

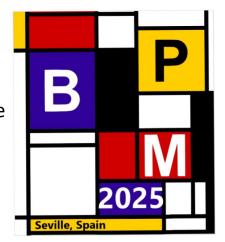
Hi! I am *ART*; Your Augmented Reality Tutor. I can assist your students 24/7.

Al Tutors in Practice: Lessons learned from the field

ART: Augmented Reality Tutor

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Speaker

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Background

- BS, Computer Engineering, BU
- MSc, Software Management, METU
- PhD, Information Systems, METU

Research Interests

- Affective computing
- Al in education
- Intelligent Virtual Agents

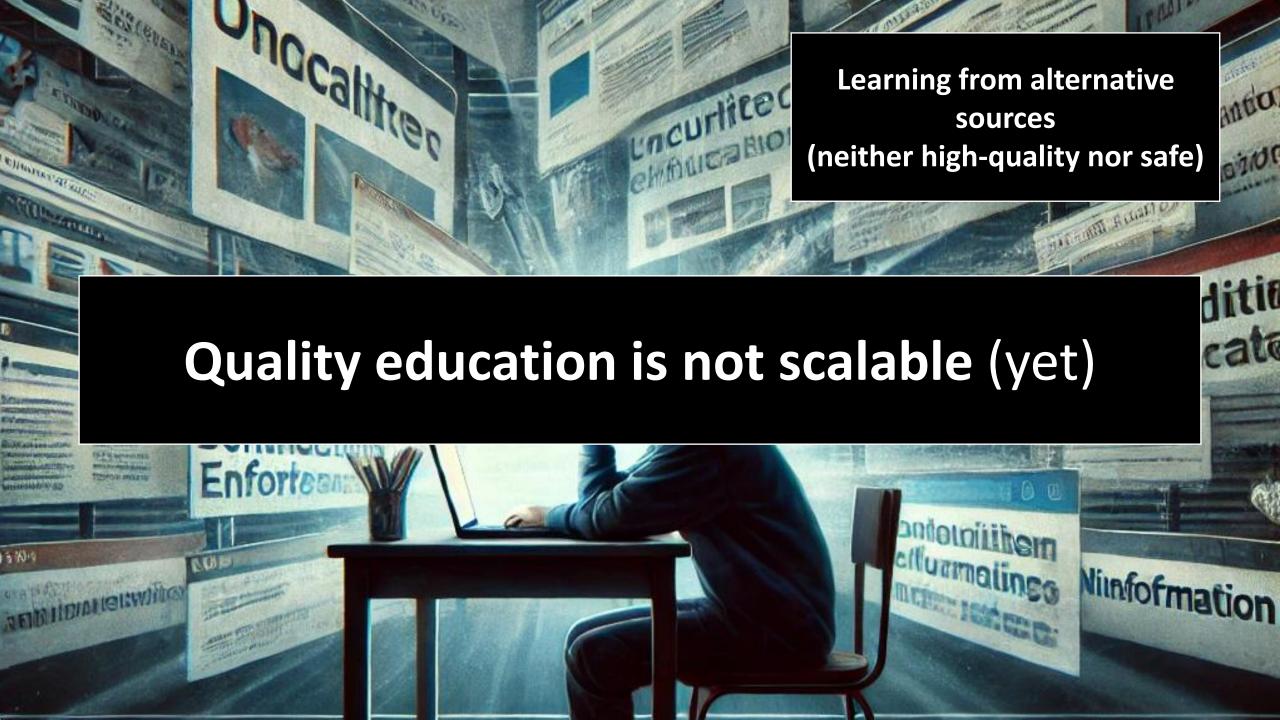




The State of Education in the Age of Al











Technical Background: GenAl, LLM, RAG, Agentic Al

What is GenAl?

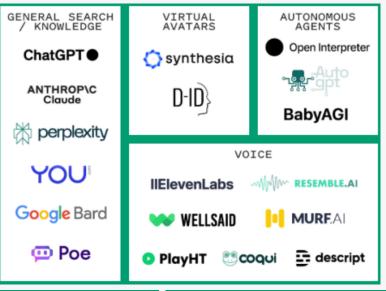


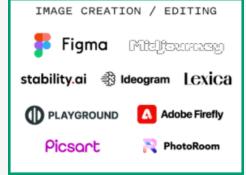
Generative AI refers to artificial intelligence systems capable of creating new content such as *text*, *images*, *audio*, *video*, or *code* based on patterns learned from data.

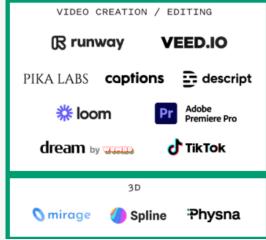
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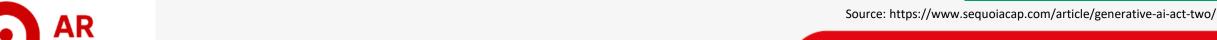
Examples of GenAl in Practice

- Text: ChatGPT, Bard generating essays, summaries, lesson plans
- Images: DALL-E, Midjourney creating visual content and graphics
- Code: GitHub Copilot assisting in software development
- Audio/Video: Synthesia, ElevenLabs creating synthetic voices and avatars





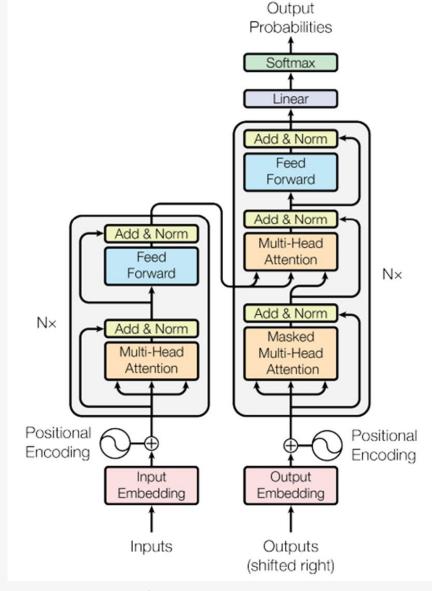




What are LLMs?

- Deep learning models
- with billions of parameters
- captures the underlying patterns of the language
- trained on large-scale datasets.

<u>Task</u>: given an input of a series of words, predict most likely sequence of words that comes next.



Transformer architecture



How do LLMs work?



The best thing about AI is its ability to

learn	4.5%	
predict	3.5%	
make	3.2%	
understand	3.1%	
do	2.9%	

https://writings.stephenwolfram.com/2023/02/what-is-chatgpt-doing-and-why-does-it-work/

In[*]:= NestList[StringJoin[#, model[#, "Decision"]] &, "The best thing about AI is its ability to", 7] Out[-] = { The best thing about AI is its ability to, The best thing about AI is its ability to learn, The best thing about AI is its ability to learn from, The best thing about AI is its ability to learn from experience, The best thing about AI is its ability to learn from experience., The best thing about AI is its ability to learn from experience. It, The best thing about AI is its ability to learn from experience. It's, The best thing about AI is its ability to learn from experience. It's not}



Limitations & Risks of LLMs in Education



Technical

- Hallucination and non-factuality: The generated text appears plausible but can be inaccurate.
- Traceability and information source attribution: No ability to verify sources or to check the validity of the produced text.
- Algorithmic transparency: Black-box neural networks. Neither the process, nor the outcome is explained.

In 2025, these technical limitations are becoming less relevant!

Societal

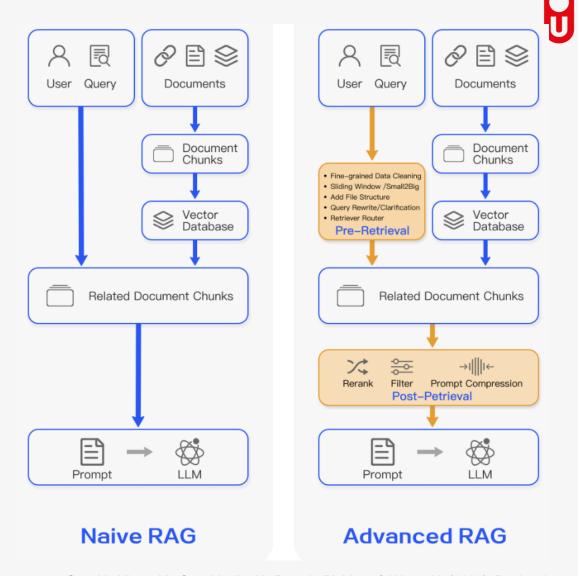
- Non-curated information: LLMs are general-purpose; they are not curated for a purpose.
- Privacy & IP Protection: LLMs has access to vast student data, which might include sensitive information.

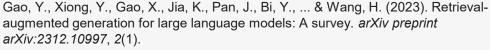


What is RAG?

Retrieval-Augmented Generation (RAG) is an Al architecture that combines two components:

- Retrieval: Fetches relevant documents or facts from an external knowledge base
- Generation: Uses an LLM to generate responses based on those retrieved documents







What is Agentic Al?



Agentic AI refers to systems that can autonomously plan, make decisions, and take actions toward a goal, often over multiple steps, rather than just responding to single prompts.

Key Characteristics

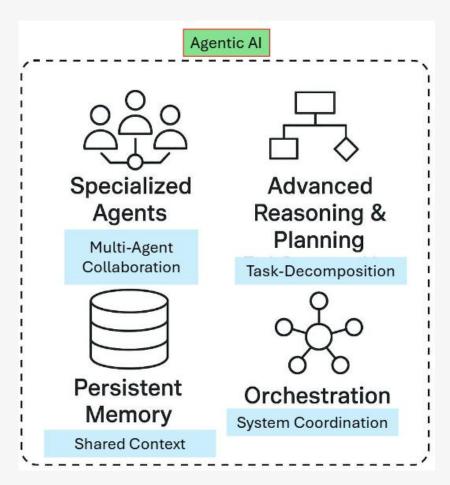
- Goal-Oriented: Operates with a defined objective or task
- Multi-Step Reasoning: Can break down tasks and sequence actions
- Memory and State Awareness: Remembers past steps or context
- Tool Use: Can call APIs, retrieve documents, or trigger other software

Relevance to Education

- Can empower adaptive learning agents that tutor, quiz, and progress over time
- Supports workflow automation (e.g., grading, content generation, feedback loops)
- Enables agents that *reason* through *educational goals*, not just one-off questions

Agentic AI ≠ Chatbot

It's AI that can reason, plan, and act responsibly and purposefully.



Sapkota, R., Roumeliotis, K. I., & Karkee, M. (2025). Ai agents vs. agentic ai: A conceptual taxonomy, applications and challenge. arXiv preprint arXiv:2505.10468.





The Case of ART – Augmented Reality Tutor

Challenges

of education in the age of Al



Teachers are **overburdened Uncontrolled AI** threatens education quality
Concerns of **AI taking away jobs**

Teachers are a scarce resource
Institutions must keep an innovative profile
Must protect student privacy and content IP

EDUCATION INSTITUTION

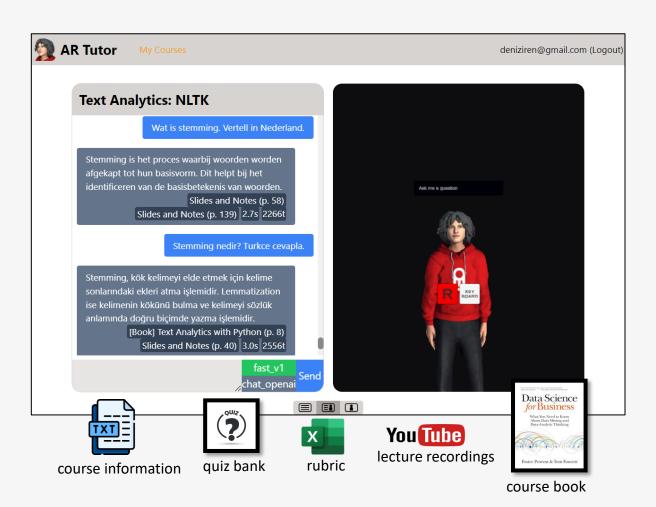
Students have **limited access** to teachers
Motivation challenges of **self-paced** learning
Non-curated AI in education has risks

STUDENT



ART for Students





ART answers student questions in a conversation.

- Both about the course content and administrative
- Cites the source of the information

Suggests follow-up questions.

Gets to know the students.

Challenges students with customized quizzes.

Provides real-time feedback.

Not the direct answers, but clues and learning activities

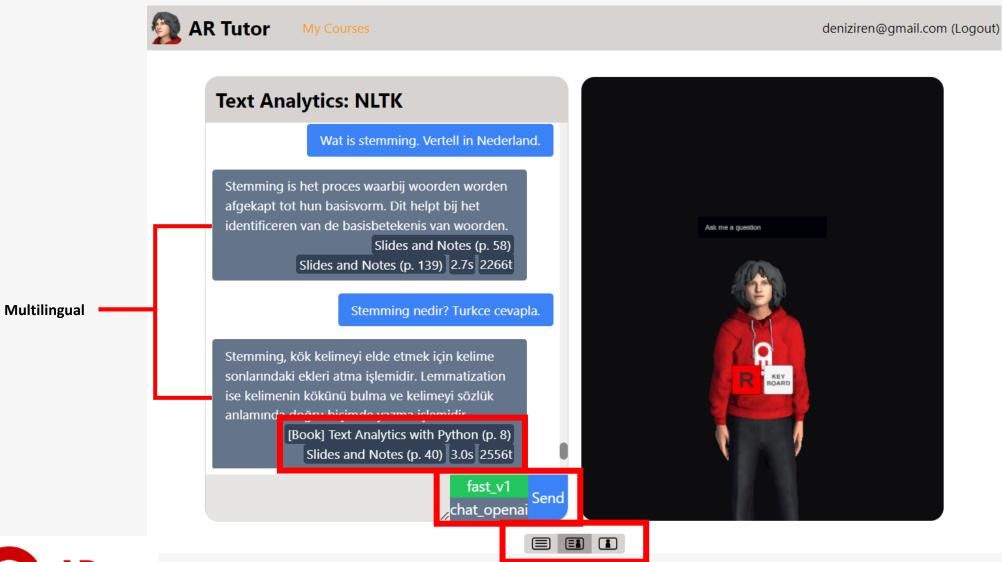
Simplifies complex topics.

Summarizes videos and book chapters.



ART for Students



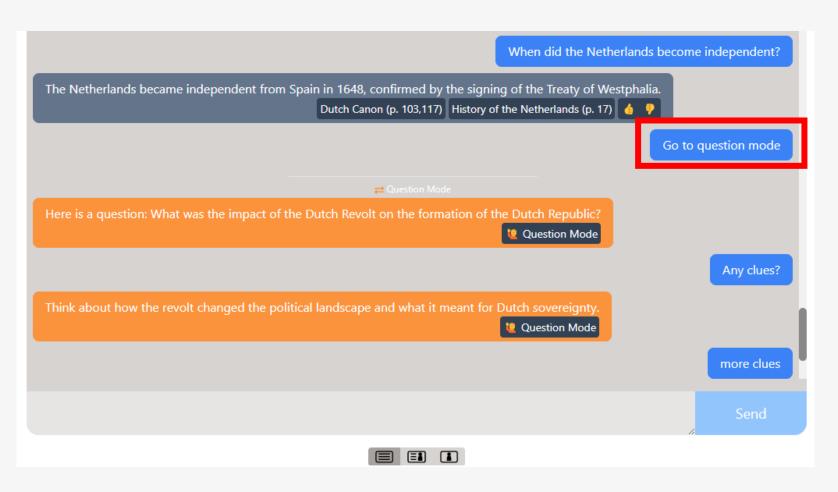




ART for Students: Quiz Mode





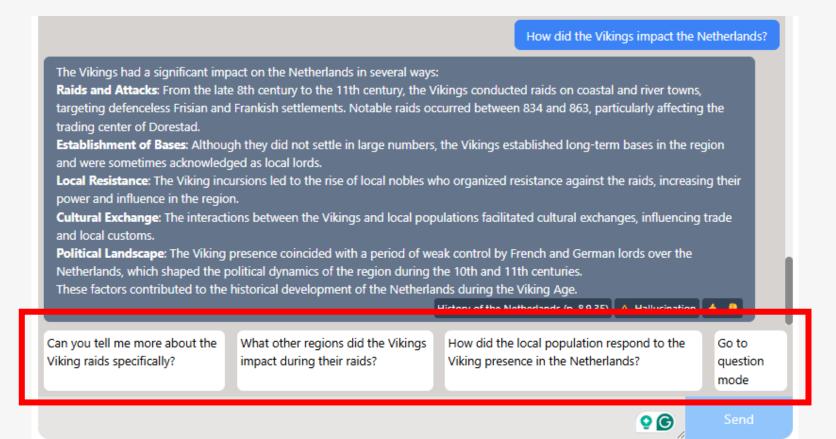




ART for Students: Follow-up Questions





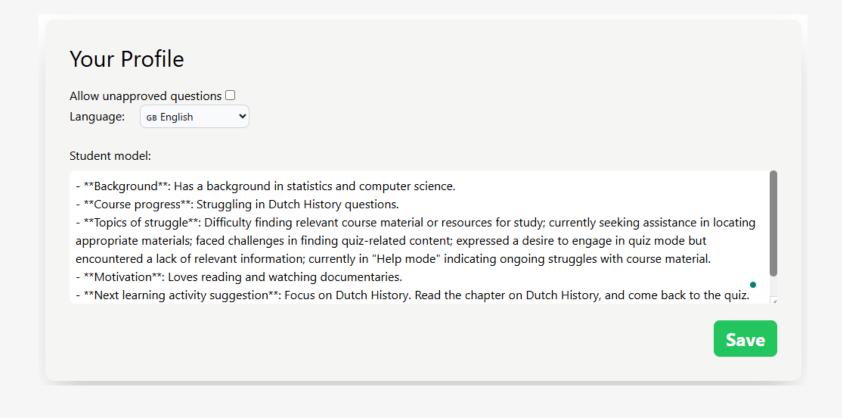




ART for Students: Student Model







Meet ART: Augmented Reality Tutor







An algorithm is a step-by-step procedure designed to solve a specific problem or accomplish a specific task..









- **Model agnostic**
- Natural interaction by **speech** (and text)
 - Language support
- **Platform independent**
- Works on any device with a browser. **No app** required!
 - Laptops, tablets, phones, even VR/XR
- **Ethics-by-design**
 - Sensitive data can stay within the education institution
 - Intellectual property of courses
 - Student data



ART for Teachers

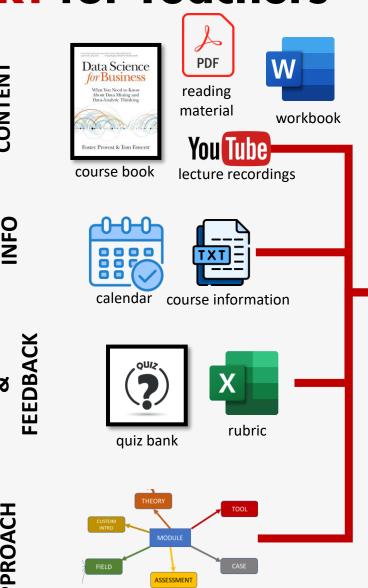


COURSE

COURSE

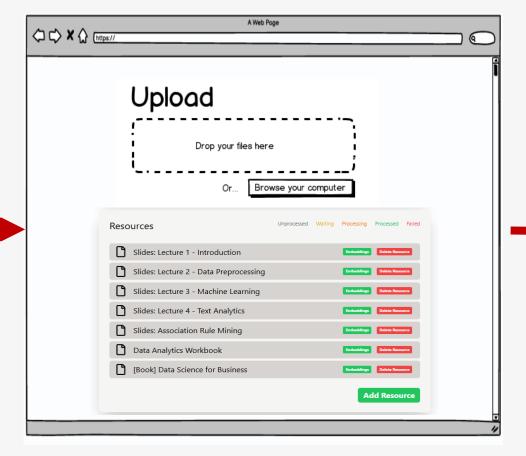
ASSESSMENT &

PEDAGIGICAL APPROACH



pedagogical model

ART: Teacher Portal



ART
Customized
for a Course



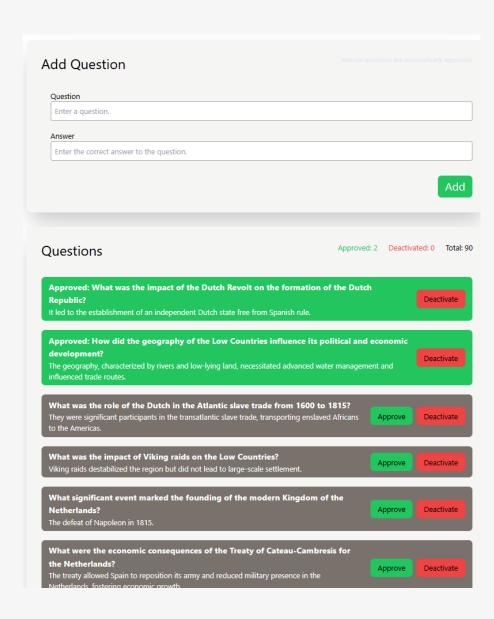


Synchronize Content with Brightspace



ART for Teachers: Quiz Curation





Teacher has full control

- ART generates candidate quiz questions and answers
- The teacher can approve/reject/edit/add questions
- Students have access to these questions in the quiz mode

ART for Teachers: Reports



III Learning Progress & Engagement

- Completion status of learning tasks
- Time spent on activities

Assessment & Feedback

- •Quiz performance and score trends
- •Common misconceptions or errors
- •Levels of question complexity handled (e.g., factual vs. analytical)

Flags for Attention (Optional & Configurable)

- •Signs of confusion, frustration, or disengagement
- •Requests for help outside content scope

Note on Privacy

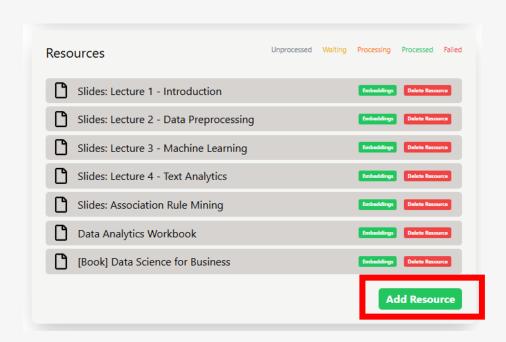
- Reports are **pseudonymized** and grounded in learning—not surveillance.
- Teachers see what helps them teach, not personal behavior profiles.

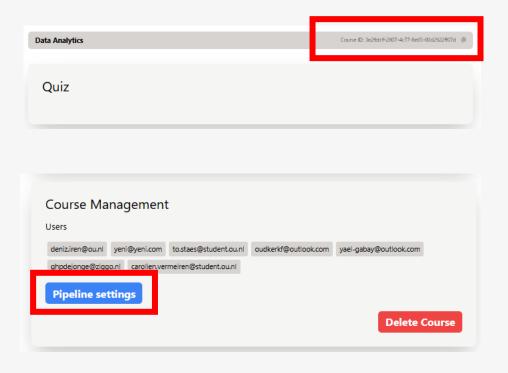
WORK IN PROGRESS



ART: Course Page



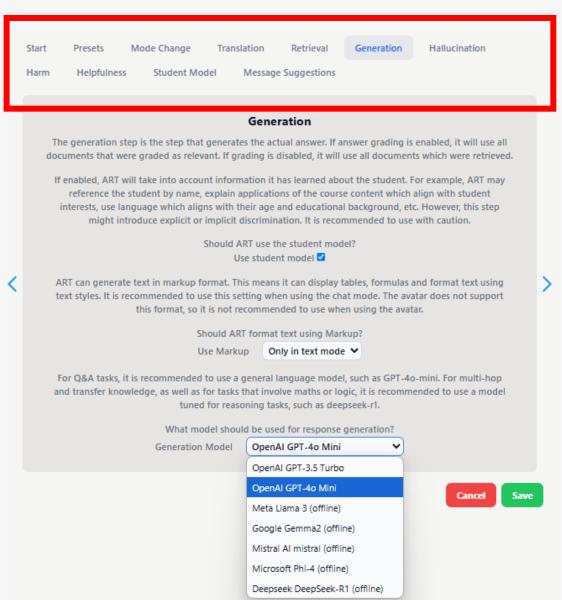






ART for Teachers: Tutor Behavior & Pedagogy





Tutor Behavior

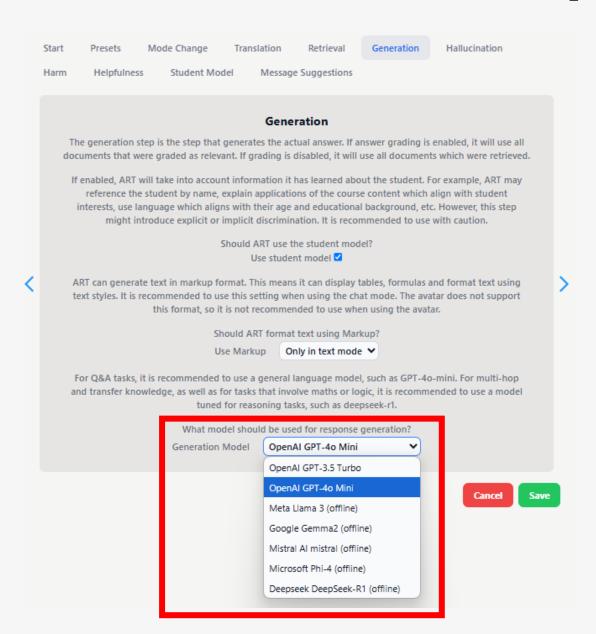
- Every aspect of the agentic workflow is configurable
- The teacher can select what happens in various cases
 - E.g., info not found in curated documents

Pedagogy

- Teachers can indicate pedagogical preferences
 - E.g., when and how feedback is given
- Teachers can select pedagogical models
 - E.g., adaptive learning, problem-based learning

ART for Institutions: Privacy and IP Protection



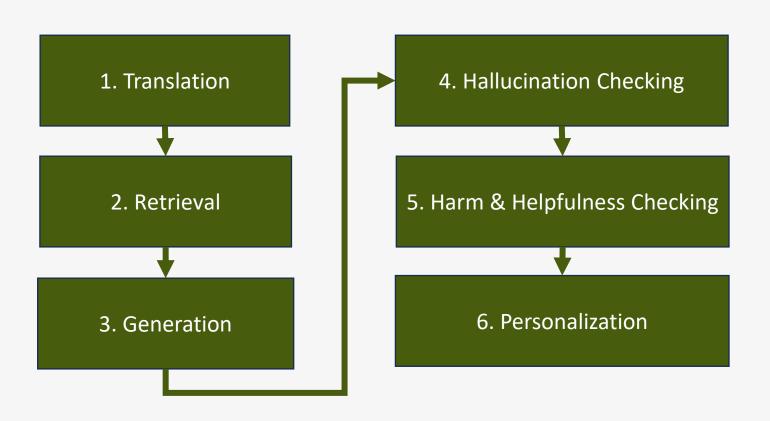


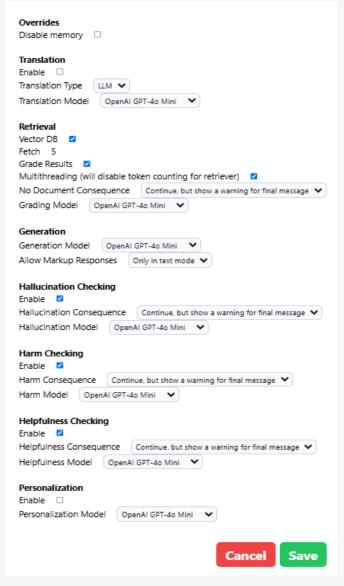
Online vs. Offline Models

- ART offers online and offline language models
- Online models use API to connect 3rd party models
 - E.g., ChatGPT
 - Fast but information travels to 3rd parties
- Offline models live on ART server
 - E.g., Ilama, Gemma, Phi, and Deepseek
 - Slower (due to our current server capacity)
 - Offer privacy and IP protection

ART: Agentic Al Workflow







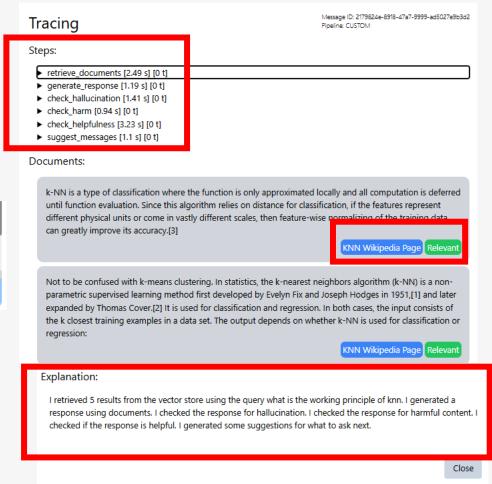


ART: Explainability



k-NN is a type of classification where the function is approximated locally, and all computation is deferred until function evaluation. The algorithm relies on distance for classification, and the output is determined by a plurality vote of the k closest training examples in a dataset. The object is assigned to the class most common among its k r arest neighbors.

Web: KNN Wikipedia Pa







Pilot Implementations & Lessons Learned

ART: Observations from Education Practice

Actual use

		2023/24	2024/25	2025/26
Open Universiteit	nds	1 course N=70	1 course N=51	5 courses N=200
Maastricht University	Netherlands			2 courses (Sep., 2025) pending pilot
TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY			2 courses N=70 ongoing pilot	
Universität Rostock	Germany	1 course N=46	1 course (May, 2025) ongoing 2 nd pilot	
Philipps Universität Marburg	Gerr	1 course N=372	1 course (May, 2025) ongoing 2 nd pilot	
M@I®	stria	1 course N-56	1 course (May. 2025)	

SCHOOL

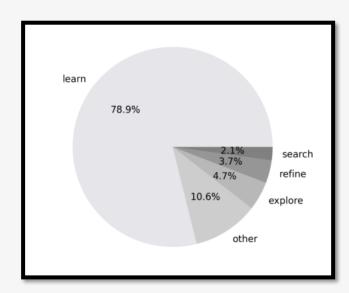
ART: Observations from Education Practice



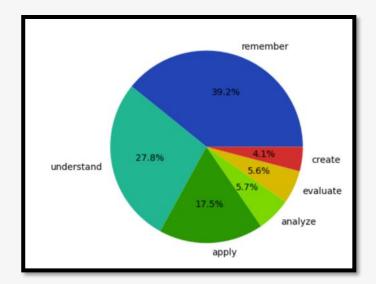
Purpose of use, and facilitation of higher-order thinking

Research questions

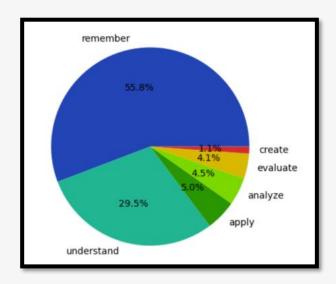
- What are the students' actual usage patterns of AR Tutor?
- Which levels of learning objectives do the students' questions correspond to?



Messages categorized by user intention N=838



Messages, categorized according to (revised) Bloom's Taxonomy
N=661

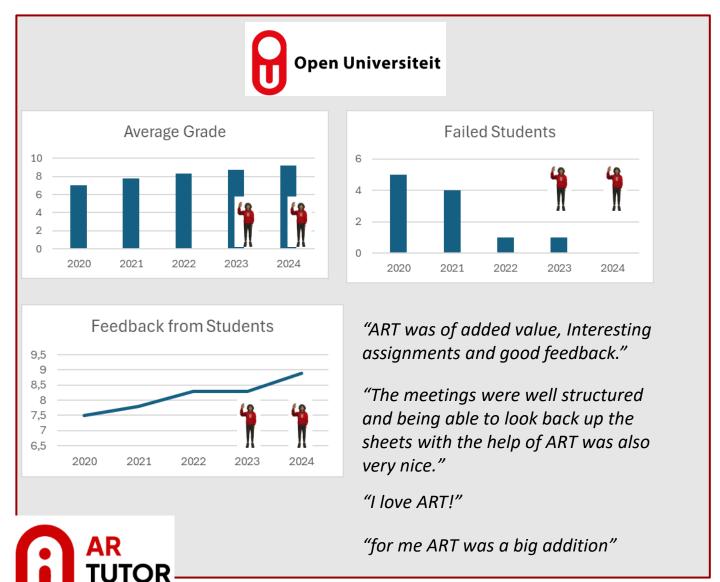


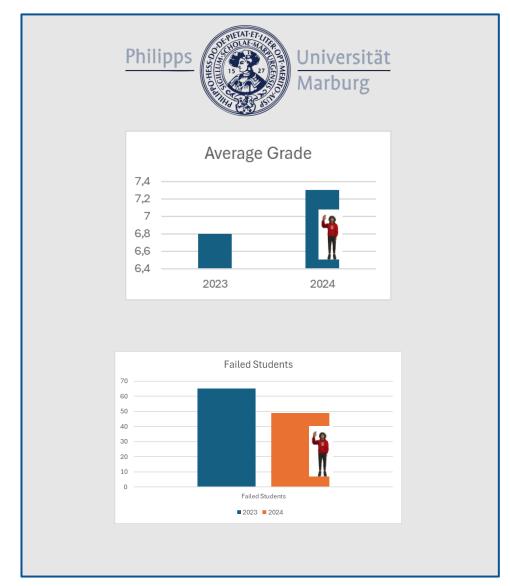
...without quiz and homework questions N=440



ART: Observations from Education Practice

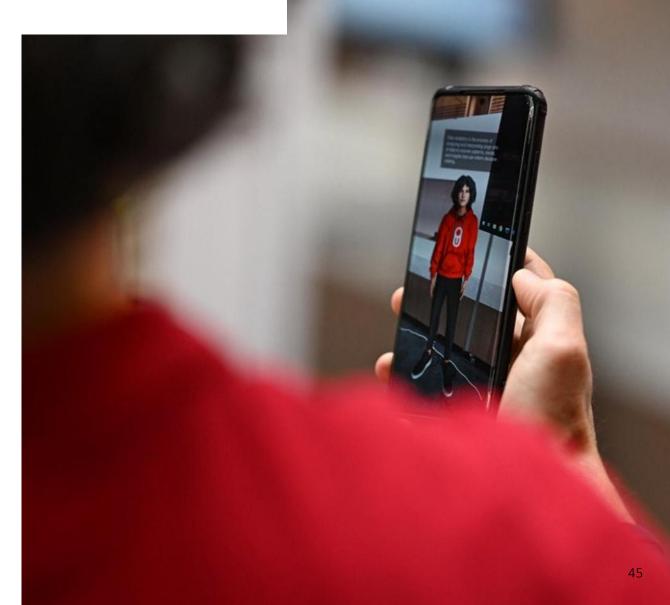
Course grades, student grades, and student dropout





ART: Good Practices & Lessons Learned

- Merely answering student questions is not sufficient.
- Focus on learning activities
- Do not replace the "thinking" process. Foster higher-order thinking
- Pedagogy first, technology later
- Consider the roles of a teacher, then use technology to enhance meaningful roles and replace tedious ones
- Actionable, meaningful feedback is more important than summative feedback
- Responsible AI: Regulations, privacy, data processing, and data security
- Continuously innovate or go extinct



Discussion: Attitude toward GenAl in Education









Questions we are asking	Questions we should be asking
 Should we allow or ban GenAI use? How do we prevent misuse? How do we comply with regulations, e.g., AI Act and GDPR? Should we update policies and honor codes? Which tools are "safe" to use? 	 Are traditional models of teaching and assessment still valid? Are our KPIs (e.g., test scores, attendance) still meaningful? How can we redesign learning ecosystems to reflect a world where AI is ubiquitous? How can we shape GenAI use to align with our institutional mission and pedagogy?
 - How do I prevent cheating? - How can I detect AI-generated work? - Will GenAI replace me? - Which tools should I allow/block? 	 - How can GenAl enhance student learning and motivation? - How can I co-create knowledge with students using Al? - How do I design assessments that reward understanding over output? - How can GenAl help me give faster, deeper feedback? - Can GenAl free me from repetitive tasks to focus more on mentoring and engagement?
Can I use AI to write my essay?How do I get away with using ChatGPT?What's the quickest way to pass this course?Will using AI be considered cheating?	 How can I use GenAI to better understand difficult concepts? What does it mean to learn and grow in an age of AI? How can I stay curious, not just efficient?



Try ART Yourself

ART: Hands-on (as a Student)



Text Analytics

https://stable.artutor.art/courses/join?c=9ac3 974b-45e3-4dda-b492-36166aef0bf0





ART: Hands-on (as a Student)



History of the Netherlands

https://stable.artutor.art/courses/join?c=aa41 89ea-bb64-4c72-95d6-2892cbedbe2b





ART: Hands-on (as a Student)



Dutch Painters

https://stable.artutor.art/courses/join?c=19d4 5f75-a35c-45e5-bbea-322e70ff7741





ART: Augmented Reality Tutor

Future of distance education

Thank you!

Please reach out for collaboration in research and education use cases.

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