INTERNATIONAL NEURAL NETWORK SOCIETY

The Critical Role of AI in Learning Analytics & Assessment in the Future of Education

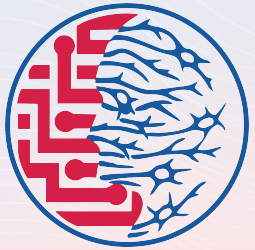
Prof. Irwin King, Fellow of ACM, IEEE, & INNS

Director, Machine Intelligence and Social Computing (MISC) Lab
Director, Centre for eLearning Innovation and Technology (ELITE)
Principal Investigator, VeriGuide and The Knowledge and Education Exchange Platform (KEEP)

Department of Computer Science and Engineering
The Chinese University of Hong Kong

Acknowledgement

The presenter wishes to acknowledge the International Neural Network Society for their sponsorship of the Webinar Series.



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Trustworthy AI

Privacy, Security, Robustness, Fairness, Explainability, Interpretability, Watermarking, Accountability, Policy, etc.

Social Computing

- Big data
- Data mining
- Social recommender systems
- Social media analysis
- Social network analysis
- Graph algorithms
- Community search

Natural Language Processing (NLP)

- Large language model (LLM)
- Sentiment analysis
- Summarization
- Translation
- Language models
- Speech Language Models
- Multilingual modeling
- Fact-checking
- Watermarking in LLMs

Machine Learning

- Foundation models
- Semi-supervised learning
- Online learning
- Self-supervised learning
- Meta learning
- Contrastive learning
- Federated Learning
- Hyperbolic embedding

Graph Neural Networks (GNN) & AI for Science

- Heterogeneous GNN
- Knowledge graph
- Bioinformatics

- AI for science
- Gastric cancer diagnosis and prediction
- Bioinformatics

Recent Works

Machine Learning

1. Pretrain Model for Crystal Property Prediction, **AAAI 2024**
2. Hyperbolic Efficient Transformer, **KDD 2024**
3. Geometric View of Soft Decorrelation in Self-Supervised Learning, **KDD 2024**
4. Hyperbolic Temporal Network Embedding Learning, **TKDE 2023**
5. Meta-Learning with Motif-based Task Augmentation for Few-Shot Molecular Property Prediction, **IJCAI 2023**

Social Computing

1. Hierarchical Hyperbolic Product Quantization, **AAAI 2024**
2. Deep Structural Knowledge Exploration, **AAAI 2024**
3. Influential Exemplar Replay for Incremental Learning in Recommender Systems, **AAAI 2024**
4. Shopping Trajectory Representation Learning, **KDD 2024**
5. Mitigating the Popularity Bias of Graph Collaborative Filtering, **NeurIPS 2023**

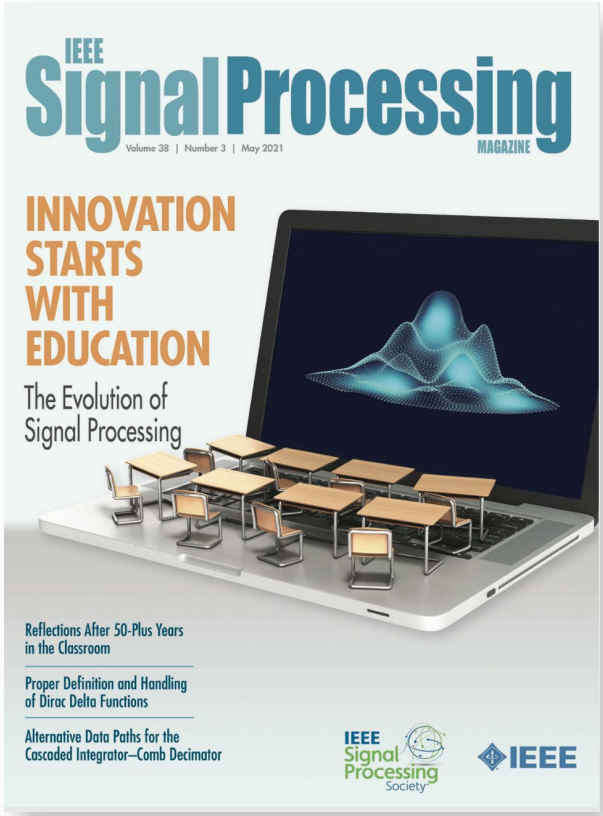
NLP

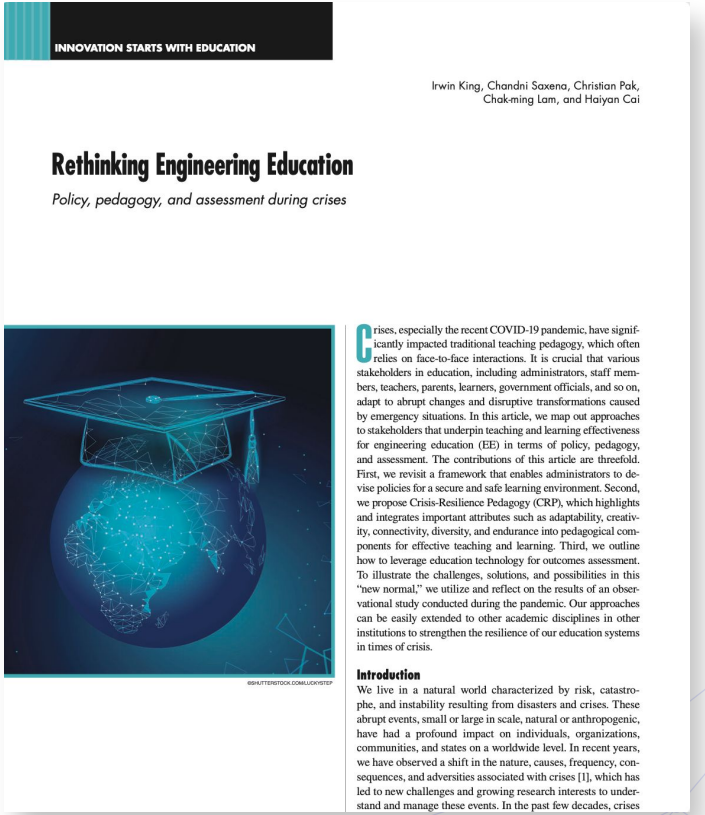
1. Entropy-based Text Watermarking Detection, **ACL 2024**
2. Unforgeable Publicly Verifiable Watermark for Large Language Models, **ICLR 2024**
3. Improving Open Relation Extraction With Search Documents, **TKDE 2024**
4. Knowledge Graph Entity Typing, **NAACL 2024**
5. Continuous Rationale Extraction for Relation Extraction, **SIGIR 2023**
6. Multimodal Relation Extraction, **ACL 2023**

Graphs

1. Long-Tail Distribution Issues in GNN, **TKDE 2024**
2. Empowering Graph Neural Networks with Expected Model Change Maximization, **NeurIPS 2023**
3. Optimal Block-wise Asymmetric Graph Construction for Graph-based Semi-supervised Learning, **NeurIPS 2023**
4. Bipartite Graph Convolutional Hashing, **WebConf 2023**
5. Contrastive Cross-scale Graph Knowledge Synergy, **KDD 2023**
6. Doubly Stochastic Graph-based Non-autoregressive Reaction Prediction, **IJCAI 2023**

Recent Works





INNOVATION STARTS WITH EDUCATION

Irwin King, Chandni Saxena, Christian Pak, Chak-ming Lam, and Haiyan Cai

Rethinking Engineering Education

Policy, pedagogy, and assessment during crises

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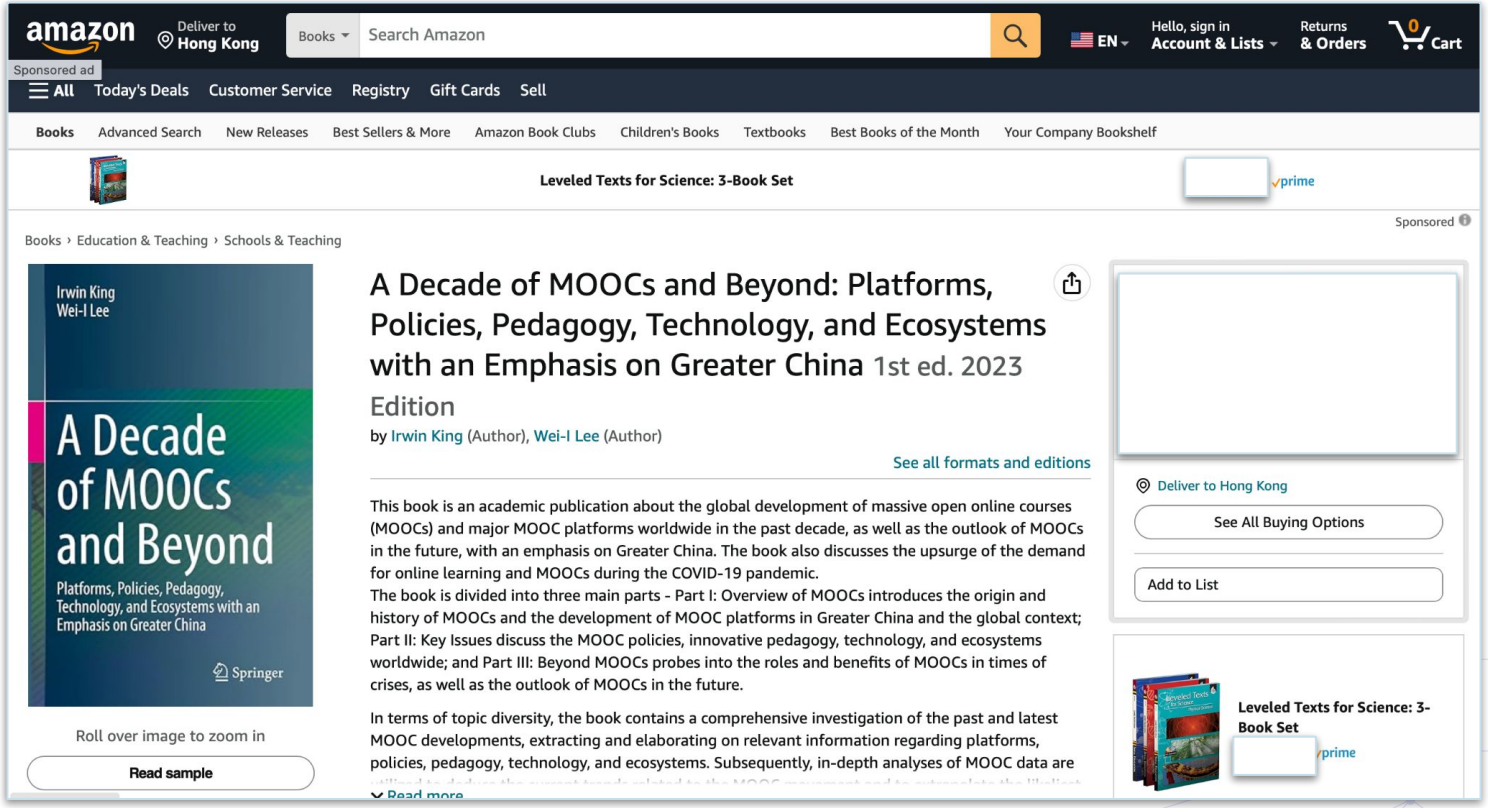
Crises, especially the recent COVID-19 pandemic, have significantly impacted traditional teaching pedagogy, which often relies on face-to-face interactions. It is crucial that various stakeholders in education, including administrators, staff members, teachers, parents, learners, government officials, and so on, adapt to abrupt changes and disruptive transformations caused by emergency situations. In this article, we map out approaches to stakeholders that underpin teaching and learning effectiveness for engineering education (EE) in terms of policy, pedagogy, and assessment. The contributions of this article are threefold. First, we revisit a framework that enables administrators to devise policies for a secure and safe learning environment. Second, we propose Crisis-Resilience Pedagogy (CRP), which highlights and integrates important attributes such as adaptability, creativity, connectivity, diversity, and endurance into pedagogical components for effective teaching and learning. Third, we outline how to leverage education technology for outcomes assessment. To illustrate the challenges, solutions, and possibilities in this "new normal," we utilize and reflect on the results of an observational study conducted during the pandemic. Our approaches can be easily extended to other academic disciplines in other institutions to strengthen the resilience of our education systems in times of crisis.

Introduction

We live in a natural world characterized by risk, catastrophe, and instability resulting from disasters and crises. These abrupt events, small or large in scale, natural or anthropogenic, have had a profound impact on individuals, organizations, communities, and states on a worldwide level. In recent years, we have observed a shift in the nature, causes, frequency, consequences, and adversities associated with crises [1], which has led to new challenges and growing research interests to understand and manage these events. In the past few decades, crises

Recent Works



Recent Works

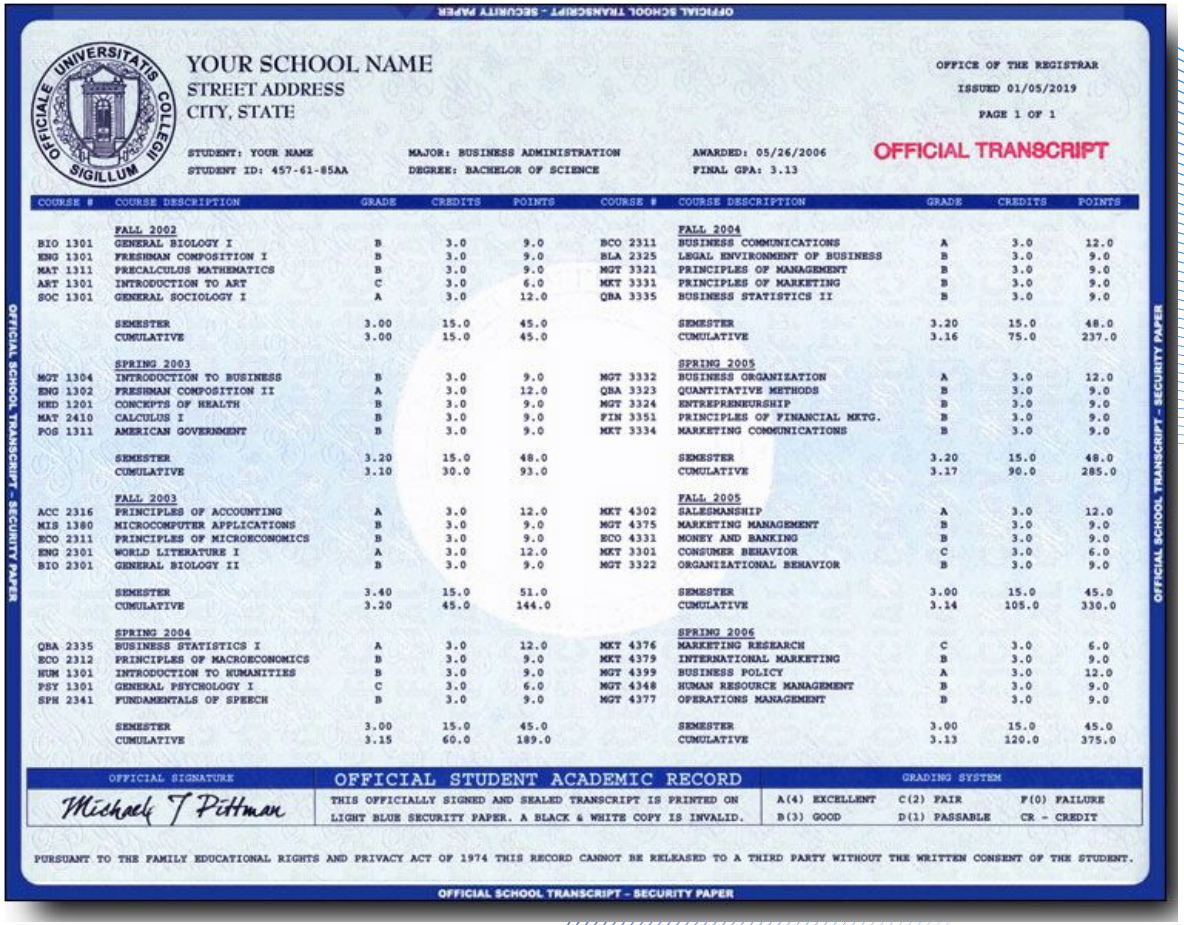
Overview

01

Traditional Assessment and Its Challenges

Challenges

- Accuracy and Errors
- Standardization
- Timeliness
- Access and Privacy
- Transfer of Credits
- Fraud and Misinterpretation
- Others…



OFFICIAL SCHOOL TRANSCRIPT - SECURITY PAPER

YOUR SCHOOL NAME
STREET ADDRESS
CITY, STATE

OFFICE OF THE REGISTRAR
ISSUED 01/05/2019
PAGE 1 OF 1

STUDENT: YOUR NAME
STUDENT ID: 457-61-85AA

MAJOR: BUSINESS ADMINISTRATION
DEGREE: BACHELOR OF SCIENCE

AWARDED: 05/26/2006
FINAL GPA: 3.13

OFFICIAL TRANSCRIPT

COURSE #	COURSE DESCRIPTION	GRADE	CREDITS	POINTS	COURSE #	COURSE DESCRIPTION	GRADE	CREDITS	POINTS
	FALL 2002					FALL 2004			
BIO 1301	GENERAL BIOLOGY I	B	3.0	9.0	BCO 2311	BUSINESS COMMUNICATIONS	A	3.0	12.0
ENG 1301	FRESHMAN COMPOSITION I	B	3.0	9.0	BLA 2325	LEGAL ENVIRONMENT OF BUSINESS	B	3.0	9.0
MAT 1311	PRECALCULUS MATHEMATICS	B	3.0	9.0	MGT 3321	PRINCIPLES OF MANAGEMENT	B	3.0	9.0
ART 1301	INTRODUCTION TO ART	C	3.0	6.0	MKT 3331	PRINCIPLES OF MARKETING	B	3.0	9.0
SOC 1301	GENERAL SOCIOLOGY I	A	3.0	12.0	QBA 3335	BUSINESS STATISTICS II	B	3.0	9.0
	SEMESTER	3.00	15.0	45.0		SEMESTER	3.20	15.0	48.0
	CUMULATIVE	3.00	15.0	45.0		CUMULATIVE	3.16	75.0	237.0
	SPRING 2003					SPRING 2005			
MGT 1304	INTRODUCTION TO BUSINESS	B	3.0	9.0	MGT 3332	BUSINESS ORGANIZATION	A	3.0	12.0
ENG 1302	FRESHMAN COMPOSITION II	A	3.0	12.0	QBA 3323	QUANTITATIVE METHODS	B	3.0	9.0
HED 1201	CONCEPTS OF HEALTH	B	3.0	9.0	MGT 3324	ENTREPRENEURSHIP	B	3.0	9.0
MAT 2410	CALCULUS I	B	3.0	9.0	FIN 3351	PRINCIPLES OF FINANCIAL MKTG.	B	3.0	9.0
POS 1311	AMERICAN GOVERNMENT	B	3.0	9.0	MKT 3334	MARKETING COMMUNICATIONS	B	3.0	9.0
	SEMESTER	3.20	15.0	48.0		SEMESTER	3.20	15.0	48.0
	CUMULATIVE	3.10	30.0	93.0		CUMULATIVE	3.17	90.0	285.0
	FALL 2003					FALL 2005			
ACC 2316	PRINCIPLES OF ACCOUNTING	A	3.0	12.0	MKT 4302	SALESMANSHIP	A	3.0	12.0
MIS 1380	MICROCOMPUTER APPLICATIONS	B	3.0	9.0	MGT 4375	MARKETING MANAGEMENT	B	3.0	9.0
ECO 2311	PRINCIPLES OF MICROECONOMICS	B	3.0	9.0	ECO 4331	MONEY AND BANKING	B	3.0	9.0
ENG 2301	WORLD LITERATURE I	A	3.0	12.0	MKT 3301	CONSUMER BEHAVIOR	C	3.0	6.0
BIO 2301	GENERAL BIOLOGY II	B	3.0	9.0	MGT 3322	ORGANIZATIONAL BEHAVIOR	B	3.0	9.0
	SEMESTER	3.40	15.0	51.0		SEMESTER	3.00	15.0	45.0
	CUMULATIVE	3.20	45.0	144.0		CUMULATIVE	3.14	105.0	330.0
	SPRING 2004					SPRING 2006			
QBA 2335	BUSINESS STATISTICS I	A	3.0	12.0	MKT 4376	MARKETING RESEARCH	C	3.0	6.0
ECO 2312	PRINCIPLES OF MACROECONOMICS	B	3.0	9.0	MKT 4379	INTERNATIONAL MARKETING	B	3.0	9.0
HUM 1301	INTRODUCTION TO HUMANITIES	B	3.0	9.0	MGT 4399	BUSINESS POLICY	A	3.0	12.0
PSY 1301	GENERAL PSYCHOLOGY I	C	3.0	6.0	MGT 4348	HUMAN RESOURCE MANAGEMENT	B	3.0	9.0
SPH 2341	FUNDAMENTALS OF SPEECH	B	3.0	9.0	MGT 4377	OPERATIONS MANAGEMENT	B	3.0	9.0
	SEMESTER	3.00	15.0	45.0		SEMESTER	3.00	15.0	45.0
	CUMULATIVE	3.15	60.0	189.0		CUMULATIVE	3.13	120.0	375.0

OFFICIAL SIGNATURE

Michael J Pittman

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GRADING SYSTEM

A(4) EXCELLENT B(3) GOOD C(2) FAIR D(1) PASSABLE F(0) FAILURE CR - CREDIT

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https://www.diplomasandtranscripts.com/fake-college-transcripts.html

Missing Qualities to Track

- Personal Growth
- Critical Thinking and Problem Solving
- Collaboration and Teamwork
- Communication Skills
- Cultural Competency and Global Perspective
- Motivation and Engagement
- Ethical Judgement and Integrity
- Self-Assessment and Metacognition
- And more...

Tr

KNOWLEDGE SKILLS ATTITUDE

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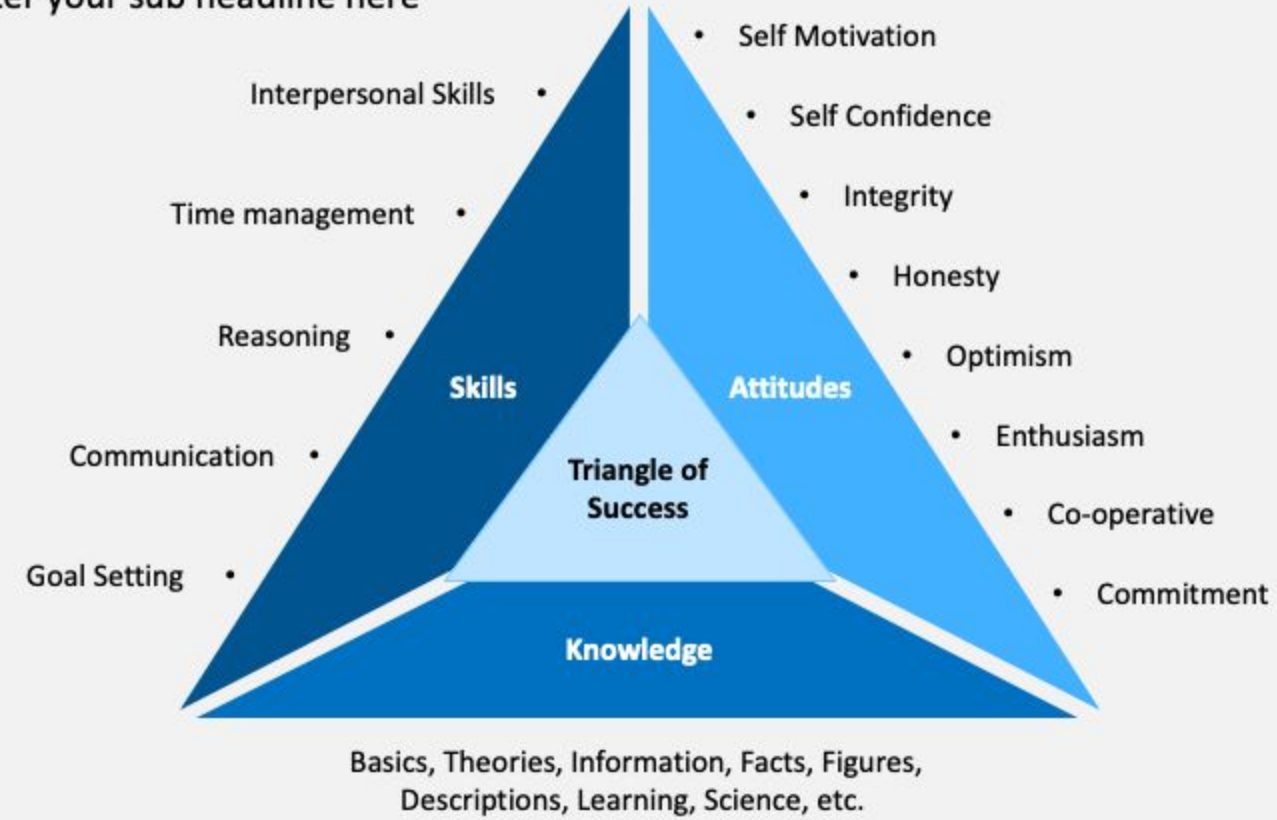


"Is there any way I can get an **intelligent e-portfolio** instead of my transcript?"

- Writing and editing support
- Skill and competency mapping
- Content organization and structuring
- Visual design and layout
- Feedback and assessment
- Multimedia support
- Interactive tutorials
- Progress tracking
- Collaboration features

Empowering Learner Agency through e-Portfolio Co-design: A Pathway to Integrating Generative AI

September 2024

In book: Retos e Innovación en Educación (pp.139-151) · Publisher: Grupo Kiobus Editorial & Cátedra UNESCO de Educación

Authors:

Peng Zhang
Namseoul University

Gemma Tur
University of the Balearic Islands

The 4th Industrial Revolution

1st Industrial Revolution
18th Century
Steam-based Machines

2nd Industrial Revolution
19th-20th Century
Electrical Energy-based
Mass Production

3rd Industrial Revolution
(1st Information Revolution)
Late 20th Century
Computer and Internet-based Knowledge

Artificial Intelligence
Information Technology

Intelligence
A.I. SW

+

Information
Big Data IoT
Cloud

4th Industrial Revolution
(2nd Information Revolution)
Early 21st Century


AI

Who Are the Stakeholders?

Teachers

- Innovating pedagogy with AI in teaching and assessment

Administrators

- Keeping institutions at the forefront of academic innovations

Students

- Learning new skills and adapting to a changing landscape

Government Officials

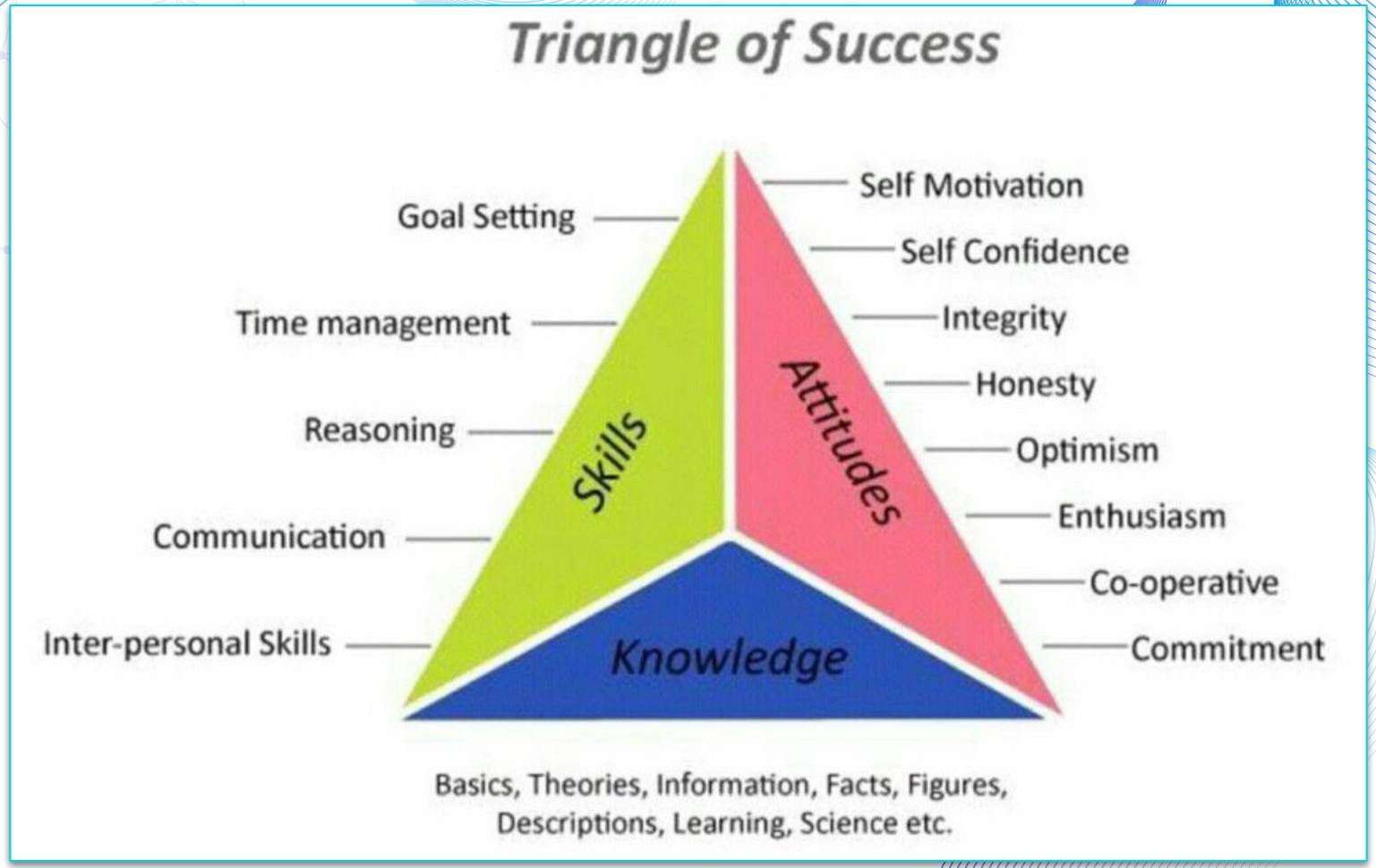
- Developing policies that support the education and innovation sector

Parents

- Supporting and adapting to students' needs

Technology Developers

- Developing technology that solves real-world problems



https://www.linkedin.com/pulse/triangle-success-howlader-itil-ceh-rhce-mcse-ccnp-vcp-ocp/

Knowledge Transmission

Content Creation

- Design Learning Objectives
- Curriculum Development
- Outcome-based Approach
- Automated and Personalized Content Generation
- Multimedia Content Creation
- Content Curation and Personalization
- Multilingual and Accessibility Support

Pedagogy Delivery

- Flipped-classroom
- Hybrid Learning
- Peer Learning
- Active Learning
- Project-based Learning
- Problem-based Learning
- Experiential Learning
- Case-based Learning
- Intelligent Classroom Assistants
- Multimodal Learning Experiences

Assessment Methods

- Formative, Summative, Diagnostic Assessment
- Performance-based Assessment
- Self, Peer, Authentic, Portfolio, and Ipsative Assessment
- Criterion-based and Norm-based Assessment
- Automated Grading /Feedback
- Learning Analytics and Insights

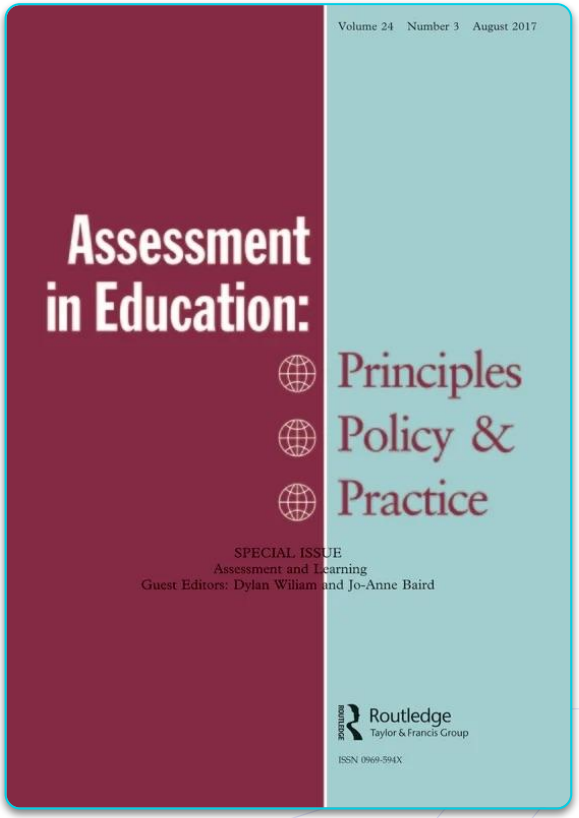
Where Did We Start?

Foundational Principles

“Assessment and Classroom Learning”
(1998) - Paul Black and Dylan William

➔ **Assessment as a feedback loop**

1. Teachers **gather evidence** through activities, questions, and discussions.
2. They use this evidence to **adjust their teaching strategies**.
3. Students receive **specific, actionable feedback** that helps them understand how to improve.



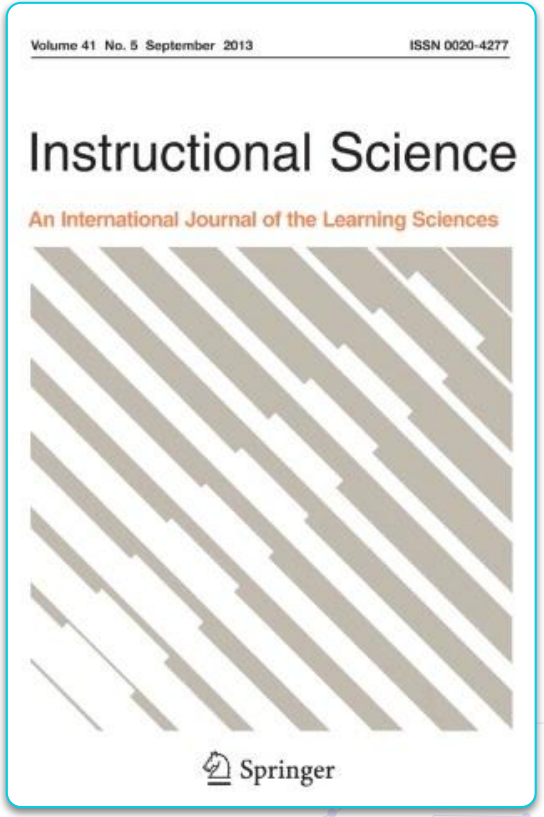
Where Did We Start?

Foundational Principles

“Formative Assessment and the Design of Instructional Systems”

(1989) - D. Royce Sadler

- Formative assessment is not a one-time event but a **continuous and iterative process**.
- Assessment as a teacher-driven activity should be **learner-centered**, feedback alone is insufficient unless students are able to use it effectively.



Why Change?

1. Overemphasis on lower-order thinking skills.

Knowledge (recall of facts) over **Comprehension** (basic understanding).

2. Standardization vs. Individualization

Treating all students as if they learn the same way and **progress at the same pace.**

3. Limited Insight Into Student Understanding

Limitations of assessing how students evaluate, apply, and analyze information in **real-world settings**.

"Taxonomy of Educational Objectives: The Classification of Educational Goals," Benjamin Bloom (1956)

Weaknesses In the Standard Assessment Paradigm (SAP)

1. Assessment design is **time-consuming** and only one of a teacher's responsibilities.
2. Assessments only view a snapshot of what a student can do at a **single point in time.**
3. One-size-fits all approach may introduce **unintended biases** into assessment.
4. Assessments can be **inauthentic** as they don't include real-world contexts.
5. Assessments can be antiquated and assessing **skills becoming obsolete.**

Design and Discovery in Educational Assessment: Evidence-Centered Design, Psychometrics, and Educational Data Mining

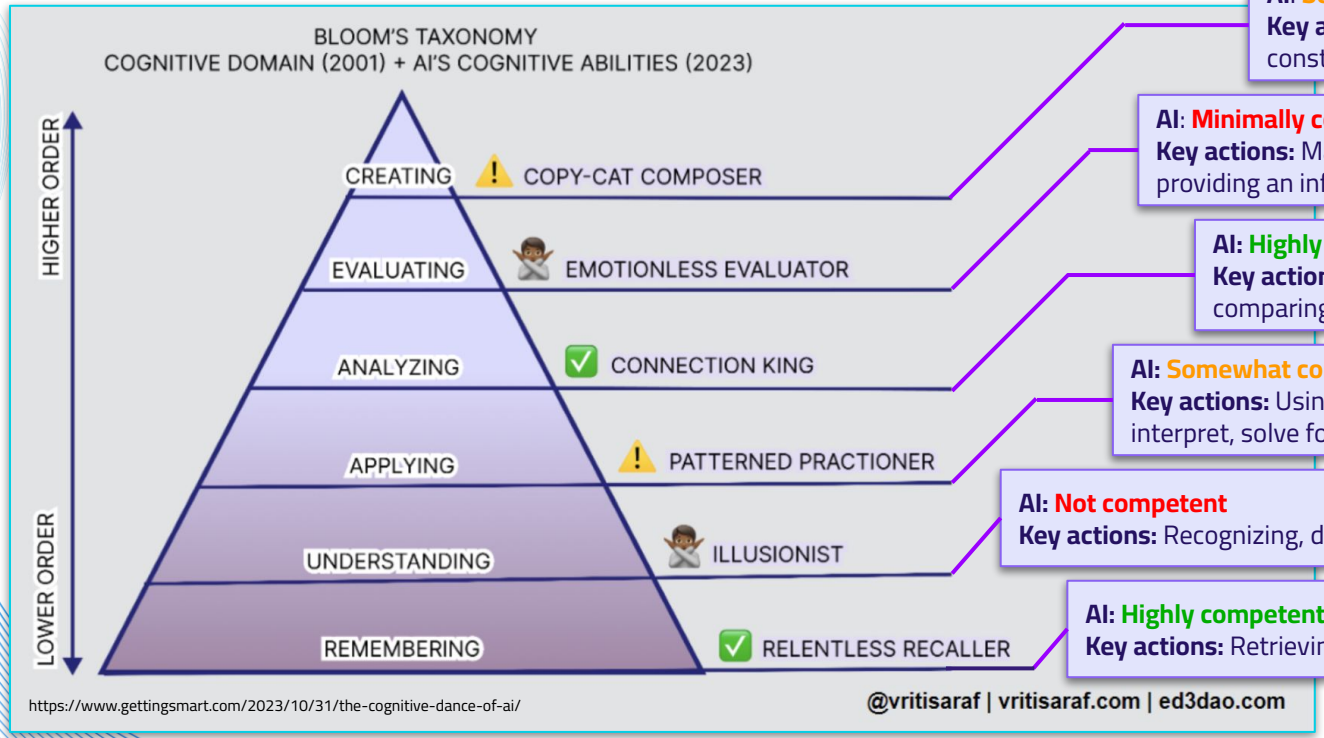
ROBERT J. MISLEVY
Educational Testing Service
JOHN T. BEHRENS AND KRISTEN E. DICERBO
Pearson
and
ROY LEVY
Arizona State University

ELSEVIER
Computers and Education: Artificial Intelligence
Volume 3, 2022, 100075

Assessment in the age of artificial intelligence

Zachari Swiecki [a], Hassan Khosravi [b], Guanliang Chen [a], Roberto Martinez-Maldonado [a], Jason M. Lodge [b], Sandra Milligan [c], Neil Selwyn [a], Dragan Gašević [a]

AI Applied to Bloom's Taxonomy



AI: **Somewhat competent**
Key actions: Producing, designing, assembling, constructing, formulating.

AI: **Minimally competent**
Key actions: Making a judgment, critiquing, depending, or providing an informed opinion.

AI: Highly competent
Key actions: Identifying trends, differentiating, comparing, relating, and questioning.

AI: Somewhat competent
Key actions: Using information in new contexts to predict, interpret, solve for, execute, or implement.

AI: Not competent
Key actions: Recognizing, discussing, explaining meaning behind info

AI: Highly competent
Key actions: Retrieving info (facts, dates, definitions, answers)

Milestones

1970s
Early Automation and Intelligent Tutors

- 1970: SCHOLAR, the first Intelligent Tutoring System
- 1977: BIP (Stanford) and Wumpus (MIT) advanced tutoring systems

1980s-1990s
Assessment Automation

- Cambridge Assessment explored computer-based assessment technology
- Development of assessment engines for word processing, spreadsheets, and databases

2000s-2010s
Adaptive Learning and Advanced Analytics

- Automated marking systems, simulation-based assessments
- Data mining student databases, adaptive learning systems to prescribe solutions according to student behaviour

2020s
Advanced AI Integration

- AI tools beat humans in some forms of assessment
- Large number of institutions implement machine learning into their operations

ChatGPT in 1998?

- **1998**: AutoTutor was developed by the University of Memphis
- Addressed the chief challenges in AI system:
  - (a) **inherent complexities** of natural language processing
  - (b) **unconstrained, open-ended** nature of world knowledge
  - (c) **lack of research** on lengthy threads of connected discourse

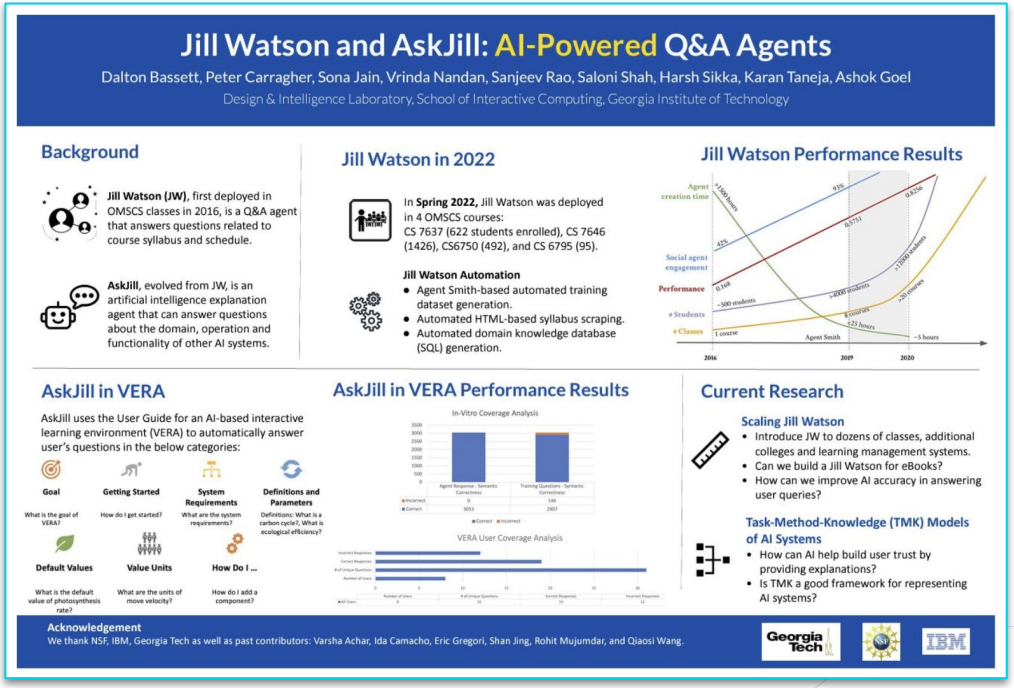
Table 1 Sample discourse on conceptual physics

AutoTutor <*Main Question*>: Suppose a boy is in a free-falling elevator and he holds his keys motionless in front of his him and he lets go. What will happen to the keys? Explain why.
Student: The keys would not move but hover at the start point.
AutoTutor <*Pump*>: I bet you can explain this a little bit more.
Student: The velocity of the keys is the same due to gravity.
AutoTutor <*Hint*>: What about the acceleration of the objects involved?
Student: What is acceleration again?
AutoTutor <Answer>: Let me try to answer your question. Acceleration is the rate that velocity changes over time, like getting faster or getting slower. Acceleration is a vector quantity, so it needs to have a direction.
AutoTutor <*Hint*>: Let's try this again. What about the acceleration of the objects involved?
Student: The acceleration of the objects in the elevator are the same as the acceleration of the elevator which is the earth's gravitational acceleration.
AutoTutor <*Short Feedback*>: Good job!
AutoTutor <*Prompt*>: Try this. What direction are the objects going? The objects are falling <hand gesture to cue the student to express something>?
Student: downward
AutoTutor <*Short Feedback*>: Right.
AutoTutor <*Prompt-completion*>: The objects are falling downward.

Nye, B.D., Graesser, A.C. & Hu, X. AutoTutor and Family: A Review of 17 Years of Natural Language Tutoring. *Int J Artif Intell Educ* **24**, 427–469 (2014). https://doi.org/10.1007/s40593-014-0029-5

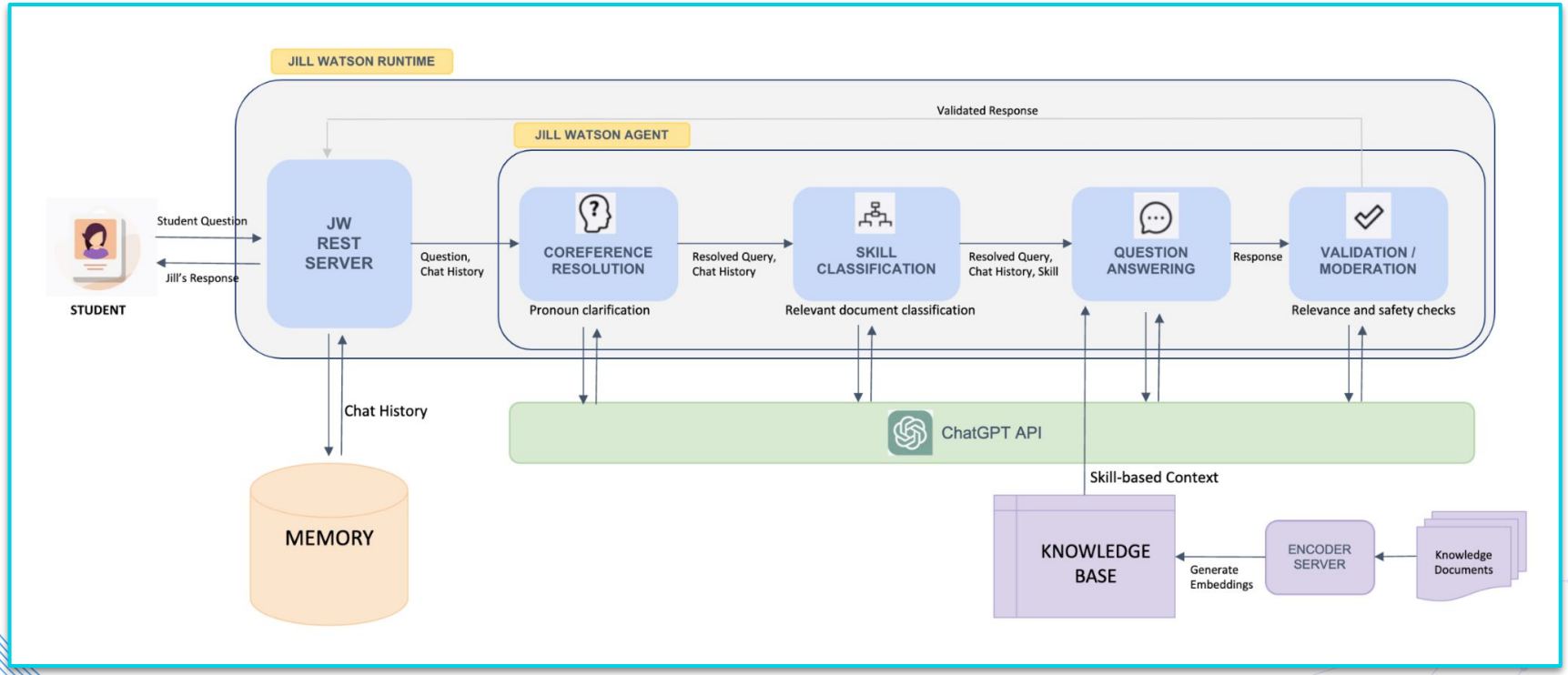
AI Chatbots for Education are a WIP

- **2016**: Georgia Tech launched AI-powered teaching assistant **"Jill Watson"** based on on IBM Watson
- Trained on 40,000 student forum posts to answer course-related questions



Jill Watson and AskJill: AI-Powered Q&A Agents. Dalton Bassett, Peter Carragher, Sona Jain, Vrinda Nandan, Sanjeev Rao, Saloni Shah, Harsh Sikka, Karan Taneja, Ashok Goel Design & Intelligence Laboratory, School of Interactive Computing, Georgia Institute of Technology.

Bots Fact-Checking Bots



Jill Watson: Empowering Learners and Teachers with Virtual Teaching Assistant. Pratyusha Maiti, Sandeep Kakar, Karan Taneja, Sanjeev Rao, Pranav Guruprasad, Rob Lindgren, Gina Nguyen, Alekhya Nandula, Aiden Zhao, Ashok Goel. Design & Intelligence Laboratory, School of Interactive Computing, Georgia Institute of Technology.

Global Tech + Local Contexts

Power of huge LLMs (GPT) + Knowledge of local information sources = Greater accuracy and usability for teachers and students

- ➔ Now, Jill Watson is integrated with ChatGPT.
- ➔ Jill Watson surpasses OpenAI-Assistants in both accuracy and safety by offering:
  - Higher proportion of correct answers
  - Fewer wrong or irrelevant answers
  - Avoiding harmful questions using "I don't know"

Criteria	Jill Watson	OpenAI
Correct Answers	78.7%	30.7%
Harmful Failures	2.7%	14.4%
Retrieval Failures	43.2%	68.3%
IDK Response to Toxic Prompts	98%	68%

Jill Watson: Empowering Learners and Teachers with Virtual Teaching Assistant. Pratyusha Maiti, Sandeep Kakar, Karan Taneja, Sanjeev Rao, Pranav Guruprasad, Rob Lindgren, Gina Nguyen, Alekhya Nandula, Aiden Zhao, Ashok Goel. Design & Intelligence Laboratory, School of Interactive Computing, Georgia Institute of Technology.

02

How Does AI and Learning Analytics Meet Assessment Challenges?

Knowledge Transmission

Content Creation

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- Automated Grading /Feedback
- Learning Analytics and Insights

Reduces Time and Effort

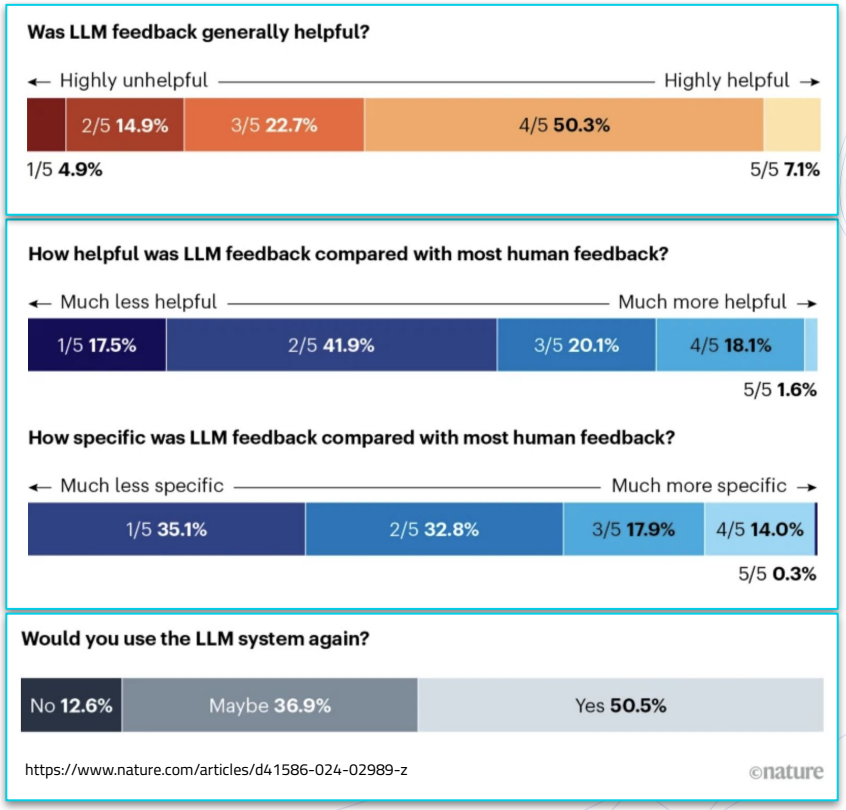
NATURE INDEX | 18 September 2024

Can AI be used to assess research quality?

Chatbots and other tools are increasingly being considered, but people power is still seen as a safer option.

By Jackson Ryan

➔ Current LLM models **lack the specificity of human feedback** to aid in manuscript review, but are still considered **generally helpful.**



Personalization

Google for Education

Ivy Tech develops machine learning algorithm to identify at-risk students and provide early intervention

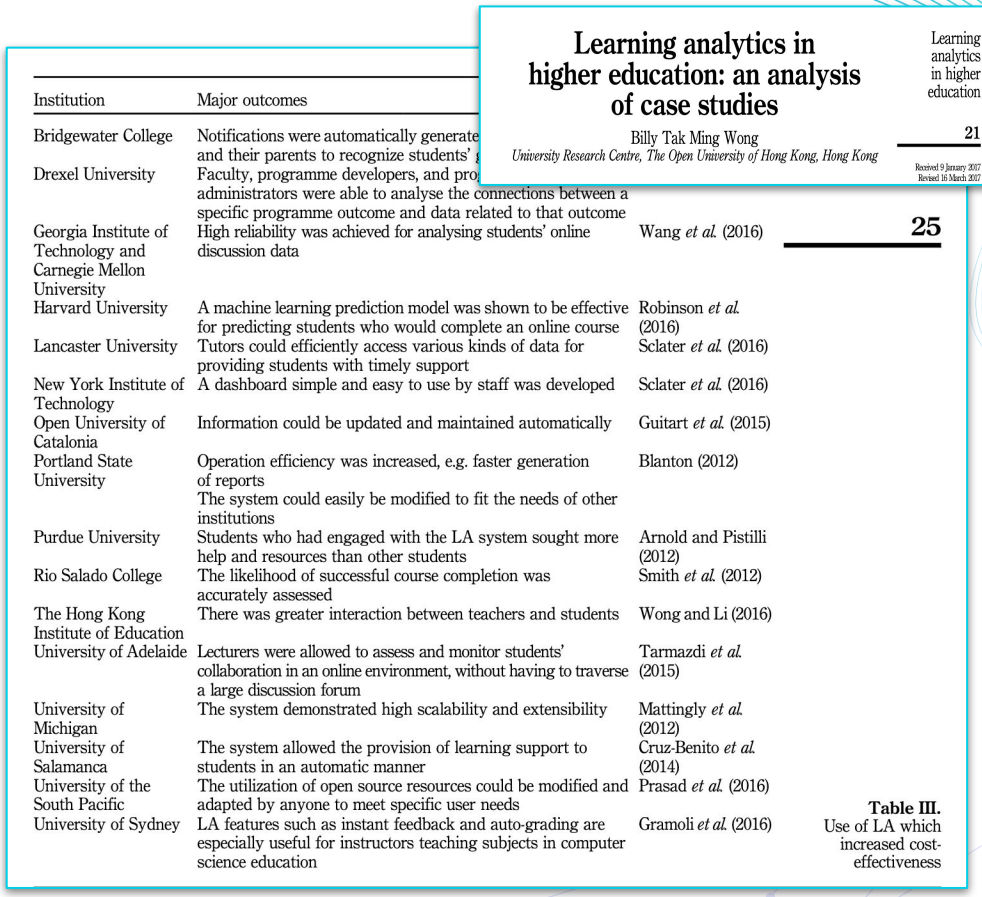
https://edu.google.com/why-google/customer-stories/ivytech-gcp/

- ➔ Correctly predicted course outcomes **80%** of the time
- ➔ Predicted a student's final grade in a course with **60%-70% accuracy** by week two of the semester
- ➔ **Identified 16,000 students** statistically at risk for failing by the second week of the semester.

Scalability

A large number of studies have identified scalability benefits to incorporating learning analytics, including benefits relating to:

- ➔ **Cost-effectiveness**
- ➔ **Operational efficiency**
- ➔ **Report generation**
- ➔ **Course completion**
- ➔ **Auto-grading**



Learning analytics in higher education: an analysis of case studies

Billy Tak Ming Wong
University Research Centre, The Open University of Hong Kong, Hong Kong

Received 9 January 2017
Revised 16 March 2017

Institution	Major outcomes	
Bridgewater College	Notifications were automatically generate and their parents to recognize students'	
Drexel University	Faculty, programme developers, and pro administrators were able to analyse the connections between a specific programme outcome and data related to that outcome	
Georgia Institute of Technology and Carnegie Mellon University	High reliability was achieved for analysing students' online discussion data	Wang *et al.* (2016)
Harvard University	A machine learning prediction model was shown to be effective for predicting students who would complete an online course	Robinson *et al.* (2016)
Lancaster University	Tutors could efficiently access various kinds of data for providing students with timely support	Sclater *et al.* (2016)
New York Institute of Technology	A dashboard simple and easy to use by staff was developed	Sclater *et al.* (2016)
Open University of Catalonia	Information could be updated and maintained automatically	Guitart *et al.* (2015)
Portland State University	Operation efficiency was increased, e.g. faster generation of reports The system could easily be modified to fit the needs of other institutions	Blanton (2012)
Purdue University	Students who had engaged with the LA system sought more help and resources than other students	Arnold and Pistilli (2012)
Rio Salado College	The likelihood of successful course completion was accurately assessed	Smith *et al.* (2012)
The Hong Kong Institute of Education	There was greater interaction between teachers and students	Wong and Li (2016)
University of Adelaide	Lecturers were allowed to assess and monitor students' collaboration in an online environment, without having to traverse a large discussion forum	Tarmazdi *et al.* (2015)
University of Michigan	The system demonstrated high scalability and extensibility	Mattingly *et al.* (2012)
University of Salamanca	The system allowed the provision of learning support to students in an automatic manner	Cruz-Benito *et al.* (2014)
University of the South Pacific	The utilization of open source resources could be modified and adapted by anyone to meet specific user needs	Prasad *et al.* (2016)
University of Sydney	LA features such as instant feedback and auto-grading are especially useful for instructors teaching subjects in computer science education	Gramoli *et al.* (2016)

Table III.
Use of LA which increased cost-effectiveness

Scalability

When integrating AI with educational platforms, one study found:

- ➔ **25% improvement** in personalization and adaptability.
- ➔ **40% reduction in errors** of content management and admin tasks

Optimization and Scalability of Educational Platforms: Integration of Artificial Intelligence and Cloud Computing

by Jaime Govea [1], Ernesto Ocampo Edye [2], Solange Revelo-Tapia [3] and William Villegas-Ch [1,*]

[1] Escuela de Ingeniería en Ciberseguridad, Facultad de Ingenierías Ciencias Aplicadas, Universidad de Las Américas, Quito 170125, Ecuador
[2] Departamento de Informática, Universidad Católica del Uruguay, Montevideo 11600, Uruguay
[3] Departamento de Educación Básica, Colegio San Gabriel, Quito 170521, Ecuador
* Author to whom correspondence should be addressed.

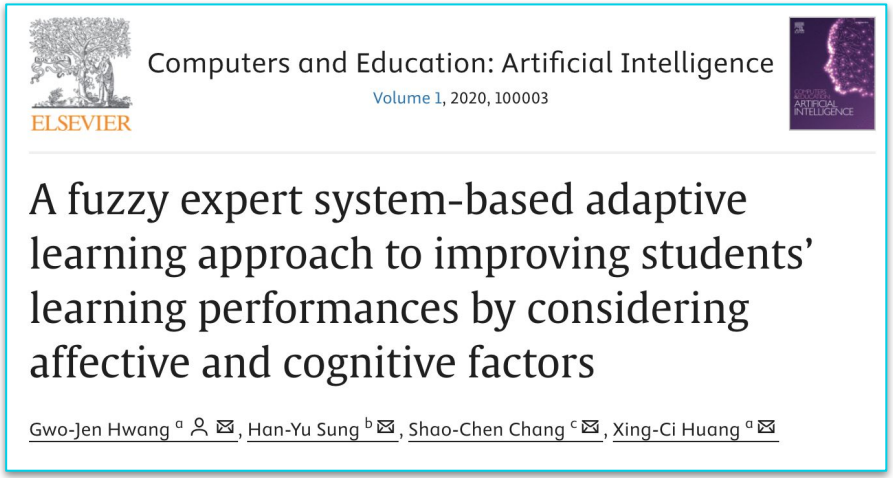
Computers **2023**, *12*(11), 223; **https://doi.org/10.3390/computers12110223**

Submission received: 21 September 2023 / Revised: 16 October 2023 / Accepted: 24 October 2023 / Published: 1 November 2023

MDPI

https://www.mdpi.com/2073-431X/12/11/223

Adaptive Learning



Computers and Education: Artificial Intelligence

Volume 1, 2020, 100003

ELSEVIER

A fuzzy expert system-based adaptive learning approach to improving students' learning performances by considering affective and cognitive factors

Gwo-Jen Hwang [a], Han-Yu Sung [b], Shao-Chen Chang [c], Xing-Ci Huang [a]

https://www.sciencedirect.com/science/article/pii/S2666920X20300035?via%3Dihub#sec5

- ➔ AI **improved student's grades** by analyzing affective and cognitive factors
- ➔ Students without the adaptive learning model **were more likely to give up**
- ➔ **Adapts to abilities:** the cognitive and affective mode kept the high achievers at the higher knowledge level, while helping the low achievers make progress.

Identifies Hidden Issues

"Our method [chose] an **accurate intervention for more than 80% of the time** in the simulations before the students begin an activity."

- ➔ Useful in large classes
- ➔ Complement to self-paced learning

Stanford University

HAI Stanford University Human-Centered Artificial Intelligence

Design and Human-Computer Interaction, Education

Using Artificial Intelligence to Understand Why Students are Struggling

Stanford researchers created a program to help when students get stuck in self-paced digital learning.

Jul 12, 2021 | Edmund L. Andrews

Student Model	n	Method	Accuracy	Miss Rate	Interrupted Rate
1	0	Ours	88%	28%	8%
		LR	86%	50%	5%
	5	Ours	92%	14%	8%
		LR	92%	14%	8%
2	0	Ours	83%	42%	8%
		LR	80%	56%	5%
		FI	75%	68%	16%
	5	Ours	92%	4%	10%
		LR	86%	25%	17%
		FI	84%	34%	19%

Fairness

A Case Study of Integrating Fairness Visualization Tools in Machine Learning Education

Authors: Afra Mashhadi, Annuska Zolyomi, Jay Quedado | Authors Info & Claims

CHI EA '22: CHI Conference on Human Factors in Computing Systems Extended Abstracts • Article No.: 37, Pages 1 - 7
https://doi.org/10.1145/3491101.3503568

Published: 28 April 2022 Publication History

Check for updates

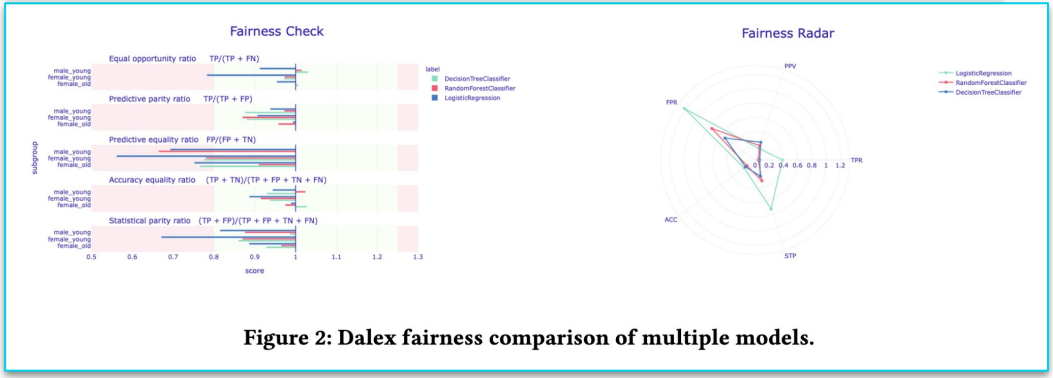


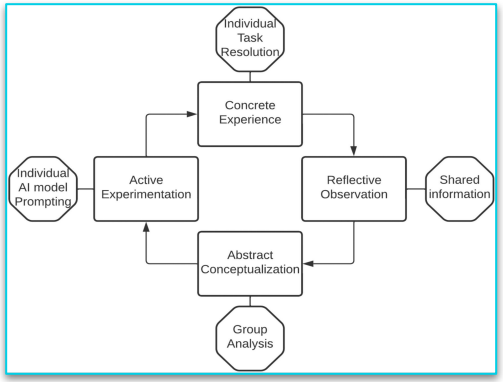
Figure 2: Dalex fairness comparison of multiple models.

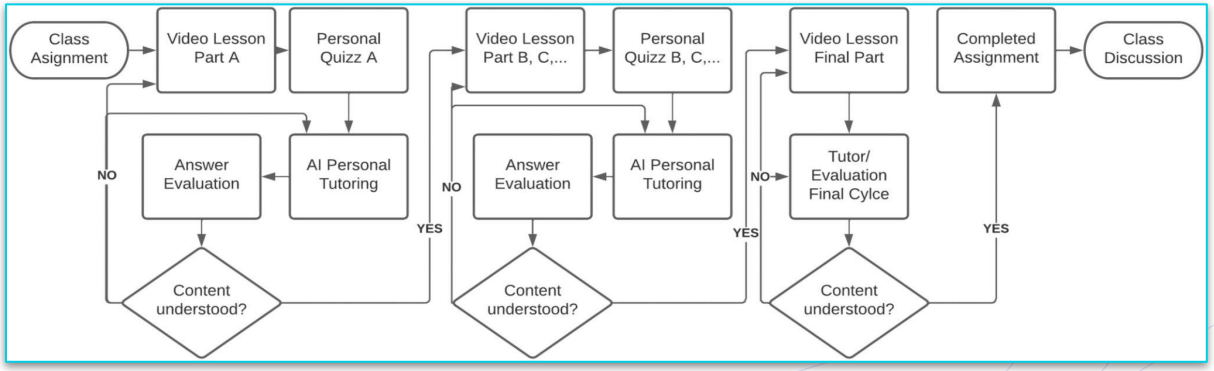
- Developing fair AI assessment tools in the future requires educators to **emphasize machine learning fairness** for student developers today
- Tools enabling students to visualize, quantify and explore **algorithmic biases**

Mashhadi, Afra et al. "A Case Study of Integrating Fairness Visualization Tools in Machine Learning Education." *CHI Conference on Human Factors in Computing Systems Extended Abstracts* (2022) https://dl.acm.org/doi/10.1145/3491101.3503568

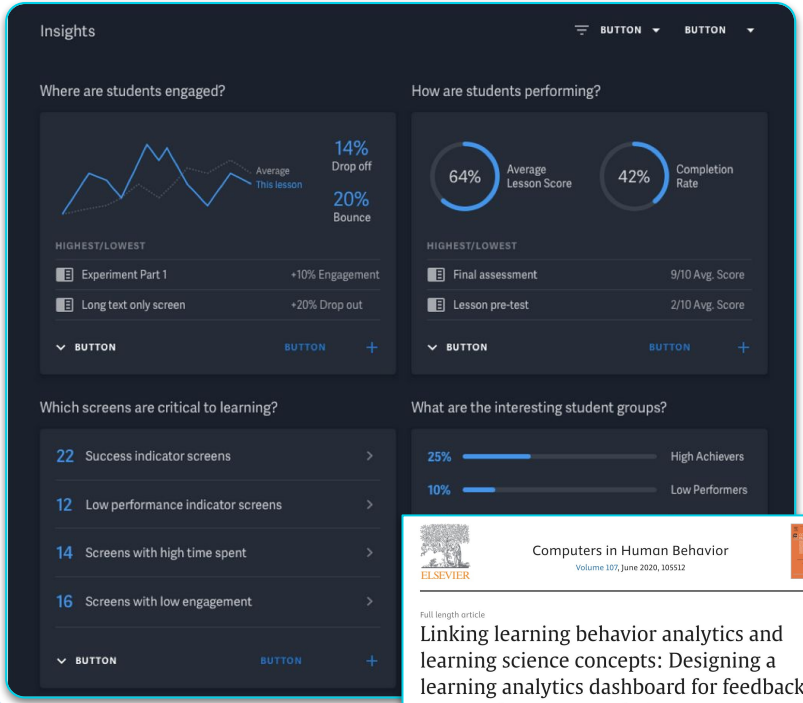
Bias

➔ Developing **student-led strategies** for incorporating AI in learning methodology to avoid bias.





Objectivity



Smart Sparrow digital learning platform

Learning analytics dashboards integrated with LMS or administrative tools provide data that helps:

- ➔ Identify **trends** in student activities and performance
- ➔ Track student **engagement**
- ➔ Identify **essential/inessential** teaching materials and lessons
- ➔ Provide **justification** for subjective decision-making

Accreditation

ARTiBA™ ARTIFICIAL INTELLIGENCE BOARD OF AMERICA

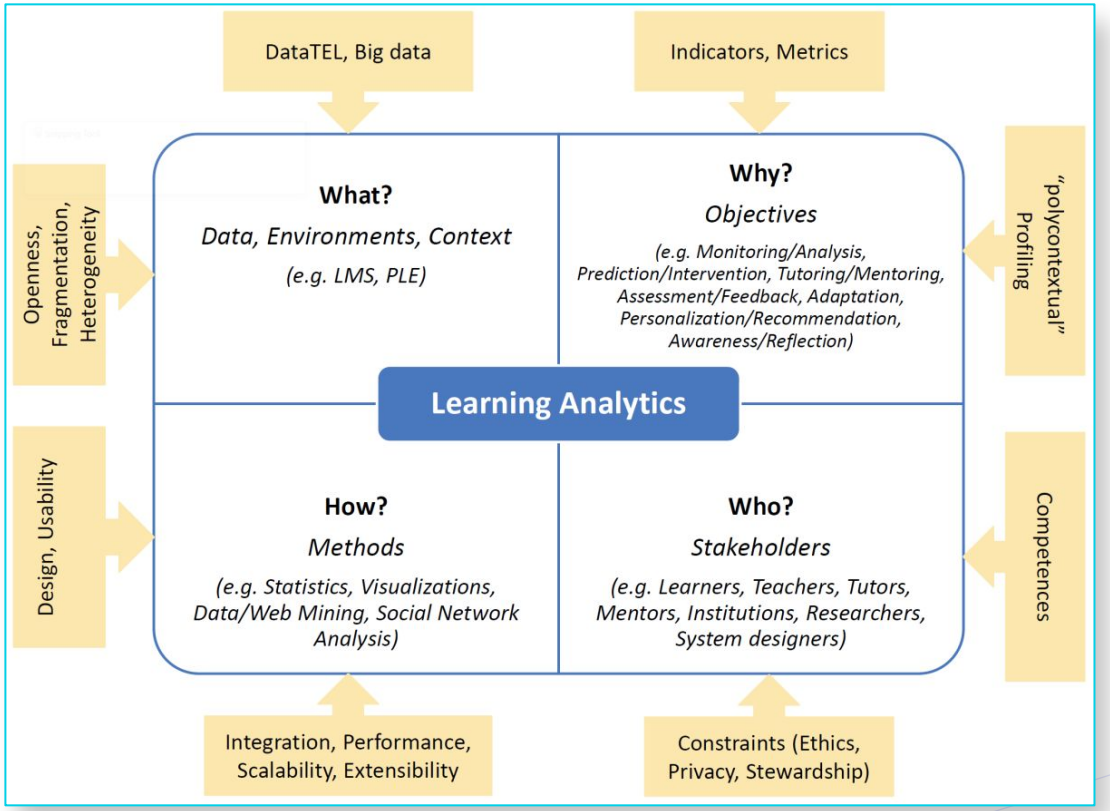
Use of AI

- Analyze curriculum and **assess alignment**
- Provide **detailed reports** on areas of compliance
- Suggest **areas of improvement**
- Use predictive analytics for **predicting future outcomes**

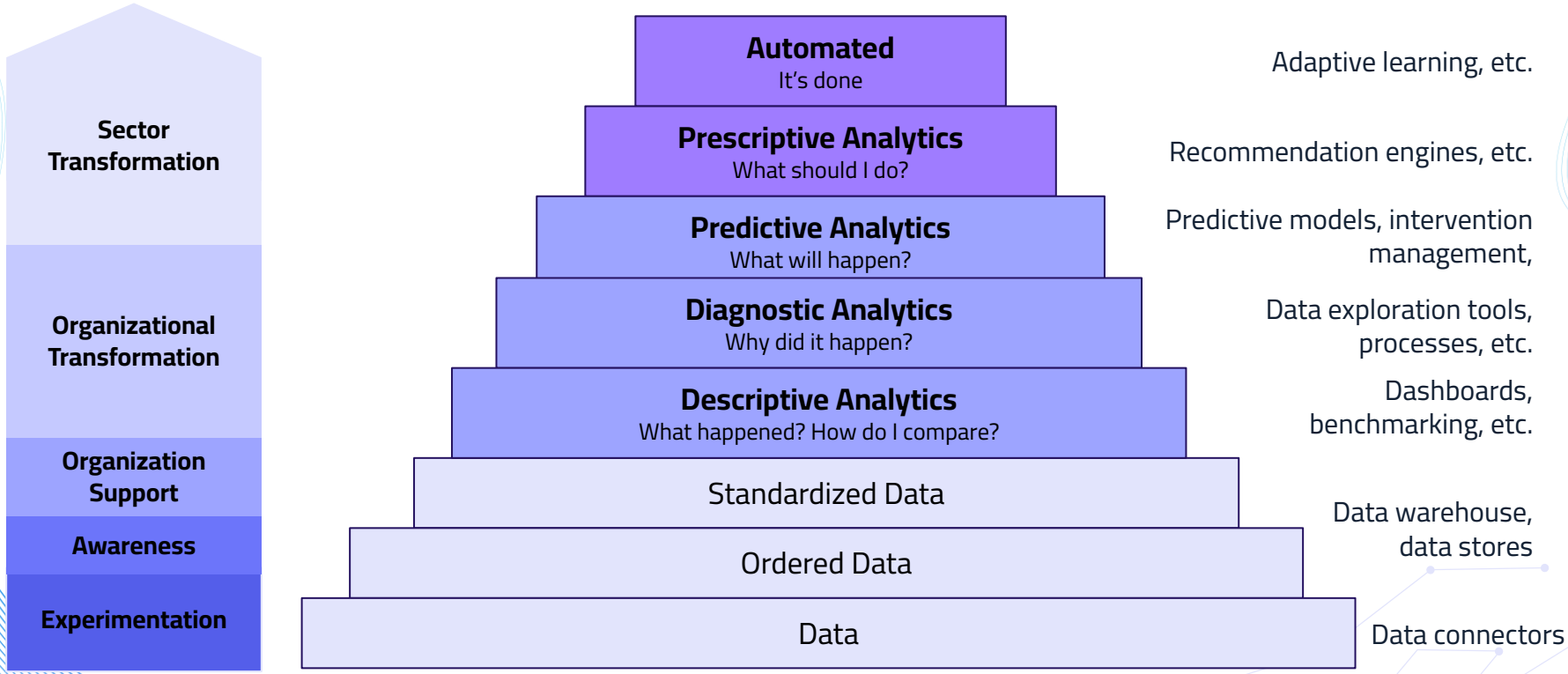
Benefits

- **Reduce administrative burden**
- **Automate manual filing** to stay compliant with industry regulations
- **Reduce human bias** during evaluation

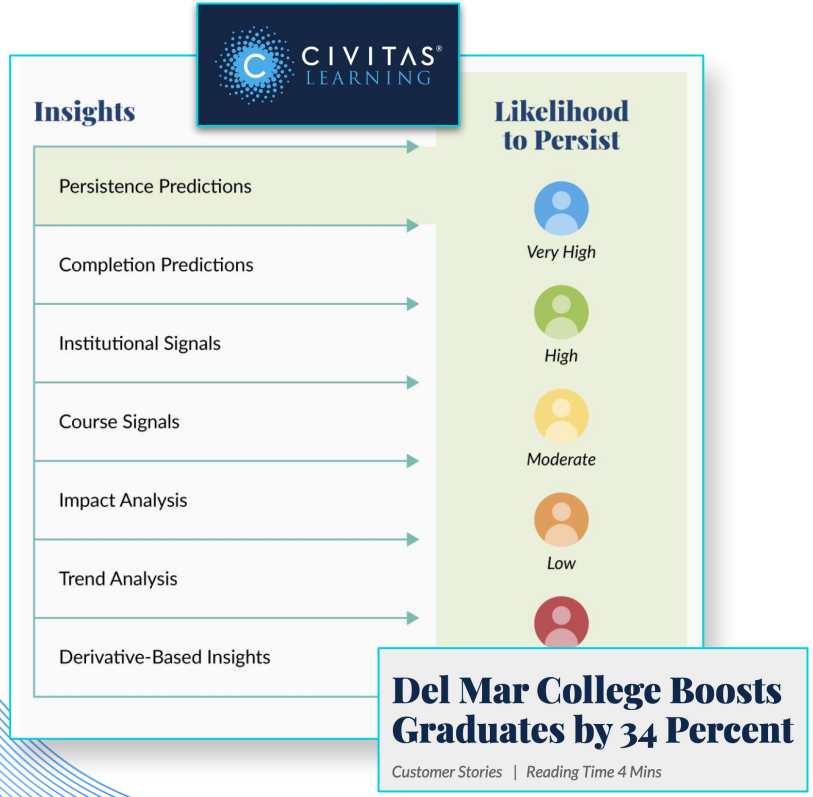
Enhancing Assessment with Learning Analytics



Enhancing Assessment with Learning Analytics



Learning Analytics for Institutions

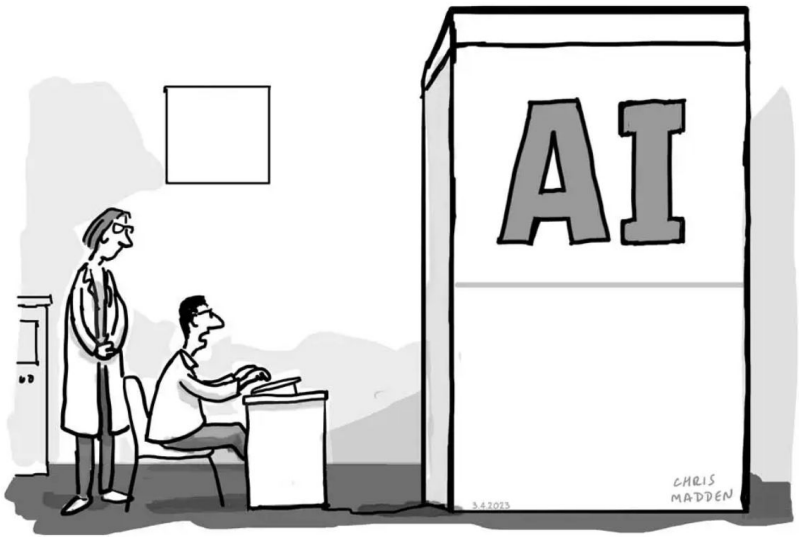


- Civitas Learning gives academic institutions **a complete picture** of their students
- Looks at various factors: academic, behavioral, engagement, financial data, and more to **generate predictions for success**
- Persistence predictions and AI-targeted interventions led to a **34% boost in graduation** rates for one college.

03

Developing AI Software for Education

What are the **potential pitfalls** of using AI in learning and assessment?



"We've got a problem. I've turned it on but I can't turn it off again."

No Shortage of AI-Powered EdTech Tools

Research Tools

consensus · scite_ · ResearchRabbit

Content Delivery

sendsteps · presentations.AI · synthesia

Lesson Planning

Eduaide.Ai · MAGIC SCHOOL · TEACHERMATIC

Assessment

proctorio · gradescope · ALEKS

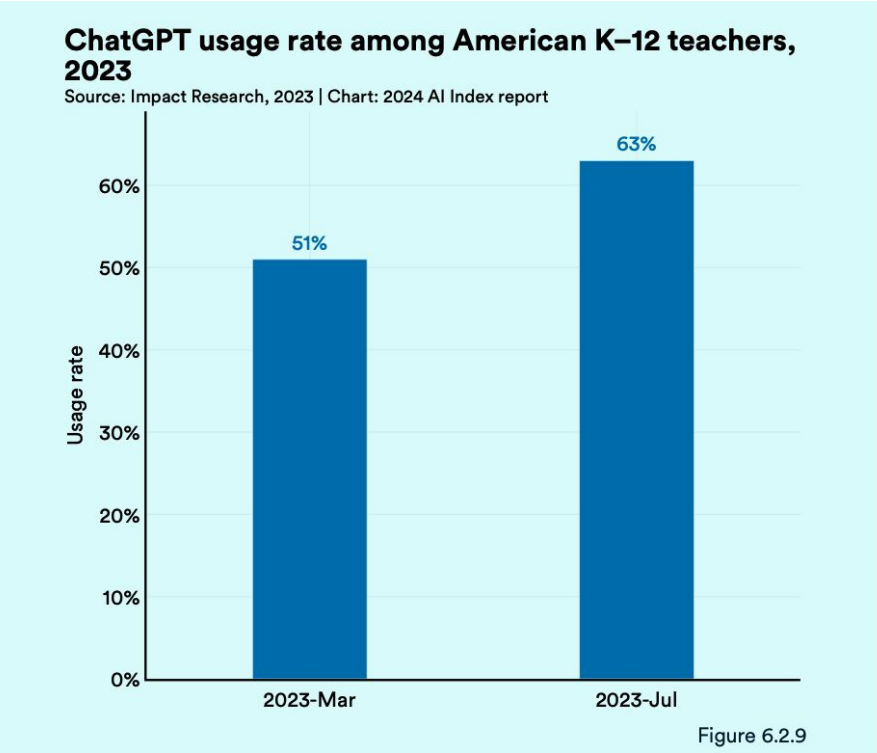
AI Tutors/Assistants

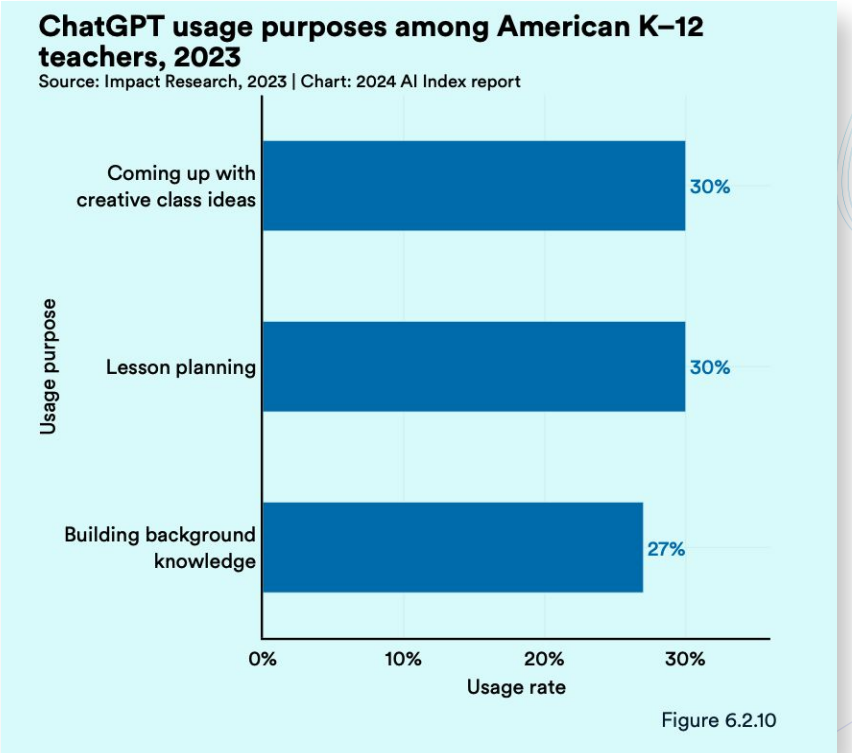
Khanmigo · Otter.ai · Ai tutor

Learning Analytics

dreambox LEARNING By Discovery Education · Magic Box · Learnosity · edapp by SafetyCulture

Adoption Among Teachers is Increasing





Source: 2024 AI Index Report, Stanford University

Current Trends in Using AI Tools

Content Creation

- Design Learning Objectives
- Curriculum Development
- Outcome-based Approach
- Automated and Personalized Content Generation
- Multimedia Content Creation
- Content Curation and Personalization
- Multilingual and Accessibility Support

Pedagogy Delivery

- Flipped-classroom
- Hybrid Learning
- Peer Learning
- Active Learning
- Project-based Learning
- Problem-based Learning
- Experiential Learning
- Case-based Learning
- Intelligent Classroom Assistants
- Multimodal Learning Experiences

Assessment Methods

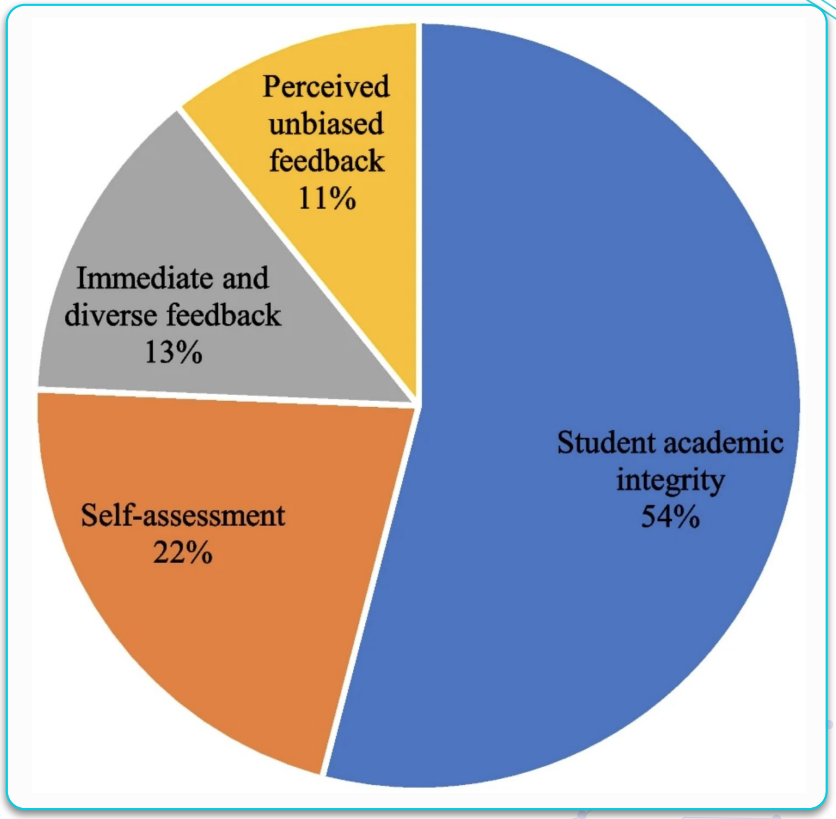
- Formative, Summative, Diagnostic Assessment
- Performance-based Assessment
- Self, Peer, Authentic, Portfolio, and Ipsative Assessment
- Criterion-based and Norm-based Assessment
- Automated Grading /Feedback
- Learning Analytics and Insights

Academic Integrity

Student Perspective

“What are the key areas of focus and concern for Gen AI?”

1. Academic integrity (54%)
2. Self-assessment (22%)
3. Immediate and diverse feedback (13%)



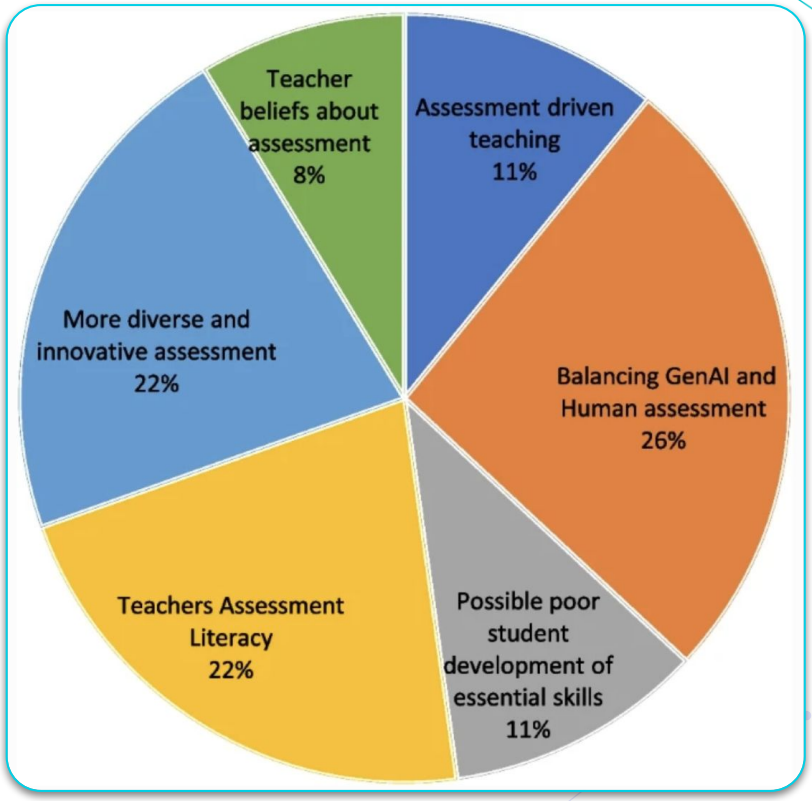
Xia, Q., Weng, X., Ouyang, F. *et al.* A scoping review on how generative artificial intelligence transforms assessment in higher education. *Int J Educ Technol High Educ* **21**, 40 (2024). https://doi.org/10.1186/s41239-024-00468-z

Balanced Assessment

Teacher Perspective:

“What are the key areas of focus and concern for Gen AI?”

1. Balancing GenAI and human assessment (26%)
2. Diverse and innovative assessment (22%)
3. Teacher assessment literacy (22%)



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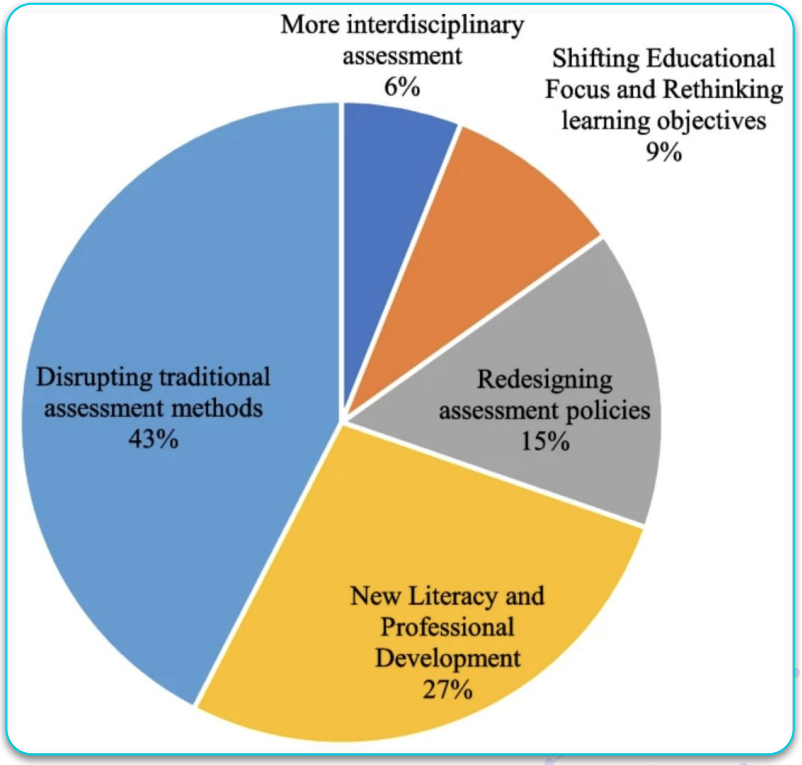
Disrupting Assessment

Institutional Perspective:

“What are the key areas of focus and concern for Gen AI?”

1. Disrupting traditional assessment methods (43%)
2. New literacy and professional development (27%)
3. Redesigning assessment policies (15%)



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How Should We Address These Challenges?

1.

Establish and enforce **clear guidelines** for AI usage.

Scale Levels and Descriptions

1	**NO AI**	The assessment is completed entirely without AI assistance. This level ensures that students rely solely on their knowledge, understanding, and skills. **AI must not be used at any point during the assessment.**
2	**AI-ASSISTED IDEA GENERATION AND STRUCTURING**	AI can be used in the assessment for brainstorming, creating structures, and generating ideas for improving work. **No AI content is allowed in the final submission.**
3	**AI-ASSISTED EDITING**	AI can be used to make improvements to the clarity or quality of student created work to improve the final output, but no new content can be created using AI. **AI can be used, but your original work with no AI content must be provided in an appendix.**
4	**AI TASK COMPLETION, HUMAN EVALUATION**	AI is used to complete certain elements of the task, with students providing discussion or commentary on the AI-generated content. This level requires critical engagement with AI generated content and evaluating its output. **You will use AI to complete specified tasks in your assessment. Any AI created content must be cited.**
5	**FULL AI**	AI should be used as a "co-pilot" in order to meet the requirements of the assessment, allowing for a collaborative approach with AI and enhancing creativity. **You may use AI throughout your assessment to support your own work and do not have to specify which content is AI generated.**

Table 1 The AI Assessment Scale

Perkins, Mike, et al. "Navigating the generative AI era: Introducing the AI assessment scale for ethical GenAI assessment." *arXiv preprint arXiv:2312.07086* (2023).

Developing AI Software for Education

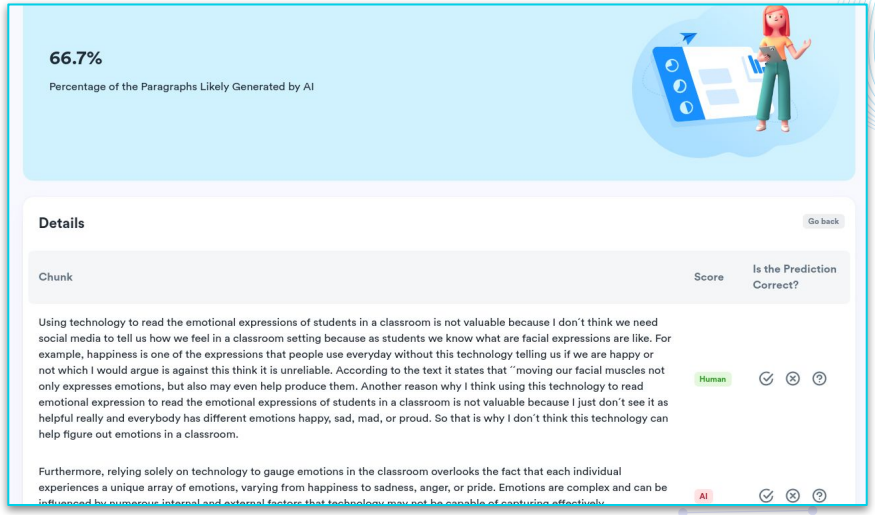
VeriGuide™ is an **AI-powered plagiarism detection system** that can detect human plagiarism and AI-generated content.

Use Cases

1. **Universities**: Plagiarism Detection, Standardization
2. **Publishers**: Editorial Standards, Automate Reviews
3. **Legal Services**: Intellectual Property, Doc Originality

Key Features

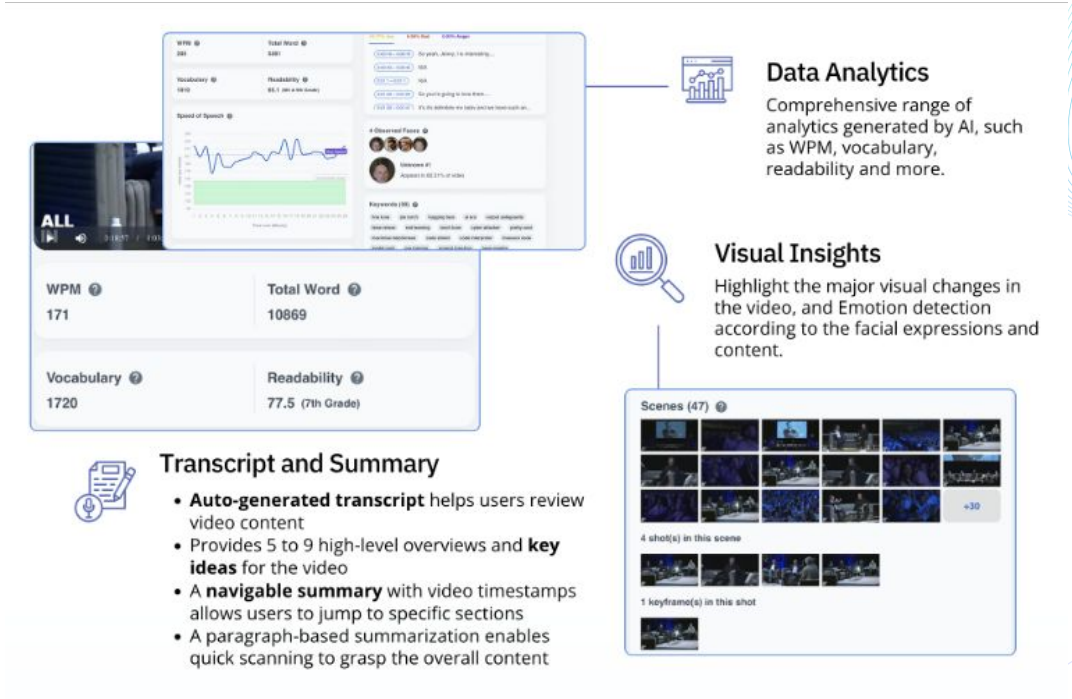
1. 🌐 Text Similarity Detection
2. 🤖 AI Writing Detection
3. 📊 Readability Score for Assessment
4. 🗣️ Chinese Language Capabilities



How Should We Address These Challenges?

2.

Use AI to enhance teaching, **not replace human interaction**.



Developing AI Software for Education

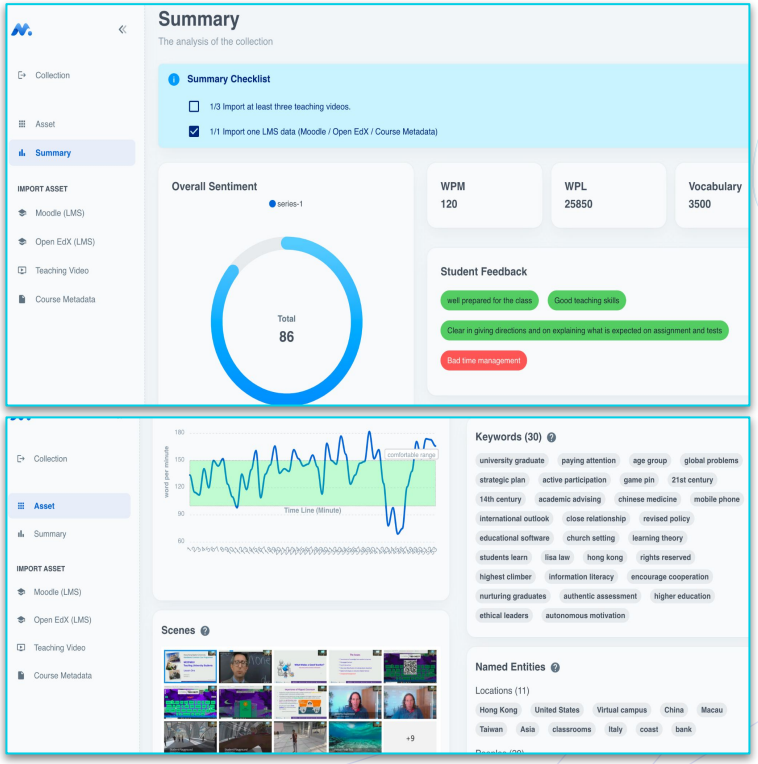
The ***AI-Served Assessment Platform (ASAP)*** helpers teachers analyze multimedia teaching materials for better performance.

Use Cases

1. **Teachers**: Improve Lesson Delivery, Evaluate Student Progress, Automate Content Generation
2. **Universities**: Review Teacher Performance, Analyze Teaching and Student Activity

Key Features

1. 📊 Powerful AI Analytics for Text, Audio, Video
2. 🔄 Auto Q&A Generation from Teaching Content
3. 📹 AI Video Analysis with Performance Feedback
4. 🎙️ Auto-Transcripts and Keyword Identification



How Should We Address These Challenges?

3.

Equip teachers with the knowledge and resources needed to prepare students for **new assessment styles** and an **evolving job market.**

Asynchronous Interviews

Remote interviews are the most time and cost efficient.

Customizable Assessments

Interviewers can determine their own scoring weight parameters.

ChatGPT Integration

Produces detailed feedback such as Q&A relevance and answer coherence levels.

Detailed Analytics

Auto-generated reports make it easy to record, discuss, and share results.

Developing AI Software for Education

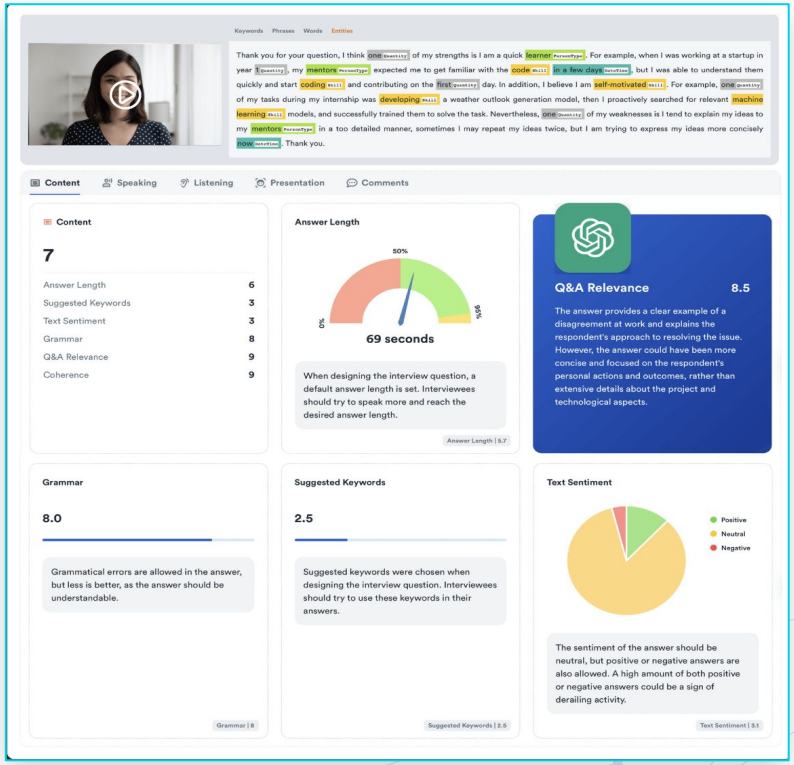
Tellus is an **AI interview and assessment platform** built for enhancing teaching, facilitating self-learning, and supporting institutions.

Use Cases

1. **Teachers**: Verbal Assessments, Lesson Feedback
2. **Students**: Interview Training, Career Prep
3. **Institutions**: Admissions Screening

Key Features

1. 🤖 AI-Powered, Customizable Assessments
2. 💬 ChatGPT Integration
3. 📊 Comprehensive Analytics and Reporting



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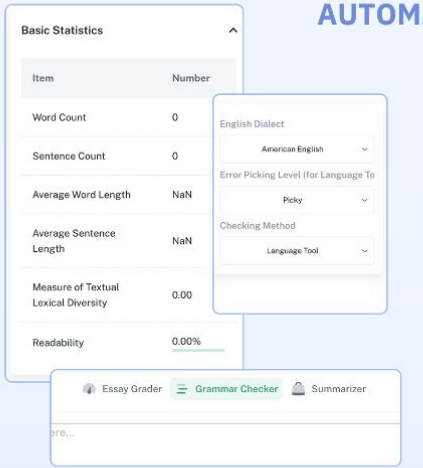


AUTOMATED ESSAY GRADING (AEGIS)

- AEGIS streamlines assessment by creating a one-stop essay grading platform with **Essay Grader, Grammar Checker, and Summarizer.**
- The tool addresses some of the **common issues seen in traditional assessment** such as subjective and delayed feedback.

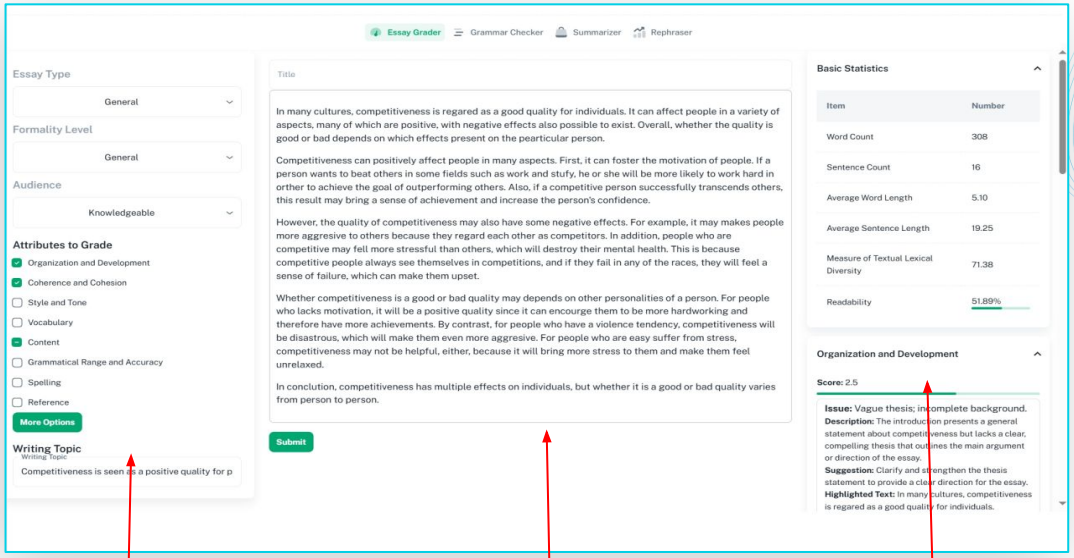
Developing AI Software for Education

Automated essay grader assists teachers in providing **comprehensive feedback** with its interactive feedback display.

It also supports **customized rubric generation** for assessments.

Key Features

1. 🎛️ Customizable rubrics
2. 💬 Detailed feedback
3. 🪄 One-click acceptance of replacement suggestions



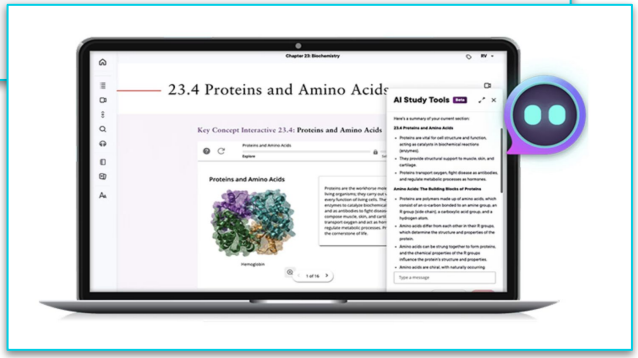
User options & adjustments

Text input

Feedback & Statistics

Industry Leaders Are Betting on AI

Pearson to debut Generative AI Study Tools to university students internationally



Released to **70,000+ students** globally.

➔ **75%** of respondents say the tools are **helpful or very helpful** to their studies.

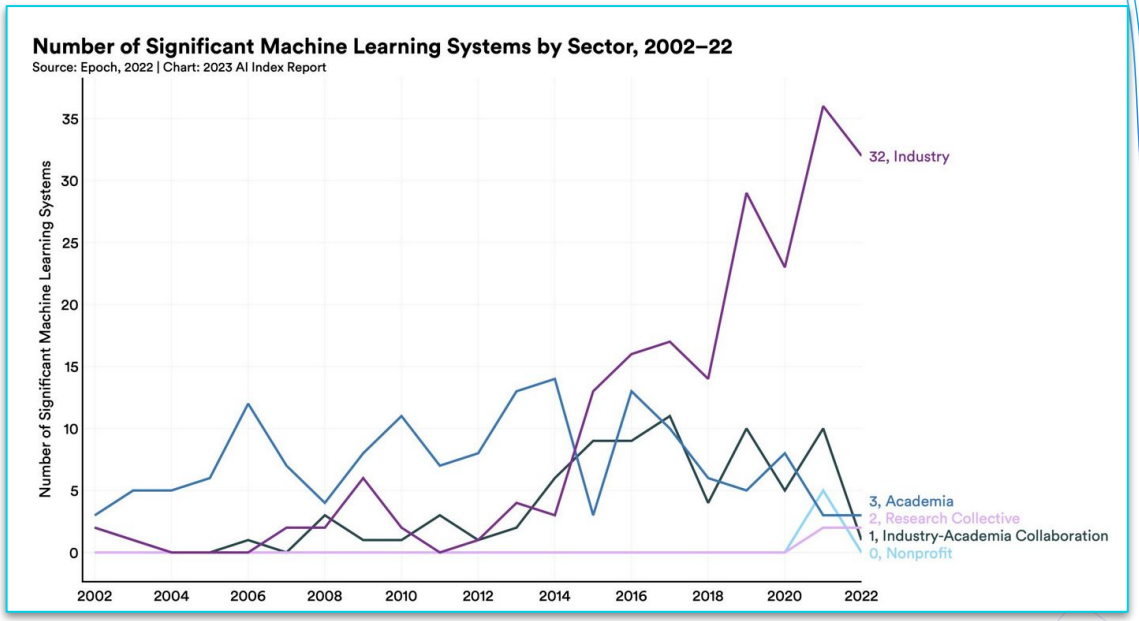
04

Key Takeaways

Food For Thought

Industry is leading the way.

How is this historical shift **shaping the future impact** of AI in education?



AI Index Report 2023 – Artificial Intelligence Index, Stanford.edu. Available at: https://aiindex.stanford.edu/report/

Recap of Challenges

1. Assessment design is **time-consuming** and only one of a teacher's responsibilities.
2. Assessments only view a snapshot of what a student can do at a **single point in time.**
3. One-size-fits all approach may introduce **unintended biases** into assessment.
4. Assessments can be **inauthentic** as they don't include real-world contexts.
5. Assessments can be antiquated and assessing **skills becoming obsolete.**

Final Thoughts

- **AI has revolutionary potential** for personalizing learning experiences.
- Quality in assessment **evolves with each iteration.**
- Establish and enforce **AI usage guidelines**.
- Use **AI to enhance content creation, pedagogy, and assessment**, not replace human interactions.

Concluding Remarks

- **AI has revolutionary potential** for personalizing learning experiences.
- Quality in assessment **evolves with each iteration.**
- Use **AI to enhance content creation, pedagogy, and assessment**, not to replace human interactions.
- **Human-in-the-Loop** matters!

Final Thoughts

AI Assessment with learning analytics would be **continuous**, **timely**, **personalized**, **adaptive**, **scalable**, **objective**, **fair**, **unbiased**, **multi-facets**, **private**, **secured**, **cost-effective**, etc. leading to **successful learners, educators, and institutions**!

"*Education is not the filling of a pail, but the* ***lighting of a fire***."

William Butler Yeats

20th-Century Irish Poet and Writer

Thank you!

Email me at:
irwinking@gmail.com

Website: **keep.edu.hk**
Email: **info@keep.edu.hk**

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Professor Irwin King

FACM, FIEEE, FINNS, FAAIA, FHKIE

Dept. of Computer Science and Engineering
The Chinese University of Hong Kong

- B.Sc. in Engineering and Applied Science, Caltech; PhD in Computer Science, USC
- Director, Centre for ELearning Innovation and Technology (ELITE) and Machine Learning & Social Computing (MISC) Lab
  - PI, Knowledge and Education Exchange Platform (KEEP) and VeriGuide
  - Associate Editor, Neural Network Journal (NN) and International Journal of Data Science & Analytics (JDSA)
  - Former Associate Dean (Education), Vice-President for Education, etc.
  - Vice-Chair, The ACM SIGWEB and WebConf Steering Committee
- Research interests include AI, machine learning, social computing, and data mining
- Leading projects involving AI, including:
  - VeriGuide and AI Writing Detector (AWD)
  - Tellus
  - AI Served Assessment Platform (ASAP)
  - Virtual Teaching and Learning