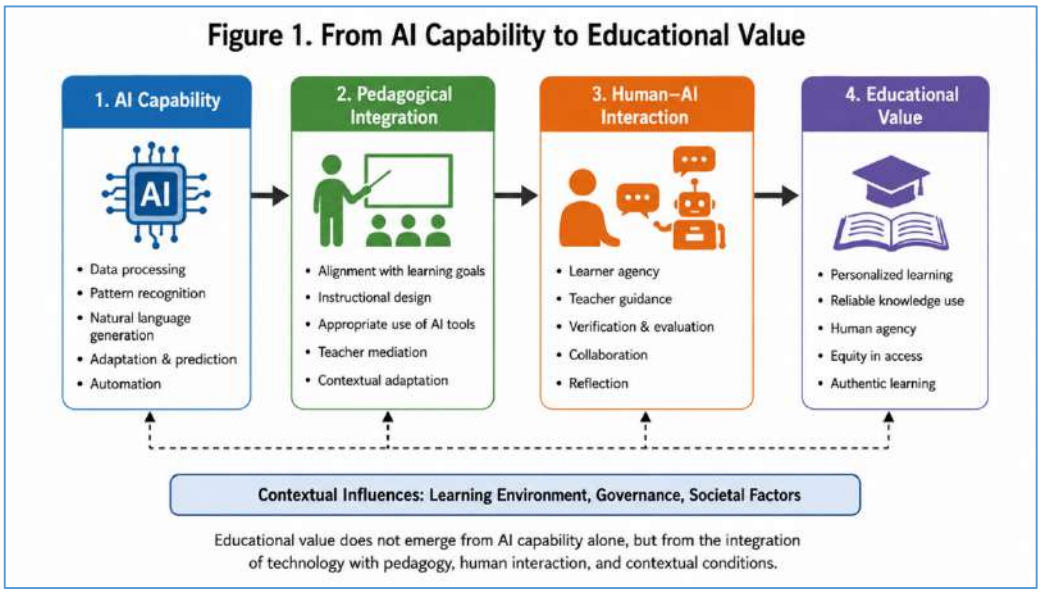
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We can represent this relationship conceptually as:

$$EV = f(AC, PQ, HA, R, EQ, LA)$$

Here, EV stands for value. AC is AI capability. PQ is quality. HA is agency. R is reliability. EQ is equity. LA is learning authenticity. This is not a math formula to be tested. It is a way to show that educational value comes from the interaction between technology and other important factors in education

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2.3 Social Cognitive Theory and Human Agency

The first theory used in this framework is Bandura's Social Cognitive Theory. A key idea here is agency. Bandura (2001) says people are not passive. They can control their actions, make decisions, think about consequences, and shape their learning environments. This is important for AI in education because AI systems are taking over tasks that learners used to do themselves.

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From this point of view, the question is not whether AI can do a task. But whether the learner stays active in the thinking and decision-making process. AI-supported learning becomes a problem when learners stop doing the work themselves and let the system take over. This can happen when learners hand over planning, reasoning, evaluation, and choices to the AI without keeping control.

The framework makes a difference between AI-supported agency and AI-substituted agency. AI-supported agency means the AI helps learners explore, ask questions, compare ideas, practice, and reflect. AI-substituted agency means the system does the work that the learner should be doing, which reduces the chance to think independently.

This idea supports the importance of agency in educational value. It also supports the role of the learner in the Human–AI Co-Learning Framework (HACLF), where learners are active participants, not just passive users of AI content.

2.4 Self-Determination Theory: Autonomy, Competence and Motivation

The second theory is Self-Determination Theory (SDT), which focuses on autonomy, competence, and relatedness as key to motivation and engagement (Deci & Ryan, 2000). AI can help support these needs by giving feedback, adapting help by offering multiple explanations, and letting learners go at their own pace. Too much automation can reduce a learner's sense of control.

Autonomy is especially important. It helps us see the difference between help and full substitution. A learner who uses AI to compare answers can find gaps in understanding. Getting feedback may still be in control. A learner who constantly asks AI to write answers, solve problems, or make decisions without checking them may lose ownership of their learning (Chi & Wylie 2014).

AI personalization can help learners feel more competent by offering support that fits their level. This only adds educational value if it helps learners become more independent over time, not if it makes them rely on AI forever.

SDT strengthens the idea that educational value should include learner freedom and meaningful involvement. It should not be judged by speed or task completion.

2.5 ICAP Framework and Cognitive Engagement

The third theory is the ICAP framework by Chi and Wylie (2014). It divides engagement into four levels: passive, active, constructive, and interactive. This is useful for analyzing AI because AI can make answers faster but also reduce the mental effort learners put in (Chi & Wylie, 2014; Kirschner et al., 2006; Mayer et al., 2021; Bjork & Kroll, 2015; Cotton et al., 2024). AI can help with constructive learning when learners use it to create questions, compare explanations, get feedback, test ideas, or change their

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thinking. When AI gives the final answer that the learner should be making, it becomes a form of cognitive substitution (Floridi et al., 2018; Magerko et al., 2020).

This difference matters because finishing a task does not mean learning has happened. A student might turn in a written AI-generated answer but still not understand the topic. So, the real value of AI should be measured by whether it supports cognitive work. The framework treats learning authenticity as a part of educational value. Authentic learning means learners must contribute meaningfully to the process even when AI is helping.

2.6 Human-Centred AI and Distributed Educational Responsibility

The fourth theory is the human-centred view of AI. This approach focuses on control, transparency, fairness, safety, privacy and meaningful participation in AI systems. In education, this is especially important because decisions about learning affect students' growth, opportunities, identity and future in society. A human-centred view does not assume that more automation is better. It says technology should serve goals and human judgment. This means teachers should not just watch AI tools. They must still make teaching decisions, interpret results, assess learning, and ensure standards. This view also considers the system. Educational value is shaped by school policies, teacher training, technology access, data rules, and social conditions. The framework sees AI-supported education as a system, not just a student using a tool. AI capability adds to value not directly, but through good teaching integration and human support.

This idea supports the Human–AI Co-Learning Framework (HACLF). In HACLF, the learner, AI assistant, teacher, learning environment, governance, and society are all parts of the educational system.

2.7 Integration of the Theoretical Perspectives

The four theoretical perspectives address different but complementary dimensions of AI-supported education.

Theoretical perspective	Central concept	Relevance to AI-supported education	Framework dimension
Social Cognitive Theory	Human agency	Maintains learner control, intentionality, and self-regulation	Human agency
Self-Determination Theory	Autonomy and competence	Explains whether AI supports learner ownership, and motivation	Human agency / Personalization
ICAP Framework	Cognitive engagement	Distinguishes productive AI assistance from cognitive substitution	Learning authenticity
Human-Centred AI	Human control, fairness, and accountability	Places AI within ethical, institutional and social conditions	Reliability / Equity / Human agency

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The integration of these perspectives produces the central theoretical proposition of this study:

AI capability contributes to educational value not directly, but through pedagogically meaningful integration and human mediation.

This proposition provides the theoretical foundation for the proposed Human–AI Co-Learning Framework (HACLF). In HACLF, the learner, AI assistant, teacher, learning environment, governance structures, and wider society are treated as interconnected components of the educational system.

2.8 Five Dimensions of Educational Value

Based on the theories above, the study identifies five dimensions for evaluating the educational value of AI-supported learning:

- Personalization means AI can adapt to what each learner needs, including their pace, background knowledge, and learning style. It must still fit good teaching practices.
- Reliability means not that AI outputs are correct, but that learners and teachers can check, understand, and use them properly.
- Human agency means learners and teachers have control over what happens in learning. They should be able to decide, interpret, evaluate and guide the process.
- Equity means that all learners, regardless of background, have access to the benefits of AI. This includes tools, skills, money, and school support.
- Learning authenticity means learners are actively involved in thinking, reflecting, creating, and judging during the learning process.

These five dimensions are linked. For example, personalized AI might be convenient. If it reduces learner control, it may not create much educational value. AI can help learners work faster. If it takes over their thinking, it may hurt authenticity. So, the framework does not judge AI by its power alone. It judges it by how it works with teaching, human participation, and the purpose of education.

2.9 Theoretical Foundation for the Human–AI Co-Learning Framework

The theoretical framework leads directly to the proposed Human–AI Co-Learning Framework or HACLF. This framework sees activity as a relational process made up of six interconnected layers:

1. Learner – stays active in learning by questioning, verifying, reflecting, and taking part in various ways. The learner keeps control over their learning journey.

2. AI Assistant – supports learning through explanation, feedback, content generation, adaptation, and cognitive scaffolding. It helps students understand and engage with material.

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3. Teacher – brings expertise to guide learning. They make judgments about context, assess student work, and oversee the learning process.

4. Learning Environment – includes everything that makes learning possible: infrastructure, assessment methods, institutional policies, and professional development for educators.

5. Governance – sets rules and expectations around privacy, transparency, accountability, academic honesty, fairness, and responsible use of intelligence.

6. Society – shapes access to education, inclusion, cultural values, economic opportunity and how people participate in technology.

These six layers are not meant to be followed step by step. They form a distributed system where responsibility is shared. The learner and teacher remain central in making decisions about education. AI plays a supporting role, helping learners grow while adapting to the needs of the classroom and school environment.

This theoretical foundation also lays the groundwork for the AI Education Value Index (AEVI). AEVI is introduced here as a tool to evaluate AI in education. It focuses on five areas: personalization, reliability, human agency, equity, and learning authenticity. At this point, AEVI is not a scale or a measure with statistical weight. It is still a concept. More research will be needed in the future to turn it into something. That includes finding indicators, deciding which parts matter most, and testing whether it can be trusted and used consistently.

2.10 Summary of the Theoretical Argument

The theoretical framework draws a line between what technology can do and what educational value means. Social Cognitive Theory shows that learners must stay in control of their learning. Without agency, motivation and understanding suffer. Self-Determination Theory adds that students need autonomy and a sense of competence to engage. The ICAP framework reminds us that real learning only happens when learners are actively involved, not just passively receiving information. Human-centred AI perspectives highlight the need for teachers to remain in charge for systems to treat all learners fairly, for accountability to exist, and for institutions to have strong governance.

All of these ideas together lead to one conclusion: AI should not be judged only by how much it can take over from teachers. Its true value lies in whether it strengthens potential without removing human control. It should support thinking, provide trustworthy resources, help more people learn equally, and stay in line with sound teaching goals.

This theoretical view gives a base for the next part of the study—the literature review—and for building both the Human–AI Co-Learning Framework and the AI Education Value Index.

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3. Critical Literature Review

3.1 Evolution of Artificial Intelligence in Education

Research on intelligence in education (AIED) came before the recent rise of generative AI. Earlier studies focused a lot on tutoring systems, learner modelling, prediction, automated assessment, adaptive learning, and educational recommender systems. These efforts showed that it is possible to use computer systems to offer instruction.

A major review by Zawacki-Richter et al. (2019), which looked at 146 studies from a group of 2,656 publications, showed how wide the range of AI uses is in higher education. However, the review also found a problem in the field: most of the research came from computer science and similar technical areas, while the role of teachers in education was not given much attention. This is important because it suggests that the growth of AI in education has often been based more on what technology can do than on how it should be used in teaching.

Studies on tutoring systems show that AI can help learning. Ma et al. (2014), in a review of studies, found positive changes in learning results. These findings helped set the stage for AI-based learning. Just because a specific technology works does not mean that AI is enough on its own to improve education. The effect on learning depends on how the technology's used in the teaching process.

This difference has become more important with the rise of AI. Unlike systems, generative AI can have open conversations, give explanations, make examples, help with writing, and coding and respond to questions in real time. This means that the relationship between students and AI is more interactive and less predictable. The research now needs to tell the difference between what AI can do and what students actually learn from using it.

3.2 AI-Assisted Personalization and Adaptive Learning

Personalization is one of the often-mentioned benefits of AI in education. AI systems can look at how students respond, find patterns in their performance, suggest materials, change the difficulty of tasks, and give types of feedback. These skills seem to fit with helping students who have different learning needs.

Personalization should not automatically mean that learning is effective. An AI system might give specific content but not notice a student’s wrong ideas, their motivation, or their bigger educational needs. Also, personalization might help students do better on tasks but not help them become more independent in the long term.

New research supports this idea. Liu and Zhong (2025), in a review of 71 studies on GenAI and student learning from a TPACK perspective, found that GenAI can help

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with thinking, feelings, and actions, but found problems with how the studies were designed and how teaching was supported (Xiaoyu, Zainuddin, & Hai Leng, 2025). Their analysis stressed how important it is to have teaching guidance and to include AI in learning.

Similarly, Qian (2025) looked at how teachers use AI and said that its use in teaching is growing fast. This research is important because it takes the discussion from the technology itself to how it's used in teaching.

The research shows that personalization can be an AI feature, but it should not be seen as an end in itself. The key question is whether the support from AI helps students understand better and become more independent or if it just makes completing tasks. This difference helps treat personalization as one part of what makes education valuable, not as a sign of education on its own.

3.3 Generative AI and Learning Outcomes

The rise of AI has brought a lot of new studies on AI-based learning. These studies have looked at things like making explanations helping, with writing, brainstorming, tutoring, giving feedback learning, languages, coding, solving problems, and preparing for tests.

Recent studies show that there are effects, but the results are different depending on the situation. Chen and Cheung (2025), who studied 57 studies and 97 results, found that GenAI helps university students with their learning, including grades, language skills, feelings, and higher-level thinking. They did not find any big effect on metacognition. The size of the effect changed depending on the students, the tools used, the role of AI, and the situation.

Another review from 2025 looked at experiments and found a moderate positive effect from GenAI on learning, but there was a lot of difference between studies (Cogaltay and Karadag, 2015). The authors said that things like the level of education, how long the study lasted, and who was involved mattered a lot.

Evidence is also found at levels of education. Liu et al. (2025), who studied 49 articles with students from K–12 and higher education, found that GenAI helps with learning and motivation and looked at the factors that affect this. Recent research still shows a conditional effect, not a completely positive one. A 2026 review of 39 studies on how university students use GenAI found that real learning results were mostly good. How students felt about the learning was mixed.

Together, these findings challenge both the idea that AI's always good and the idea that it is always bad. The evidence does not say that GenAI is always helpful or always harmful. Instead, the results seem to depend on how the technology's used in learning, which thinking tasks are given to AI, what support teachers give, and how

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learning is measured. This evidence supports the point of this study: AI should be seen as a possible tool for education, not as proof that education is good on its own.

3.4 AI Help, Thinking and Real Learning

One of the questions in the research is how AI help affects how students think. Generative AI can make it easier to get answers. That does not always mean students are learning.

The ICAP model from Chi and Wylie (2014) gives a way to think about this. It separates levels of thinking: passive, active, constructive, and interactive. From this view, AI can help learning when it makes students ask questions, compare ideas, explain things, evaluate, and change their thoughts. If AI does the thinking that students should do, it might lower the value of learning.

New reviews back up this idea. Chen and Cheung (2025) found that GenAI helps with higher-level thinking but not with metacognition. This mix is important because it suggests that doing better on tasks or thinking level doesn't mean students are learning to manage their own learning better.

This issue is especially important in writing, solving problems, and tests. If a student asks AI to write an answer and submits it with little change, the result might show what AI can do, not what the student has learned. But if the student uses AI to get ideas, find mistakes, challenge assumptions, and improve their own answer, then AI could be a helpful tool.

This study makes a difference between AI help and AI taking over. AI help supports learning while keeping students involved. AI taking over moves most of the thinking from the student to the system. This difference is the basis for thinking about learning in the education framework. Real learning is not about not using technology. It is about whether the student's truly involved in the thinking and doing that builds and shows knowledge.

3.5 Trust, Checking and Learning Risks

Another big issue is how reliable the information from AI is. Traditional education tools. Suggest information from defined sources. Generative AI, on the other hand, gives answers that look sure but may have mistakes, unsupported ideas, or wrong thinking. This creates a problem for learning. Students might think that what AI says is true just because it sounds confident. Teachers might not be able to check every mistake from AI. So, AI-based learning needs more than access to information. It also needs ways to check and evaluate sources and make judgments.

The research now sees this as a problem. Recent studies say that GenAI can help learning if used right, but different situations and results make it hard to say that more

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AI use always means learning. The point is that trust should be seen more broadly than just how accurate the AI is. Educational trust involves at least three parts: the quality of what AI says, how well students can check it, and how well teachers can give the right advice. So, this study sees trust as something that's not just about the software. An AI answer becomes useful in education when there are ways to check and understand it.

3.6 Choices and Teacher Choices

The research also shows a change from focusing on technology to focusing on people. Bandura's (2001) theory says that people are active in making choices, regulating themselves, thinking, and controlling their actions. This theory is important for AI learning because, as more things become automated, students might start giving up their thinking and decision-making to AI.

Self-Determination Theory also says that being able to make choices and feeling capable is important for learning (Deci & Ryan, 2000). AI can help with this by giving help when needed. It can also take away choices if students rely too much on automated tools.

Teachers also play a role. Zawacki-Richter et al. (2019) found that teachers were not often part of early AIED, studies showing that there was a balance between tech and teaching. Recent GenAI research now says that how teachers guide learning is very important. Liu and Zhong (2025), for example, say that teaching support is important when using GenAI in student learning.

This shows that teacher agency should not be thought of as being against AI. Instead, the teacher's job changes from being the one who gives information to becoming someone who designs, helps guide, checks and makes sure AI used in learning is ethical.

The theory part says that educational AI should work in a system where humans, and AI share work. In this system the AI, students, and teachers still have important jobs making decisions about education.

3.7 Educational Equity, Access and Governance

Another problem with focusing on ability is that it might assume AI helps all students the same. In reality, how much students can use AI depends on things like technology, internet, devices, how good they're with technology, what the school has, how prepared teachers are, and their money situation.

Recent studies have looked at this. A review from 2025 about GenAI and education inequality found that personal help, teacher support, chances to learn, and checking how students learn are good factors. It also said that if AI is not managed well, it can make existing differences in education worse.

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So, the value of education can't just be seen from the students' point of view. An AI tool might work well for a student who has a lot of help but not much for a student who doesn't have good internet or know how to use AI. Also, automatic systems can cause problems with privacy and fairness, making sure things are fair and keeping work honest.

This makes it even stronger to think of fairness and managing AI as parts of educational value, not just extra things to think about. A human-centred AI way means that schools need to think about more than just if an AI tool works. They also need to think about who it helps when it helps and who gets the parts and the bad parts.

3.8 From Focusing on Tools to a Full View of Education Value

The studies we looked at show that research on AI in education has given a lot of proof about specific tools and results. The evidence is spread out in different areas that are not all connected.

The first studies on tutoring and systems that change how they teach mainly look at personal help and how well the teaching works. Second, research on GenAI looks more at how students learn, writing, help given, solving problems, and how students use the tools. Third, studies from learning science look at how students are involved, how independent they are, and how real their learning is. Fourth, human-centred AI research talks about being in charge, being clear, being fair, keeping things private, and making sure things are fair.

These areas do not provide complete ideas when looked at on their own. For example, proof that AI helps students learn doesn't say if students are still thinking a lot. Proof that AI can help make learning fit each student doesn't say if that helps them be more independent. Proof that AI can help give help doesn't say if the help is good enough. Also, proof that the technology works well doesn't say if all students can use it.

This study finds that the problem is not about the technology. It is about putting everything.

The gap can be summarised as follows:

Literature emphasis	Major contribution	Remaining limitation
Intelligent tutoring and adaptive learning	Demonstrates potential for personalised support	Limited attention to broader human and institutional conditions
Generative AI and learning outcomes	Provides emerging empirical evidence of learning effects	Outcomes vary substantially by context and instructional design
Cognitive engagement research	Explains active and constructive learning	Not originally developed specifically for AI-mediated learning
Agency and motivation research	Explains autonomy, self-regulation and learner control	Requires integration with AI-specific risks and opportunities
Human-centred AI	Emphasises fairness, transparency,	Often remains insufficiently

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	human control and accountability	connected to measurable educational value
AI ethics and governance	Identifies privacy, bias, integrity and accountability concerns	Does not by itself explain pedagogical effectiveness
AI literacy research	Emphasises the capacity to understand and use AI responsibly	Needs stronger integration with teacher mediation and authentic learning

The central research gap therefore concerns the absence of a sufficiently integrated conceptual account of how technological capability, pedagogical integration, human agency, reliability, equity, and learning authenticity interact to produce educational value.

3.9 Critical Synthesis and Research Gap

The literature does not support a simple technological-determinist conclusion that increasing AI capability will automatically improve education. Nor does it support a purely risk-oriented conclusion that AI necessarily undermines learning. Instead, recent evidence suggests conditional effects shaped by learners, teachers, instructional design, educational context, and the particular cognitive functions delegated to AI.

Three gaps are particularly important.

First, a capability–value gap exists. Existing studies frequently evaluate whether an AI intervention improves a particular outcome, but less attention is given to the conceptual distinction between what an AI system can do and the educational value generated through its use.

Second, an integration gap exists. Personalization, learning outcomes, cognitive engagement, agency, reliability, equity, and governance are often investigated in separate research streams. A unified framework connecting these dimensions remains necessary.

Third, an evaluation gap exists. Existing evidence provides many outcome-specific measures but offers limited conceptual guidance for evaluating AI-supported education simultaneously in terms of personalization, reliability, human agency, equity, and learning authenticity.

The present study responds to these gaps by developing the Human–AI Co-Learning Framework (HACLF) and the AI Education Value Index (AEVI). HACLF conceptualises AI-supported education as a multi-level socio-pedagogical system involving the learner, AI assistant, teacher, learning environment, governance, and society. AEVI provides a complementary conceptual evaluation structure organised around personalization, reliability, human agency, equity, and learning authenticity. The contribution is, therefore, not the claim that AI is beneficial or harmful in general. Rather, the contribution lies in proposing an analytical framework for examining the conditions under which AI capability can be translated into meaningful educational value.

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4. Methodology: Conceptual Research Design

4.1 Research Design

This study uses a research design that builds on a critical review of existing papers about artificial intelligence in education (AIED), generative artificial intelligence (GenAI), intelligent tutoring systems, adaptive learning, learner and teacher agency, cognitive engagement, educational equity, AI reliability, and human-centred AI.

The goal of this method is not to measure cause and effect or to run tests. Instead, the goal is to see how different strands of existing research can be brought together in theory to explain the conditions that allow AI capability to become value. Therefore, the study follows a conceptual development approach in which we critically look at, compare, merge, and use existing theory and data to create a framework.

The logical steps of the method are four stages:

Literature Synthesis → Critical Analysis → Conceptual Integration → Framework Development

The first stage looks for relevant theory, data, reviews, and policy papers.

The second stage critically checks where papers agree, disagree, limit, and leave questions

The third stage blends the concepts that were found into a shared map.
The fourth stage uses that map to build the proposed Human–AI Co-Learning Framework (HACLF) and the AI Education Value Index (AEVI).

4.2 Scope and Sources of the Literature

The literature that the study looks at covers research about how AI is used in schools and the human, teaching, thinking, moral and institutional conditions that come with that use. Special focus was on papers about:

- intelligence in education;
- intelligent tutoring and adaptive learning systems;
- AI-supported personalization;
- generative AI and large language models;
- AI-supported feedback and assessment;
- learner and teacher agency;
- autonomy and motivation;
- cognitive engagement and learning authenticity;
- reliability and checking of AI-generated information;
- AI literacy;
- educational equity and access;
- privacy, accountability and governance;

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- and human-centred approaches to educational AI.

We gave priority to peer-reviewed studies, systematic reviews, meta-analyses, theory papers, and strong policy and ethics guidance. Foundational theory papers were added when they provided ideas needed to explain AI-supported teaching. The literature was not treated as a uniform set of evidence. Instead, we looked at each study based on its theory setting, type of AI tool outcome, and what it means for learners and teachers. This helped us gather evidence about technical power learning results and broader educational worth.

4.3 Analytical Focus

The analysis is built around the research question:

Under what teaching institutional conditions does AI capability become educational value?

To answer, we looked at the papers through five lenses:

- Personalization– does AI change learning help to fit each learner while staying pedagogically appropriate and letting learners stay independent?
- Reliability – is the information and feedback trustworthy and backed by proper checking and human judgment?
- Human agency– do learners and teachers keep control over learning, assessment, decisions, and teaching steps?
- Equity – does AI help learning chances and benefits reach all kinds of learners and schools?
- Learning authenticity– do learners stay truly involved in the thinking, reflecting, creating, and judging steps that make learning happen?

These lenses were chosen because the papers show that learning results cannot be fully understood by looking at tech power or test scores.

4.4 Critical Literature Synthesis

Rather than just adding up results, the study uses a critical thematic synthesis. The goal of this approach is to find links and clashes across groups of papers. Three guiding questions shaped the synthesis:

1. What can AI actually do? This looks at AI capability: making, changing, giving feedback, guessing, explaining, recommending, and automating.

2. What happens when those powers are used in schools? This looks at reported effects on learning outcomes, motivation, thinking engagement, teacher-learner talk, assessment, and teaching methods.

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3. Under what settings does AI capability bring educational worth? This looks at the context factors found in the papers, such as teacher help, learner power, thinking engagement, reliability, AI know-how infrastructure, equity, and rules.

This step keeps the study from assuming that tech power alone makes learning

4.5 Identification of Theoretical Constructs

The study developed its ideas by blending different theories. Social Cognitive Theory helped us think about agency, especially how learners can act intentionally, manage themselves, think, and control. Self-Determination Theory helped us read about freedom and skill, especially how AI helped learning can strengthen rather than weaken learner ownership. The ICAP framework helped us separate kinds of thinking engagement and see the difference between helpful AI and AI that just replaces thinking. Human-centred AI views helped us add ideas about control, fairness, rules, openness, privacy and school responsibility. These theories were not kept apart. They were mixed together to build the base for spotting the gap between tech power and learning worth.

4.6 Conceptual Model Development

After the synthesis, the study drew a link between AI capability and learning worth:

$$EV = f(AC, PQ, HA, R, EQ, LA)$$

where EV means educational value, AC means AI capability, PQ means teaching quality, HA means human agency, R means reliability, EQ means educational equity, and LA means learning authenticity.

This formula is a theory; it does not have numbers or prove a cause. Its job is to show the idea that learning worth comes from the mix of tech power and teaching, human, knowledge, and school conditions. The study then pointed to a map:

AI Capability → Teaching Integration → Human–AI Interaction → Learning Worth

That map is not a straight line. Teacher choices, learner power, reliability, fairness, and rules all act like cross-cutting limits that can make AI power turn into learning worth or keep it from doing so

4.7 Development of the Human–AI Co Learning Framework

- The Human–AI Co Learning Framework (HACLF) was made by putting the ideas found in the review. The framework has six linked layers:
- Learner – participation, asking questions, checking, thinking, self-control, and power (Bandura 2001; Deci & Ryan 2000; Chi & Wylie 2014).
- AI Assistant – explaining, giving feedback, creating, changing, recommending, and helping with thinking (Kasneci et al. 2023; Holmes et al. 2019).

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- Teacher– teaching mediation, context judgement, checking, course design and oversight (Zawacki Richter et al. 2019; Seo et al. 2021; Selwyn 2019; Gupta et al. 2026).
- Learning Environment – tech, checking methods, school support, curriculum and teacher training (Mayer 2021; Kirschner et al. 2006; Miao & Cukurova, 2024).

4.8 Development of the AI Education Value Index

The AI Education Value Index (AEVI) was subsequently developed as a conceptual evaluation framework. It consists of five dimensions:

$$AEVI = f(P, R, HA, EQ, LA)$$

where:

P= Personalization

R= Reliability

HA = Human Agency

EQ = Equity

LA = Learning Authenticity.

AEVI is intended to give a multi-layered foundation for judging AI-supported teaching practices, rather than depending only on scores, speed, or how happy users feel. At this moment, AEVI should not be seen as a test or a weighted score. The parts of AEVI come from theory in the literature. Need real data and proof in future research. Later studies could create signs, weight methods, reliability checks, and validity tests.

4.9 Conceptual Propositions

The synthesis also created a set of ideas for future real-world research. These ideas turn the theory into links that can later be examined.

P1. The value of learning from help should grow when a teacher guides it, and students have choice.

P2. The value of AI help should rise when AI encourages students to think rather than taking over their thinking.

P3. The value of AI that creates content should grow when students and teachers check and judge the AI output carefully.

P4. Partnerships between teachers and AI should give learning value when teachers keep the teaching and judging duties.

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P5. Knowing how AI works should make the link between AI use and learning value stronger because students and teachers can judge, understand, and use AI results correctly.

P6. Not everyone having the AI tools, computer skills, or school help is expected to cause differences in how much learning value comes from AI-supported study.

These ideas are conceptual. Have not yet been checked with data in this study.

4.10 Methodological Boundaries

The study's conceptual design creates limits. First, this study does not gather data from students, teachers, or schools. Second, the links we suggest are theoretical. Should not be seen as proven cause and effect. Third, HACLF and AEVI are ideas that need real data to confirm. Fourth, AI tools and teaching ways change fast, so the framework must stay flexible, not fixed. These limits are not seen as flaws in the design. As boundaries that tell how to read the results. The method's goal is to build a theory that later real research can test.

4.11 Methodological Summary

The method shows a route from current books and papers to theory and a new framework. First, we gather literature, then we look at it closely through lenses of personal touch, trust, student choice, fairness, and real learning. From that, we build HACLF and AEVI. Write ideas for later real research. So, the study's contribution is not that it proves the links with data but that it offers a theory-based structure for real research to see when, how, and under what situations AI power adds learning value.

5. Human–AI Co-Learning Framework

The Human–AI Co-Learning Framework (HACLF) is the idea of this study. It is built on the idea that learning value does not come from AI alone. From how students, AI tools, teachers, classrooms, rules, and society work together. The framework goes past views that judge AI mainly by how it works, how right it is, or how much it automates. The HACLF shown in Figure 2 brings together learner, AI assistant, teacher, learning environment, governance, and society. It shows the need to place AI use inside teaching and school settings (Bandura et al., 2001; Floridi et al., 2018; Zawacki-Richter et al., 2019). HACLF sees AI-enhanced education as a multi-level system where technology is guided by people and the schools' conditions. The model has six parts: learner, AI assistant, teacher, learning environment, governance, and society. Each part has its job, but no part works alone. The results of using AI in education come from how these parts work.

The model can be shown as:

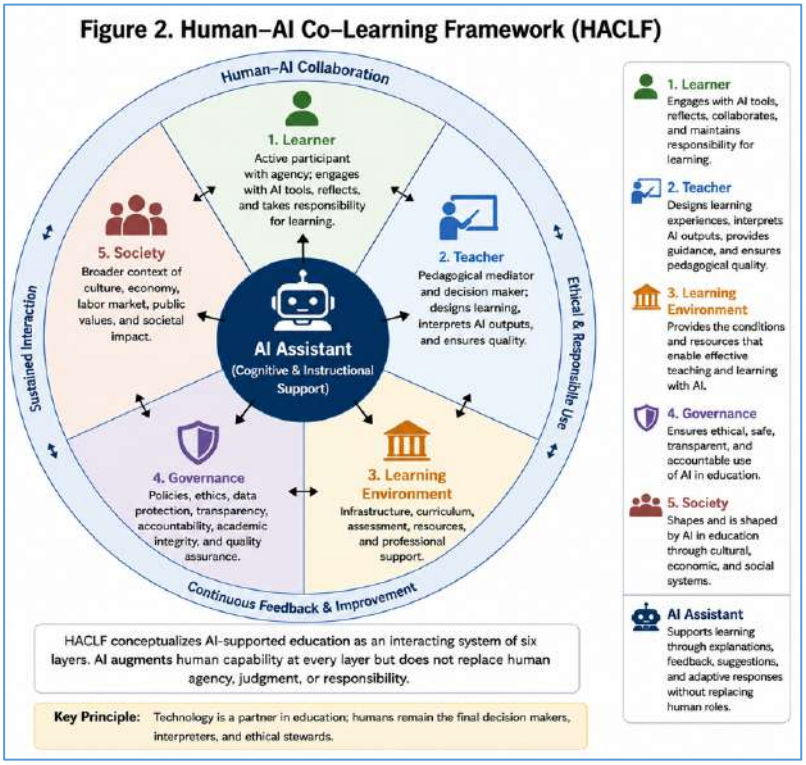
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Learner↔ AI Assistant ↔Teacher

Inside a system that includes:

Learning Environment↔ Governance↔ Society

These connections are expected to affect five areas of value that were discussed in Section 2: personalization, reliability, human responsibility, fairness, and real learning.



5.1 Learner

The learner is in the middle of HACLF because the main goal of using AI in education is not just to make tasks easier but to help build knowledge, skills, judgment, and thinking ability. The model sees the learner as someone who takes part in the process, not someone who gets information from AI.

AI can help learners by offering explanations, examples, feedback, ways to look at things, practice questions, and chances to explore. These abilities only help when learners keep asking questions, checking facts, thinking about what they learned, applying it, and reflecting.

The learner's role can be described through three steps:

Questioning→ Verification→ Reflection

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Questioning means learners have to create good questions instead of just asking AI for answers. Verification means checking if the AI's answers are correct, relevant, based on facts, and supported by evidence. Reflection means thinking about how using AI changed what they understand and whether they can use what they learned on their own.

This role is very important for continuing to learn. If AI does most of the thinking, the learner might get a result without really learning. If AI helps by giving support, different views, or feedback, the learner can still take charge while using technology.

So, in HACLF, the learner is not someone who uses AI but someone who works with it. Learner responsibility is a part that helps AI become useful in education.

5.2 AI Assistant

The second part is the AI assistant. This includes systems like AI that can create content, smart teaching tools, learning systems that change based on the student, feedback tools, and other AI-powered learning technologies. In HACLF, AI is seen as a helper and a thinking tool, not as something that replaces teachers completely.

AI assistants may perform several functions, including:

- generating explanations and examples;
- adapting learning materials;
- providing formative feedback;
- identifying possible misconceptions;
- generating practice activities;
- supporting brainstorming and inquiry;
- assisting with information organization and synthesis; and
- providing alternative approaches to problems.

The educational value of these functions depends on how they're used in learning activities. An AI system that answers quickly may help learners get things done fast. An AI system that offers hints, counterexamples, questions, or different ways to explain a concept may encourage learners to think more deeply and get more involved in the learning process. Because of this, the AI assistant works with learners and teachers within teaching and learning rules. It is not meant to act as an authority in education. Its responses must be understood in context. When needed checked for accuracy and truthfulness.

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Reliability is a part of this role. AI-generated content can sometimes include facts, unsupported statements, or advice that isn't appropriate. For this reason, the framework treats AI as a helper, not a decision-maker. Humans—teachers and learners—keep the responsibility for making educational choices.

We can summarize the AI assistant's role like this:

AI Capability → Scaffolding and Assistance → Human Evaluation

The goal is not to remove the need for thinking or effort. Instead, it's to use technology in ways that support effective learning.

5.3 Teacher

The teacher plays the role of guiding instruction within HACLF. Even though AI can support or automate some parts of teaching, real teaching involves more. This includes understanding the curriculum, making decisions based on context, motivating students, managing classroom interactions, designing assessments, handling issues, and recognizing the personal needs of each learner.

In HACLF, the teacher has four roles:

Pedagogical selection – deciding when using AI makes sense for learning.

Mediation– linking AI-generated content to the goals of the curriculum and the needs of learners.

Evaluation – checking how accurate, reliable, and useful the AI-supported learning activities are.

Oversight – staying in charge of the learning process, assessments, ethical use and student growth.

This does not mean teachers must manage every interaction with AI. Instead, the idea is that teacher judgment and AI capability work together. AI can handle tasks and provide extra tools, freeing up teachers to focus on deeper teaching—like explaining ideas, guiding students in conversations, giving feedback, and making important teaching decisions.

The main idea can be expressed as:

AI Assistance + Teacher Judgment > AI Assistance Alone

This is not a math equation. It means that education gains more when technology is used alongside teaching judgment. The teacher is not seen as a rival to AI. Instead, the teacher acts as a bridge—connecting AI's power to educational goals.

5.4 Learning Environment

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The learning environment is the space (both physical and digital) where people and AI work together. It includes classrooms, online learning tools, grading systems, school buildings, curriculum plans, digital materials, teacher training, and how schools organize their work. The same AI tool can have different effects depending on the environment. For example, an AI tutoring system might help students a lot if teachers are well trained and students have access to devices and the internet. But in places where the technology's poor or teachers don't know how to use AI well, the system might not help much at all. The results depend not on the tool but on how it fits into the larger learning setting.

The learning environment therefore influences:

- quality of teacher preparation;
- opportunities for collaborative learning;
- assessment practices;
- technical support;
- institutional expectations concerning AI use; and
- opportunities for learners to engage critically with AI.

The environment also determines whether AI use becomes integrated into meaningful learning activities or remains an isolated technological intervention.

HACLF therefore treats educational AI as an embedded technology rather than a standalone tool. Educational value depends partly on whether the surrounding learning environment supports purposeful, inclusive, and pedagogically coherent human–AI interaction.

5.5 Governance

The governance layer establishes the rules and safeguards under which AI is used in education. This layer is particularly important because educational AI involves sensitive issues concerning privacy, transparency, accountability, assessment, academic integrity, bias, data security, and acceptable use.

Governance should establish clear expectations concerning:

- collection and use of learner data;
- transparency regarding AI-supported decisions;
- acceptable and unacceptable uses of generative AI;
- human oversight of high-stakes educational decisions;

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- academic integrity and authorship;
- mechanisms for correcting inaccurate or harmful AI outputs;
- accessibility and nondiscrimination; and
- accountability for AI-supported educational practices.

Governance is not treated merely as an administrative constraint. It can function as an enabling condition for educational value by creating trust, reducing harmful uses, protecting learner rights, and establishing predictable conditions for responsible AI adoption. This layer is also closely related to equity. Policies that permit unrestricted AI use without addressing unequal access to technology, digital competence, or institutional resources may unintentionally increase educational disparities. Governance must therefore address both responsible use and equitable opportunity. Within HACLF, governance acts as a mediating structure between technological capability and educational practice:

$$\text{AI Capability} \xrightarrow{\text{Governance}} \text{Responsible Educational Use}$$

The emphasis is consequently on human oversight rather than complete technological autonomy.

5.6 Society

The sixth layer understands that educational AI works inside a social, cultural, economic, and technological world. Getting access to AI and being able to use it depends on more than just the students and schools. Societal conditions include differences in tools, financial resources, language, cultural ideas, trust in public systems, job market situations, and how good people are with technology. These things can decide who has access to AI tools and who can use them properly. Because of this, the societal layer is very important for looking at fairness. Just because a tool is available to everyone doesn't mean it gives everyone the chances. Students might be very different in how they ask questions, check what AI says, see mistakes, keep their privacy safe, and use AI in their learning. The societal part also sees that what is important to learn is created by society. What is seen as learning can change between different subjects, cultures, school systems, and groups. So, AI in education should not just be judged by how fast or efficient it's

In HACLF, society is the picture where schools and people make choices about AI. This layer connects the framework to questions about being part of the group, fairness, and cultural fit. Who gets the benefits from education?

5.7 AI Education Value Index (AEVI)

To make clear the difference between AI skill and real learning value, this study introduces the AI Education Value Index (AEVI) as a way to look at things. AEVI is

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meant to see if using AI in school helps learning in a way not just making things faster or more advanced. The idea is to solve a problem in the research: better AI skills don't always mean better learning, especially when using AI takes away a student ‘s ability to think, makes them less involved, brings wrong info, or makes some students miss out.

AEVI has five parts that work together: personalization, reliability, human control, fairness, and real learning. These parts show what is needed for AI to help in learning.

Figure 3. AI Education Value Index (AEVI): Dimensions and Indicators

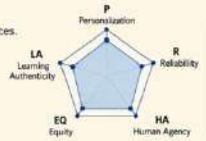
Dimension	1. Personalization	2. Reliability	3. Human Agency	4. Equity	5. Learning Authenticity
Definition	The extent to which AI adapts learning support to individual needs, abilities, preferences, and goals.	The extent to which AI-generated information and recommendations are accurate, consistent, transparent, and verifiable.	The extent to which learners and teachers retain control over decisions, choices, and learning processes.	The extent to which AI-supported education is accessible, inclusive, and beneficial across diverse learner groups.	The extent to which AI use promotes genuine cognitive engagement, intellectual effort, and knowledge construction.
Key Indicators (examples)	• Adapted content & pathways • Individualized explanations and feedback • Alignment with learner needs • Timely support • Support for self-regulation and progress	• Factual accuracy • Source transparency • Consistency of responses • Verifiability & citation • Uncertainty recognition • Bias and error mitigation	• Learner autonomy & choice • Control over AI use • Teacher decision-making authority • Critical judgment & evaluation • Reflection and self-direction	• Access to infrastructure and devices • Digital/AI literacy support • Inclusiveness & accessibility • Cultural and linguistic responsiveness • Fair distribution of benefits	• Active cognitive engagement • Deep understanding • Original thinking & creativity • Problem solving & reasoning • Appropriate AI assistance (not substitution) • Reduced over-reliance on AI
AEVI Code	P	R	HA	EQ	LA

AEVI Concept

AEVI is a multidimensional framework to evaluate the educational value of AI-supported practices.

$$AEVI = f(P, R, HA, EQ, LA)$$

where P = Personalization, R = Reliability, HA = Human Agency, EQ = Equity, LA = Learning Authenticity.



Higher educational value is achieved when all five dimensions are adequately addressed in context.

Note: AEVI is a conceptual framework; indicators and weights require empirical validation in future research.

Figure 3 shows AEVI as a way to look at things with five parts: personalization, reliability, human control, fairness, and real learning (Ma et al. 2014; Bandura et al., 2001; Chi & Wylie, 2014; Floridi et al., 2018; UNESCO, 2021).

5.7.1 Personalization

Personalization is how much AI systems change what they say, how they give feedback, the lessons they offer, how fast they go, or the way they teach to fit what each student needs. AI can give help to each student in a way that's hard for a teacher to do alone. Personalization is not just about machines changing things. Good personalization must match what the student is learning, how they act, and what the teacher wants (Ma et al. 2014; Holmes et al. 2019; Zawacki-Richter et al. 2019). AEVI says personalization is good when AI helps students understand, see their mistakes, manage their learning, and reach real goals. Too much machine help or wrong changes can make learning less varied or make students rely too much on the AI's ideas.

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5.7.2 Reliability

Reliability is about whether what AI says is right, stays the same, is open, and can be checked. This part is very important for AI because what it says can be smooth and look right but still be wrong, have made-up facts, be unfair, or not make sense (Kasneci et al., 2023; Dwivedi et al., 2023; Cotton et al., 2024).

In AEVI, reliability is more than being correct. For learning, the AI must let people check where the info comes from, know when it's not sure, and have people watching. AI should be a tool to ask questions, not an answer. So reliability is linked to how students and teachers can check what the AI says.

5.7.3 Human Agency

Human agency is how much students and teachers can decide what happens in learning. For students, it means they ask questions, choose, understand, check, and think about what the AI says. For teachers, it means they pick when, why, and how to use AI in class (Bandura et al., 2001; Deci & Ryan, 2000; Floridi et al., 2018). This part is important because AI can help or hurt learning. When AI supports thinking and teaching, it helps students and teachers do better. If students and teachers give too much thinking or decision-making to AI, it can stop them from thinking on their own. AEVI sees control as needed for real learning, not just something to think about.

5.7.4 Equity

Equity is how much AI in school helps all students. Real learning value can't be seen without looking at differences in tech access, internet, how good people are with tech and AI language, disabilities, money, and school help (UNESCO 2021; Miao et al. 2021; Noble et al., 2018). Equity asks if AI helps more people join in or if it makes things worse for some. AI that works well for students but not for others can’t be seen as good for learning.

5.7.5 Learning Authenticity

Learning authenticity is when AI helps students stay involved, think hard, reflect, solve problems, and build knowledge. AI can make some hard parts easier. It becomes a problem when it takes over the thinking that students need to do (Chi & Wylie, 2014; Kirschner et al., 2006; Mayer et al., 2021; Cotton et al., 2024). AEVI tells the difference between AI helping with thinking and AI doing the thinking. Learning is better when AI lets students look into, compare, think, create, explain, and reflect. It is worse when AI does these things for students without giving them a chance to do it themselves.

5.7.6 Conceptual Structure of AEVI

The five dimensions can be represented conceptually as:

$$AEVI=f\ (P, R, HA, EQ, LA)$$

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where:

P= Personalization

R= Reliability

HA = Human Agency

EQ = Equity

LA = Learning Authenticity

This is not a mathematical way to show things. The study doesn't give numbers to the five parts to make one score or say AEVI has been proven. It shows a way to think about things that can help tests and tools. The five parts don't work alone. For example, AI that gives help may not be good if the help is not right. Right AI may not help if it takes away control or real thinking. Fairness decides if the good things from the parts are given to more than just the lucky ones. So, AEVI is a way to look at AI in school before claiming it helps learning

5.7.7 AEVI and the Human–AI Co-Learning Framework

AEVI goes well with the Human–AI Co-Learning Framework (HACLF). HACLF explains who is in charge and how people and AI work together, while AEVI checks if that work creates learning value.

The link can be shown as:

AI Skill → Teaching Use → People and AI Working Together → Learning Value

AEVI looks at the end of that path with personalization, reliability, human control, fairness and real learning. HACLF says who is involved and what the world is like—student, AI helper, teacher, classroom, rules and society—that shape that path. This way of looking at things adds more to the study. It doesn't just ask if AI works. It asks under what situations AI helps learning and for whom.

5.7.8 Proposed AEVI Evaluation Questions

For future empirical application, each AEVI dimension can be translated into observable evaluation questions:

AEVI Dimension	Core Evaluation Question
Personalization	Does AI provide learning support that is meaningfully adapted to learner needs and educational objectives?
Reliability	Are AI-generated explanations, recommendations, and resources sufficiently accurate, transparent, and verifiable?
Human Agency	Do learners and teachers retain meaningful control over learning and pedagogical

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	decisions?
Equity	Are the benefits and opportunities associated with AI accessible across diverse learner groups?
Learning Authenticity	Does AI support genuine cognitive engagement, reflection, problem solving, and knowledge construction?

These questions provide a foundation for future development of survey instruments, observation protocols, learning analytics measures, or mixed-method evaluation designs. Empirical studies can subsequently determine whether the five dimensions are statistically distinguishable, whether some dimensions should receive greater contextual weight, and whether AEVI predicts learning, engagement, or other educational outcomes.

5.7.9 Contribution of AEVI

The principal contribution of AEVI is to shift evaluation from a technology-centred question- "What can AI do?"- to an educational-value question- "What educational value does AI create, under what conditions, and for whom?" The framework consequently avoids treating automation, personalization, or generative capability as sufficient evidence of educational improvement.

AEVI should therefore be regarded as a proposed conceptual framework for evaluation rather than a validated index or measurement instrument. Its empirical validation represents an important direction for future research. Such validation could involve developing indicators for each dimension, establishing content and construct validity, testing reliability, examining relationships among dimensions, and evaluating associations with learning and educational outcomes.

5.8 Integrative Interpretation of HACLF

The six layers of HACLF should not be interpreted as a linear sequence. Instead, they form a system of reciprocal relationships. Learners interact with AI systems; teachers mediate those interactions; learning environments provide the institutional context; governance establishes safeguards and responsibilities; and societal conditions influence access and participation.

The framework can therefore be summarized conceptually as:

Society
↓
Governance
↓
Learning Environment
↓
Teacher ↔ AI Assistant ↔ Learner
↓
Educational Value

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The five AEVI dimensions- personalization, reliability, human agency, equity, and learning authenticity- operate across these layers rather than belonging exclusively to a single actor. The central proposition of HACLF is therefore that AI capability becomes educationally valuable when technological assistance is embedded within pedagogically purposeful, human-centred, reliable, equitable, and authentic learning processes. This proposition shifts the focus from the question of whether AI can perform educational tasks to the more consequential question of whether and under what conditions those capabilities contribute to educational development.

HACLF consequently provides the conceptual bridge between the literature reviewed in Section 3 and the propositions developed in the Discussion section. The framework does not claim that all AI-supported learning produces positive outcomes. Instead, it identifies the interacting conditions that may explain variation in educational value and provides a basis for empirical testing in future research.

6. Discussion

6.1 Interpreting the Central Argument: From AI Capability to Educational Value

The central argument of this study is that AI capability should not be confused with value. Modern AI systems can generate explanations, give feedback, customize learning materials, help solve problems, and handle teaching tasks. The real impact these capabilities have on learning depends on how they are used in actual classrooms. This view matches growing research showing that AI and generative AI can improve student learning in some ways. Results vary widely across different schools, subjects, teaching styles, and student needs (Deng et al., 2024; Chen & Cheung, 2025; Liu & Zhong, 2025). Recent reviews and meta-analyses often find effects from using generative AI, but the size and direction of those effects change based on grade level, subject area, how the technology was used, the students involved, and how frequently it was applied. This difference suggests that simply using AI isn't enough to guarantee learning.

For this reason, the framework proposed here separates four ideas: capability, integration, interaction, and value. Capability refers to what the AI system can do. Integration is about how those abilities fit into classroom activities. Interaction looks at how learners and teachers use and understand the AI's features. Value is about whether all of this leads to learning. This separation encourages a careful way of thinking about AI in education. Instead of asking if AI is good overall, we should ask whether a specific AI feature fits a particular learning goal.

6.2 Relationship with Previous Research on AI-Supported Personalization

The framework agrees with studies that personalization and adaptive support can help students learn. For instance, work on tutoring systems has shown that tailored instruction improves learning outcomes (Ma et al., 2014). Generative AI now allows for natural conversational forms of adaptation.

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However, this framework adds a point: personalization does not automatically mean better learning. An AI system might adjust content based on a student's answers. It could still offer wrong explanations, make students too dependent, or miss chances to build deeper understanding. This doesn't reject past findings— it just shifts the focus. Earlier studies usually asked whether an adaptive system improved learning. This framework asks what conditions must be met for personalization to truly help. From the Self-Determination Theory viewpoint, personalization works best when it supports autonomy and competence, not when it makes learners feel controlled. From Social Cognitive Theory, it should strengthen self-regulation— not weaken it.

So, HACLF sees learners and teachers as partners alongside the AI. Personalization only becomes valuable when AI adjustments are shaped by judgment and learner involvement.

6.3 Generative AI: Assistance Versus Cognitive Substitution

A question in the literature is whether AI acts as a cognitive helper or replaces the learner's mental work. Research shows that generative AI can assist with writing, solving problems, giving explanations, offering feedback, brainstorming, and higher-level thinking. Analytic studies also suggest overall benefits for learning (Qian, 2025; Marzano et al., 2025; Albadarin et al., 2024). Not all areas show improvement—especially in things like metacognition—so more AI help doesn't always mean deeper learning. The ICAP framework helps explain this. Learning depends not on seeing information but on how deeply someone engages with it. AI supports learning when students use it to ask questions, challenge ideas, compare solutions, spot mistakes, and revise their thinking. But when AI does all the heavy lifting and students just accept the answer, learning may suffer because the learner never gets to practice the thinking process.

So, the key distinction is between AI-supported cognition and AI-substituted cognition. The issue isn't whether to use AI but which parts of thinking should stay with the learner. This explains the idea of learning authenticity introduced here. Authentic learning doesn't mean avoiding technology. It means learners keep responsibility for reasoning, evaluating, reflecting, and building knowledge.

6.4 Reliability and the Problem of Epistemic Dependence

Another concern with AI is reliability. AI responses can sound convincing. Contain false facts, incomplete logic, or misinterpretations (Sun & Zhou 2024; Zhang & Tur 2024). So just because something sounds clear doesn't mean it's accurate or educational. This framework goes beyond correctness. Educational reliability also depends on how people interact with AI. An incorrect response can still be useful if students are taught to question it, check sources, compare answers, and notice uncertainty. On the other hand, even perfectly accurate AI can cause harm if learners take everything it says without thinking. This connects reliability to AI literacy and human agency. Students need more than access—they need skills to evaluate what AI

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gives them. Teachers also need AI literacy to know when outputs are suitable and when they need correction or context. So, verification is not optional. AI offers tools and information. Learners and teachers must take responsibility for deciding what's educationally sound.

6.5 Learner and Teacher Agency

The findings suggest a shift from technology-centered to agency-centered approaches to AI. Bandura's Social Cognitive Theory helps explain why. Learning happens through action, self-regulation, and interaction with the environment. If AI takes over planning, reasoning, judging, and decision-making, a student's role may shrink. The problem isn't automation itself— shifting too much control away from the learner. The same applies to teachers. Early work on AI in education often ignored educators even though teachers shape lessons and guide instruction (Zawacki-Richter et al., 2019). This framework positions teachers as mediators—not just people who operate tools. That doesn't mean teachers must do everything by hand. AI can reduce tasks and bring new resources. Teacher agency should focus more on choosing the right AI tools, designing learning experiences, reading student needs, assessing AI outputs, managing assessments, and keeping ethical and instructional oversight.

So, the framework proposes a model:

AI Assistance + Learner Agency + Teacher Judgment → Educational Value

This equation is conceptual. It shows how these elements must work together to create educational value—not a strict cause-and-effect formula.

6.6 Equity and the Distribution of Educational Value

Another key point is that educational value cannot be understood apart from access and institutional support.

Another key point is that educational value cannot be understood apart from access and institutional support.

AI can help students who have internet, proper devices, digital skills, supportive teachers, and strong school policies (Liu & Zhong 2025; Qian et al. 2025). Where those conditions are missing, the same technology may fail to deliver results. That means having access to AI doesn't mean everyone gets educational benefits. This matters because people often talk about AI as a way to democratize education. While AI can provide tutoring, explanations, and resources, unequal access to infrastructure, digital skills, language options, and school support can deepen existing inequalities. So, the equity dimension of AEVI asks questions: Who really benefits? Under what conditions? Are the advantages and risks shared fairly? This also ties AI to human-centered tech design. Privacy, transparency, accessibility, accountability, and fairness shouldn't be

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added after implementation. They must be built in from the start—because they affect whether AI-based education can genuinely be called valuable.

6.7 Theoretical Contribution of HACLF

The main contribution of this study is the Human–AI Co-Learning Framework (HACLF).

Most research looks at one relationship at a time—like AI and learning outcomes or AI and motivation or AI and teacher practices. HACLF brings these together into a social and pedagogical system. It includes six layers: learner, AI assistant, teacher, learning environment, governance, and society (Deng et al., 2024; Chen & Cheung, 2025).

The framework contributes in three ways.

First, it changes the focus of analysis. Instead of treating the AI tool as the main object, HACLF sees educational value as coming from interactions among human and technical actors.

Second, it spreads responsibility. AI provides computing power and information. Learners must stay actively engaged in thinking. Teachers keep decision-making authority. Institutions supply support. Governance sets rules for fair use.

Third, it links pedagogy and ethics. Personalization, reliability, agency, equity, and authenticity are not issues. They're parts of a whole.

So, HACLF moves beyond the idea of humans versus machines. Its core message is about complementarity. Technology can help learning happen more easily or more effectively—but it cannot replace the human judgment and participation needed for deep, meaningful learning.

6.8 The role of AEVI as an evaluation framework

The second conceptual contribution is the AI Education Value Index (AEVI). Most assessments of educational technologies place a strong emphasis on outcome variables such as achievement, completion, satisfaction, efficiency, or engagement. While these measures are still important, they may not reflect all the educational effects of AI. For instance, a learner might finish an assignment more quickly because of AI assistance even if their independent understanding is reduced. Likewise, an AI system might raise average achievement without providing equal benefits to all groups of learners. AEVI addresses this limitation by proposing five dimensions:

$$AEVI = \{P, R, HA, EQ, LA\}$$

A more comprehensive conceptual framework for assessing educational AI can be established through the combined influence of personalization, reliability, human

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agency, equity, and learning authenticity (Marzano et al. (2025); Albadarin et al. (2024); Sun & Zhou (2024); Zhang & Tur (2024)). AEVI's importance, therefore, does not lie in the fact that it offers an immediately usable numerical score; at the current conceptual stage, its value is in indicating which aspects should be evaluated before researchers decide how each dimension should be measured. Future empirical research could define each dimension by means of observable indicators and investigate whether the dimensions constitute a reliable and valid measurement structure. Until this type of research has been carried out, AEVI should be treated as a conceptual evaluation framework rather than as a validated index.

6.9 Ideas for Testing with Data

The theoretical framework together with the review of the critical literature shows that the educational value of artificial intelligence is conditional and not automatic. The Human–AI Co-Learning Framework (HACLF) and the AI Education Value Index (AEVI) form the conceptual basis for looking at these conditions. On this basis, six propositions are developed for further empirical investigation. These propositions are conceptual and have not been tested empirically in this study.

Proposition 1: AI-Supported Personalization and Teacher Mediation

P1: The educational value of AI-assisted personalisation is expected to rise if AI-driven personalisation is combined with teacher mediation and learner agency. AI systems are able to adjust the content, speed, feedback, and learning materials according to individual learners. Yet personalisation may offer only limited educational value if it functions without some pedagogical guidance. Teachers can play a role in deciding if the recommendations produced by the AI are suitable with regard to curriculum goals, the needs of the learners, and the requirements of the subject discipline. Meanwhile, learner autonomy makes it possible for personalisation to support rather than take the place of learners' responsibility for their own learning. The AEVI dimensions that are relevant are personalization and human agency.

Proposition 2: AI Assistance and Cognitive Engagement

P2: The educational value of having AI assistance is likely to go up if the AI promotes genuine cognitive engagement rather than largely replacing the learner's own cognition. AI is able to act as a cognitive scaffold by assisting learners in exploring ideas, comparing different solutions, getting feedback, and improving their reasoning. On the other hand, if the AI carries out the main task of reasoning or production for the learner, the chances of cognitive engagement may decrease. Since this is the case, the educational value of AI in part relies on whether or not its use encourages active, constructive, and interactive learning. The AEVI dimensions that are relevant are Human Agency and Learning Authenticity.

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Proposition 3: AI Reliability and Verification

P3: The educational value of generative AI is likely to grow if the information produced by AI is subjected to systematic verification and critical assessment by both learners and teachers. Since generative AI is capable of producing responses that are both fluent and persuasive, even when they include factual errors or flawed reasoning, reliability in educational AI should not be seen merely as a technical feature of the system. Instead, verification, assessment of sources, disciplinary judgment, and critical interpretation can help make AI-generated information useful for educational purposes. The AEVI dimensions in question are Reliability and Human Agency.

Proposition 4: Teacher–AI Collaboration and Educational Value

P4: It is expected that collaborative arrangements between teachers and AI will produce more educational value if the teachers continue to have responsibility for pedagogy and evaluation. AI is able to reduce the amount of routine teaching work and offer extra resources for explanation, feedback, and support for learners. However, decisions relating to teaching need to be based on a judgment that takes into account learners' needs, curriculum objectives, assessment, and ethical issues. For this reason, AI is seen as an assisting element in the teaching process and not as a complete substitute for the teacher's judgment. The HACLF layers that are relevant are the Teacher, the AI Assistant, and the Learning Environment. The AEVI dimensions that are relevant are Human Agency, Reliability, and Learning Authenticity.

Proposition 5: AI Literacy as a Supporting Condition

P5: AI literacy will help to strengthen the link between responsible use of AI and educational value. Effective learning with the aid of AI involves more than just having access to AI tools. In order to do so, both learners and teachers need to be able to understand the capabilities and limitations of AI, to formulate suitable requests, to assess the outputs, to identify possible errors, to verify the information, and to make informed decisions as to when it is appropriate to use AI assistance. It follows that a higher degree of AI literacy could thus lead to more responsible and pedagogically significant interactions with AI systems. The HACLF layers that are relevant are the Learner, the Teacher, and the Learning Environment. The AEVI dimensions that are relevant are reliability, human agency, and learning authenticity.

Proposition 6: Equity and the Distribution of Educational Value

P6: It is expected that differences in access to AI infrastructure, digital skills, and institutional support will lead to different amounts of educational value being derived from AI-assisted learning. Just because an AI system is available doesn't mean that all learners will gain the same educational benefit. Differences in access to connectivity, the type of devices available, the quality of technical support, users' level of AI literacy, the extent of teacher training, the availability of language resources, and the institutions' overall capacity may affect learners' ability to use AI effectively. As a result, educational

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equity should be seen as an essential aspect of the educational value of AI rather than as a separate issue for policy. The HACLF layers that are relevant are Learning Environment, Governance, and Society. Relevant AEVI dimension: Equity.

6.9.1 The integration of the propositions

Together, the six propositions indicate that educational value is the result of the interaction between technological capability and pedagogical, human, epistemic, and institutional conditions. They may be conceived as follows:

$$AI\ Capability \rightarrow Pedagogical\ Integration \rightarrow Human - AI\ Interaction \rightarrow Educational\ Value$$

with teacher mediation, learner agency, AI literacy, verification, equity, and governance operating as cross-cutting conditions.

The propositions can therefore be summarised as follows:

Proposition	Core relationship	Primary HACLF component	AEVI dimension
P1	Personalization → educational value under teacher mediation and learner agency	Learner–Teacher–AI	Personalization, Human Agency
P2	AI assistance → educational value when cognitive engagement is preserved	Learner–AI	Human Agency, Learning Authenticity
P3	AI output → educational value when verification is maintained	Learner–Teacher–AI	Reliability, Human Agency
P4	Teacher–AI collaboration → educational value when teacher responsibility is retained	Teacher–AI	Human Agency, Reliability, Learning Authenticity
P5	AI literacy → strengthens responsible AI use and educational value	Learner–Teacher–Environment	Reliability, Human Agency, Learning Authenticity
P6	Unequal AI access/resources → differences in educational value	Environment–Governance–Society	Equity

The fact that these propositions do not mean that the use of AI will always lead to educational results should be noted. Instead, they outline the conditions and mechanisms that can be explored through real-world data. This is important because the current study does not assume that AI has a positive or negative impact. It aims to explain when and why AI capability may bring value.

6.9.2 Instructions for carrying out tests

The propositions provide a foundation for future research. P1 and P2 can be tested using quasi-experimental studies that compare different levels of AI personalization and cognitive delegation. P3 can be studied by looking at how

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verification procedures affect the accuracy and quality of AI-assisted learning. P4 can be examined through studies of classrooms where teachers and AI work together versus those where AI operates alone. P5 can be tested by using established measures of AI literacy as a moderating variable. P6 can be investigated by comparing outcomes across groups that have different levels of infrastructure, digital skills, and institutional support.

Future empirical studies should also examine whether the five AEVI dimensions are related constructs. They should also explore if the importance of each dimension changes across educational settings. This kind of research can help turn AEVI from a model into a fully validated evaluation tool.

6.10 The practical and policy implications

The framework has real-world relevance for education practice and policy. Teachers need development not just to use AI tools but to build skills in AI literacy, verify outputs, design effective prompts, redesign assessments, make ethical decisions, and integrate AI into teaching methods.

For learners, AI literacy should go beyond just getting information. It should include the ability to question, check, compare, interpret, and use AI-generated outputs in various ways. For learners, AI literacy should go beyond just getting information. It should include the ability to question, check, compare, interpret and use AI-generated outputs in ways.

Institutions must evaluate AI adoption based on their goals; not just how new the technology is. They should consider infrastructure, teacher training, assessment design, data governance, accessibility, academic integrity, and systems for monitoring outcomes.

Policymakers should balance innovation with rights. If money is spent on AI infrastructure without investing in teacher capacity, learner AI literacy, accessibility, and governance, the technology may be available but not bring real educational value.

6.11 The limitations and future research

The conceptual contribution of this study must be understood in light of its limits. Since no primary data was collected, causal relationships between AI capability, pedagogical integration, agency, reliability, equity, and learning authenticity cannot be proven. Also, HACLF and AEVI have not yet been tested empirically.

Future research should test the framework across education levels, disciplines, cultural settings, and institutional environments. Quantitative studies can. Validate AEVI indicators and test the proposed propositions. Qualitative studies can examine how learners and teachers manage agency, verification, and responsibility in AI-supported learning. Longitudinal research can explore whether using AI repeatedly improves learning and independence or leads to dependence. Comparative research can also look

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at how educational value varies based on access, institutional capacity, teacher preparation and learner AI literacy.

6.12 Overall Interpretation

Together, the discussion shows that the educational value of AI cannot be fully understood by asking only whether it improves performance, saves time, or automates tasks. While these are relevant, they are not enough. Educational value is multi-dimensional. It depends on the interaction between capability, pedagogical purpose, human agency, reliability, equity, and authentic learner participation.

The main message of this study is that AI should be seen as a capability. Its value depends on the quality of the human, teaching, and institutional systems in which it is used. HACLF offers a model of that system. AEVI outlines the aspects that can be used to assess its educational value. Together they provide a foundation for shifting research and practice away from the question of what AI can automate, toward an important educational question: how can AI support learning while preserving the human elements that make learning meaningful?

7. Conclusion

Artificial intelligence is now having an ever-greater impact on educational practices by means of personalized learning, intelligent tutoring, generative feedback, adaptive support, and automated instructional assistance. Yet the main question is not whether AI has the necessary technical capability to carry out educational tasks, but rather whether those capabilities result in real educational value. This conceptual study set out to answer the question: Under what pedagogical, human, and institutional conditions do AI's capabilities lead to educational value? The analysis shows that AI capability and educational value should not be seen as the same. The educational benefit that AI can provide depends on how its technological capabilities are incorporated and mediated by learners, teachers, institutions, and the governing structures. The study thus defines educational value in terms of five closely related dimensions: personalisation, reliability, human agency, equity, and authentic learning. These dimensions offer a more comprehensive basis for assessing AI-supported education than do technological performance, efficiency, or learning outcomes taken by themselves.

The study, drawing on Social Cognitive Theory, Self-Determination Theory, the ICAP framework, and human-centred AI perspectives, maintains that meaningful AI-supported learning depends on keeping both learners' and teachers' agency, ensuring appropriate cognitive engagement, making sure that information produced by AI is used and verified reliably, guaranteeing equitable access, and promoting meaningful participation by learners. AI is thus most educationally valuable in so far as it enhances rather than unnecessarily replaces human cognitive and pedagogical abilities.

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Based on this theoretical foundation, the study put forward the Human–AI Co-Learning Framework (HACLF), a framework which views AI-supported education as a relational system comprising six closely connected layers: the learner, the AI assistant, the teacher, the learning environment, governance, and society. The framework goes beyond those that focus on technology by acknowledging that educational outcomes result from the interactions between technological, pedagogical, human, institutional, and social conditions. In this system, the AI assistant is seen as providing cognitive and instructional support, while both learners and teachers continue to have a significant responsibility for learning, judgment, evaluation, and reflection.

The study also suggested that the AI Education Value Index (AEVI) should be used as a conceptual framework for evaluation, with the framework being based on personalization, reliability, human agency, equity, and learning authenticity. The purpose of the AEVI is to extend the way in which AI-supported education is assessed beyond the traditional criteria of achievement and efficiency. It is important to note that the AEVI is not offered as a validated measurement tool or as a statistically weighted index. Each of its dimensions will need to be empirically operationalised in the future, along with reliability testing and construct validation.

The conceptual propositions outlined in the study also indicate that educational value will be enhanced if AI-assisted personalisation is combined with teacher mediation and learner autonomy; if the AI support encourages rather than substitutes cognitive engagement; if information generated by the AI is subjected to critical verification; if teachers continue to hold responsibility for teaching and assessment; if both learners and teachers have sufficient AI literacy; and if access to the infrastructure related to AI and the necessary competencies is fair. These propositions offer specific guidelines for future empirical research rather than representing established causal conclusions.

The study has several limitations. It is based on theory and does not include any primary empirical data or statistical verification of HACLF or AEVI. The relationships that are suggested between AI capability, pedagogical quality, agency, reliability, equity, and learning authenticity are therefore only theoretically derived and have not been demonstrated through empirical evidence. Furthermore, since generative AI is changing so quickly, specific technologies and educational practices may evolve faster than the conceptual models can keep up with. It is therefore necessary for future research to empirically examine the proposed framework across different educational levels, disciplines, learner groups, and institutional settings and to develop validated measures for the various dimensions of AEVI.

The main contribution of this study is to change the way in which educational AI is assessed from focusing on its capabilities- that is, 'What can AI do?'- to posing an education-focused question instead, namely, 'Under what conditions does AI's capability lead to educational value?' The HACLF and AEVI frameworks offer a conceptual basis for this kind of shift. Instead of judging advances by how much educational work can be automated, AI-supported education should be judged on its ability to promote

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meaningful learning while maintaining human judgment, learner autonomy, reliable knowledge practices, equitable participation, and genuine cognitive engagement.

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