Artificial Intelligence

in

Personalized Adaptive Learning

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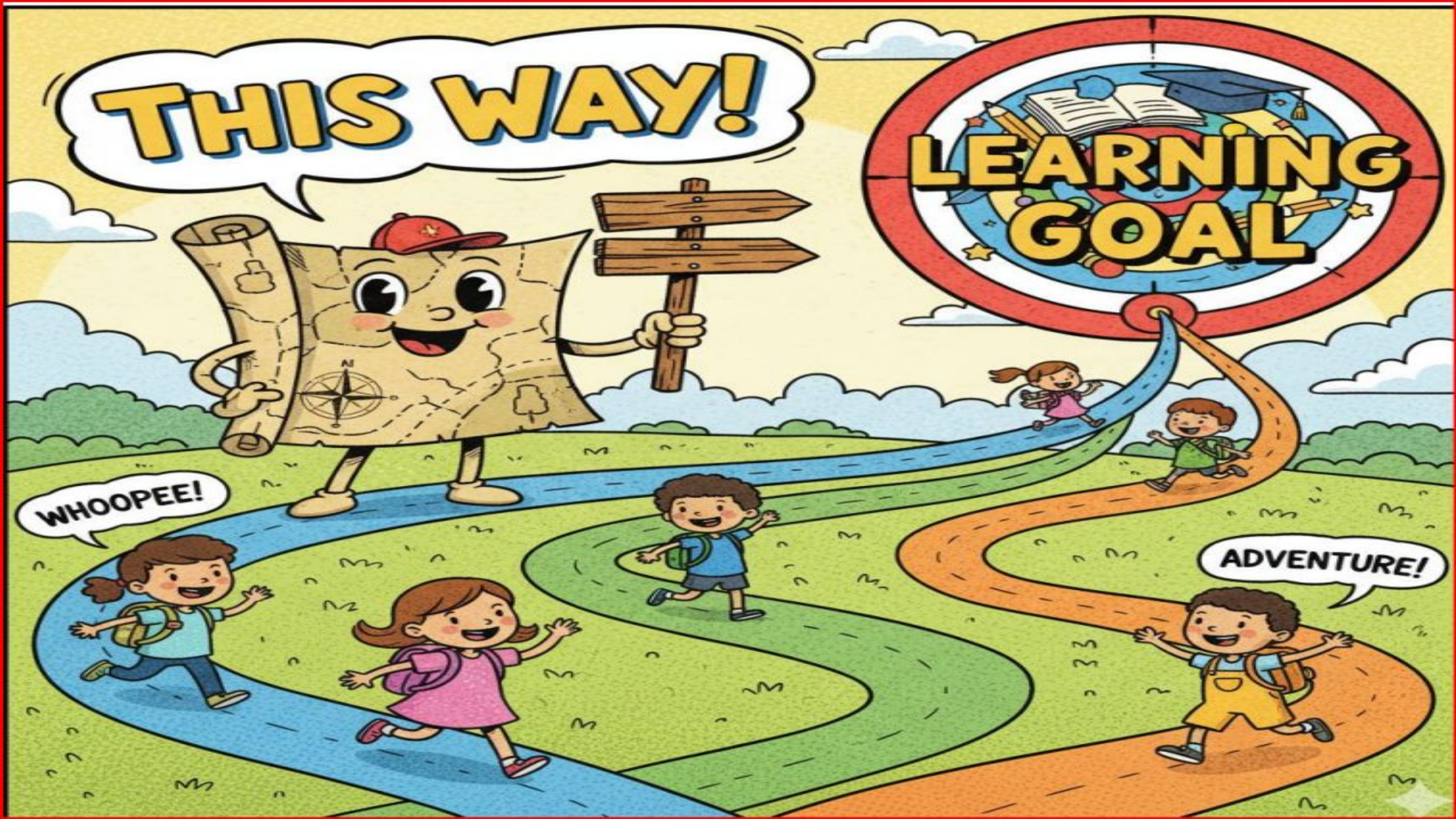
Key points of the conversation

- Personalized Learning
- Adaptive Learning
- Personalized Adaptive Learning (PAL)
- AI in Personalized Adaptive Learning (PAL)

- The traditional "one-size-fits-all" approach to teaching, where all students are given the same worksheets or assignments.

- Every learner possesses unique learning characteristics—such as learning preferences, knowledge, goals, experiences, interests, and background.


THIS WAY!
LEARNING GOAL
WHOOPEE!
ADVENTURE!

Differentiated Instruction

Differentiated Instruction is a teaching method in which teachers provide instruction while taking into account the individual needs, interests, abilities, and learning styles of all students in the classroom.

Personalized Learning

Personalized learning is an approach that incorporates the learner's strengths, needs, personal interests, and learning goals into the teaching-learning environment.

Like all student-centered approaches, this method expects the teacher to serve as a guide rather than a mere provider of information.

Factors

- ✔ Learner profile
- ✔ Personalized learning path
- ✔ Competency-based curriculum
- ✔ Flexible teaching-learning environment

Adaptive Learning

- An adaptive learning system customizes the learning experience in real-time based on individual needs.
- It assesses each learner's strengths, weaknesses, and learning styles using data and analytics.
- It provides immediate, personalized feedback and assessment based on learner performance.
- It predicts future learning needs to assist learners.
- It fosters learner autonomy by allowing students to control their own learning

Adaptive Learning

Adaptive learning is an interactive method that typically utilizes computer-based logic systems to create personalized learning paths for students.

Adaptive learning is a form of interactive instruction that addresses individual needs through tailored learning paths, effective feedback, and supplementary resources (Kurt, 2021).

Personalized learning

- Personalized learning—which aims to foster the personal development of students—emphasizes that the teaching process should incorporate appropriate teaching methods, techniques, content, starting points, procedures, and assessment strategies that take into account students' individual characteristics and developmental potential, thereby enabling the complete, independent, and harmonious development of all aspects of the students. (Li 2015)

Adaptive learning

- Adaptive learning strategies create an experience that is modified based on a student's performance and their engagement with course material. At its core lies an instructional approach that relies on technology and data on student performance to adjust content and methodologies, thereby creating a pathway for students to master specific learning objectives (Waters 2014).

Personalized and Adaptive Learning

- Personalized, adaptive learning offers a powerful, data-driven approach to directly address learning gaps.
- It tailors educational content and pacing to each student's specific needs, ensuring mastery before progressing.
- Personalized pace → Students learn at their optimal speed
- Adaptive content → Curriculum tailored to the student's strengths and weaknesses
- AI-driven insights → Identify specific learning challenges
- Focus on mastery → Ensures understanding before moving forward

Personalized Adaptive Learning

- It can customize e-learning content and services according to user profiles.

This includes:

- how to search for and filter learning materials based on user preferences, needs, background, learning style, etc.;
- how to present them;
- how to optimize the learning process—that is, how to provide the right content to the learner on-demand and in a timely manner;
- how to provide tools for the user to reconfigure the system;
- how to create effective user models and track their continuous changes, etc.

Examples of Personalized Adaptive Learning

- Examples of adaptive personalized learning include popular educational platforms like Khan Academy and Duolingo, which adjust content difficulty based on user performance, and corporate learning platforms like LinkedIn Learning, which recommend specific courses.

Examples

- Khan Academy: A platform that personalizes learning by analyzing student performance and adjusting the difficulty and pace of lessons to target individual knowledge gaps.

- Duolingo: A language-learning app that adjusts exercise difficulty based on user progress and provides extra practice on topics where mistakes frequently occur.

- DreamBox Learning: An online learning tool that uses algorithms to adapt content and activities based on student performance, helping them master concepts.

Artificial Intelligence (AI)

UNESCO's approach to AI focuses on the imitation of human intelligence: "machines capable of imitating certain functionalities of human intelligence, including such features as perception, learning, reasoning, problem-solving, language interaction, and even producing creative work" (UNESCO, 2019b, p. 24).

Artificial intelligence (AI) refers to computer systems capable of performing complex tasks that historically only humans could do, such as reasoning, decision-making, and problem-solving.

How does AI contribute to adaptive learning platforms?

- Adaptive learning platforms integrate **machine learning**, **natural language processing, and predictive analytics** to collect and analyze data and apply the results in practice.
- AI helps platforms analyze data from **learner profiles** and **learning resources**, identify patterns and relationships within that data, and use the information to **predict each learner's needs and performance**.
- AI also helps platforms to respond while in use, **adjusting the content, pacing**, and strategies according to your performance.
- AI is the driving factor behind these platforms' ability to continuously evaluate learners' progress, adapt, and adjust the learning path accordingly.

How does AI contribute to adaptive learning platforms?

It typically does so using three primary models:

- **Learner model:** Each learner's profile undergoes educational data mining for dynamic, continual updates based on factors such as demographics, real-time feedback, and assessment responses.
- **Domain model:** This model provides the content's structure and organizes it according to the subject.
- **Adaptation model:** These models select the resources learners interact with based on information from the learner model. They might repeat questions on topics learners are still working to master or provide feedback within each learning activity.

Imagine a student learning algebra:

The **Learner Model** records that the student just missed three fraction questions in a row.
The **Domain Model** knows that *fractions* must be mastered before *linear equations*.
The **Adaptation Model** intervenes, overrides the planned equation lesson, and serves an easier fraction review game instead.

How does AI contribute to adaptive learning platforms?

- AI technologies, such as Deep Learning, Machine Learning, Natural Language Processing (NLP), and Intelligent Tutoring Systems, enable AI to tailor instructional content to students' pace and learning style and provide real-time feedback, accelerating the learning process.

- In 2020, the integration of AI into virtualized and physical learning environments marked the introduction of adaptive and context-aware systems.

- By 2021, the field began leveraging big data infrastructures, cloud computing, and intelligent algorithms such as LinUCB and artificial neural networks to enhance precision and scalability.

How does AI contribute to adaptive learning platforms?

- The year 2022 signaled the adoption of deep learning frameworks in personalized learning pathways, further strengthening the system's capacity to tailor instruction dynamically.
- In 2023, research attention moved toward real-time personalized feedback, natural language processing, and predictive analytics, reflecting the growing use of intelligent technologies to support immediate and adaptive decision-making in learning environments.
- Most recently, in 2024, generative AI and large language models such as ChatGPT triggered a new phase focused on autonomous content generation, smart tutoring, and pathway optimization through technologies like ITS, IoT integration, and conversational AI.

The core AI technologies in personalized learning include:

a. **Machine Learning** Models analyze patterns in student performance and learning behaviors, enabling predictions about areas where students need additional support or learning resources.

b. **Natural Language Processing (NLP)** allows the AI system to understand and respond to student queries in natural language, creating a more interactive learning experience by providing instant feedback and accelerating material comprehension.

c. **Data analysis and visualization** involve presenting student progress in clear and accessible formats, such as charts or interactive maps. These tools assist educators in making precise decisions by providing actionable insights.

d. **Adaptive Learning Algorithms** adjust the difficulty of materials based on the student's understanding and development level.

Key AI Technologies Driving PAL

Intelligent Tutoring Systems (ITS): use generative AI and natural language processing to act as 24/7 personal tutors. Rather than just giving answers, they employ the Socratic method to guide students through questioning and adapt instruction to individual skill levels.

Adaptive Engines: Platforms such as **DreamBox** and Adaptemy automatically adjust content and sequencing. They collect micro-level data on how users interact with the material and alter the lesson's difficulty or modality in real time.

Gamified Adaptation: Language apps like **Duolingo** use initial assessments to place learners and adaptively modify difficulty to keep them in their optimal learning zone

Opportunities in AI-driven personalized learning systems

- AI can tailor educational content to align with individual student needs, enabling learners to study according to their unique style, pace, and requirements.
- AI-based systems can design personalized training plans tailored to students' career objectives.
- AI-based systems have the ability to adapt the learning experience to individual preferences and abilities, representing a significant opportunity to improve learning outcomes and make personalized education more interactive and meaningful.

Benefits of AI-driven personalized learning systems

- ✔ Substantial improvements in student engagement, performance, and overall learning outcomes.
- ✔ AI-based personalized learning can significantly reduce cognitive load while improving the accuracy and adaptability of learning materials.
- ✔ AI-based systems improved student performance, indicating the effectiveness of personalized feedback in enhancing educational outcomes.
- ✔ AI-based personalized learning systems helped improve learning outcomes, especially for students with diverse learning styles, such as those with dyslexia.

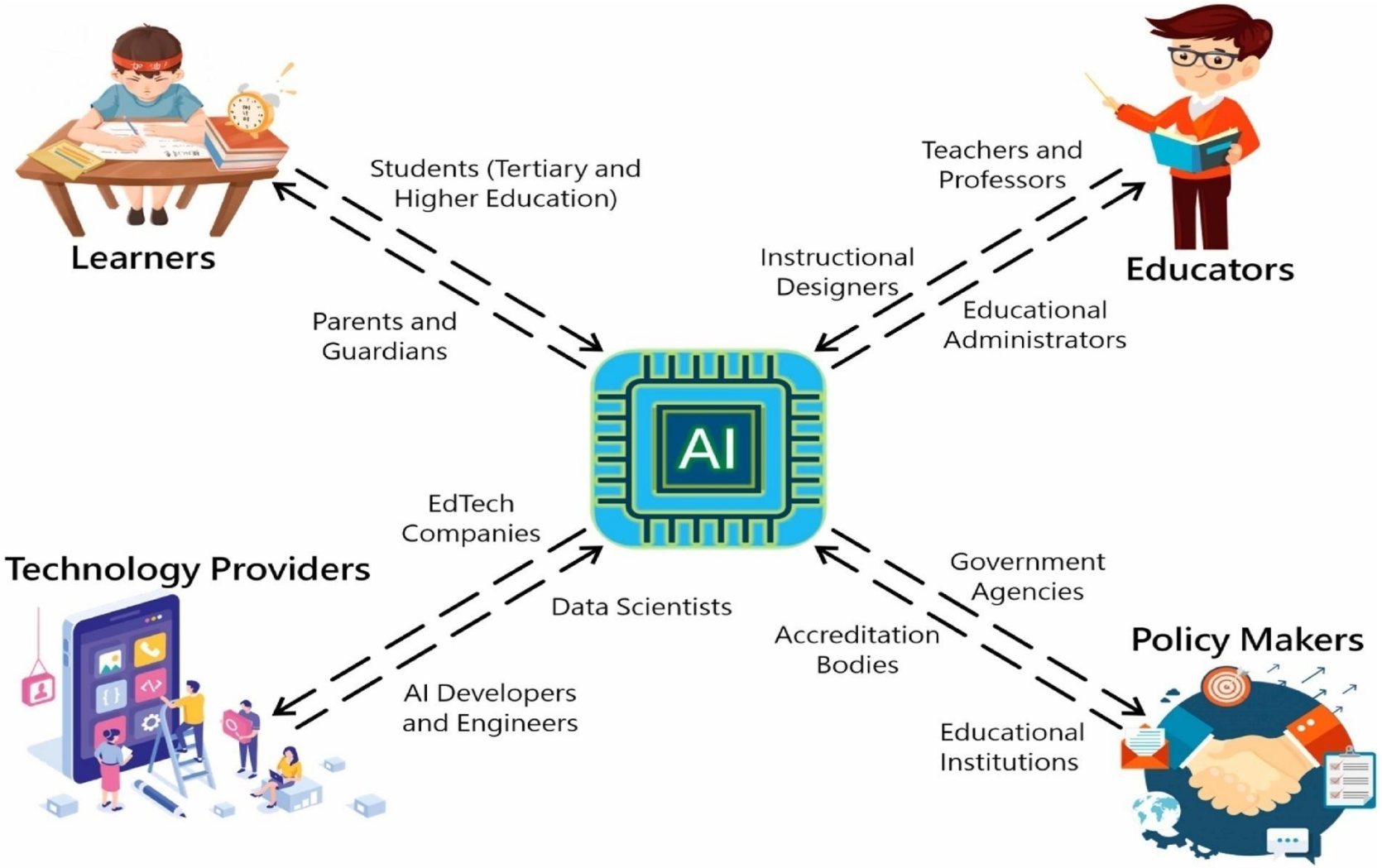
Challenges in AI-driven personalized learning systems

- It is evident that while AI-based learning systems have garnered attention, their integration is still hindered by infrastructure gaps and resistance from both educators and students.

- The lack of adequate teacher training and robust systems to manage personalized learning content are recurring issues

Limitations of AI-based personalized learning systems

- Concerns regarding the readiness and implementation of such systems across various educational sectors.
- For example, AI-based personalized learning systems often overlook external factors, such as the learning environment and social interactions.
- These limitations may restrict the system's effectiveness outside the digital learning environment, even though this technology can potentially enhance student motivation and engagement.
- However, these limitations are not only technical but also involve the preparedness of educational institutions and the skills of educators in adopting such technology.

AI in PAL

Baseline ecosystem of artificial intelligence in personalized learning.