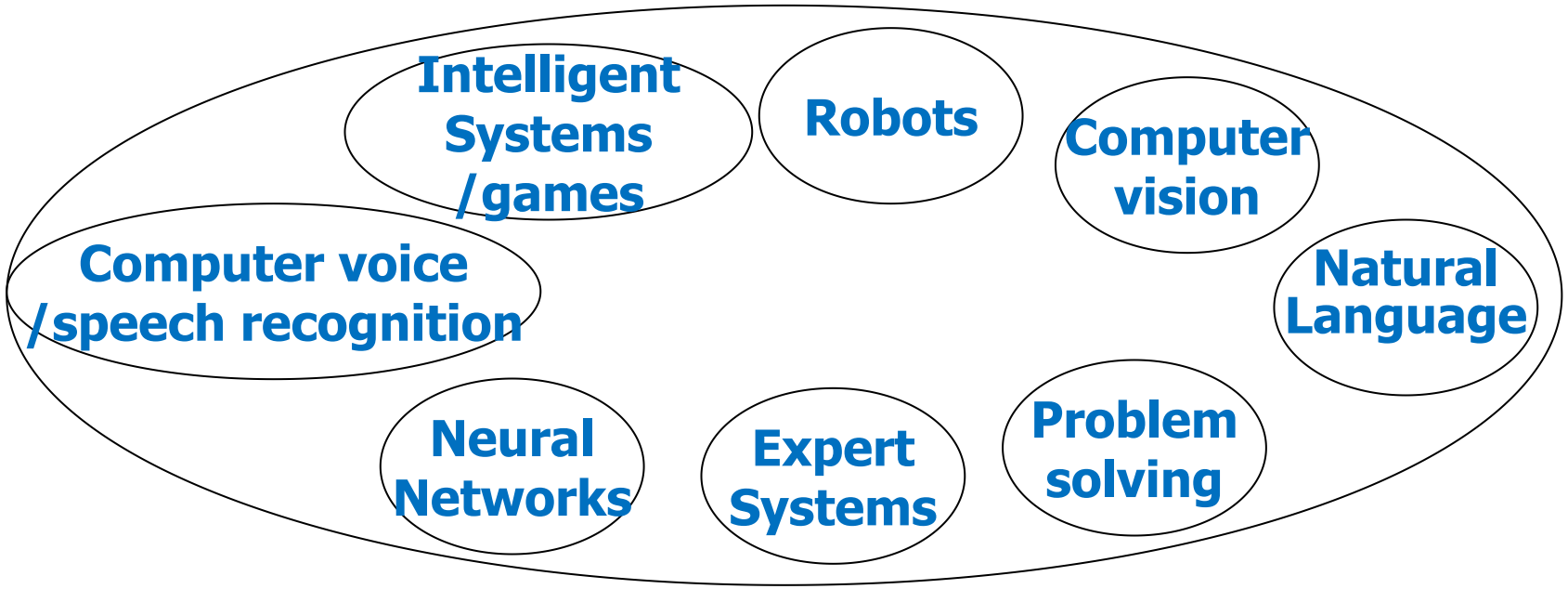
Pedagogical theories and Applications of Artificial Intelligence in Education

Gwo-Jen Hwang

National Taiwan University of Science and Technology

What is Artificial Intelligence?

- Computer programs with the ability to **perceive, reason, and solve problems.**



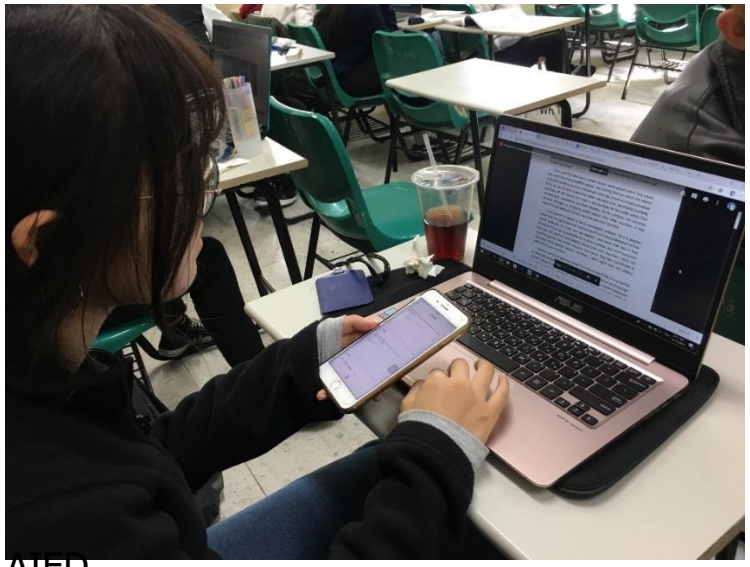
Forms of AI applications for educational purposes

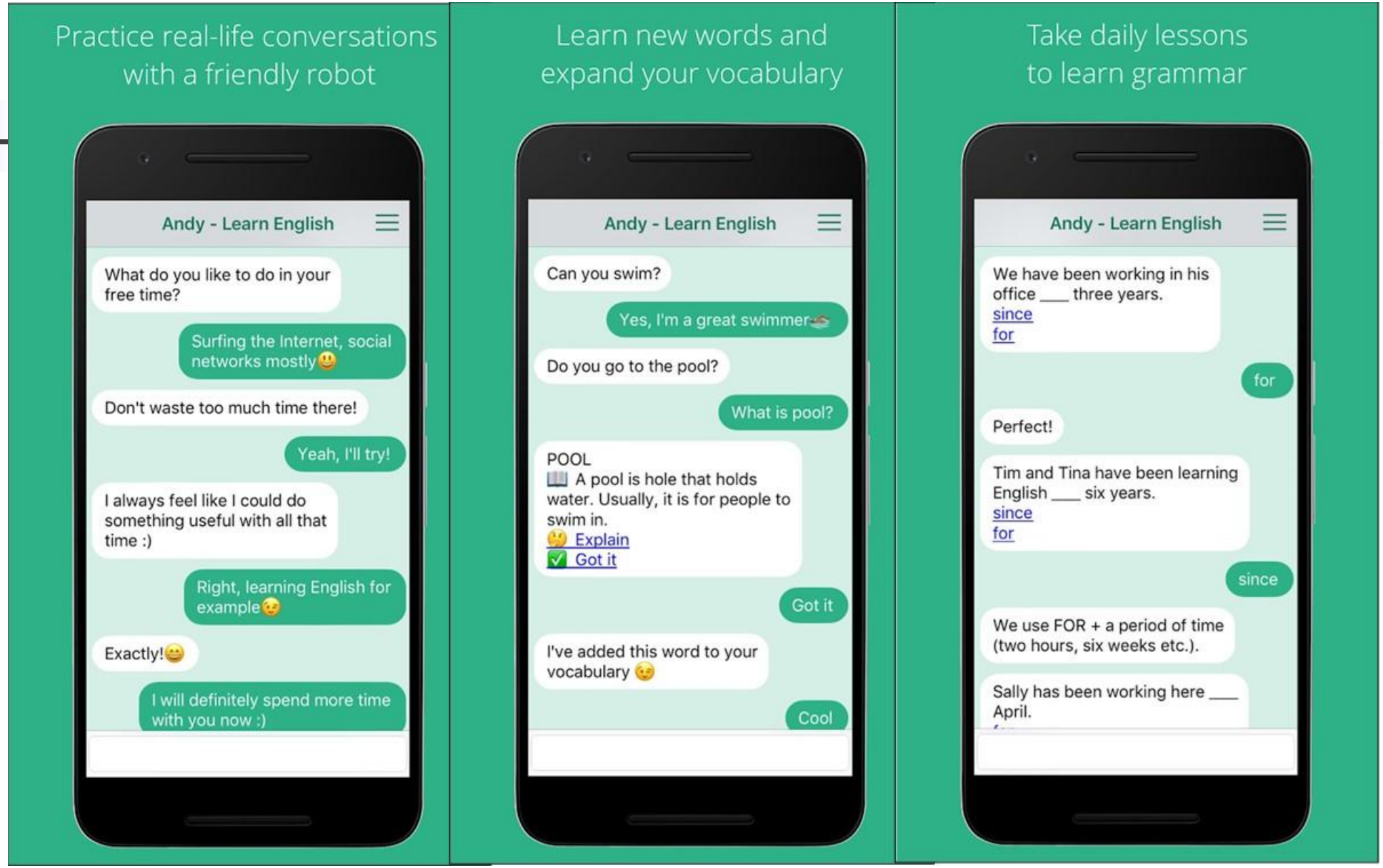
- Robots with AI technologies
  - Reasoning, image recognition, voice recognition, natural language
- Web-based intelligent tutoring systems
- Apps using AI technologies
  - AI chatbots

Educational robot- help autistic children learn to interact with people

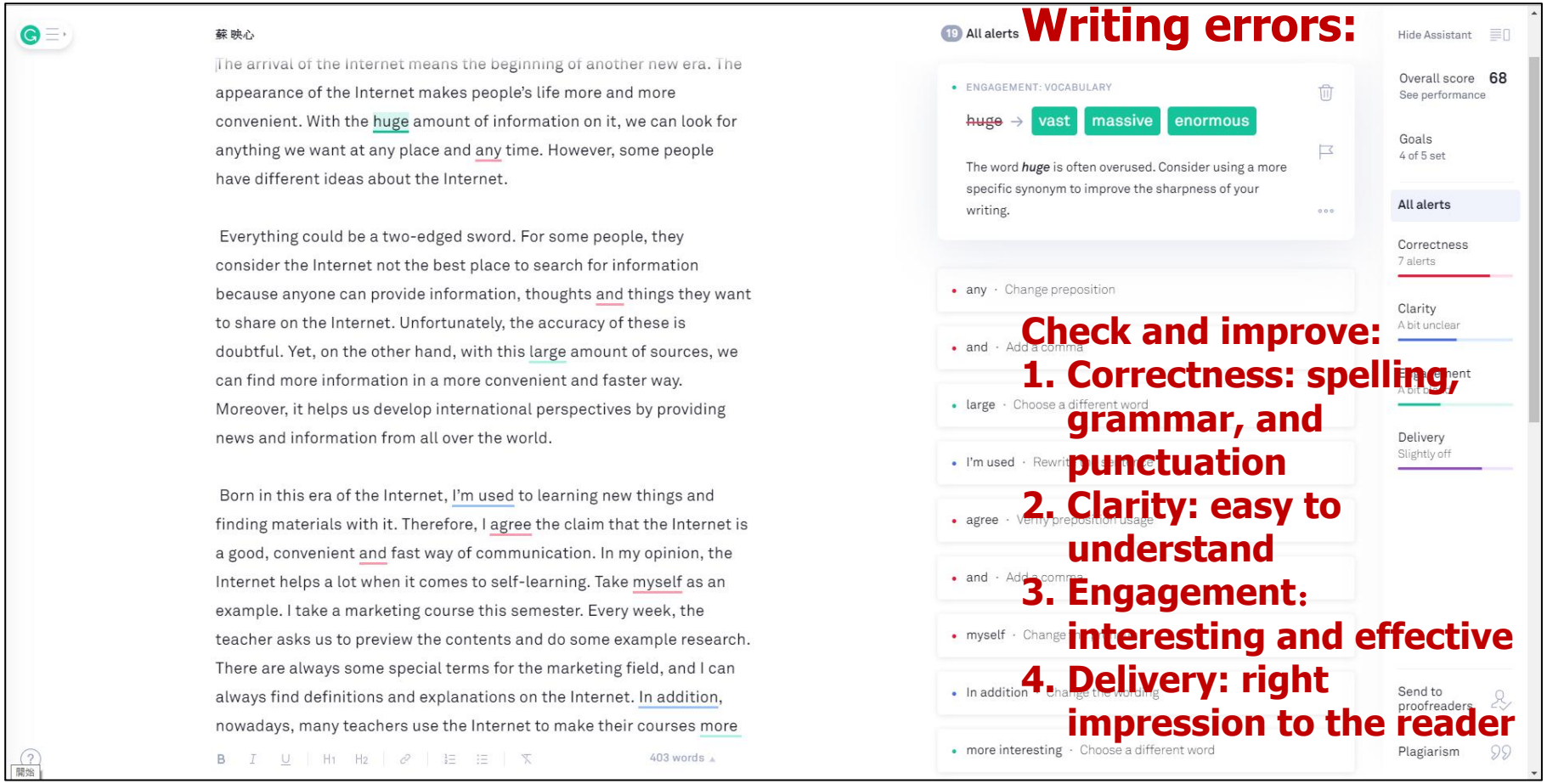
Apps for language learning

- Andy English Bot
  - Practice casual day-to-day interactions
  - Practice asking and answering questions
  - Discuss various topics
  - Learn grammar
    - Grammar explanation and test
    - Corrects mistakes in messages




Practice real-life conversations with a friendly robot
Andy - Learn English
What do you like to do in your free time?
Surfing the Internet, social networks mostly😃
Don't waste too much time there!
Yeah, I'll try!
I always feel like I could do something useful with all that time :)
Right, learning English for example😉
Exactly!😄
I will definitely spend more time with you now :)
Learn new words and expand your vocabulary
Andy - Learn English
Can you swim?
Yes, I'm a great swimmer🚤
Do you go to the pool?
What is pool?
POOL
📖 A pool is hole that holds water. Usually, it is for people to swim in.
🤔 Explain
✅ Got it
Got it
I've added this word to your vocabulary 😉
Cool
Take daily lessons to learn grammar
Andy - Learn English
We have been working in his office ___ three years.
since
for
for
Perfect!
Tim and Tina have been learning English ___ six years.
since
for
since
We use FOR + a period of time (two hours, six weeks etc.).
Sally has been working here ___ April.

Grammarly.com
Intelligent system for providing English writing advices



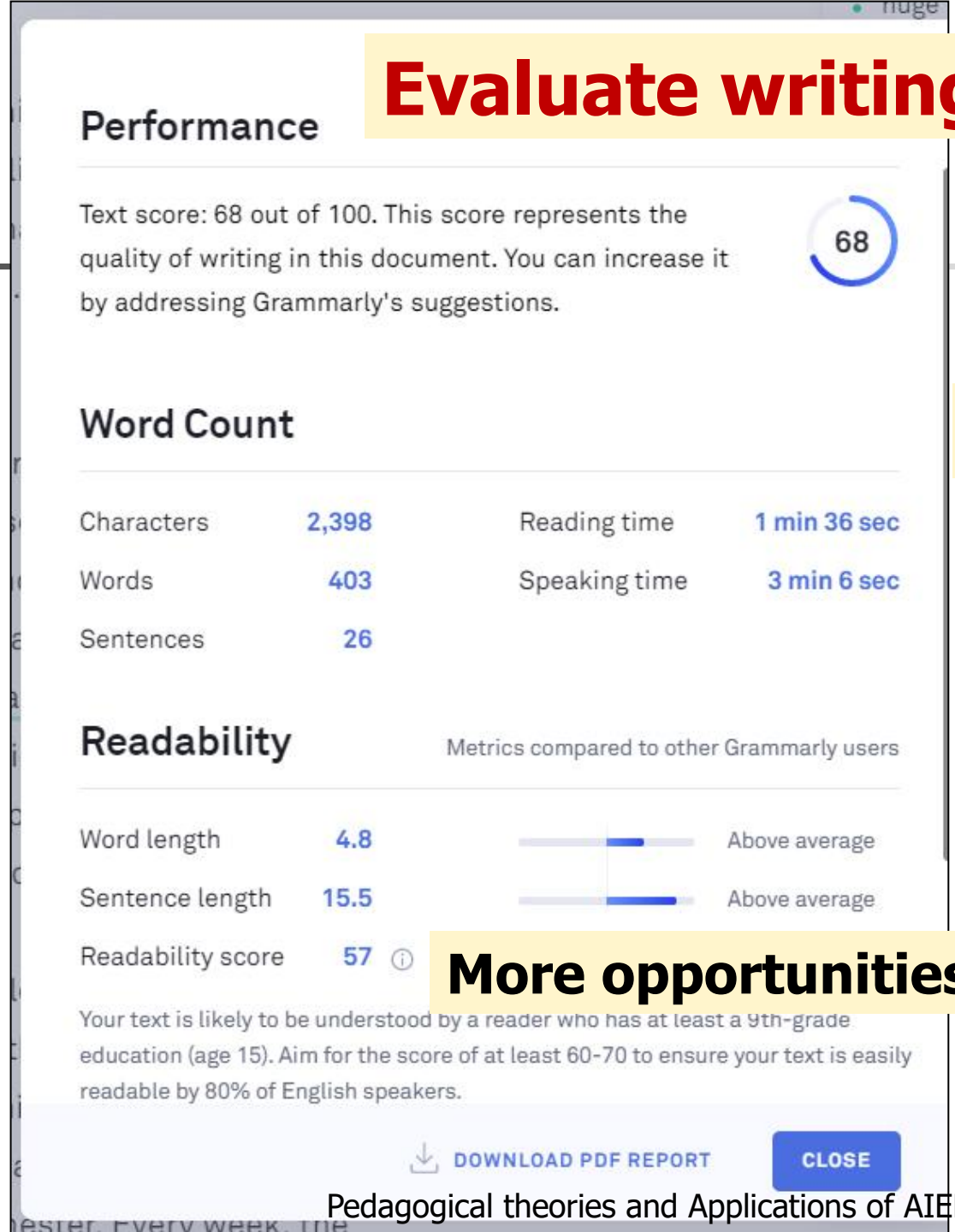
Writing errors:

Check and improve:

1. **Correctness: spelling, grammar, and punctuation**
2. **Clarity: easy to understand**
3. **Engagement: interesting and effective**
4. **Delivery: right impression to the reader**

Student's writing essay

Evaluate writing performance



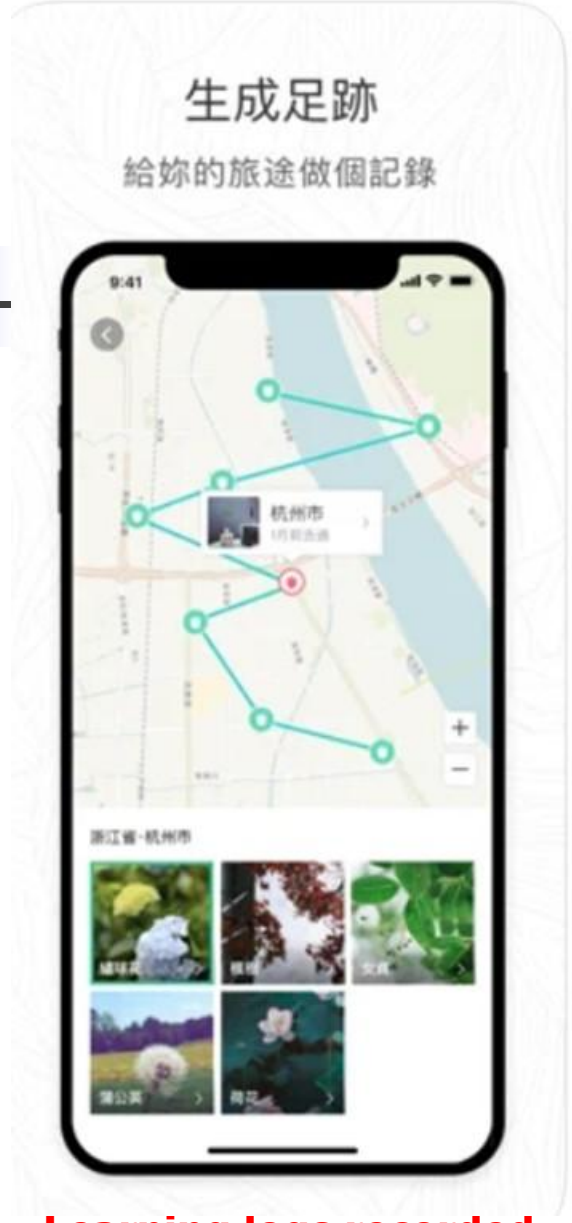
Score

Word count

Readability

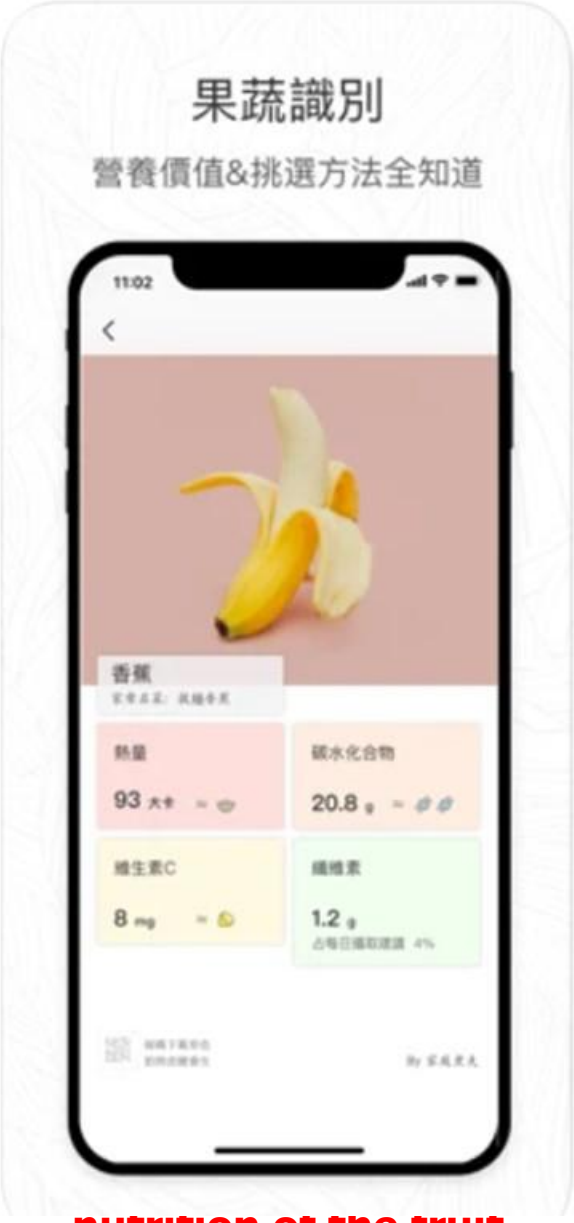
More opportunities to practice writing

形色(Shape and Color)-Identify flowers and plants by using image recognition



Learning logs recorded in the journey

exhibition for the findings



nutrition of the fruit

Roles of AI in education

- **Intelligent Tutor**
  - **Personalized learning guidance, support, and/or interface**
  - **Most of the AI-based learning systems/apps belong to this category**
- **Intelligent Tool**
  - **Assisting learners to complete learning tasks**
  - **Helping learn search for, analyze and organize information (e.g., ChatGPT)**
- **Intelligent systems for learning management or policy making**

Hwang*, G. J., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, Challenges, Roles and Research Issues of Artificial Intelligence in Education. *Computers & Education: Artificial Intelligence*, *1*, 100001.

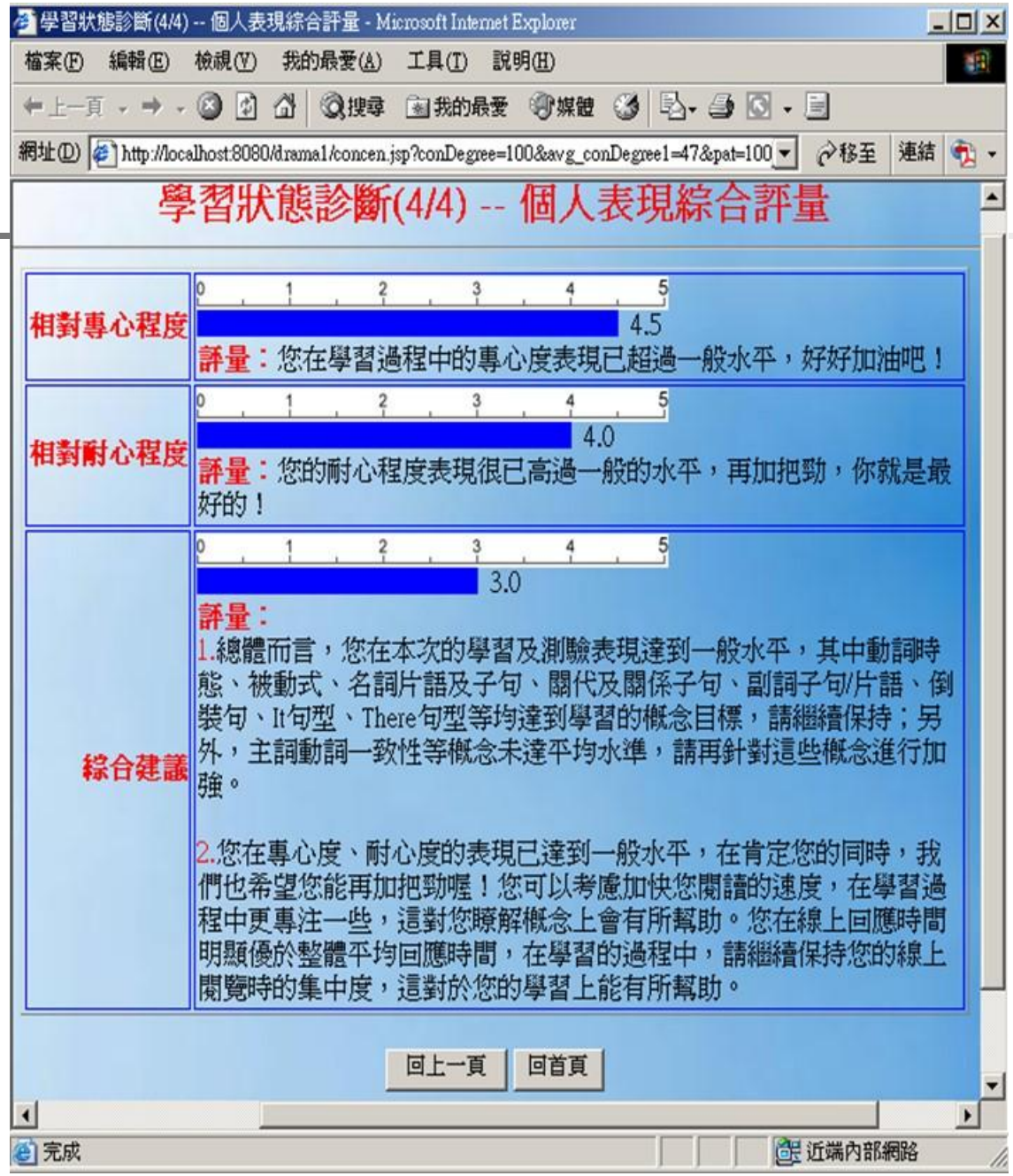
I. Intelligent tutors

- Personalized learning content
- Personalized learning paths
- Personalized interface
- Personalized learning guidance or supports

Providing personalized suggestions based on online learning behavior analysis

- Using a fuzzy expert system to examine individual students' learning states to provide personalized guidance based on their online behaviors:
  - 學習效率 (Efficiency of Learning)
  - 學習意願 (Willingness of Learning)
  - 耐心度 (Patience)
  - 專心度 (Concentration)
  - 理解度 (Degree of comprehension)
  - 聊天或討論 (Chatting or discussing)

Gwo-Jen Hwang (1998), "A tutoring strategy supporting system for distance learning on computer networks", *IEEE Transactions on Education*, Vol. 41, No. 4, pp. 343. (SCI & EI)


學習狀態診斷(4/4) -- 個人表現綜合評量 - Microsoft Internet Explorer
檔案(F) 編輯(E) 檢視(V) 我的最愛(A) 工具(T) 說明(H)
上一頁 搜尋 我的最愛 媒體
網址(D) http://localhost:8080/drama1/concen.jsp?conDegree=100&avg_conDegree1=47&pat=100
移至 連結
學習狀態診斷(4/4) -- 個人表現綜合評量
相對專心程度
0 1 2 3 4 5
4.5
評量：您在學習過程中的專心度表現已超過一般水平，好好加油吧！
相對耐心程度
0 1 2 3 4 5
4.0
評量：您的耐心程度表現很已高過一般的水平，再加把勁，你就是最好的！
綜合建議
0 1 2 3 4 5
3.0
評量：
1.總體而言，您在本次的學習及測驗表現達到一般水平，其中動詞時態、被動式、名詞片語及子句、關代及關係子句、副詞子句/片語、倒裝句、It句型、There句型等均達到學習的概念目標，請繼續保持；另外，主詞動詞一致性等概念未達平均水準，請再針對這些概念進行加強。
2.您在專心度、耐心度的表現已達到一般水平，在肯定您的同時，我們也希望您能再加把勁喔！您可以考慮加快您閱讀的速度，在學習過程中更專注一些，這對您瞭解概念上會有所幫助。您在線上回應時間明顯優於整體平均回應時間，在學習的過程中，請繼續保持您的線上閱覽時的集中度，這對於您的學習上能有所幫助。
回上一頁
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PERGAMON

Computers & Education 40 (2003) 217–235

COMPUTERS & EDUCATION

www.elsevier.com/locate/compedu

A conceptual map model for developing intelligent tutoring systems☆

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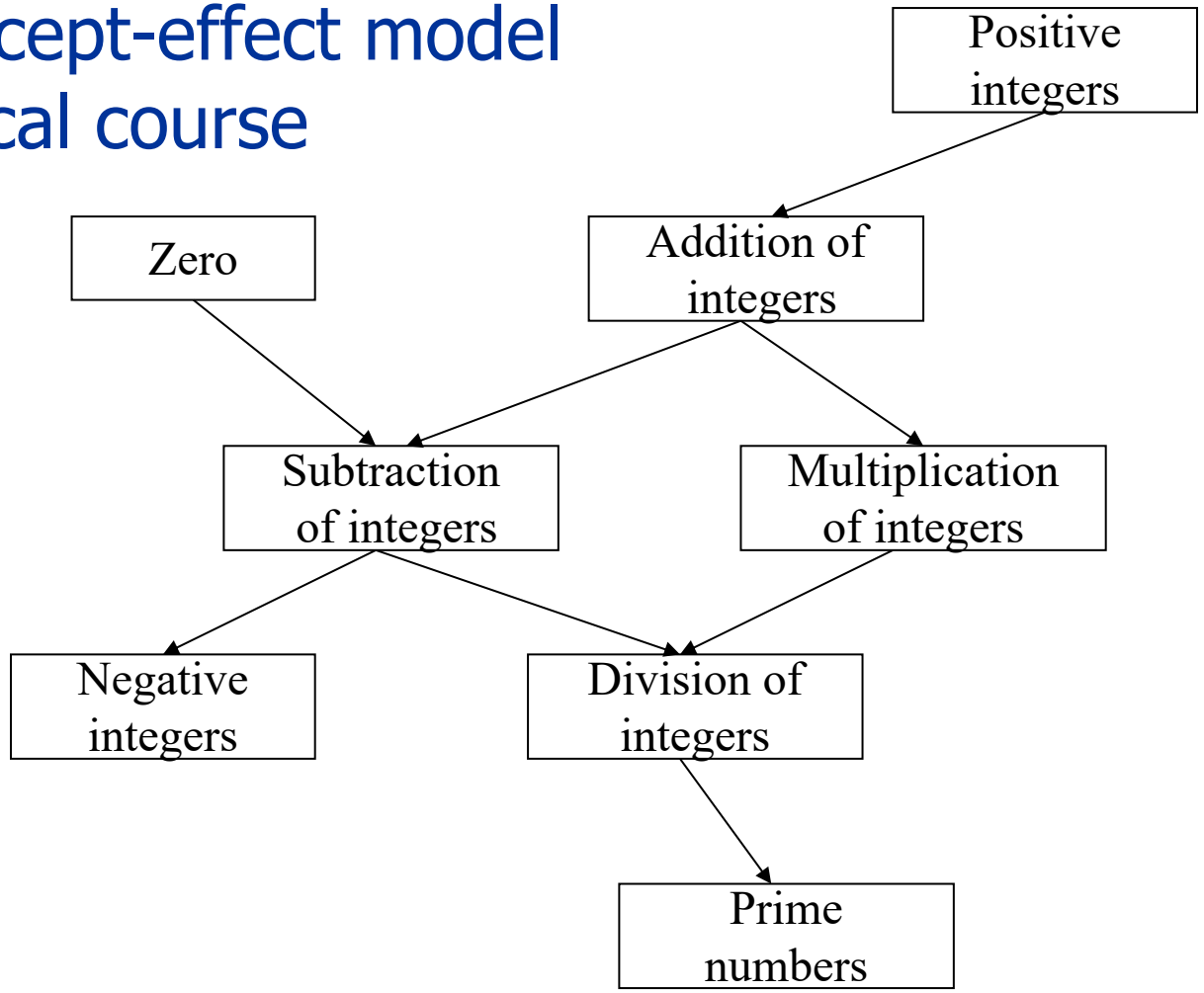
Received 15 October 2001; accepted 14 August 2002

Abstract

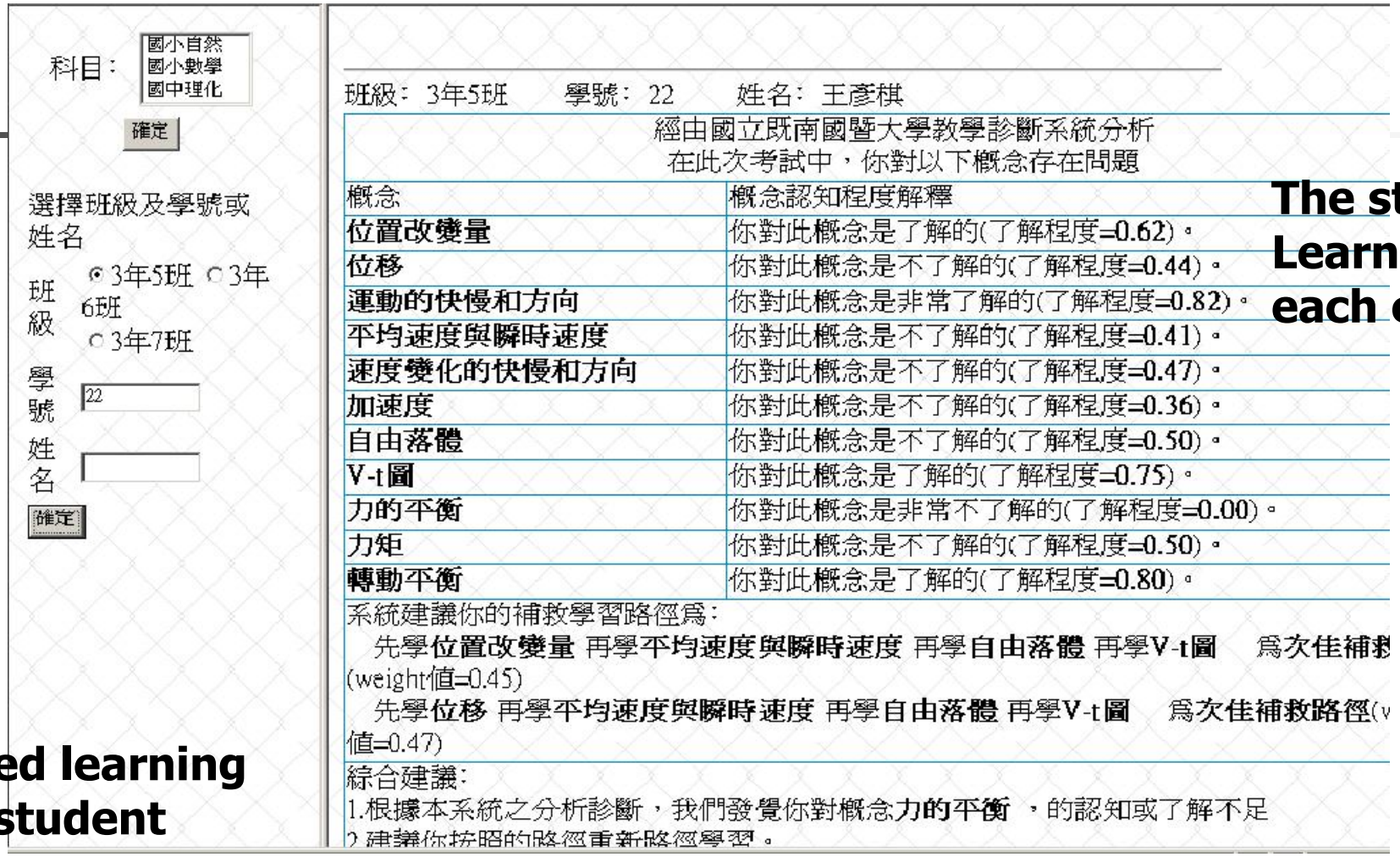
With the recent rapid progress of computer technology, researchers have attempted to adopt artificial intelligence and use computer networks to develop computer-aided instruction systems. Meanwhile, researchers have also attempted to develop more effective programs to test and enhance the learning performance of students. However, conventional testing systems simply give students a score, and do not give them the opportunity to learn how to improve their learning performance. Students would benefit more if the test results could be analyzed and hence advice could be provided accordingly. This study proposes a conceptual map model, which provides learning suggestions by analyzing the subject materials and test results. A testing and diagnostic system is also implemented on computer networks based on the novel approach. Experimental results have demonstrated that the novel approach benefits students and deserves further investigation.

Personalized learning problem diagnosis

Example of concept-effect model in a mathematical course



Learning path generated by the system



科目： 國小自然 國小數學 國中理化

確定

選擇班級及學號或姓名

班級 3年5班 3年6班 3年7班

學號 22

姓名

確定

班級：3年5班　學號：22　姓名：王彥棋

經由國立既南國暨大學教學診斷系統分析
在此次考試中，你對以下概念存在問題

概念	概念認知程度解釋
位置改變量	你對此概念是了解的(了解程度=0.62)。
位移	你對此概念是不了解的(了解程度=0.44)。
運動的快慢和方向	你對此概念是非常了解的(了解程度=0.82)。
平均速度與瞬時速度	你對此概念是不了解的(了解程度=0.41)。
速度變化的快慢和方向	你對此概念是不了解的(了解程度=0.47)。
加速度	你對此概念是不了解的(了解程度=0.36)。
自由落體	你對此概念是不了解的(了解程度=0.50)。
V-t圖	你對此概念是了解的(了解程度=0.75)。
力的平衡	你對此概念是非常不了解的(了解程度=0.00)。
力矩	你對此概念是不了解的(了解程度=0.50)。
轉動平衡	你對此概念是了解的(了解程度=0.80)。

系統建議你的補救學習路徑爲：

先學位置改變量 再學平均速度與瞬時速度 再學自由落體 再學V-t圖　爲次佳補救路徑(weight值=0.45)

先學位移 再學平均速度與瞬時速度 再學自由落體 再學V-t圖　爲次佳補救路徑(weight值=0.47)

綜合建議：

1.根據本系統之分析診斷，我們發覺你對概念力的平衡 ，的認知或了解不足

2.建議你按照的路徑重新路徑學習。

The student's Learning status of each concepts

Recommended learning path for the student

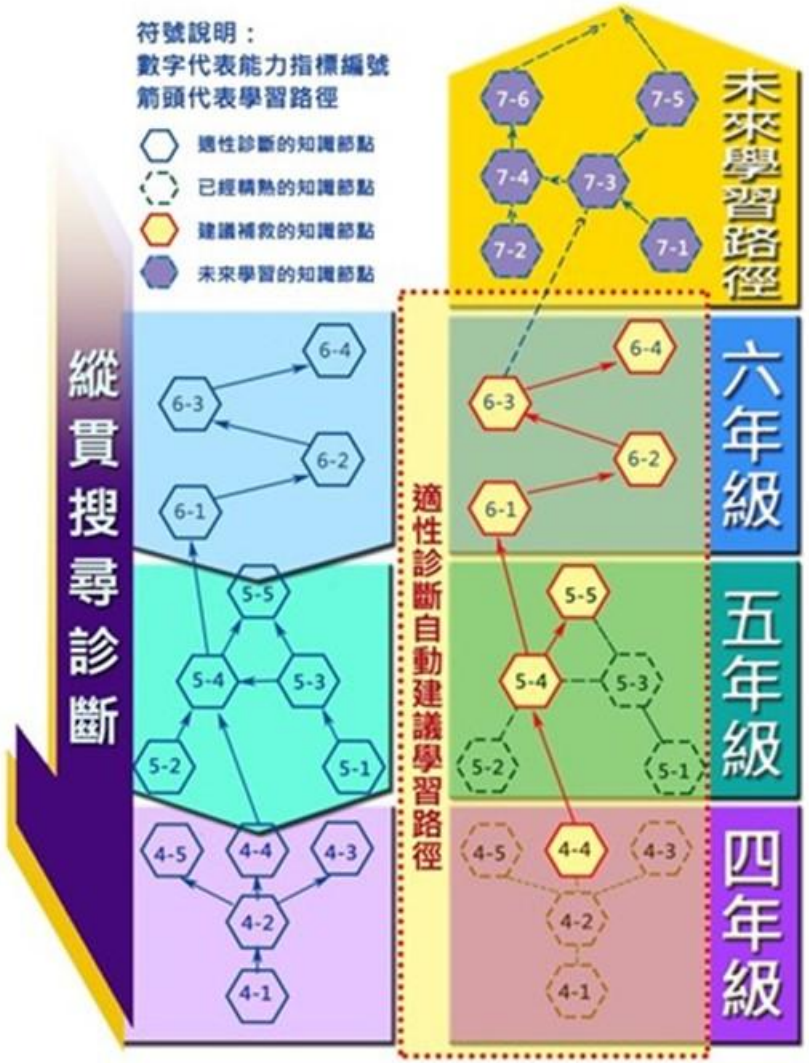
Gwo-Jen Hwang (2003), "A Concept Map Model for Developing Intelligent Tutoring Systems", *Computers & Education*, Vol. 40. No. 3, pp. 217-235. (SSCI & SCI, EI)

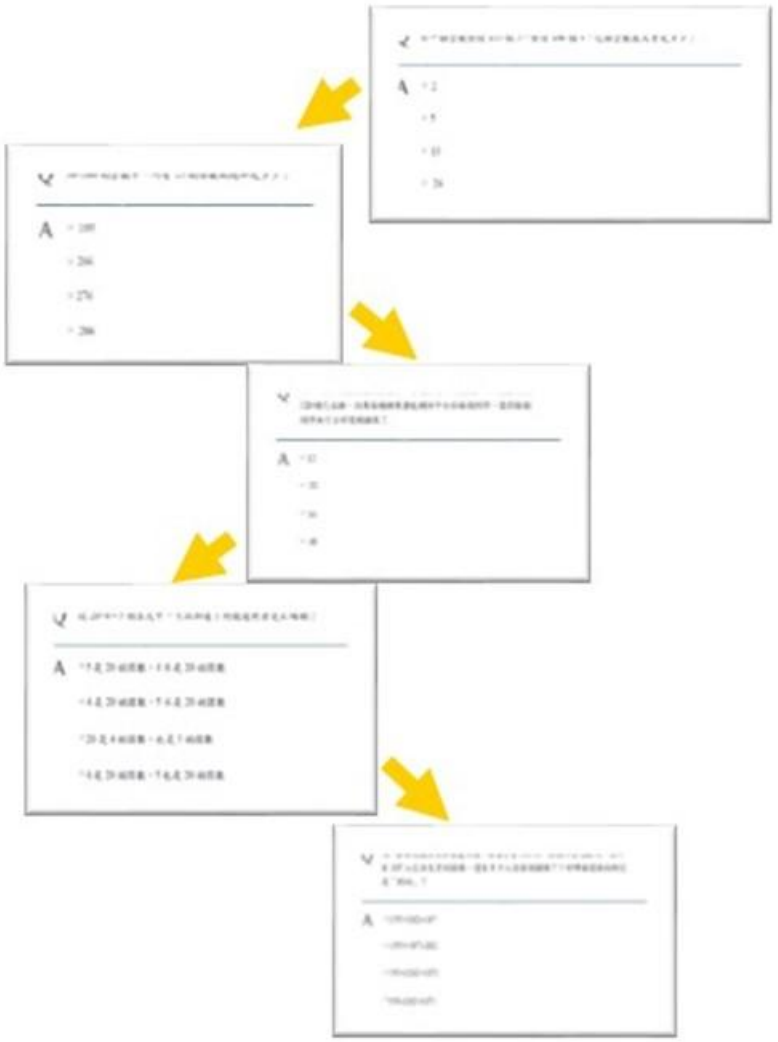
因材網-A diagnosis-based learning system in Taiwan (more than 100,000 users)

- **Providing learning content and test items for the courses in elementary and high schools.**
- **Using learning fuzzy diagnosis technologies to provide personalized learning paths.**

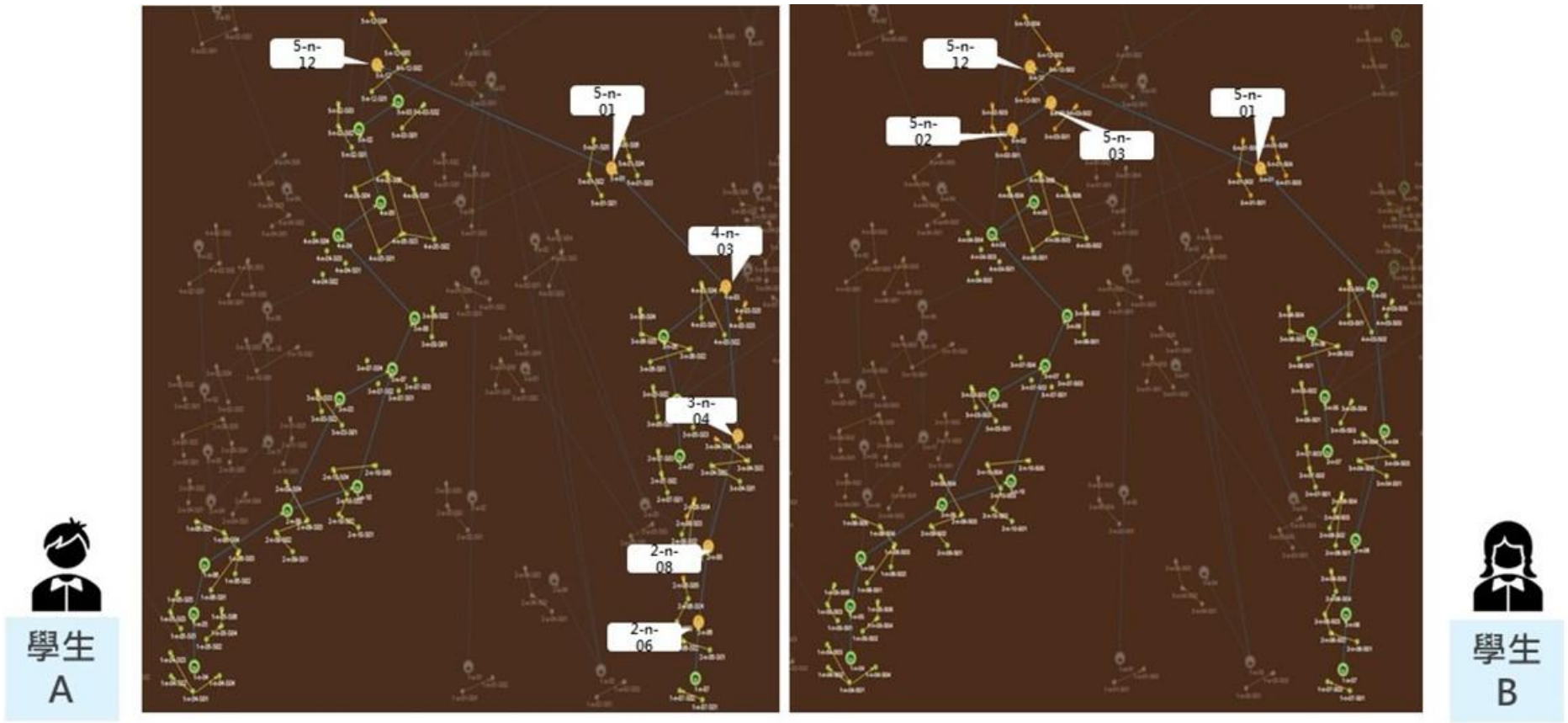
https://adl.edu.tw/HomePage/home/

Exam learners' prior knowledge before allowing them to learn a new concept

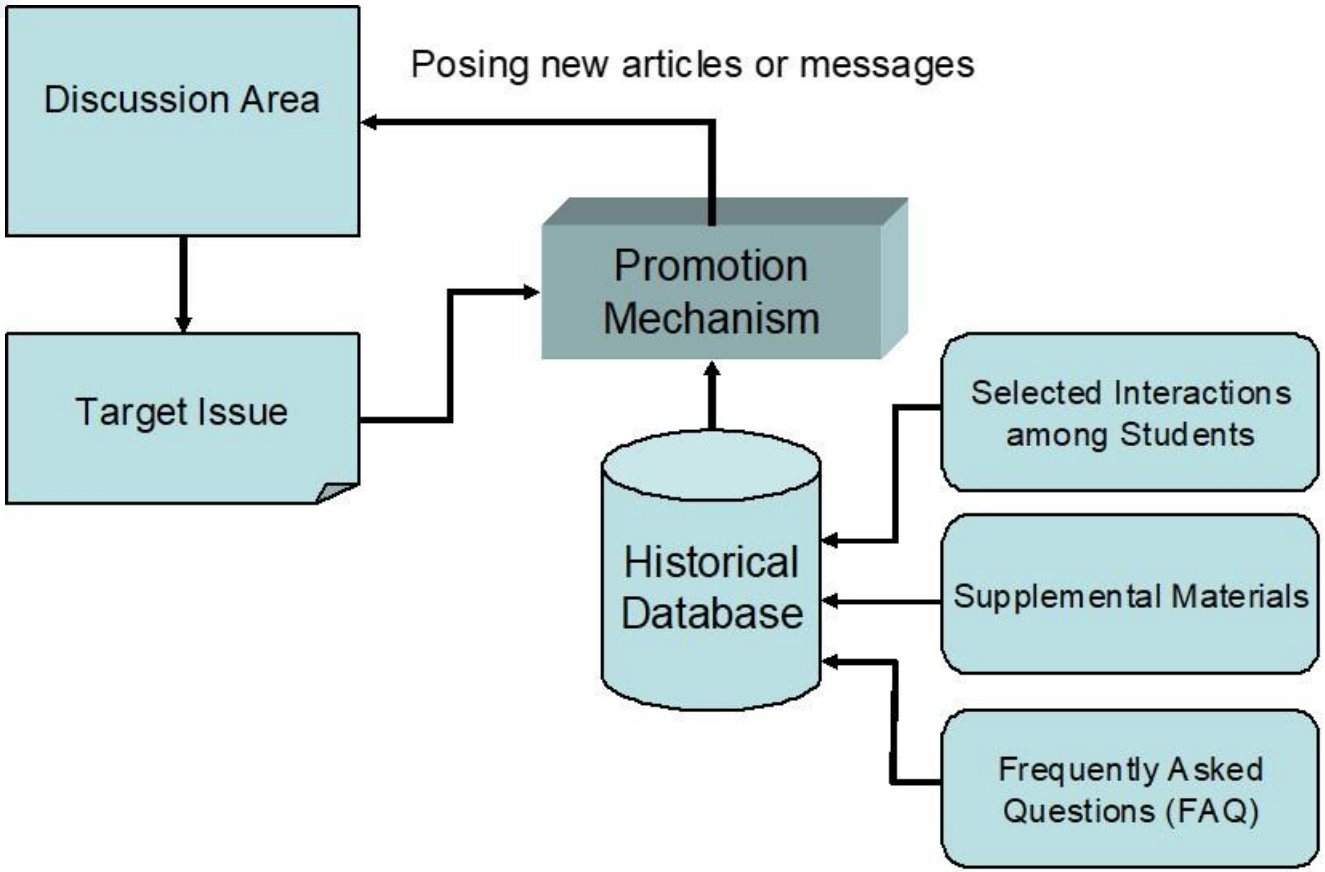




Recommend personalized learning paths based on diagnosis results



II. Intelligent learning partners



Virtual peers in an online discussion forum

Chu, H. C., Hwang*, G. J., Tsai, C. C., & Chen, N. S. (2009). An innovative approach for promoting information exchanges and sharing in a web 2.0-based learning environment. *Interactive Learning Environments*, *17*(4), 311-323.

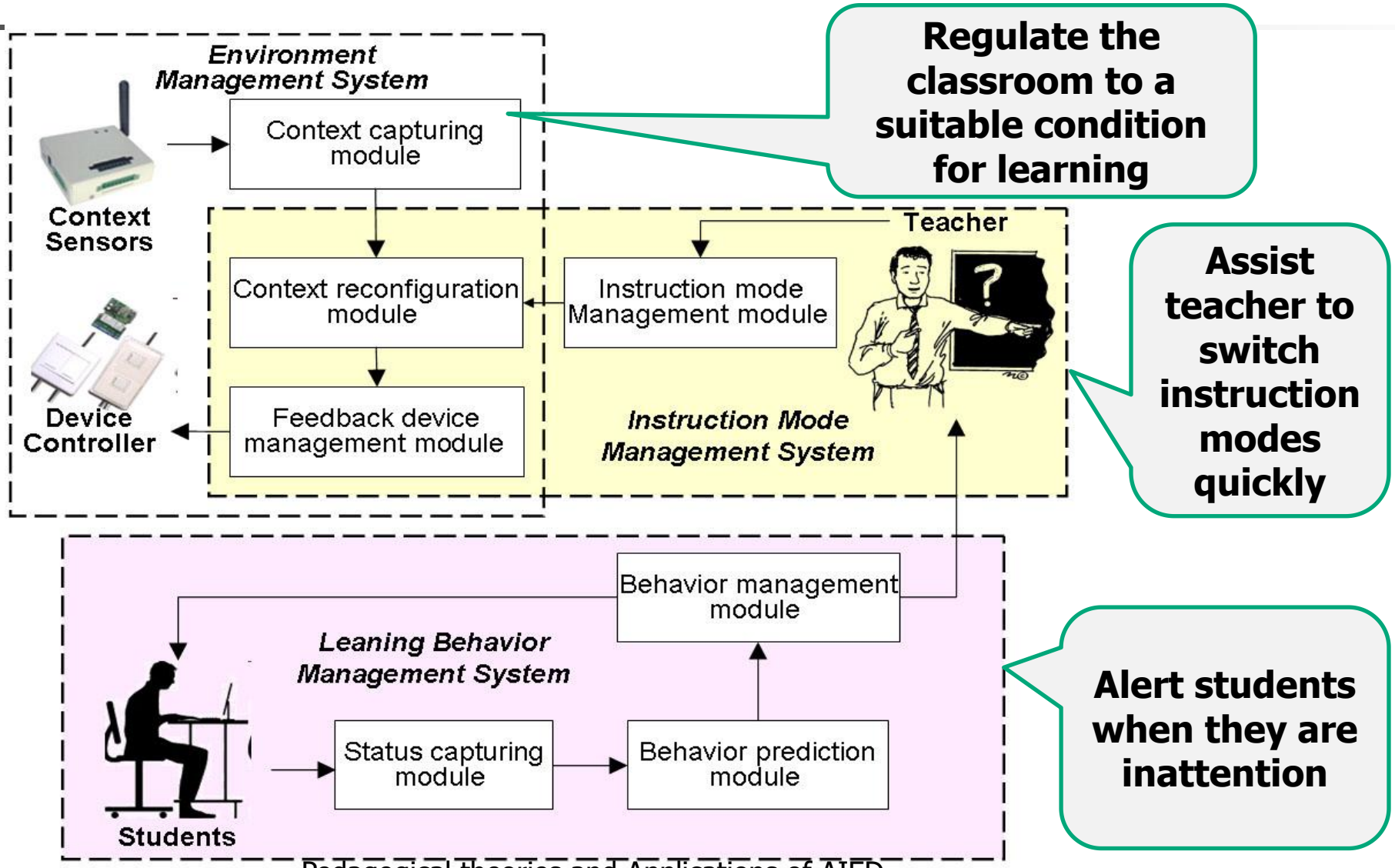
Virtual patient with natural language process and expert systems

- Provide different cases for trainees to interact with virtual patients
- Allow learners to interact with VP for history taking and physical assessment using natural language
- Provide complete laboratory and imaging results
- Guide learners to collect and analyze data from VT to make a diagnosis
- Provide immediate feedback to learners

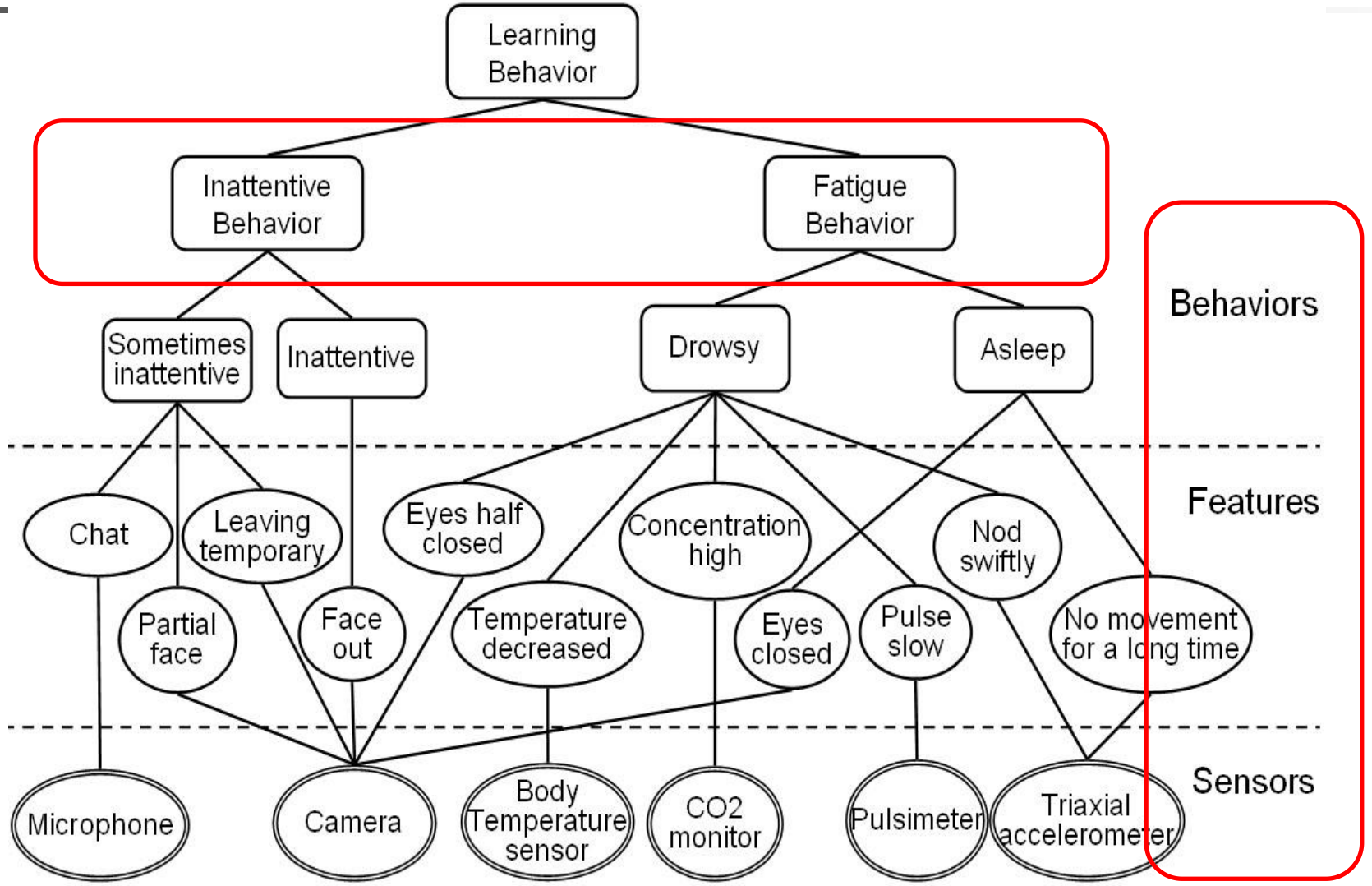
Developed by Kaohsiung Medical University


就像你我一般，虛擬病人可以聽懂你說的話，與你對話
病史詢問
0:52 / 2:50

III. Intelligent classroom management system using facial recognition and sensing technologies



Learning behavior categories

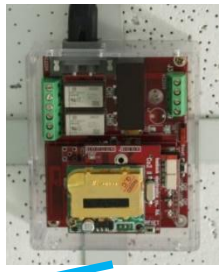


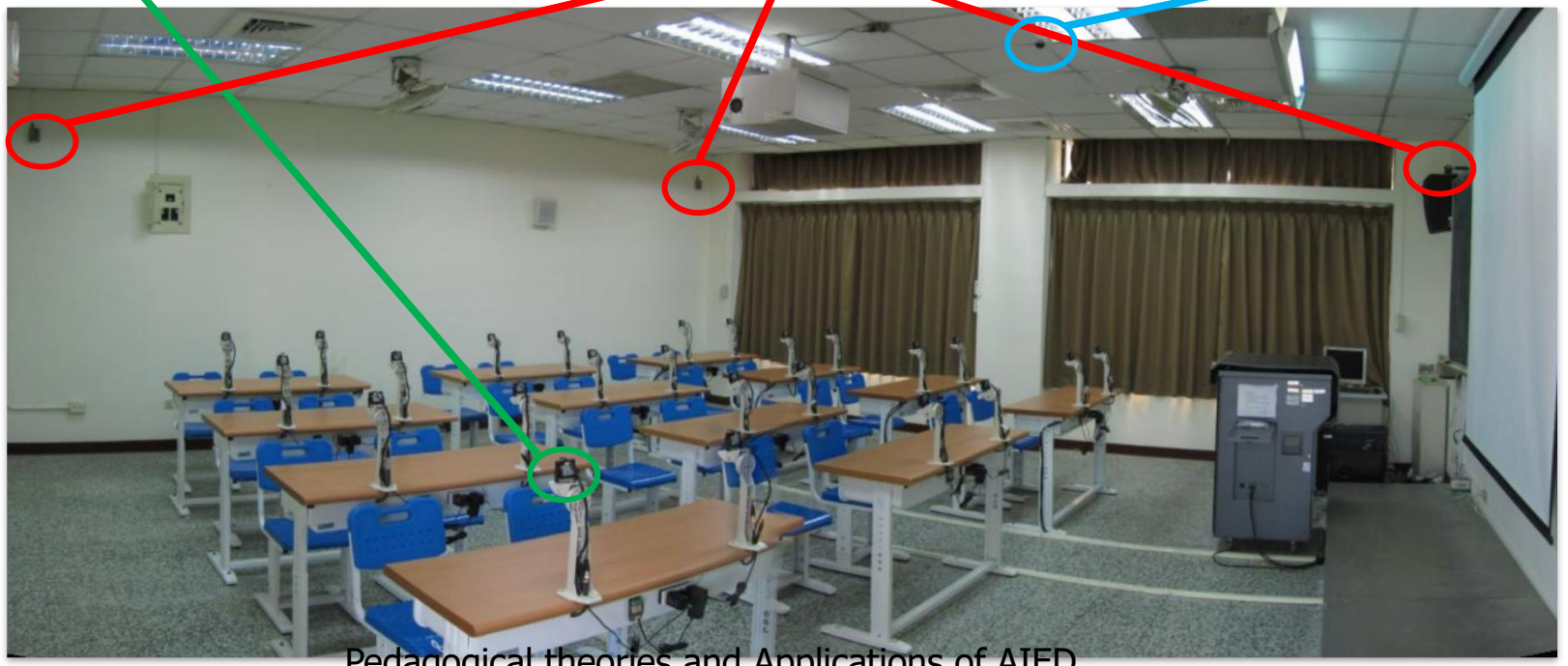
Intelligence Classroom (Sensors & controllers)

Cameras x24

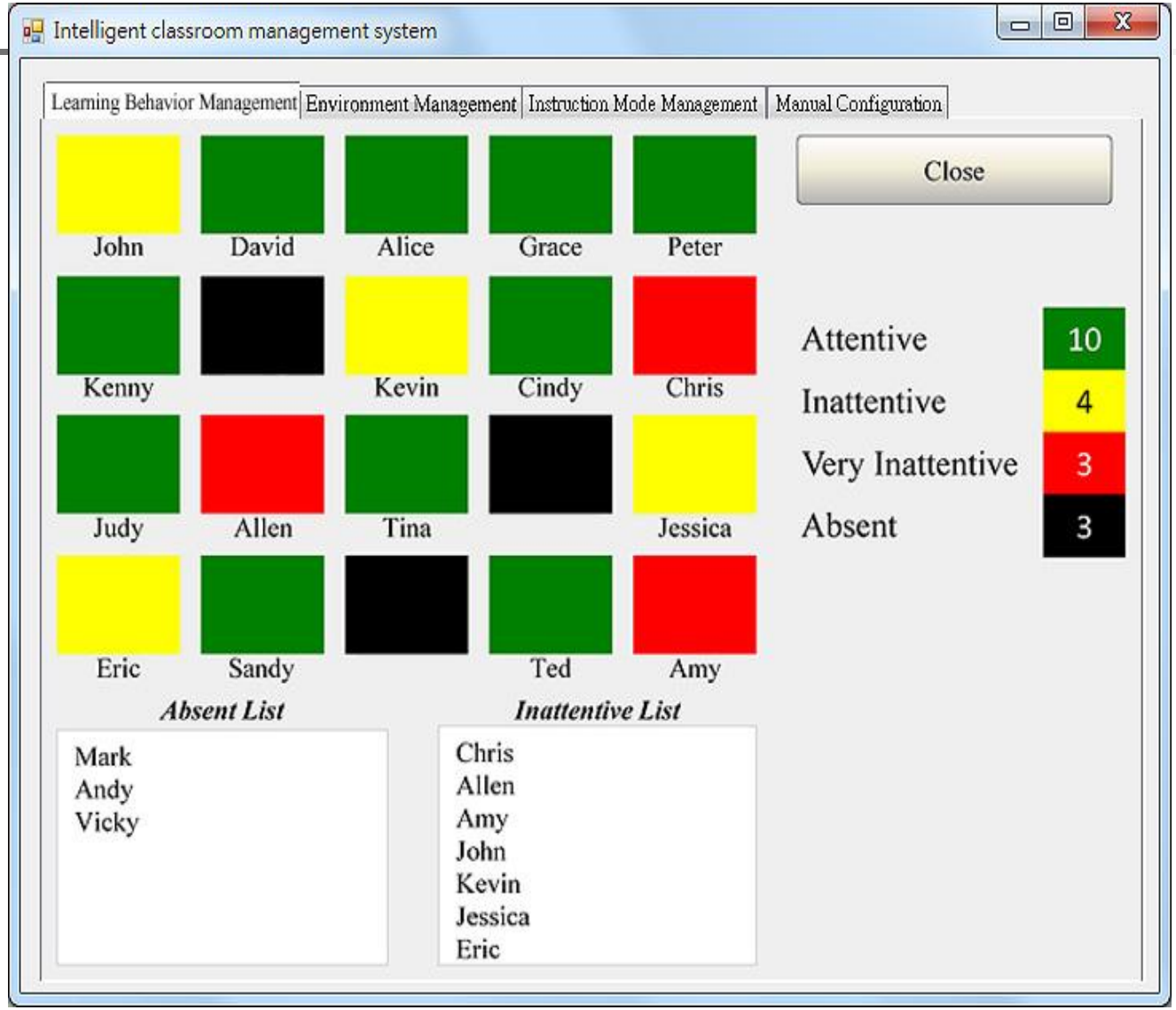
3-in-1 Sensor (temperature, humidity, illumination) X3

CO_2 monitor X1

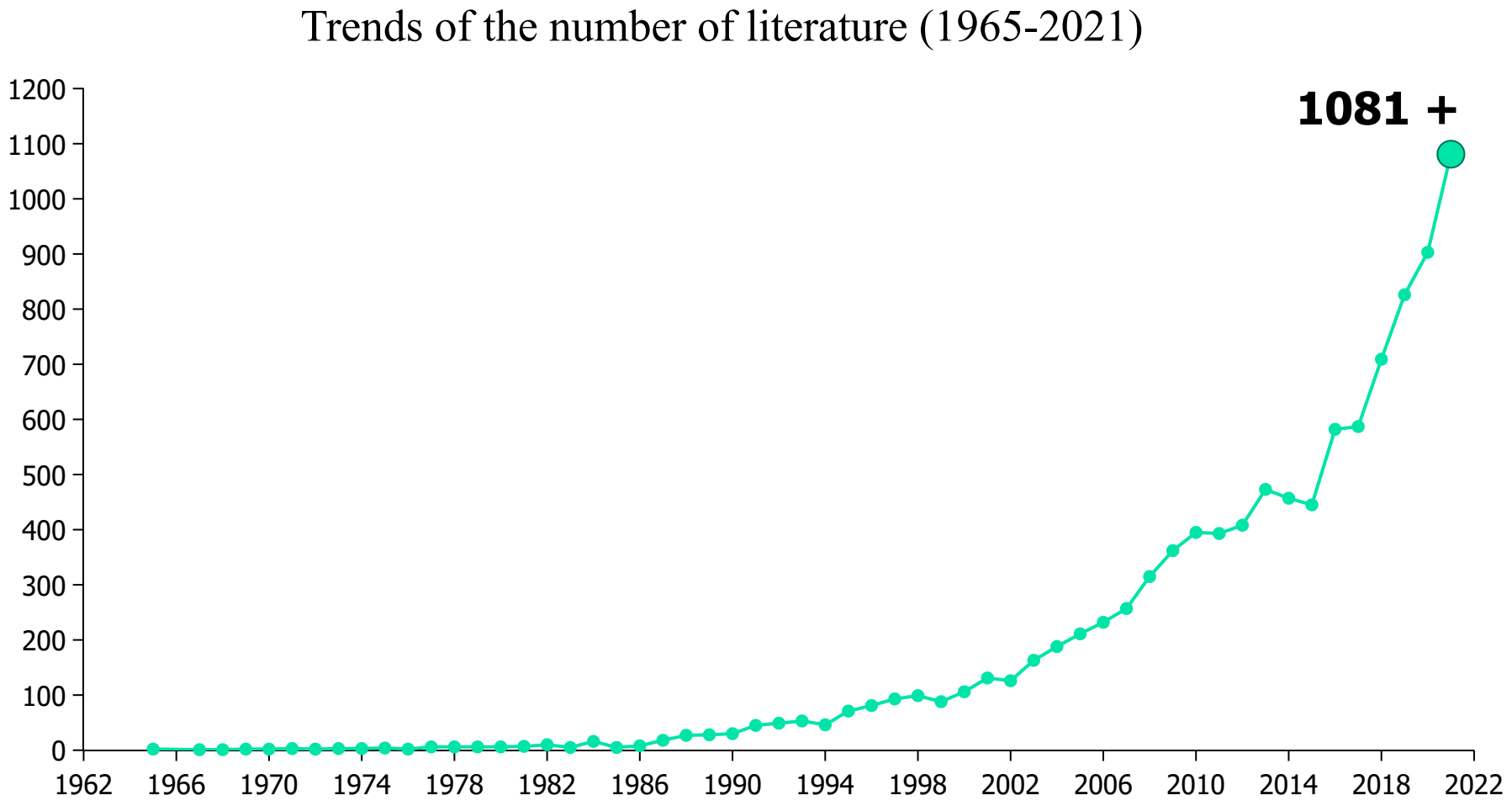




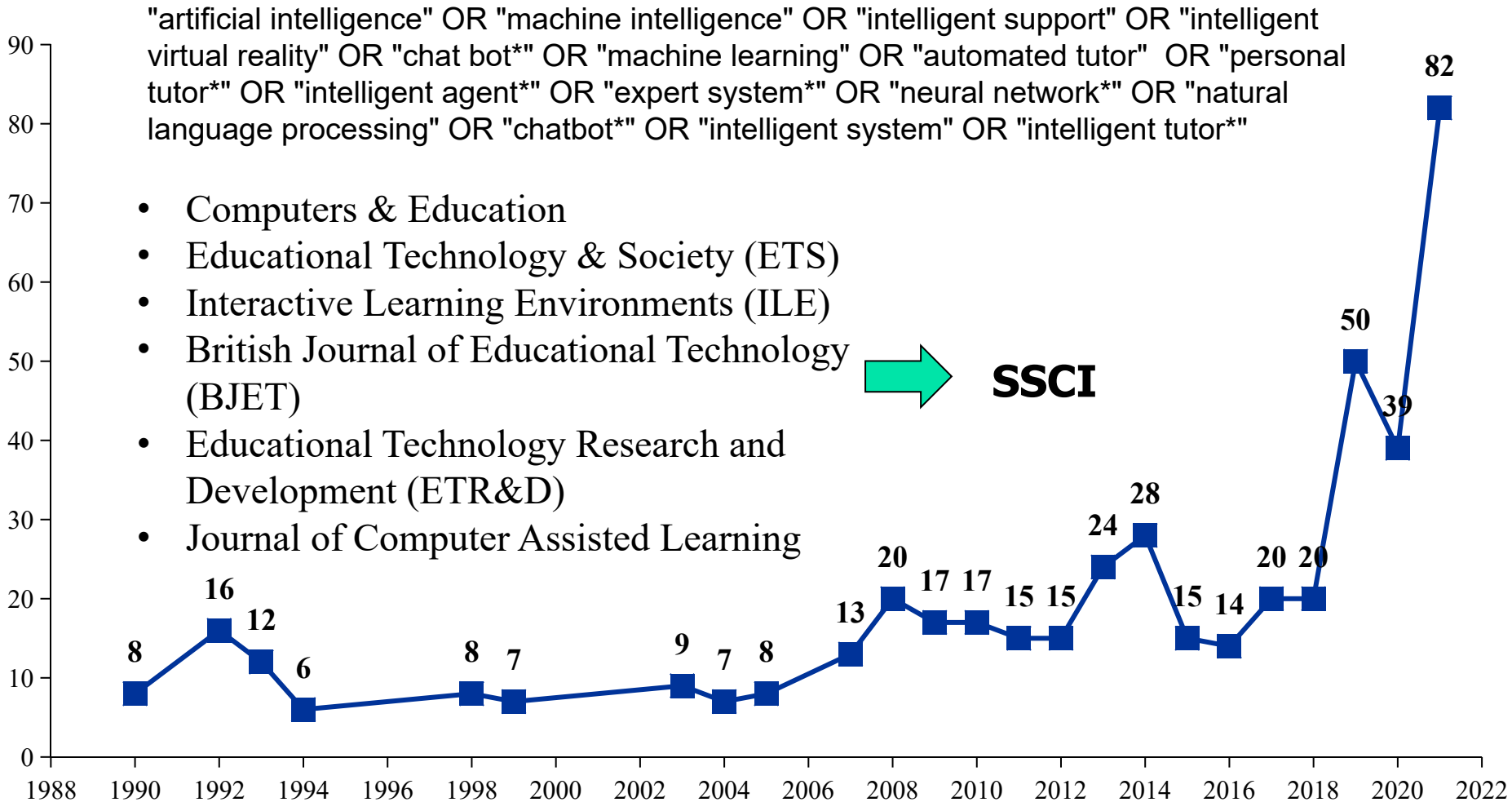
Interface for teachers



Scopus: "Intelligent learning system" or "adaptive learning" or "smart learning"



AIED in six well-recognized SSCI journals of educational technology



What kinds of papers have been published in SSCI journals?

- Review papers: too many
- Investigation of learners' or instructors' perceptions or acceptance of AI in educational settings: too many
- Position papers: too challenging to be accepted
- Experimental studies: not many and with great potential

Chen, X., Xie, H., & Hwang, G. J. (2020). A multi-perspective study on artificial intelligence in education: Grants, conferences, journals, software tools, institutions, and researchers. *Computers and Education: Artificial Intelligence*, *1*, 100005.

Tang, K. Y., Chang, C. Y., & Hwang, G. J. (2021). Trends in artificial intelligence-supported e-learning: A systematic review and co-citation network analysis (1998–2019). *Interactive Learning Environments*, https://doi.org/10.1080/10494820.2021.1875001.

Chen, X., Xie, H., Zou, D., & Hwang, G. J. (2020). Application and theory gaps during the rise of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, *1*, 100002.

Liang, J. C., Hwang, G. J., Chen, M. R. A., & Darmawansah, D. (2021). Roles and research foci of artificial intelligence in language education: an integrated bibliographic analysis and systematic review approach. *Interactive Learning Environments*, https://doi.org/10.1080/10494820.2021.1958348.

Hwang, G. J., & Tu, Y. F. (2021). Roles and research trends of artificial intelligence in mathematics education: A bibliometric mapping analysis and systematic review. *Mathematics*, *9*(6), 584.

Chu, S. T., Hwang, G. J., & Tu, Y. F. (2022). Artificial intelligence-based robots in education: A systematic review of selected SSCI publications. *Computers and education: Artificial intelligence*, 100091.

Hwang, G. J., Chang, P. Y., Tseng, W. Y., Chou, C. A., Wu, C. H., & Tu, Y. F. (2022). Research trends in Artificial Intelligence–associated nursing activities based on a review of academic studies published from 2001 to 2020. *CIN: Computers, Informatics, Nursing*, *40*(12):p 814-824.

Hwang, G. J., Tang, K. Y., & Tu, Y. F. (2022). How artificial intelligence (AI) supports nursing education: profiling the roles, applications, and trends of AI in nursing education research (1993–2020). *Interactive Learning Environments*, https://doi.org/10.1080/10494820.2022.2086579.

Xie, H., Chu, H. C., Hwang, G. J., & Wang, C. C. (2019). Trends and development in technology-enhanced adaptive/personalized learning: A systematic review of journal publications from 2007 to 2017. *Computers & Education, 140*, 103599.

Routledge
Taylor & Francis Group

Interactive Learning Environments

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/nile20

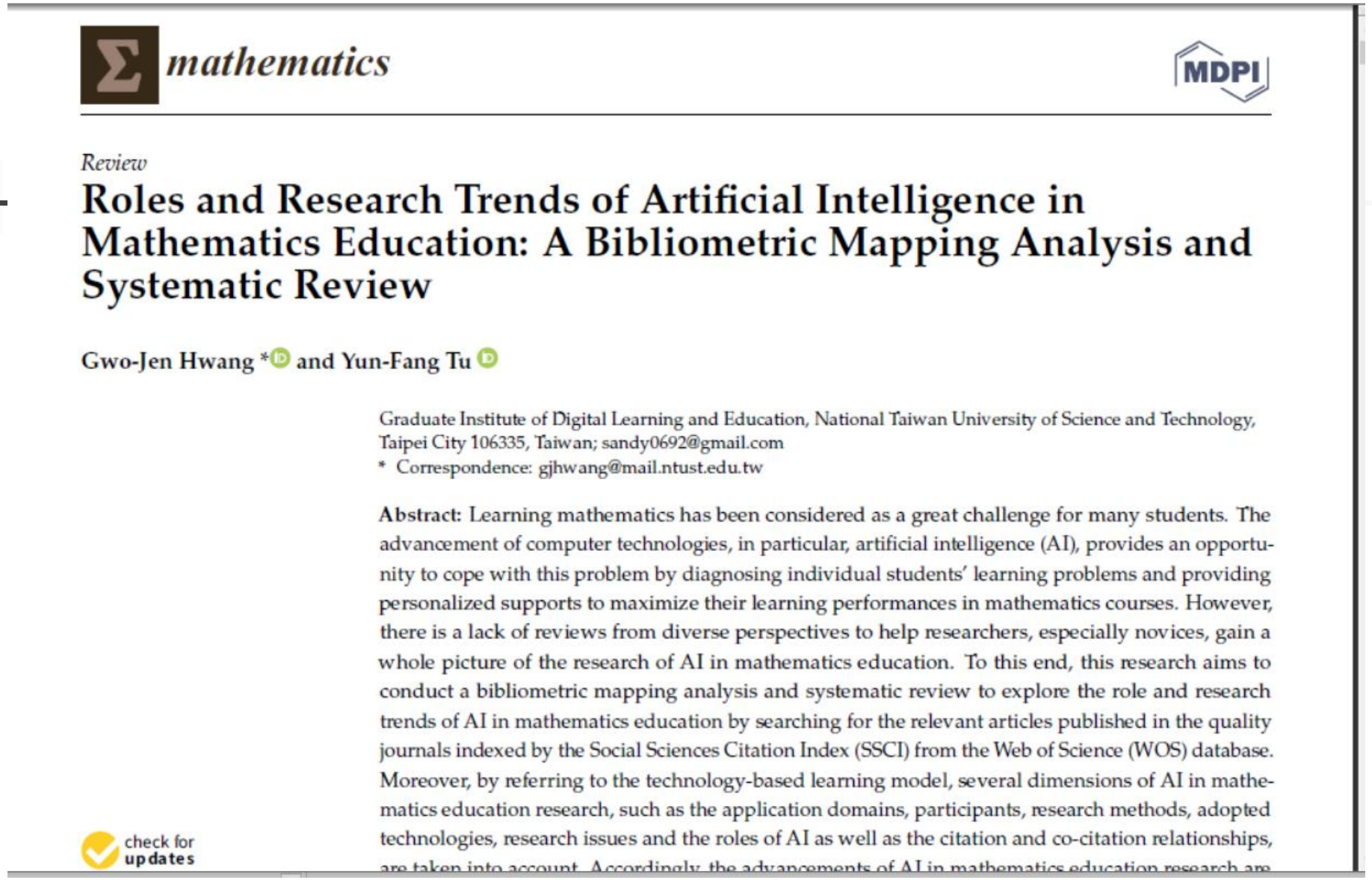
Trends in artificial intelligence-supported e-learning: a systematic review and co-citation network analysis (1998–2019)

Kai-Yu Tang , Ching-Yi Chang & Gwo-Jen Hwang

To cite this article: Kai-Yu Tang , Ching-Yi Chang & Gwo-Jen Hwang (2021): Trends in artificial intelligence-supported e-learning: a systematic review and co-citation network analysis (1998–2019), Interactive Learning Environments, DOI: 10.1080/10494820.2021.1875001

To link to this article: https://doi.org/10.1080/10494820.2021.1875001

Tang, K. Y., Chang, C. Y., & Hwang*+, G. J. (2021). Trends in artificial intelligence-supported e-learning: A systematic review and co-citation network analysis (1998–2019). *Interactive Learning Environments.* Doi:10.1080/10494820.2021.1875001.



mathematics

MDPI

Review

Roles and Research Trends of Artificial Intelligence in Mathematics Education: A Bibliometric Mapping Analysis and Systematic Review

Gwo-Jen Hwang * and Yun-Fang Tu

Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taipei City 106335, Taiwan; sandy0692@gmail.com

* Correspondence: gjhwang@mail.ntust.edu.tw

Abstract: Learning mathematics has been considered as a great challenge for many students. The advancement of computer technologies, in particular, artificial intelligence (AI), provides an opportunity to cope with this problem by diagnosing individual students' learning problems and providing personalized supports to maximize their learning performances in mathematics courses. However, there is a lack of reviews from diverse perspectives to help researchers, especially novices, gain a whole picture of the research of AI in mathematics education. To this end, this research aims to conduct a bibliometric mapping analysis and systematic review to explore the role and research trends of AI in mathematics education by searching for the relevant articles published in the quality journals indexed by the Social Sciences Citation Index (SSCI) from the Web of Science (WOS) database. Moreover, by referring to the technology-based learning model, several dimensions of AI in mathematics education research, such as the application domains, participants, research methods, adopted technologies, research issues and the roles of AI as well as the citation and co-citation relationships, are taken into account. Accordingly, the advancements of AI in mathematics education research are

Hwang*, G. J., & Tu, Y. F. (2021). Roles and research trends of artificial intelligence in mathematics education: A bibliometric mapping analysis and systematic review. *Mathematics*, *9*(6), 584.

Routledge
Taylor & Francis Group

Interactive Learning Environments

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/nile20

Roles and research foci of artificial intelligence in language education: an integrated bibliographic analysis and systematic review approach

Jia-Cing Liang, Gwo-Jen Hwang, Mei-Rong Alice Chen & Darmawansah Darmawansah

To cite this article: Jia-Cing Liang, Gwo-Jen Hwang, Mei-Rong Alice Chen & Darmawansah Darmawansah (2021): Roles and research foci of artificial intelligence in language education: an integrated bibliographic analysis and systematic review approach, Interactive Learning Environments, DOI: 10.1080/10494820.2021.1958348

To link to this article: https://doi.org/10.1080/10494820.2021.1958348

Liang, J. C., Hwang, G. J., Chen, Alice M. R., & Darmawansah (2021). Roles and research foci of Artificial Intelligence in language education: An integrated bibliographic analysis and systematic review approach. *Interactive Learning Environments.* DOI: 10.1080/10494820.2021.1958348.

Advancements and hot research topics of artificial intelligence in mobile learning: a review of journal publications from 1995 to 2019

Gwo-Jen Hwang, Yun-Fang Tu* and Chi-Jen Lin

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Email: gjhwang.academic@gmail.com
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*Corresponding author

Abstract: Based on the Technology-based Learning model, the present study reviewed the Artificial Intelligence-supported Mobile Learning (AImL) studies by searching for journal articles published from 1995 to 2019 in the Scopus database. Various dimensions, such as countries/areas, authors, subject areas and subject categories, hot topics and adopted technologies, were considered in this review study. Regarding the hot topics of AImL studies, the main focuses were 'situated learning' in 1995–2007, 'mobile learning', 'intelligent tutoring systems' and 'ubiquitous learning' in 2008–2013, and 'mobile learning', 'artificial intelligence', 'machine learning' and 'intelligent tutoring systems' in

Who are the potential researchers of AIED studies?

- Researchers who can develop AI systems:
  - Computer science researchers
- Researchers who are AI users:
  - Education or educational technology researchers
  - Other fields

The challenges are quite different to them.

Challenges to **computer science researchers** in conducting AIED studies

- They might develop an AI-based educational systems, but do not know how to show the contribution of their studies
  - Lack of the experience of designing an experiment to show the effectiveness of the AI systems and the knowledge of using pedagogical theories to support their studies
  - It is not good enough to evaluate the performance of an AI-based learning system using only students' self-reported data, such as "satisfaction."
  - It is also not good enough to compare the "speed" and "accuracy" of AI algorithms using some test data.

A possible solution to **computer science researchers** who conduct AIED studies

1. Learn to design a quasi-experiment:
   - Find two classes of students
     - Experimental group: learn with the AI-based system
     - Control group: learn with the conventional approach
   - Learn to use some statistical analysis methods, such as t-test and ANCOVA to analyze the data collected from the two groups
2. Collaborate with educational researchers

Computers and Education: Artificial Intelligence 1 (2020) 100003

Contents lists available at ScienceDirect

Computers and Education: Artificial Intelligence

journal homepage: www.elsevier.com/locate/caeai

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]

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ARTICLE INFO

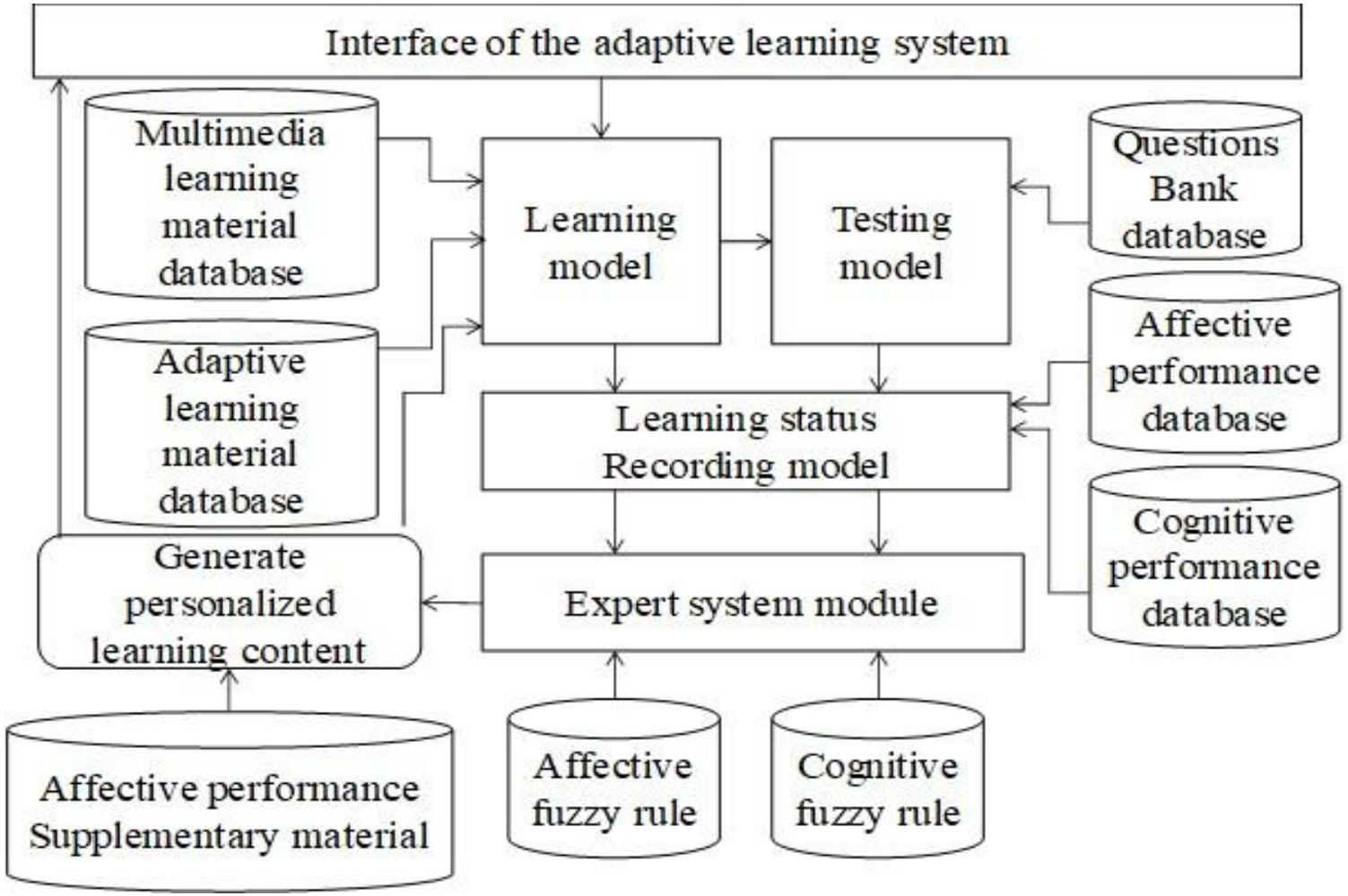
Keywords:

ABSTRACT

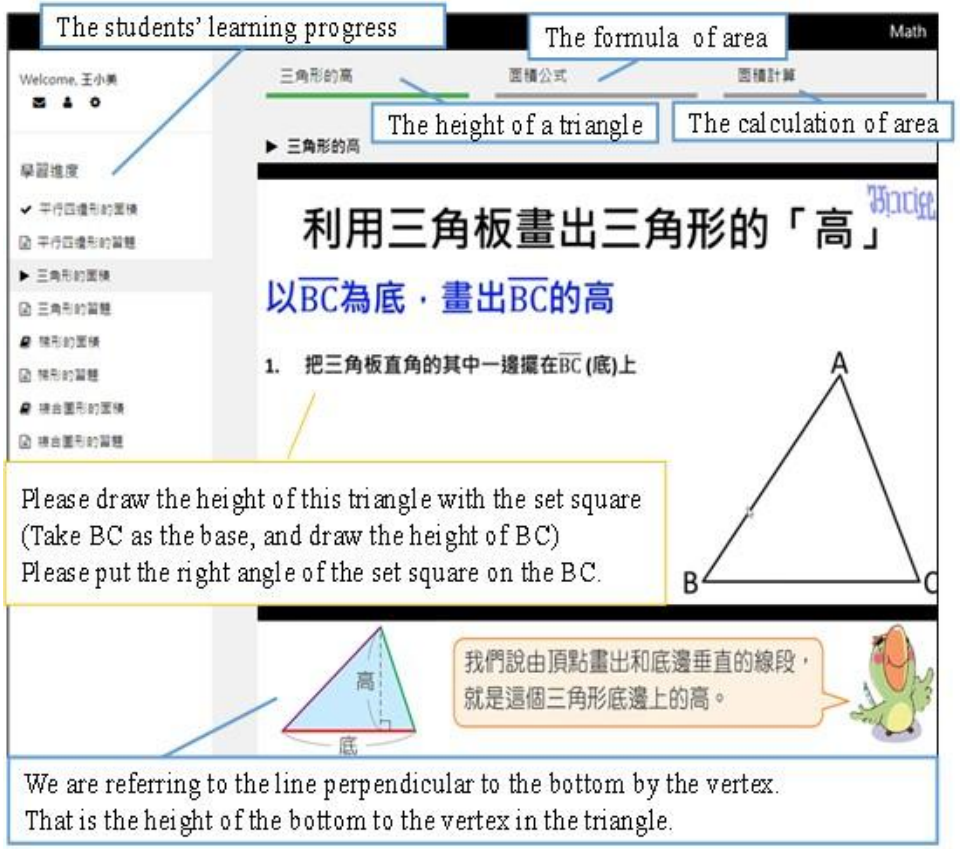
Scholars have indicated the importance of providing guidance and support for individual learners. In the past

Hwang, G. J., Sung, H. Y., Chang, S. C., & Huang, X. C. (2020). A fuzzy expert system-based adaptive learning approach to improving students' learning performances by considering affective and cognitive factors. *Computers & Education: Artificial Intelligence*, *1*, 00003.

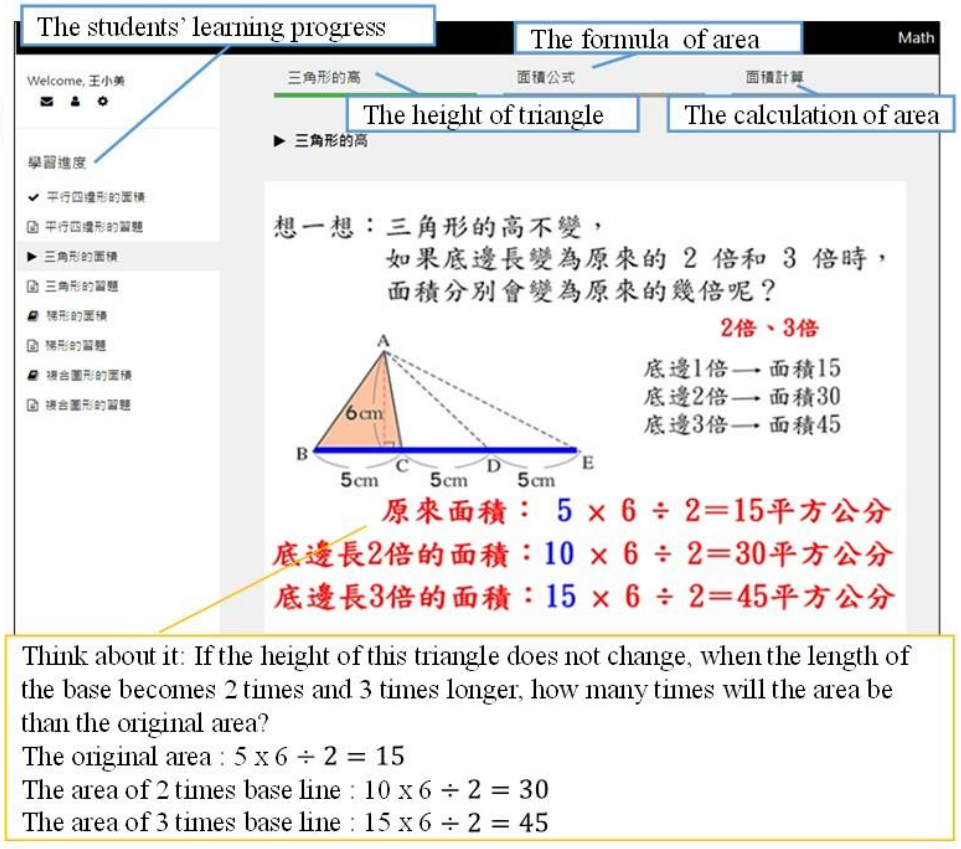
A fuzzy expert system for adaptive learning was developed



The system is able to adapt learning paths based on students' cognitive performance



Low achievers



High achievers

The system can also adapt learning content based on students' affection status
-Pop-up window to examine concentration

Experimental design

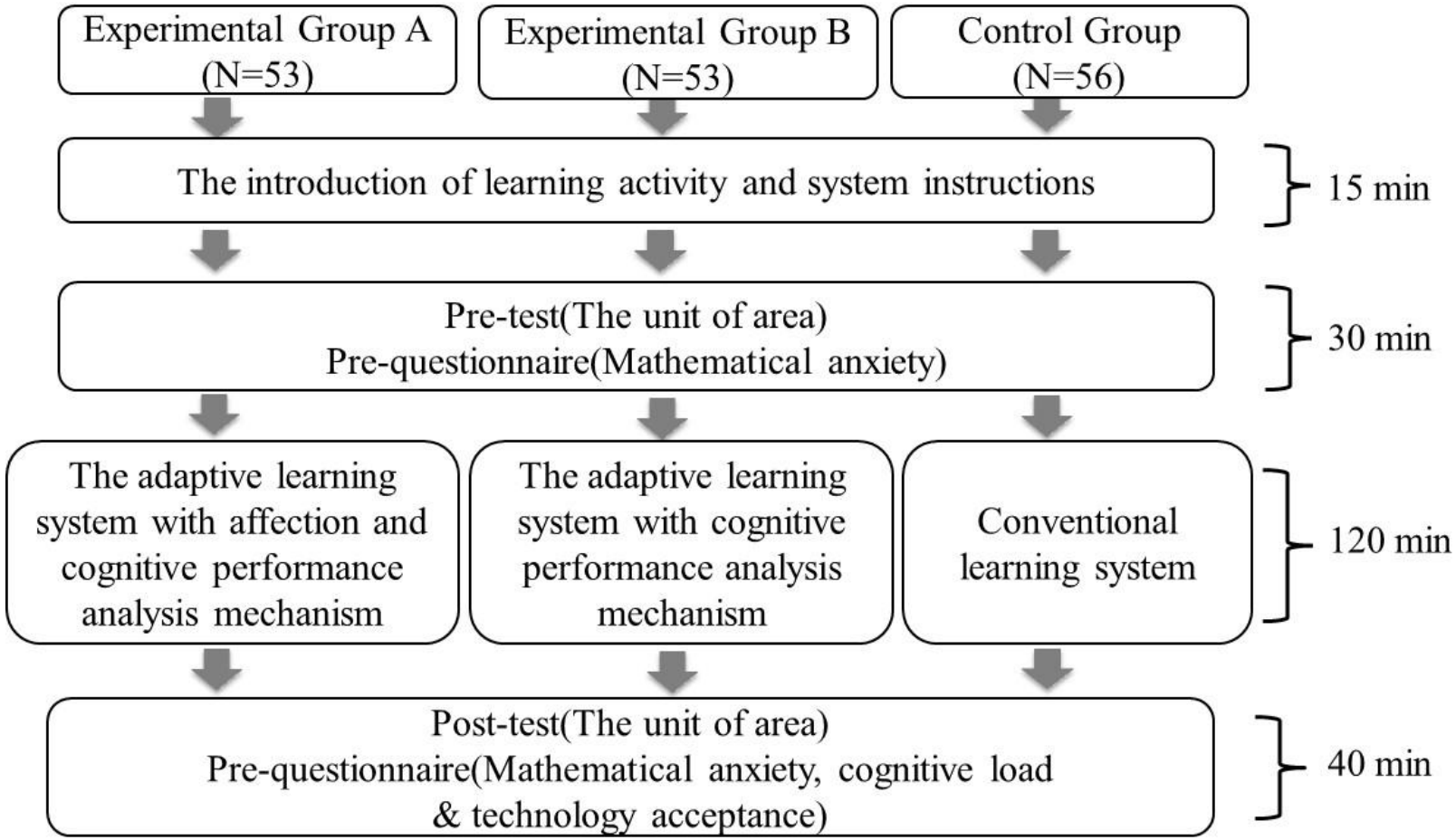


Table 1. The ANCOVA results of students' learning achievement

Group	N	Mean	SD	Adjusted Mean	SE	F	η^2	Post Hoc (LSD)
(a)Experimental Group A	53	66.32	18.37	67.31	2.44	3.12*	0.038	(a)>(b)
(b)Experimental Group B	53	58.77	20.73	58.17	2.44			(a)>(c)
(c)Control Group	56	59.02	16.52	58.65	2.37			

*p<.05

Table 2. The ANCOVA results of students' mathematical anxiety

Group	N	Mean	SD	Adjusted Mean	SE	F	η^2	Post Hoc (LSD)
(a)Experimental Group A	53	2.52	1.05	2.53	0.07	5.59**	0.066	(a)<(c)
(b)Experimental Group B	53	2.64	1.02	2.72	0.07			
(c)Control Group	56	2.86	0.99	2.78	0.07			

**p<.01

Challenges to **educational technology researchers** in conducting AIED studies

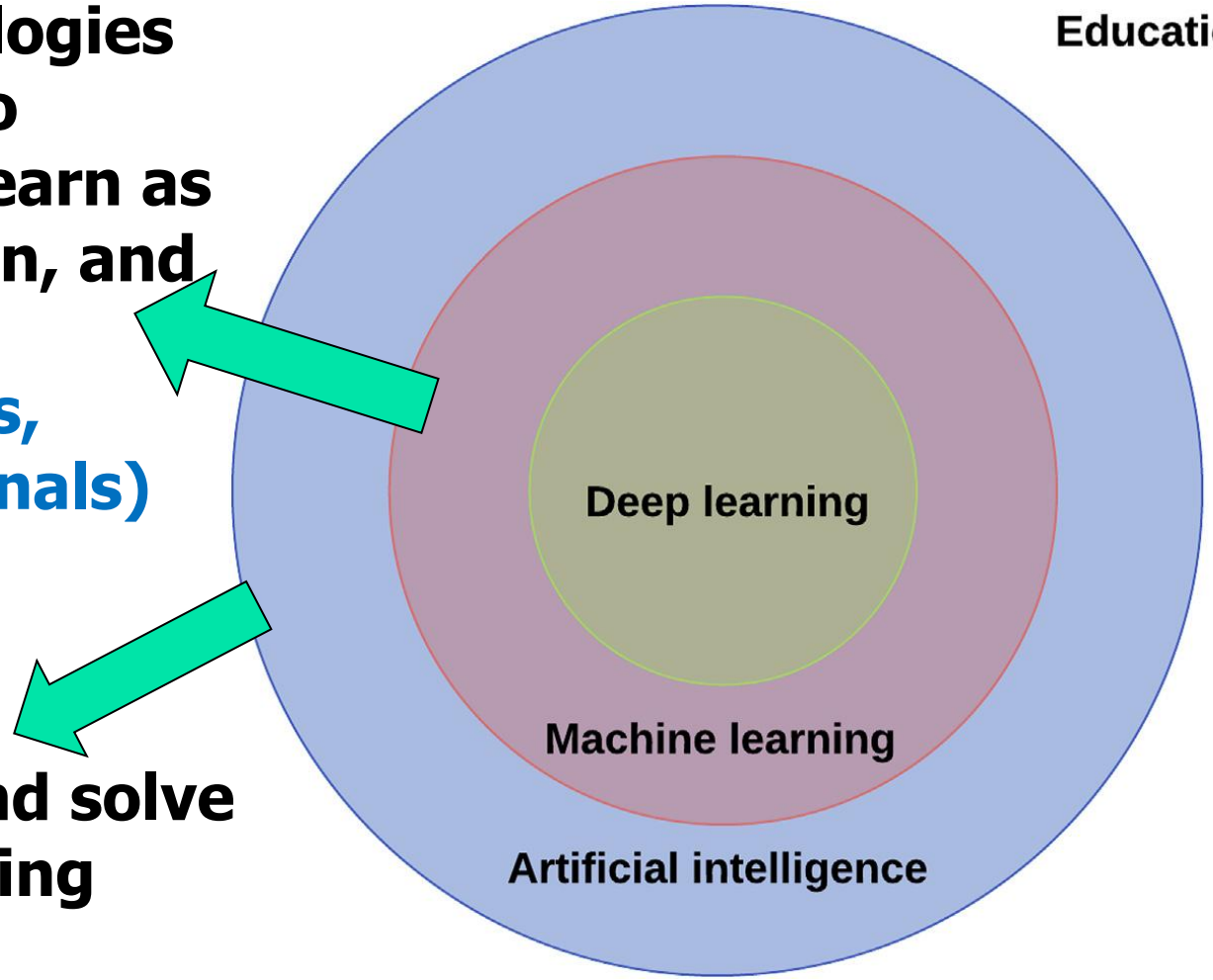
- They might need help in implementing or finding available AI-based learning systems or apps
- They might be unaware of what AI is.

Possible solutions to **educational technology researchers** intending to conduct AIED studies

- Knowing the definition of AI and the functions of AI systems
- Learn to identify whether an application is AI-related or not
- Learn to search for applicable AI systems for educational usage
  - e.g., Are the adopted chatbots AI-based systems?
- Learn to design AI-based activities and studies

What is AIED? Broad sense and narrow sense perspectives (Sze, Chen, Yang, & Emer, 2017).

Use modern AI technologies (e.g., Deep learning) to enable the system to learn as well as perceive, reason, and solve problems
(Science Fiction Movies, Computer science journals)



Can perceive, reason, and solve problems like human being
(Education technology)

AI algorithms taken into account from a broad sense perspective

Evolutionary algorithms	e.g., genetic algorithms, ant colony, Tabu
Bayesian inferencing and networks	
Search and optimization	
Fuzzy set theory	
Deep learning/neural networks	e.g., **image or voice recognition** systems (e.g., voice-to-text translation)
Case-based reasoning	Making decisions by referring to similar cases provided by domain experts
Data mining	Classification, clustering, association rules
Traditional machine learning approach	e.g., developing a decision tree based on the cases provided by domain experts for classification or decision supports
Statistical learning	e.g., linear regression, polynomial regression (for prediction or reasoning)
Natural language processing	e.g., Chatbots (e.g., Andy) with free-style conversation interface
Knowledge elicitation methods via interviewing domain experts	repertory grid, EMCUD for developing expert systems

Hwang, G. J., & Tu, Y. F. (2021). Roles and research trends of artificial intelligence in mathematics education: A bibliometric mapping analysis and systematic review. *Mathematics, 9*, 584.

Some solutions to educational technology researchers

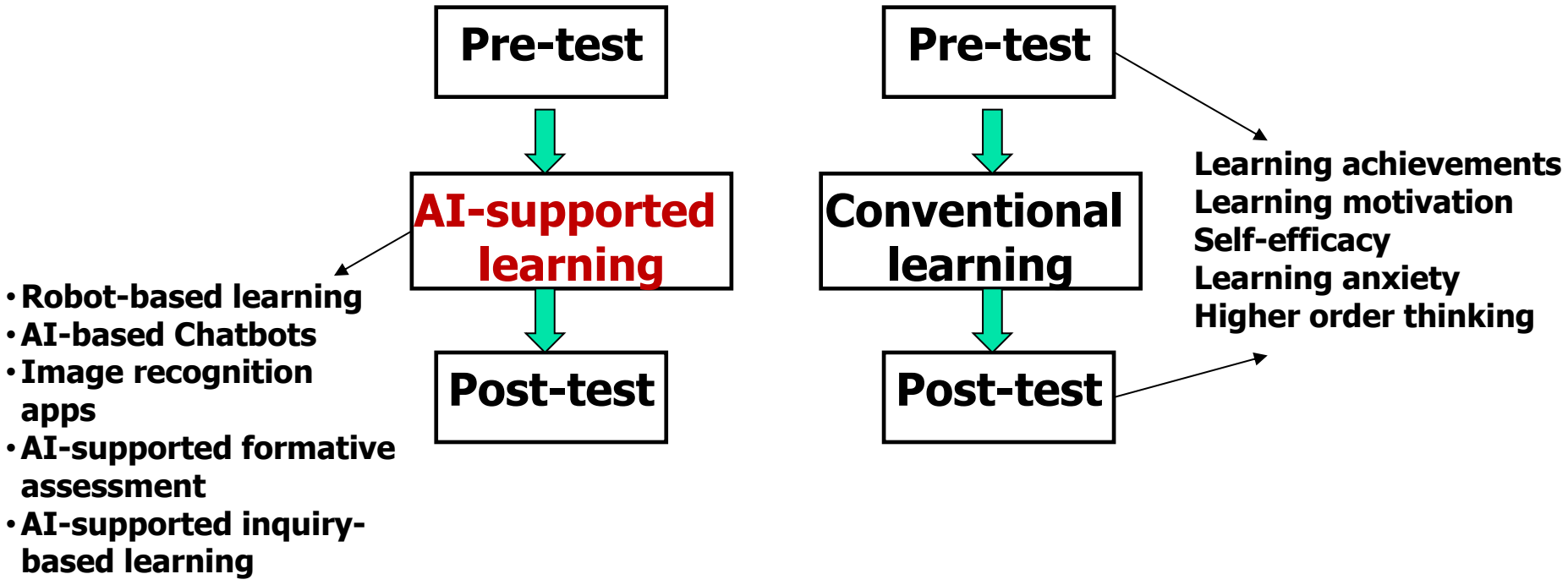
- Using existing apps in research design
  - Learn to search for those "intelligent," "image recognition" or "voice recognition" apps
  - Learn to identify the AI algorithms used in the applications
- Cooperate with computer science researchers who are able to develop AI systems or apps
  - image recognition (using neural networks or deep learning
  - expert systems (using rule-based inference or other AI algorithms)

Pedagogical theories for AIED research

- **Social Constructivism**
  - **Emphasizing that knowledge is constructed through interaction with others**
- **Double-loop learning theory**
  - **Emphasizing the importance of acquiring additional knowledge or seeking advices before making attempts to solve problems.**
- **Embodied cognition theory**
  - **Many features of cognition are shaped by aspects of a person's entire body.**

Potential AIED research design (1)

- **Investigating the impacts of using AI applications on students' learning performances and perceptions**



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DOI: 10.1111/bjet.13158

ORIGINAL MANUSCRIPT

British Journal of Educational Technology BERA

Promoting students' learning achievement and self-efficacy: A mobile chatbot approach for nursing training

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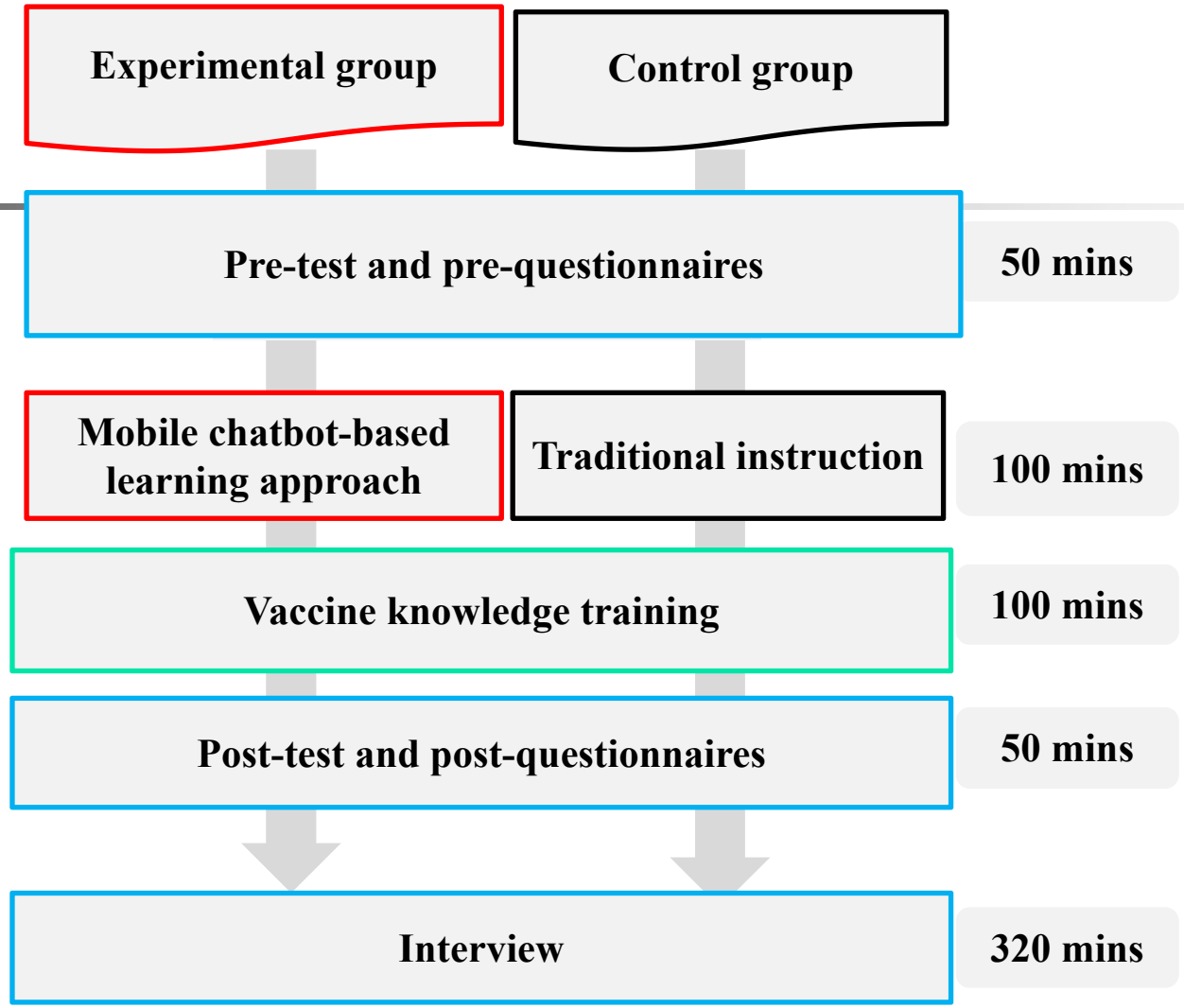
[2]Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taipei, Taiwan

[3]Department of Midwifery and Women Health Care, National Taipei University

Abstract

The aims of nursing training include not only mastering skills but also fostering the competence to make decisions for problem solving. In prenatal educa-

Chang, C. Y., Hwang, G. J., & Gau, M. L. (2021). Promoting students' learning achievement and self-efficacy: A mobile chatbot approach for nursing training. *British Journal of Educational Technology.* DOI: 10.1111/bjet.13158


Experimental group
Control group
Pre-test and pre-questionnaires
50 mins
Mobile chatbot-based learning approach
Traditional instruction
100 mins
Vaccine knowledge training
100 mins
Post-test and post-questionnaires
50 mins
Interview
320 mins


The conversation window between a student and chatbot
疾管家
謝謝關心
沒問題！
附近哪裡有孕婦就醫院所？
請透過地圖指定區域，由我來查詢附近的孕婦就醫院所
Prevent COVID-19
Clarify false news
Where to buy masks
View domestic and international epidemics
Telephone consultation
Know all infectious diseases
Check when the vaccine is given
CDC
假訊息
預防武漢肺炎
澄清專區
口罩哪裡買
查看國內外疫情
了解所有傳染病
查詢疫苗何時打
電話諮詢
iPAQ

A. Start using the chatbot

I want to learn about infectious diseases

What infectious disease do you want to know about?

Please tell me the correct name of the infectious disease you want to inquire (both Chinese and English). For example, if you want to inquire about measles, please enter "measles"

Wuhan pneumonia

This was discovered in Wuhan City, Hubei Province, China at the end of 2019, so it is called Wuhan pneumonia. The World Health Organization has confirmed that it is caused by a new coronavirus strain and named it COVID-19 (Taiwan referred to as Wuhan pneumonia). Taiwan's Department of Disease Control has announced that it is the fifth category of statutory infectious diseases, and the notified name is severe special infectious pneumonia

What should I do if I am infected with the 2019 novel coronavirus?

If you have fever, cough and other uncomfortable symptoms when you return to the country and enter the country, you should take the initiative to notify the airport and port quarantine personnel

Remember to tell the doctor your travel history, occupation, contact history and whether anyone around you has similar symptoms when you seek medical treatment, to help the doctor diagnose in time

ANCOVA of learning achievement by comparing the experimental and control groups

Group	N	Mean	SD	Adjusted mean	F	η2
Experimental	18	88.58	11.02	87.36	22.80***	.409
control	18	60.51	15.01	61.73		

***p<.001

ANCOVA of self-efficacy by comparing the experimental and control groups

Group	*N*	Mean	*SD*	Adjusted mean	*F*	*η2*
Experimental	18	4.54	0.53	4.45	34.75***	.513
control	18	3.31	0.45	3.40		

***p<.001

Routledge
Taylor & Francis Group

Interactive Learning Environments

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/nile20

Artificial intelligence-supported art education: a deep learning-based system for promoting university students' artwork appreciation and painting outcomes

Min-Chi Chiu, Gwo-Jen Hwang, Lu-Ho Hsia & Fong-Ming Shyu

To cite this article: Min-Chi Chiu, Gwo-Jen Hwang, Lu-Ho Hsia & Fong-Ming Shyu (2022): Artificial intelligence-supported art education: a deep learning-based system for promoting university students' artwork appreciation and painting outcomes, Interactive Learning Environments, DOI: 10.1080/10494820.2022.2100426

Computers & Education 201 (2023) 104827

Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

A robot-based digital storytelling approach to enhancing EFL learners' multimodal storytelling ability and narrative engagement

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[a] Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan
[b] Graduate Institute of Educational Information and Measurement, National Taichung University of Education, Taiwan
[c] Yuan Ze University, Taiwan

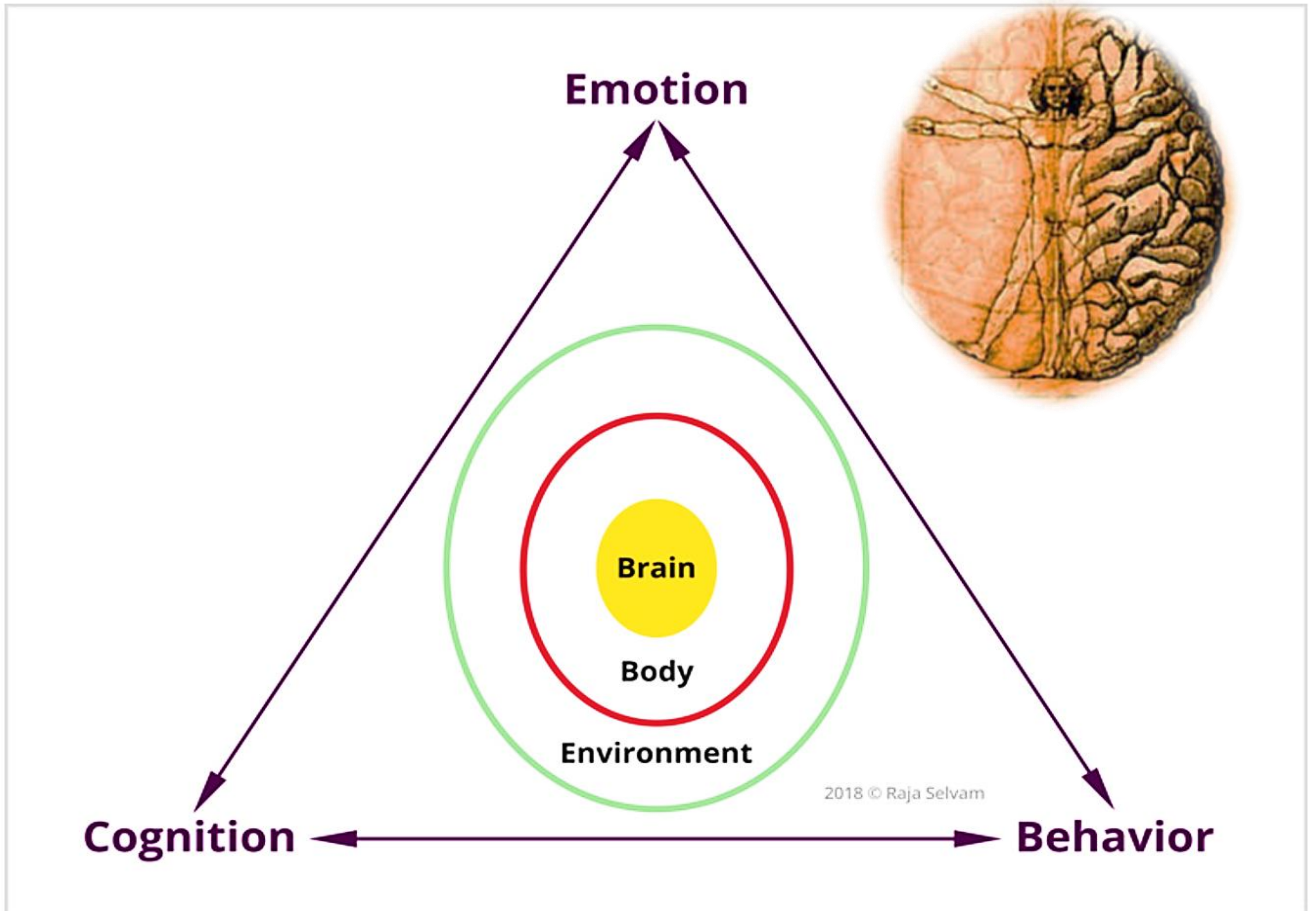
ARTICLE INFO

Keywords:
Teaching/learning strategies
Improving classroom teaching
Pedagogical issues
Secondary education

ABSTRACT

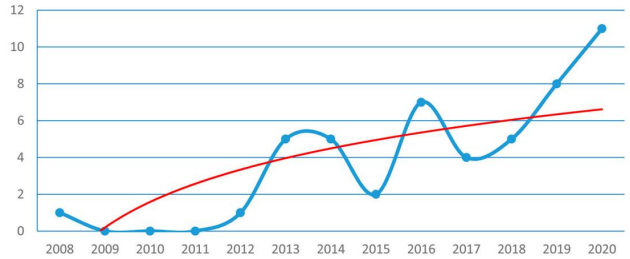
Digital technology has brought new opportunities for language education. Multimodal literacy refers to the ability to read, watch, understand, respond to, and generate multimodal texts. Multimodality, promoted by scholars, generates meaning in multiple modes. Hence, digital storytelling (DST) presented with multimodal content has been extensively applied in second language instruction. However, traditional DST is mostly presented in videos with one-way communication; it lacks two-way communication with the audience and is only regarded as a learning method for knowledge acquisition. As a result, the present study proposed a robot-based DST (robot-DST) approach to facilitate the interaction in the DST process and to enhance students' engagement. In order to evaluate its effectiveness, a quasi-experiment was conducted in an EFL course at a senior high school. Two classes of 11th graders participated in the experiment. One class with 40 students was the experimental group adopting the robot-DST approach, while the other class with 40 students was the control group adopting the conventional animation-based DST (CA-DST) approach. The results showed that the robot-DST approach could significantly reduce students' communication apprehension, as well as enhance their English speaking ability, storytelling ability, narrative engagement, and communication tendency. The findings show that using robots in the context of digital storytelling design has great potential for promoting learners' language learning performances. Accordingly, in-depth discussion and suggestions for future research are provided for researchers and school teachers who intend to use robots in educational settings.

Embodied cognition theory



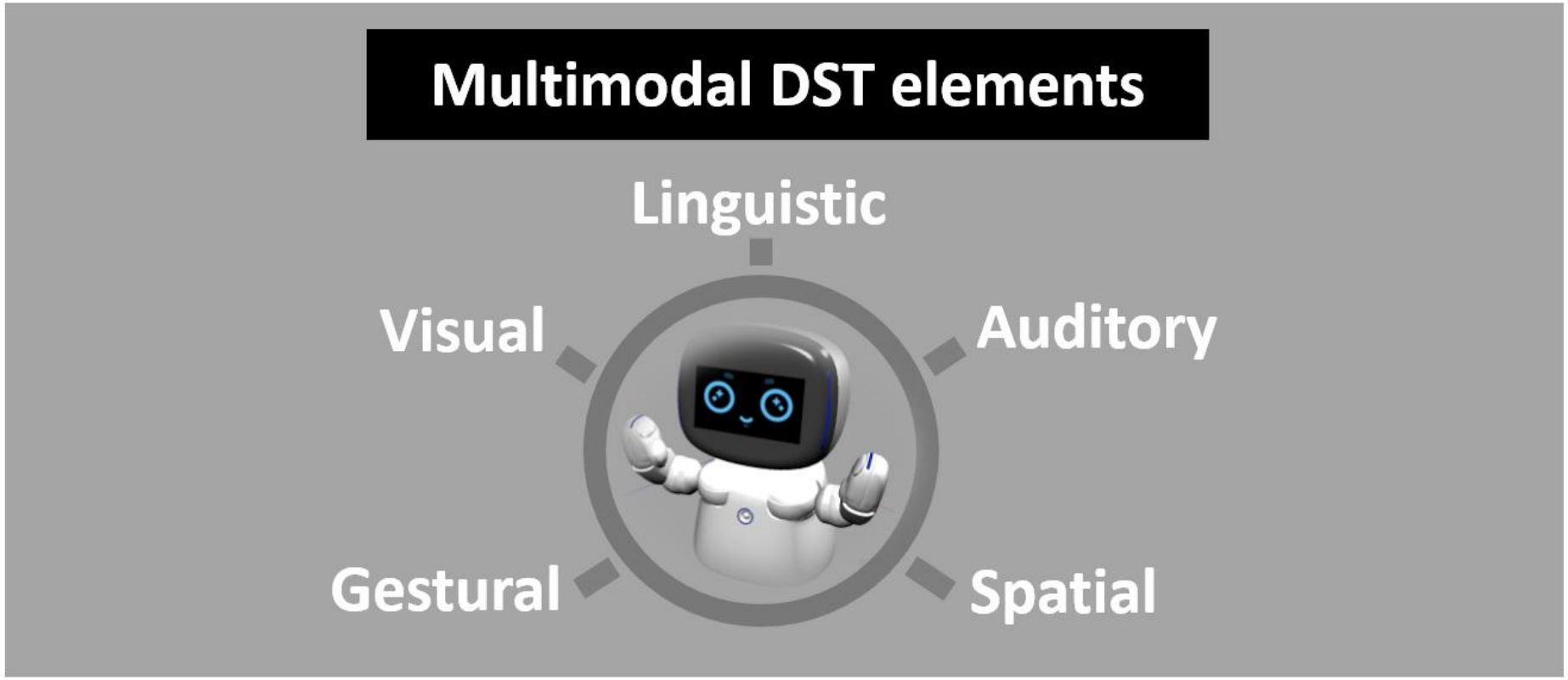
- **Human cognition comes from developmental, embodied interactions with physical environment.**
- **Cognition, emotion, and behavior are all embodied and embedded in the brain, body, as well as the environment.**

Embodied cognition theory



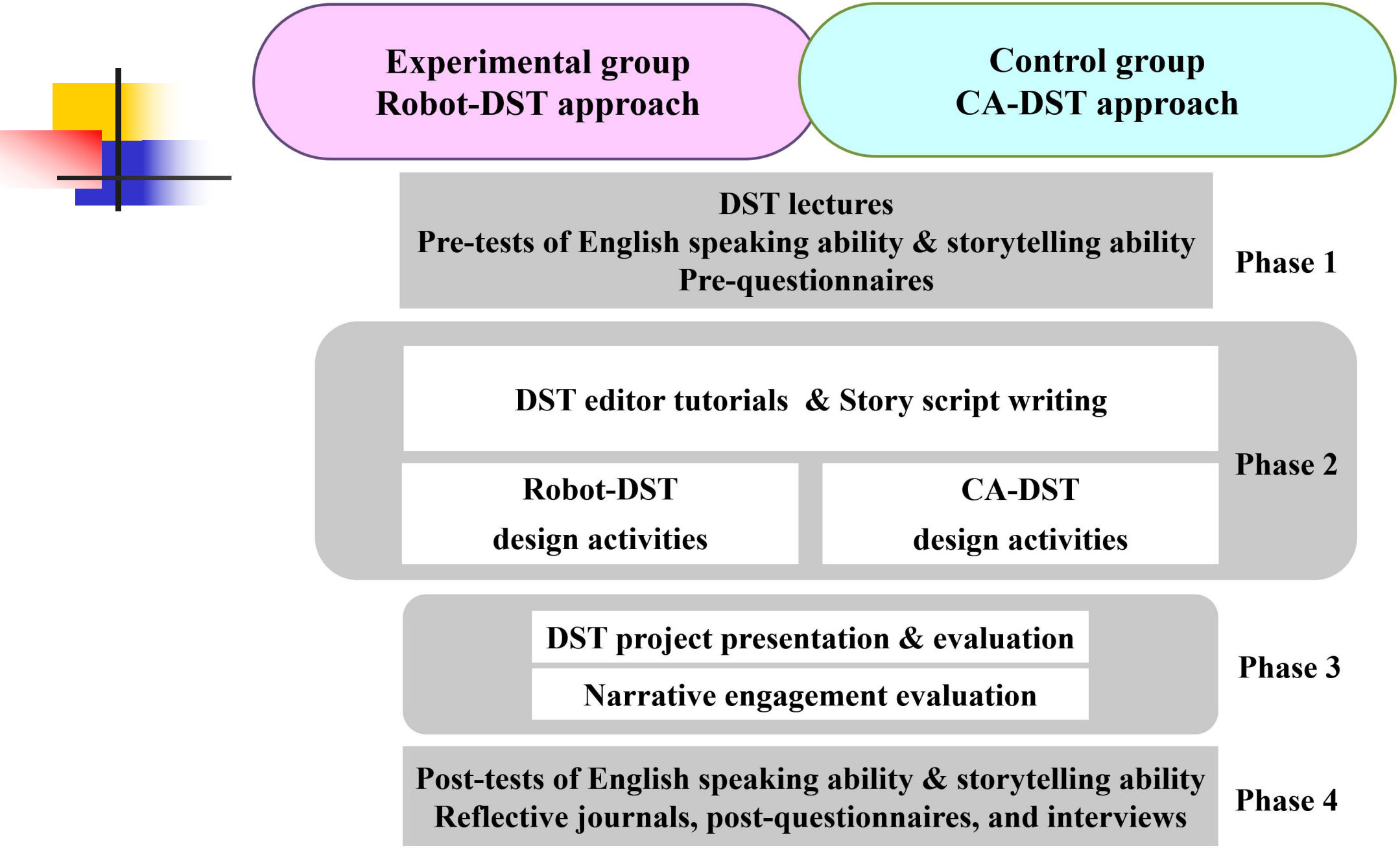
- The body & mind are no longer regarded as separate entities.
- Perceptual rich experiences shape the cognitive process, which in turn facilitates learners' construction of meaning in the process (Gallese & Lakoff, 2005).
- This can be used to explain why robot-based digital storytelling is better than conventional video-based digital storytelling.

Robot-based Digital Storytelling

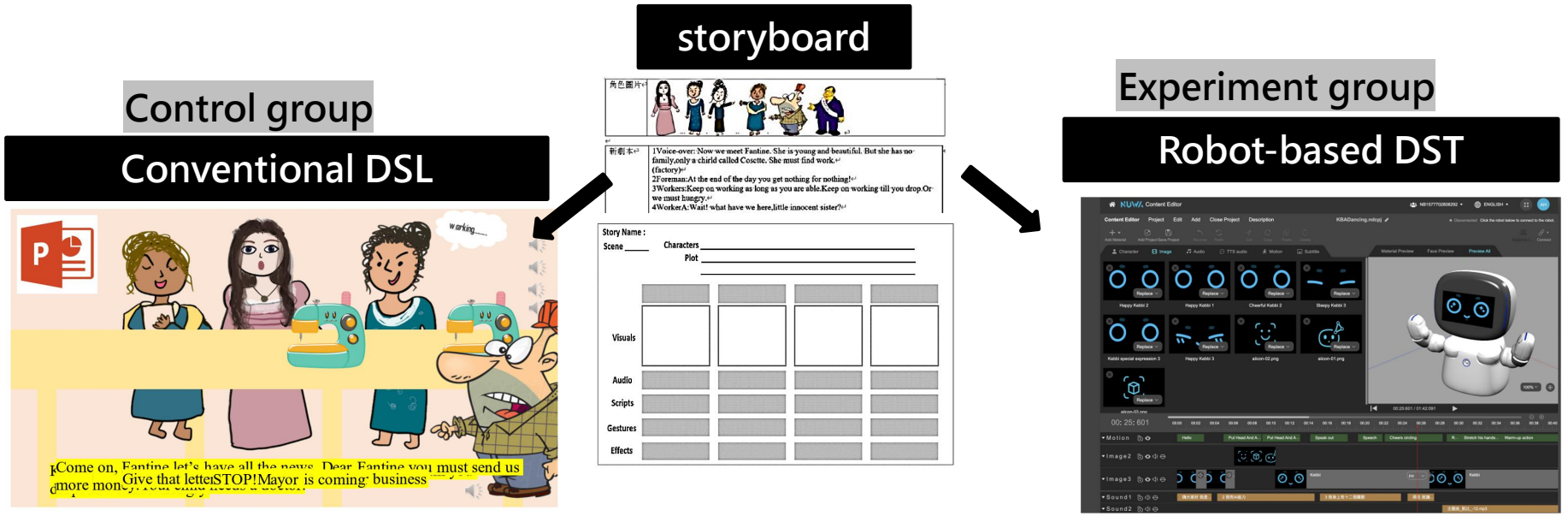


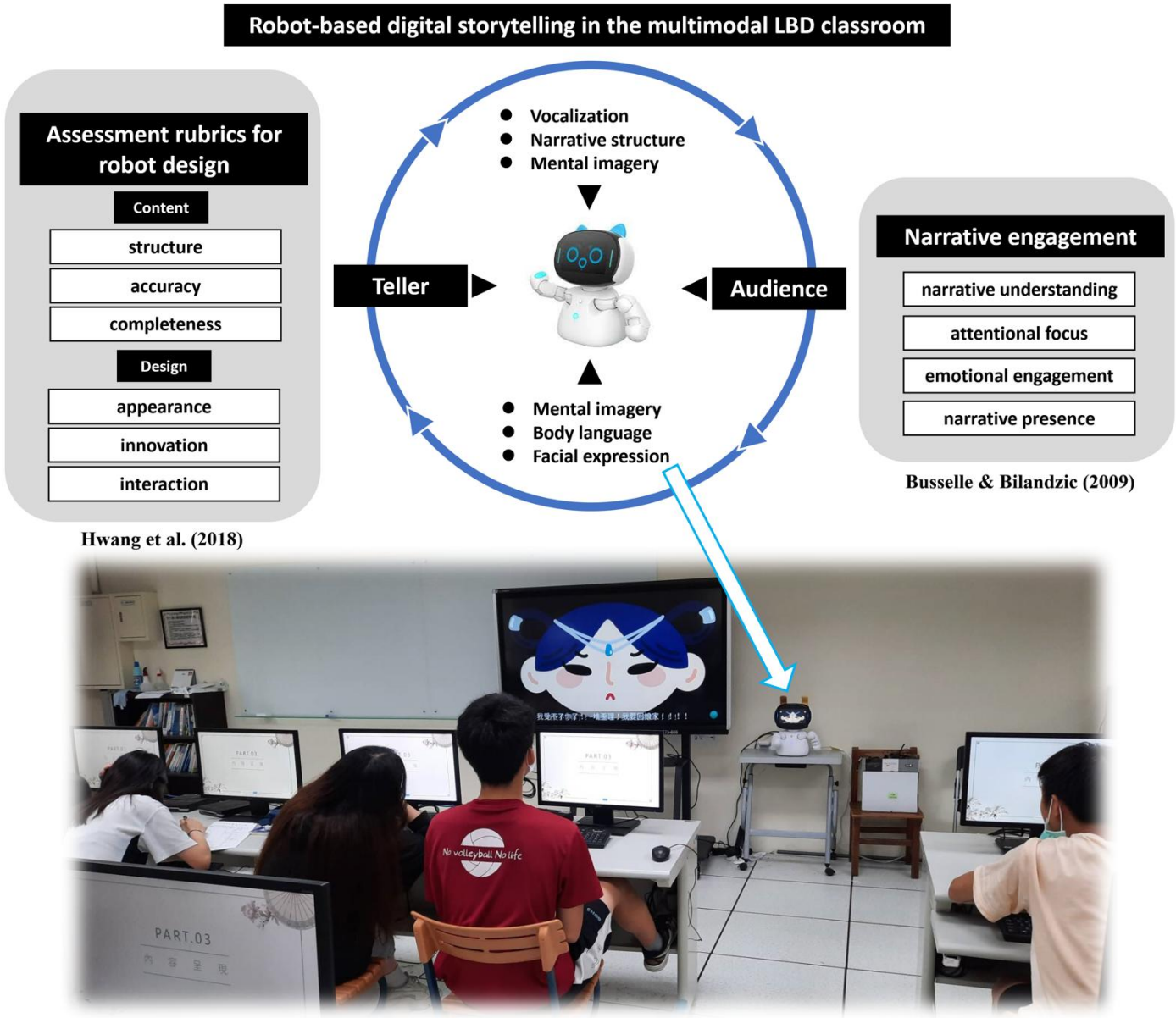
Four degrees of embodiment

	Level 1	Level 2	Level 3	Level 4
	Small screen	Small screen	Small or large display	Mixed-Reality
	Observational/passive	Interactive	Motion Sensing Interfaces	Sensing with Locomotion
Visual stimuli	O	O	O	O
Limb movement	X	O	O	O
gestural relevancy	X	X	O	O
immersive environment	X	X	O	O
body movement	X	X	X	O
	Video-based DSL		**Robot-based DSL**	


Experimental group
Robot-DST approach
Control group
CA-DST approach
DST lectures
Pre-tests of English speaking ability & storytelling ability
Pre-questionnaires
Phase 1
DST editor tutorials & Story script writing
Robot-DST
design activities
CA-DST
design activities
Phase 2
DST project presentation & evaluation
Narrative engagement evaluation
Phase 3
Post-tests of English speaking ability & storytelling ability
Reflective journals, post-questionnaires, and interviews
Phase 4

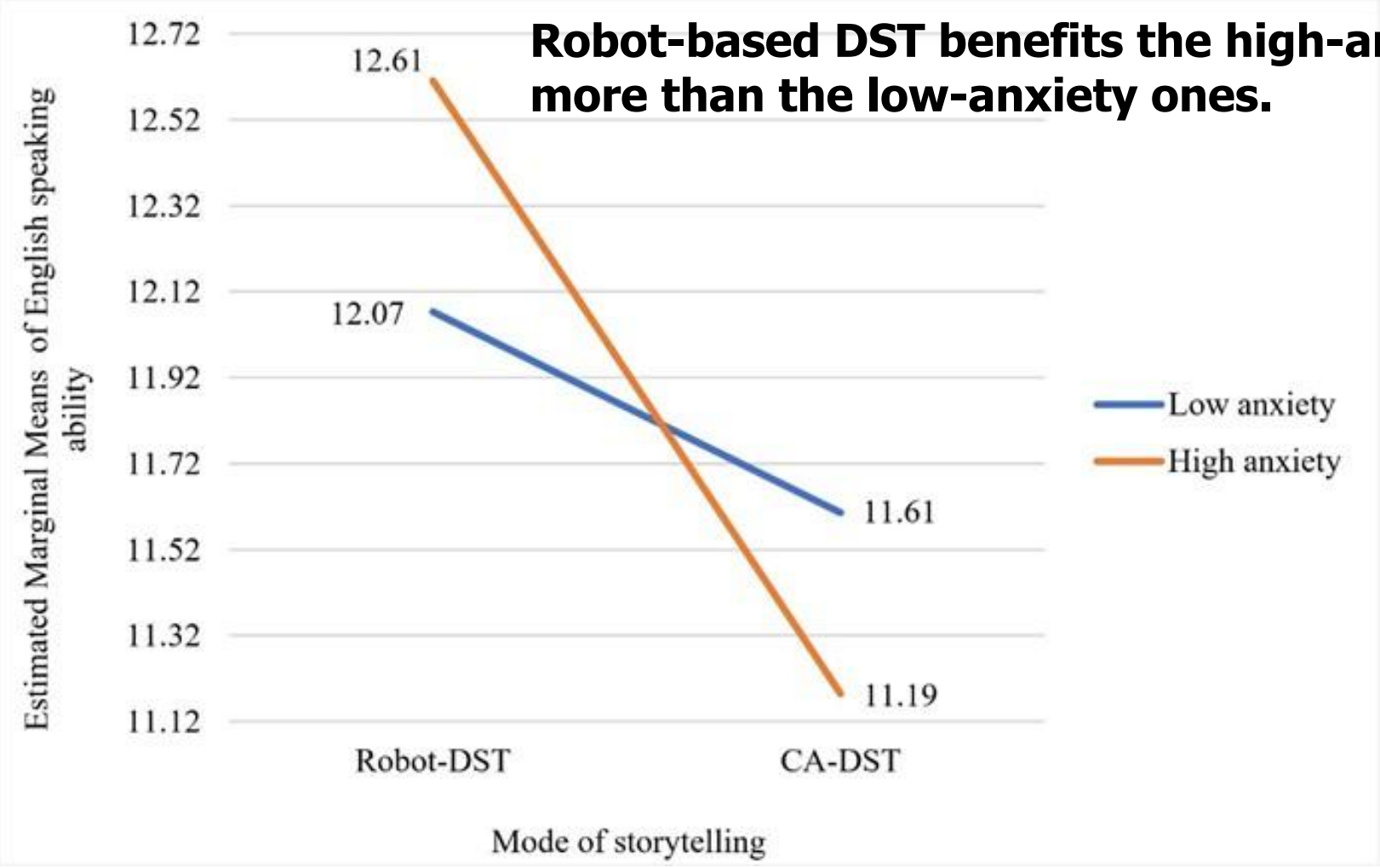
- From the perspective of embodied cognition theory, the essential difference between the Robot-DST and CA-DST approaches lies in the levels of embodied cognition the students were involved in.
- Higher-level embodied cognitive learning lead to better learning outcomes.




Robot-based digital storytelling in the multimodal LBD classroom
Assessment rubrics for robot design
Content
structure
accuracy
completeness
Design
appearance
innovation
interaction
Hwang et al. (2018)
Vocalization
Narrative structure
Mental imagery
Teller
Audience
Mental imagery
Body language
Facial expression
Narrative engagement
narrative understanding
attentional focus
emotional engagement
narrative presence
Busselle & Bilandzic (2009)
PART.03
No volleyball No life

Interaction of anxiety levels and DST approaches on English speaking ability

Robot-based DST benefits the high-anxiety students more than the low-anxiety ones.



Computers & Education 202 (2023) 104834

Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

Fostering professional trainers with robot-based digital storytelling: A brainstorming, selection, forming and evaluation model for training guidance

Chun-Chun Chang [a], Gwo-Jen Hwang [b,c,d,*], Kuan-Fu Chen [b]

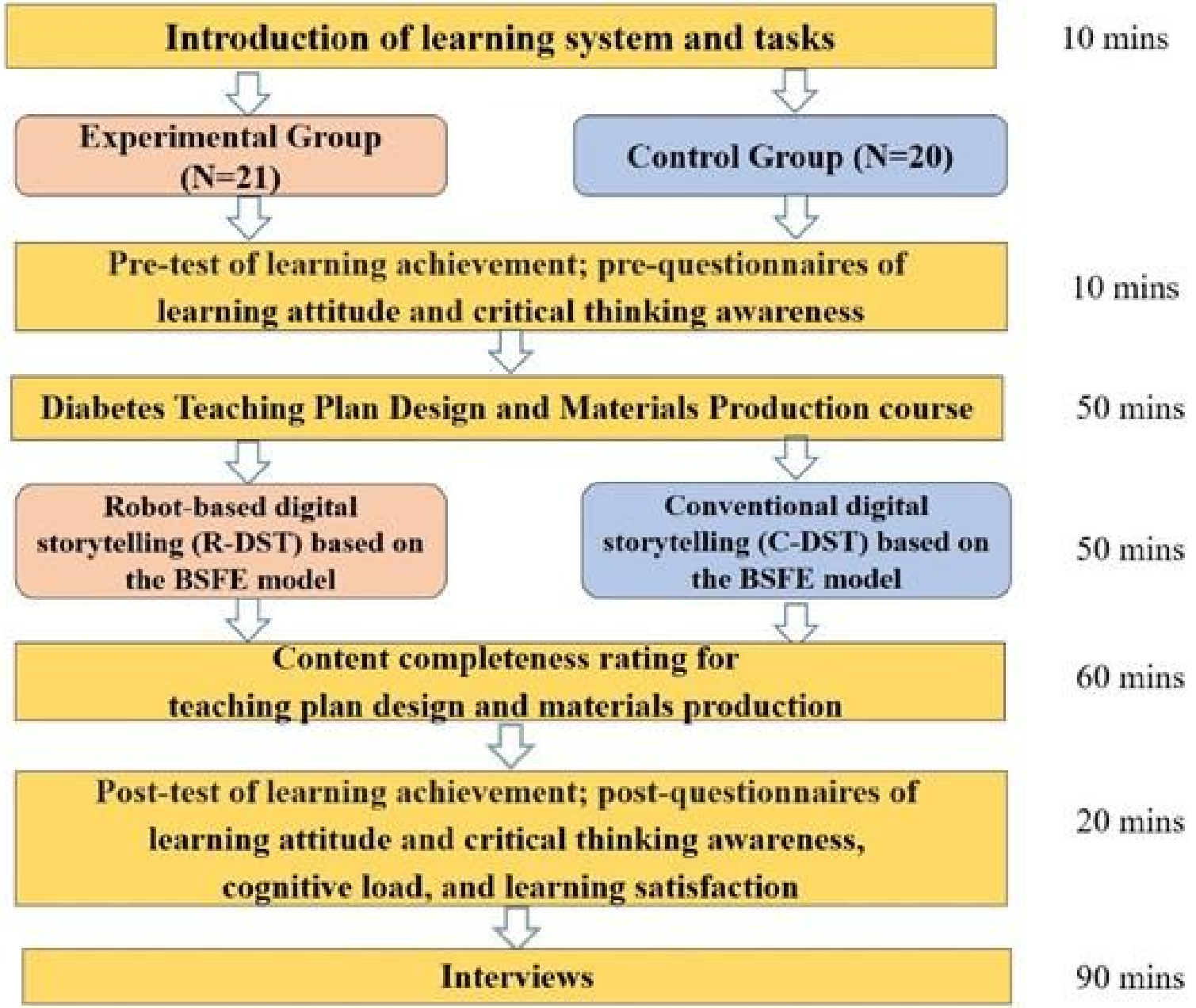
[a] Department of Nursing, Chang Gung University of Science and Technology, Taiwan
[b] Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan
[c] Graduate Institute of Educational Information and Measurement, National Taichung University of Education, Taiwan
[d] Yuan Ze University, Taiwan

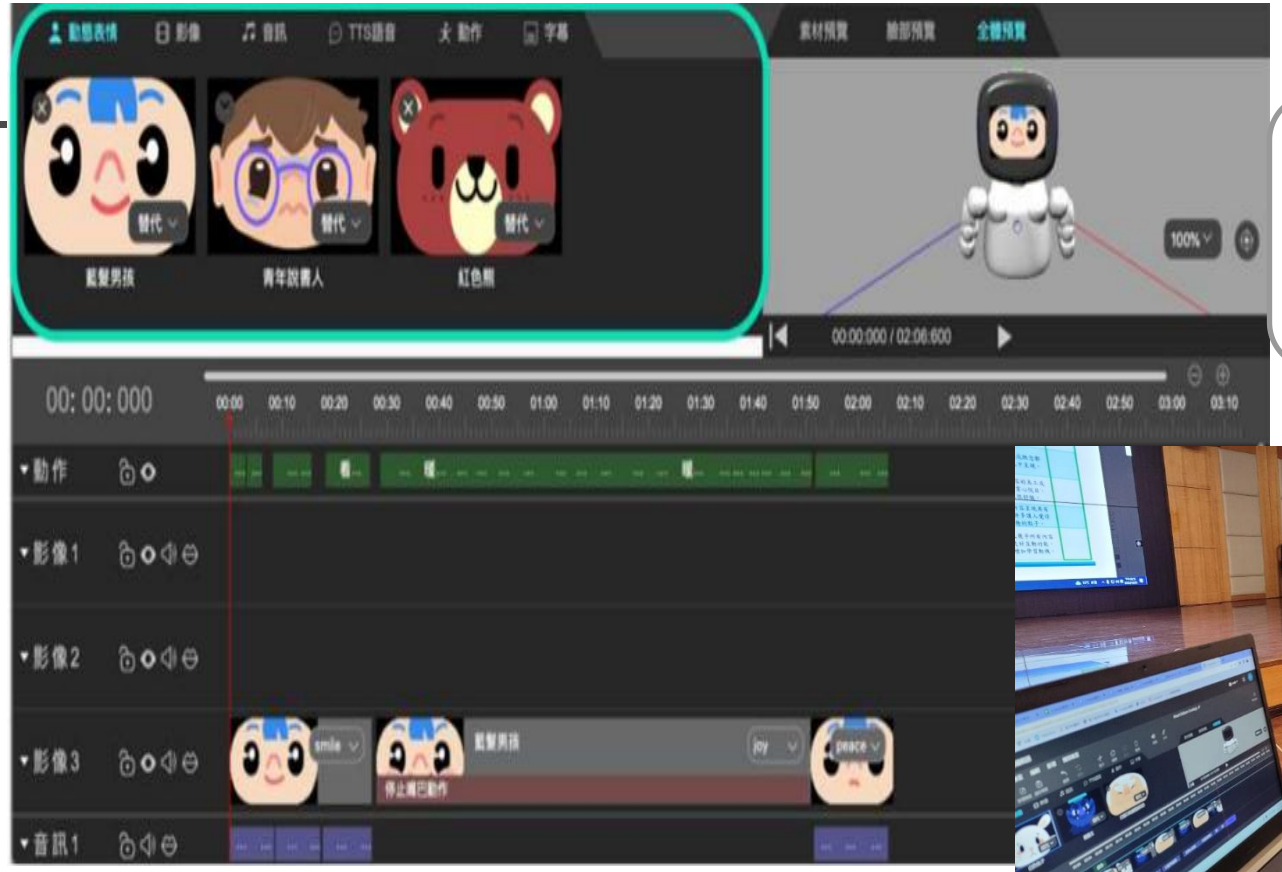
ARTICLE INFO

Keywords:
Teaching/learning strategies
Storytelling
Performance
Improving classroom teaching
Interactive learning environments

ABSTRACT

In a working environment which requires professional knowledge and judgment-making ability, professional trainers play an important role; through effective professional training, they can help newcomers to successfully apply their expertise in the workplace. Hence, how to cultivate excellent professional trainers has become an important issue of talent cultivation for various enterprises.


Introduction of learning system and tasks
10 mins
Experimental Group (N=21)
Control Group (N=20)
Pre-test of learning achievement; pre-questionnaires of learning attitude and critical thinking awareness
10 mins
Diabetes Teaching Plan Design and Materials Production course
50 mins
Robot-based digital storytelling (R-DST) based on the BSFE model
Conventional digital storytelling (C-DST) based on the BSFE model
50 mins
Content completeness rating for teaching plan design and materials production
60 mins
Post-test of learning achievement; post-questionnaires of learning attitude and critical thinking awareness, cognitive load, and learning satisfaction
20 mins
Interviews
90 mins



Trainees used an editor to develop digital stories for robots

Robots presented the developed stories with gestures, facial expressions and movements - Embodied learning theory

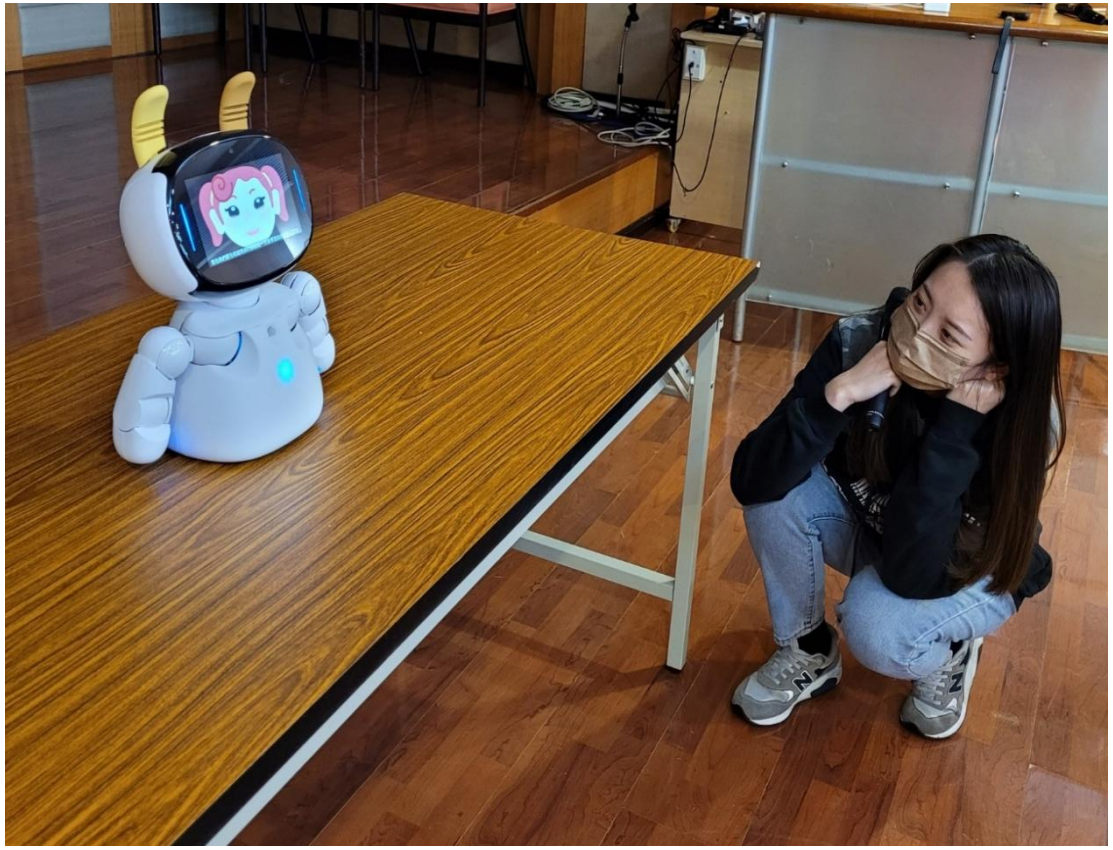


Table 2. ANCOVA results of learning achievement

Group	N	Mean	SD	Adjusted mean	Adjusted SD	F	η2
Experimental group	21	87.14	11.46	87.23	2.06	38.38***	0.50
Control group	20	69.00	7.18	68.91	2.12		

***$p < .001$

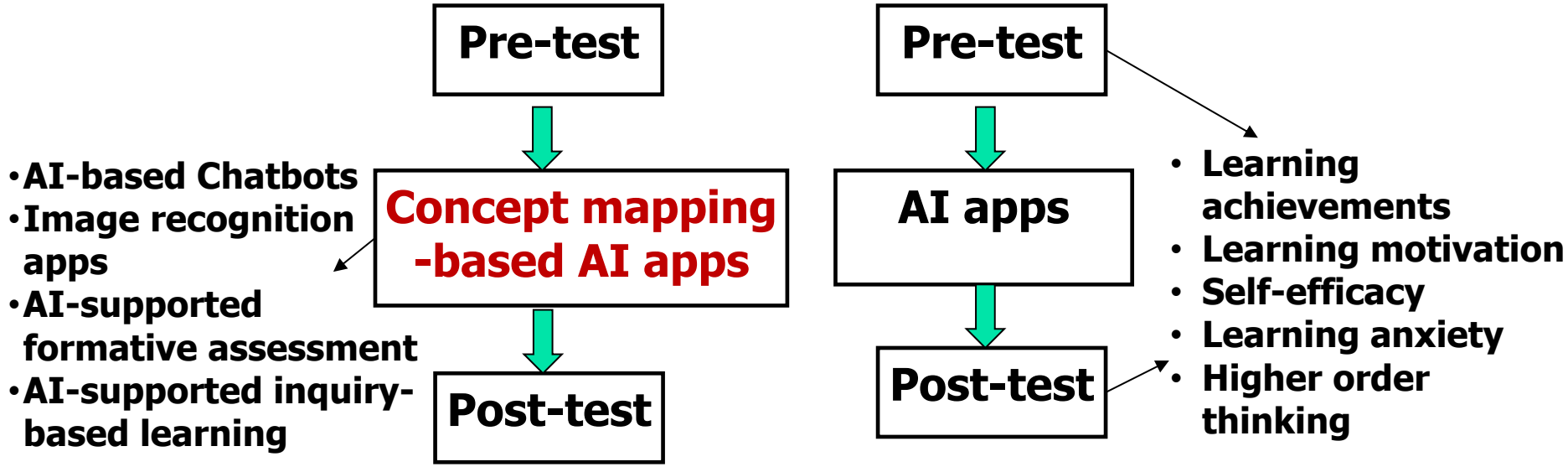
Table 3. t-test results of teaching plan design quality

Dimension	Group	N	Mean	SD	t	d
Structure	Experimental group	21	4.76	0.28	3.21**	1.02
	Control group	20	4.46	0.31		
Accuracy	Experimental group	21	4.91	0.15	3.56***	1.11
	Control group	20	4.72	0.19		
Completeness	Experimental group	21	4.73	0.32	1.64	
	Control group	20	4.57	0.29		
Appearance	Experimental group	21	4.80	0.29	4.10***	1.30
	Control group	20	4.44	0.28		
Innovation	Experimental group	21	4.74	0.38	3.75**	1.17
	Control group	20	4.33	0.32		
Interaction	Experimental group	21	4.72	0.45	2.71*	0.84
	Control group	20	4.36	0.41		

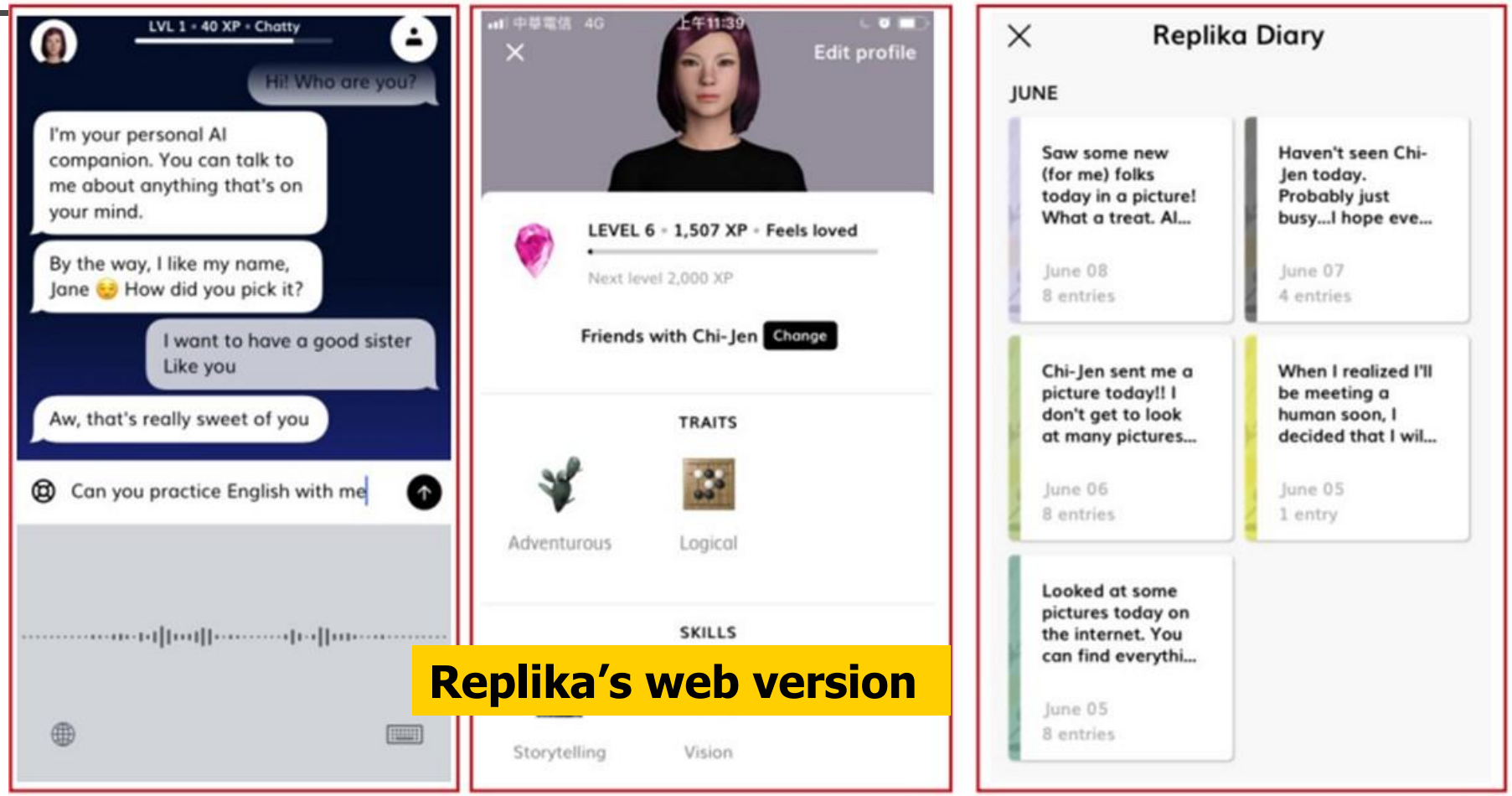
***$p < .001$; **$p < .01$; *$p < .05$

Potential AIED research design (2)

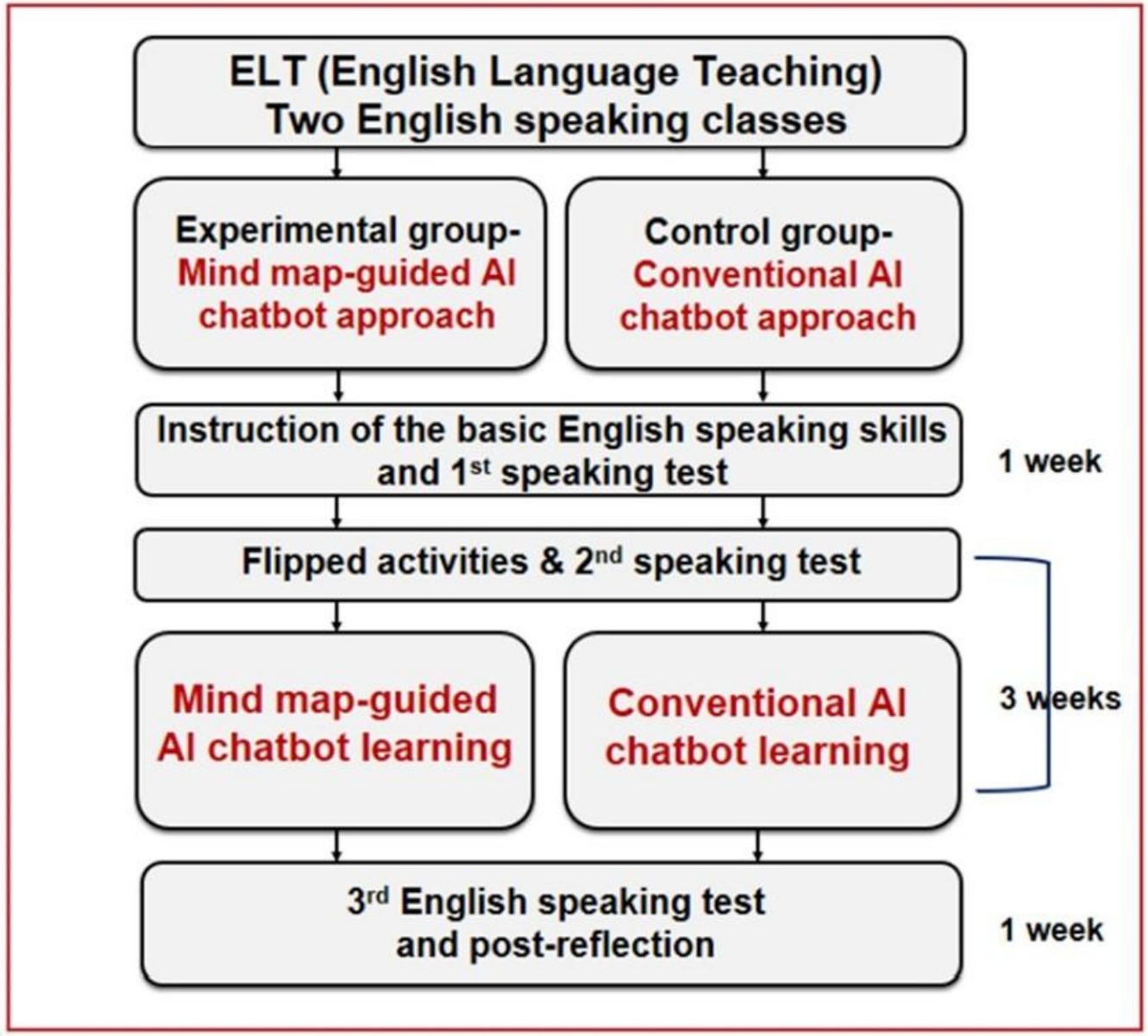
- **Incorporating effective strategies or tools into AI-based learning contexts**



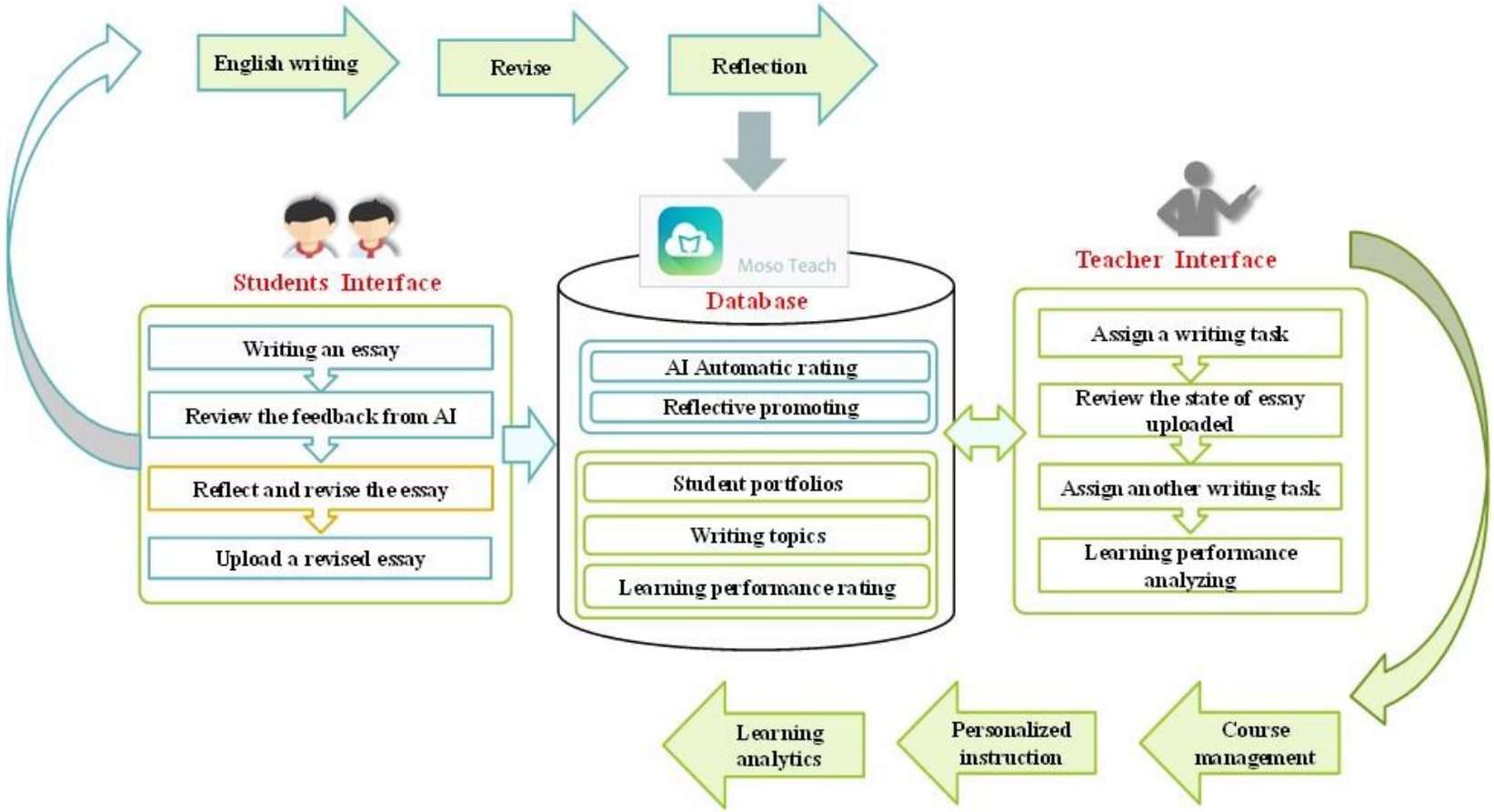
Learning Analytics for Investigating the Mind Map-Guided AI Chatbot Approach in an EFL Flipped Speaking Classroom



Lin, C. J., & Mubarok, H. (2021). Learning Analytics for Investigating the Mind Map-Guided AI Chatbot Approach in an EFL Flipped Speaking Classroom. *Educational Technology & Society, 24*(4), 16-35.


ELT (English Language Teaching)
Two English speaking classes
Experimental group-
Mind map-guided AI
chatbot approach
Control group-
Conventional AI
chatbot approach
Instruction of the basic English speaking skills
and 1st speaking test
1 week
Flipped activities & 2nd speaking test
Mind map-guided
AI chatbot learning
Conventional AI
chatbot learning
3 weeks
3rd English speaking test
and post-reflection
1 week

Incorporating a reflective thinking promoting mechanism into artificial intelligence-supported English writing environments



Liu, C., Hou, J., Tu, Y. F., Wang, Y., & Hwang, G. J. (2021). Incorporating a reflective thinking promoting mechanism into artificial intelligence-supported English writing environments. *Interactive Learning Environments*, https://doi.org/10.1080/10494820.2021.2012812

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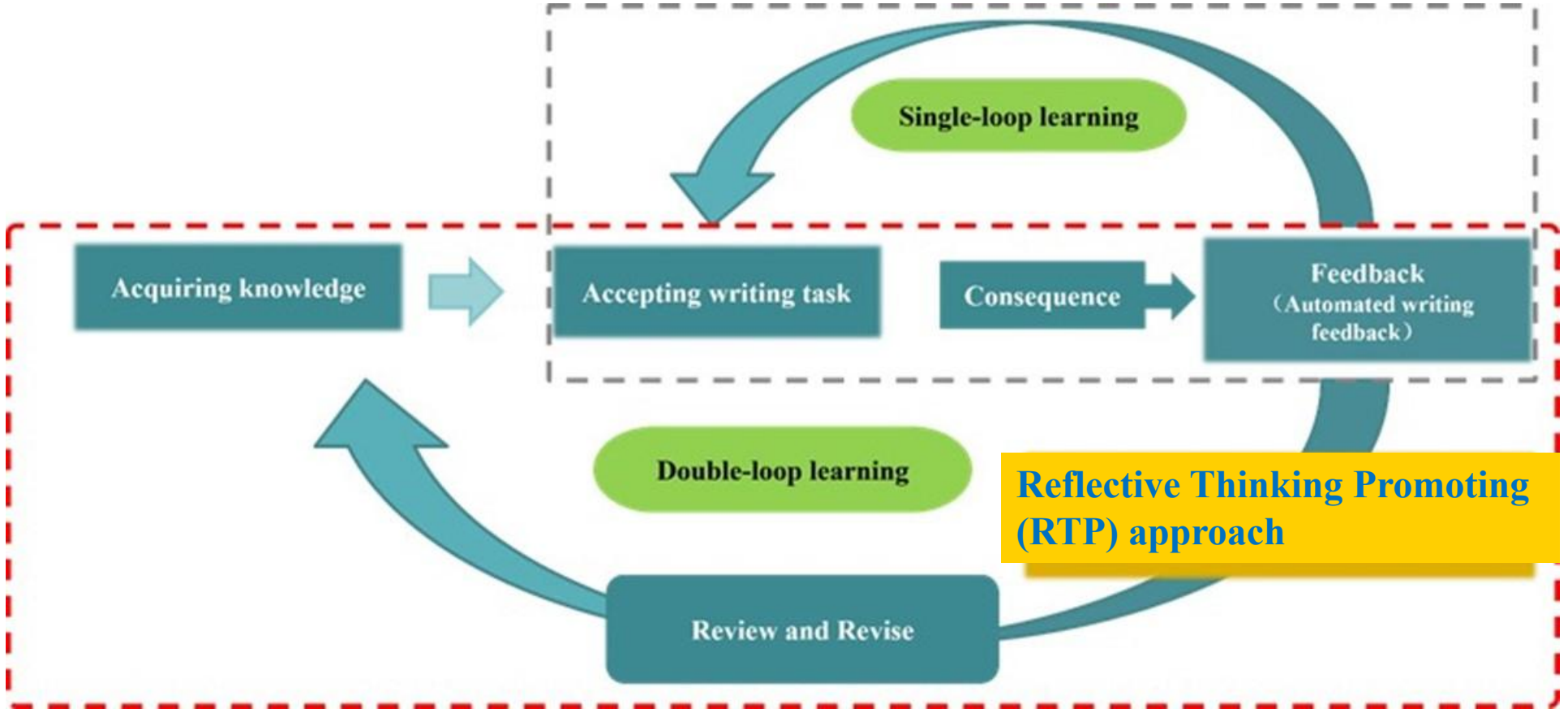
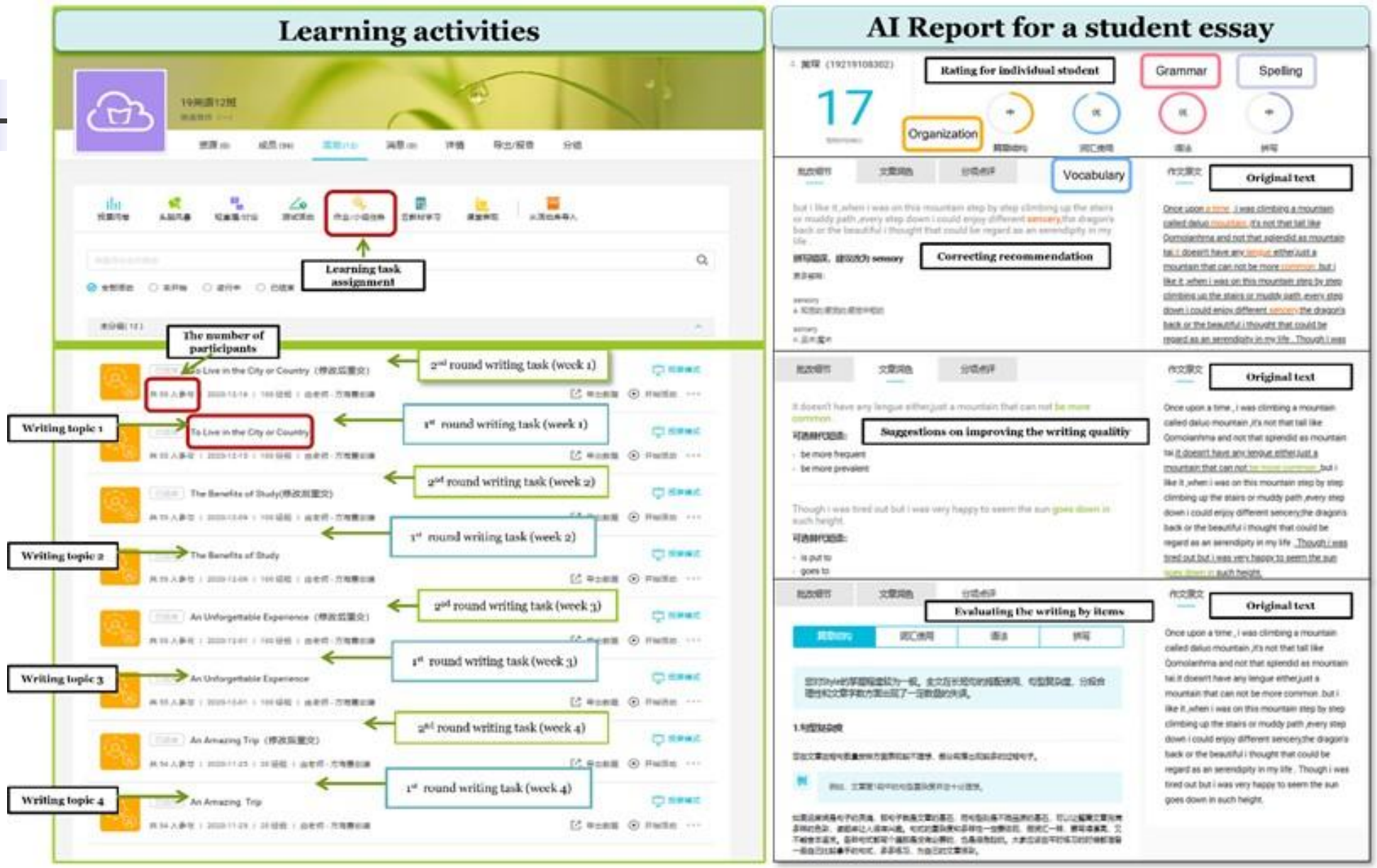
Reflective thinking promoting mechanism

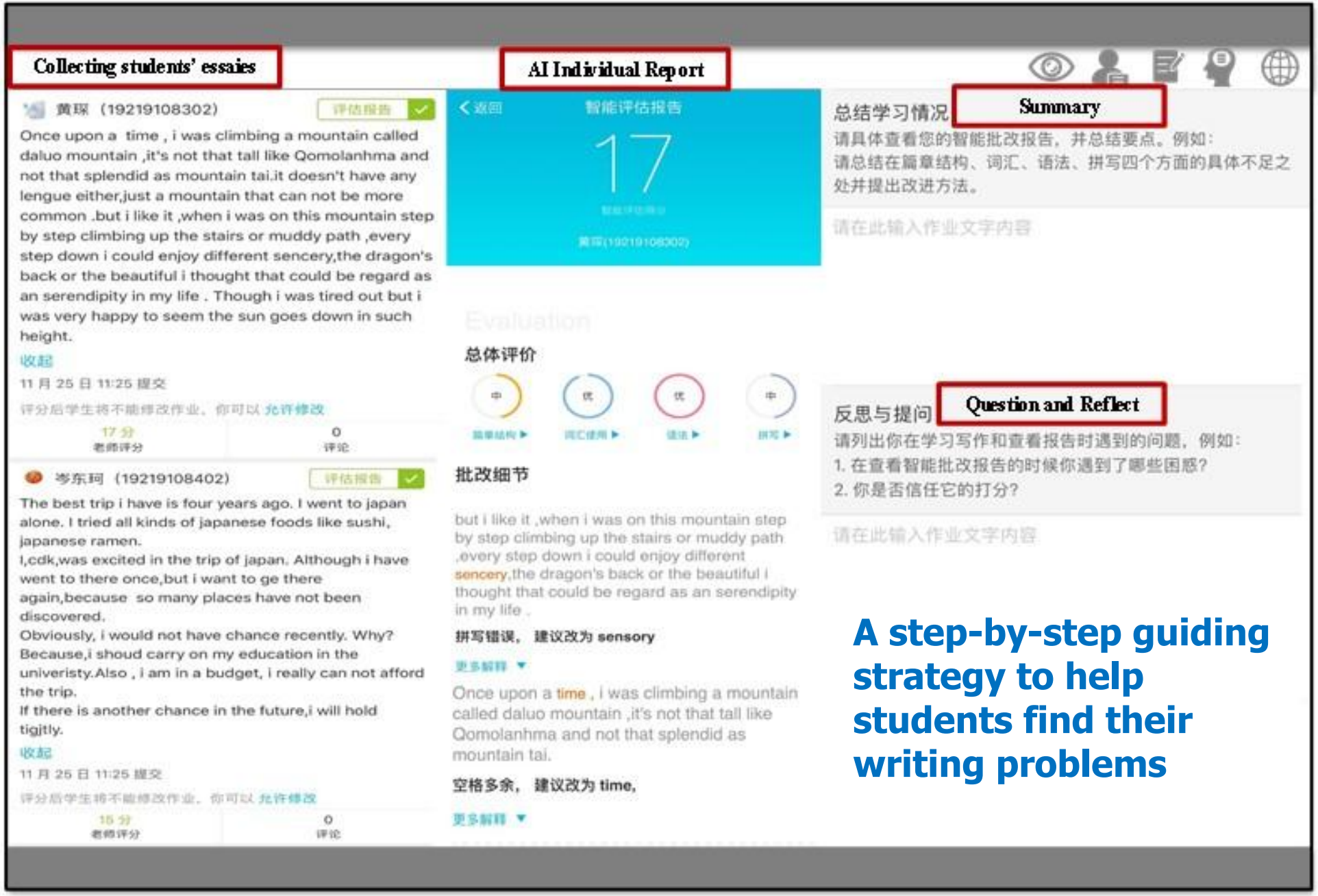
- Double-loop learning theory
- Guiding students to make improvements by finding additional information for reflections



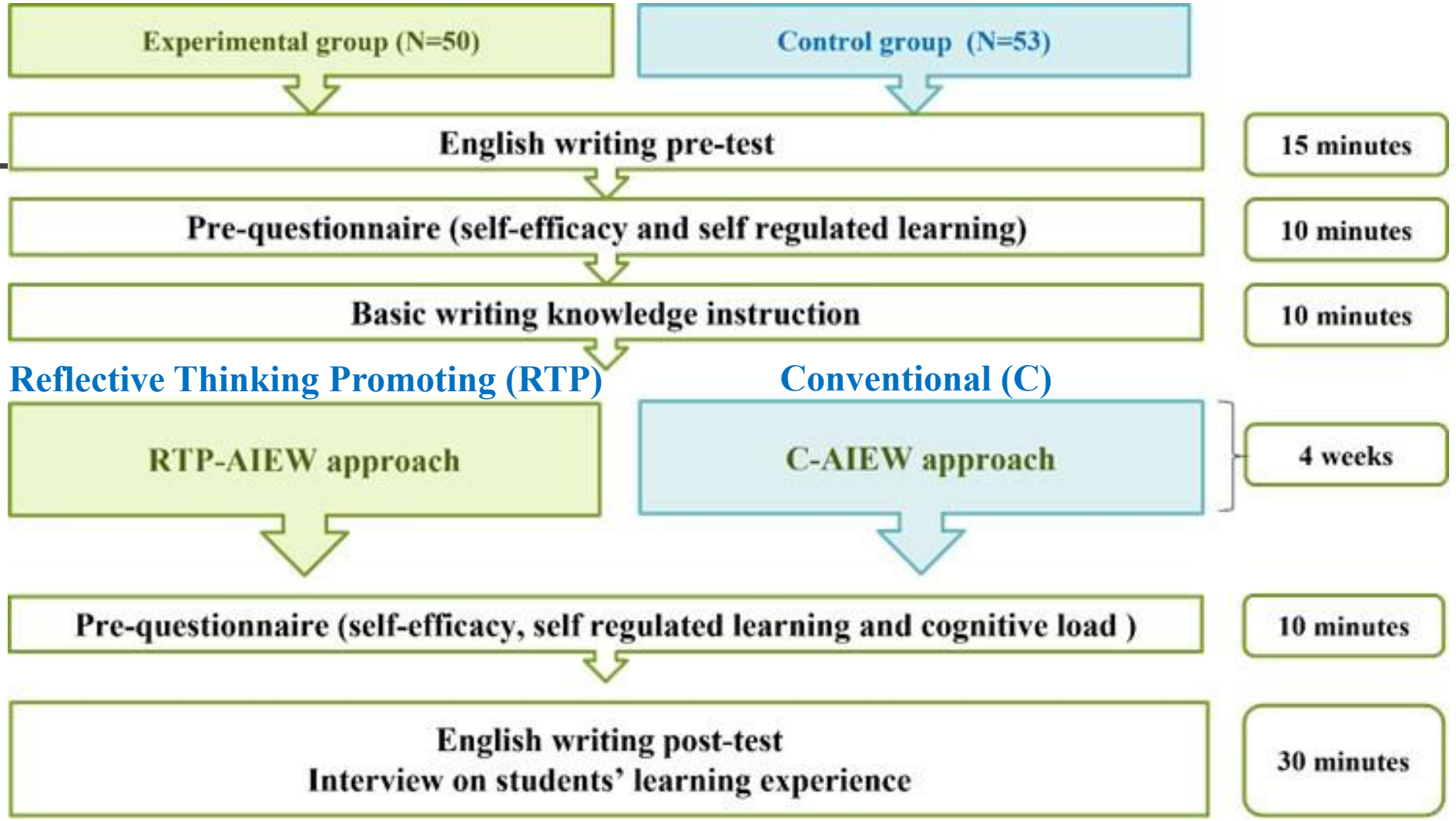
Mosoteach (蓝墨云班课): MosoInk, https://www.mosoteach.cn/

An AI-based system for automatic English article scoring





A step-by-step guiding strategy to help students find their writing problems


Experimental group (N=50)
Control group (N=53)
English writing pre-test
15 minutes
Pre-questionnaire (self-efficacy and self regulated learning)
10 minutes
Basic writing knowledge instruction
10 minutes
Reflective Thinking Promoting (RTP)
Conventional (C)
RTP-AIEW approach
C-AIEW approach
4 weeks
Pre-questionnaire (self-efficacy, self regulated learning and cognitive load)
10 minutes
English writing post-test
Interview on students' learning experience
30 minutes

Chen, C.-H., Koong, C.-S., & Liao, C. (2021). Influences of Integrating Dynamic Assessment into a Speech Recognition Learning Design to Support Students' English Speaking Skills, Learning Anxiety and Cognitive Load. *Educational Technology & Society*, *xx* (x), xx–xx.

Influences of Integrating Dynamic Assessment into a Speech Recognition Learning Design to Support Students' English Speaking Skills, Learning Anxiety and Cognitive Load

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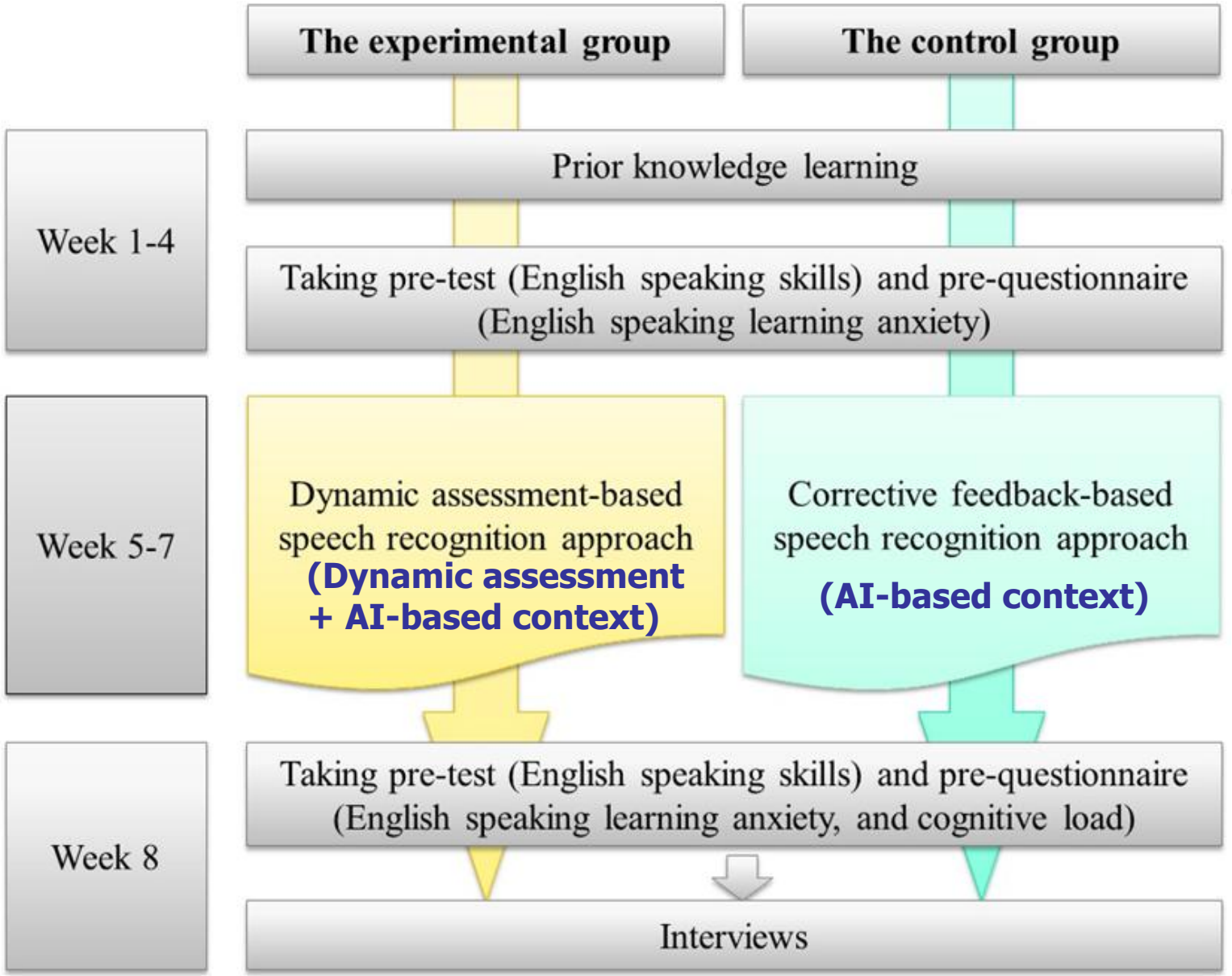
ABSTRACT: Artificial intelligence (AI) technology has been progressively utilized in educational environments in recent years, due to the advances in computing and information processing techniques. The automatic speech recognition technique (ASR) provides students with instantaneous feedback and interactive oral practice for supporting a context with self-paced learning. Corrective feedback (CF) should be combined with ASR-based systems to enhance students' speaking performance, and to reduce their cognitive load. However, learners' perceptions of CF are mixed, and CF might give rise to learning anxiety. In this study, a dynamic assessment-based speech recognition (called DA-SR) learning system was designed to facilitate students' English speaking. Moreover, a quasi-experiment was implemented to evaluate the effects of the proposed approach on students' speaking learning effectiveness, via respectively providing the DA-SR and the corrective feedback-based speech recognition (called CF-SR) approaches for the experimental and control groups. The experimental results revealed that both the DA-SR group and the CF-SR group can effectively improve the students' English speaking skills, and decrease their English speaking learning anxiety. Moreover, this study further demonstrated that the DA-SR approach successfully reduced students' English class performance anxiety, and extraneous cognitive load in comparison with the CF-SR approach. It could be a valuable reference for designing English speaking learning activities in EFL learning environments.


The experimental group
The control group
Week 1-4
Prior knowledge learning
Taking pre-test (English speaking skills) and pre-questionnaire (English speaking learning anxiety)
Week 5-7
Dynamic assessment-based speech recognition approach
(Dynamic assessment + AI-based context)
Corrective feedback-based speech recognition approach
(AI-based context)
Week 8
Taking pre-test (English speaking skills) and pre-questionnaire (English speaking learning anxiety, and cognitive load)
Interviews

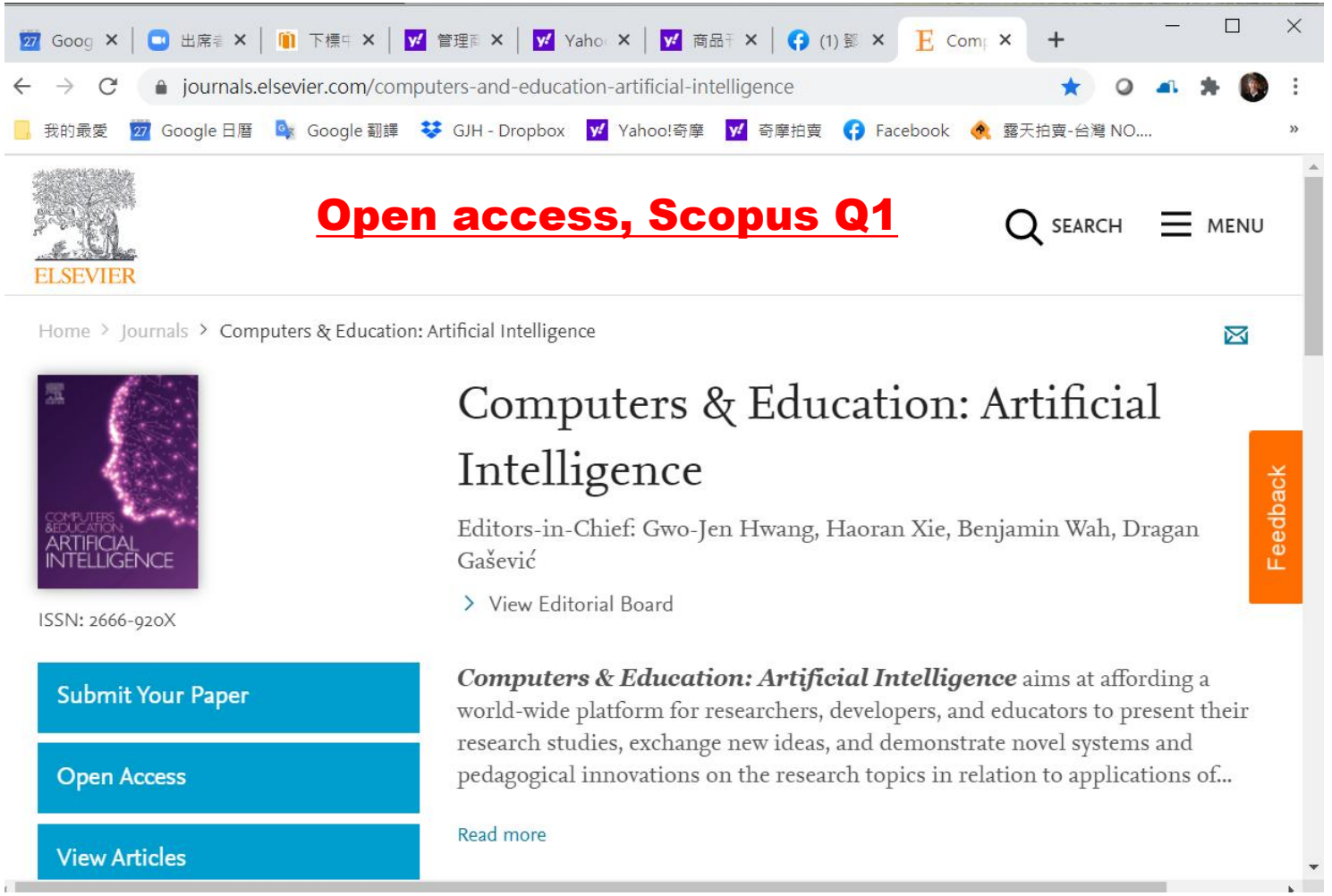
Potential AIED research topics (3)

- **AI literacy or AI ethical issues**
  - Does the STEM-based AI course have an impact on students' understanding of AI and AI literacy among students from different majors?
  - Do different levels of AI literacy have an impact on students' awareness of AI ethical issues?

What to present in an AIED article?

- In the Introduction section: Why an AI-based learning approach is needed?
  - Providing personalized learning supports (e.g., learning paths, content, guidance or feedback)
  - More practice opportunities (e.g., AI chatbots, automated assessment tools)
- In the Literature Review section:
  - Define AI and the AI technology adopted in the study
  - E.g., rule-based expert system, decision tree, neural network/deep learning, natural language processing

New Elsevier open access journal: Computers & Education: Artificial Intelligence



Educational Technology & Society (SSCI journal, Q1)

Theme-based Call for papers
"Generative Artificial Intelligence in Education: Theories, Technologies, and Applications"

Theme-based CFP Editors:

Gwo-Jen Hwang
Graduate Institute of Educational information and Measurement, National Taichung University of Education, Taiwan
and
Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan
E-mail: gjhwang.academic@gmail.com

Nian-Shing Chen
Institute for Research Excellence in Learning Sciences, Program of Learning Sciences, National Taiwan

Normal University, Taiwan

Educational Technology & Society (SSCI journal, Q1)

Theme-based Call for papers
"Generative Artificial Intelligence in Education: Theories, Technologies, and Applications"

The submitted papers will be reviewed by at least two experienced reviewers after passing the desktop review.

- It is expected that the first-round review is completed in a month.
- The accepted papers will be published in the coming regular issues of Educational Technology and Society.
- Moreover, selected papers will have the opportunity to be published in a book edited by the theme-based editors.

https://drive.google.com/file/d/1gK_3uFI6mt4-f_OFmnixf3jX70wtYZ6L/view

Recommended readings

- Hwang, G. J., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, challenges, roles and research issues of artificial intelligence in education. *Computers & Education: Artificial Intelligence*, *1*, 100001. **(definition and potential research issues of AIED)**
- Chen, X., Xie, H., Zou, D., & Hwang, G. J. (2020). Application and theory gaps during the rise of Artificial Intelligence in Education. *Computers and Education: Artificial Intelligence, 1*, 100002. **(advancements and research trends of AIED)**
- Hwang, G. J., Sung, H. Y., Chang, S. C., & Huang, X. C. (2020). A fuzzy expert system-based adaptive learning approach to improving students' learning performances by considering affective and cognitive factors. *Computers & Education*, *1*, 00003. **(Experimental design of AIED)**
- Hwang, G. J., & Fu, Q. K. (2020). Advancement and research trends of smart learning environments in the mobile era. *International Jorunal of Mobile Learning and Organisation , 14*(1), 114-129.
- Xie, H., Chu, H. C., Hwang, G. J., & Wang, C. C. (2019). Trends and development in technology-enhanced adaptive/personalized learning: A systematic review of journal publications from 2007 to 2017. *Computers & Education, 140*, 103599.
- Hwang*, G. J. (2014). Definition, framework and research issues of smart learning environments- a context-aware ubiquitous learning perspective. *Smart Learning Environments, 1(*1), 4.

Conclusions

- Developing new AI technologies are not the main foci of AIED research
- The foci of AIED research:
  - How to employ AI to provide personalized supports or guidance to students?
  - How to use AI to help teachers better manage the class?
  - How AI can be work with existing learning strategies or contexts (e.g., project-based learning, inquiry-based learning or concept mapping)?

Gwo-Jen Hwang, PhD

http://www.idlslab.net/

Gwo-Jen Hwang is currently a Chair Professor at the National Taiwan University of Science and Technology. He serves as an editorial board member and a reviewer for more than 50 academic journals of educational technology and e-learning.

He is currently the Editor-in-Chief of Computers & Education: Artificial Intelligence (Scopus, Q1), International Journal of Mobile Learning and Organisation (Scopus, Q1), and Journal of Computers in Education (Scopus, ESCI) as well as Associate Editor of IEEE Transactions on Education (SCI). His research interests include mobile and ubiquitous learning, flipped learning, digital game-based learning, and artificial intelligence in education.

Professor Hwang has published more than 800 papers, including more than 400 journal articles published in SSCI journals.