MetaACES 2022

The 1st International Workshop on
Metaverse and Artificial Companions in Education and Society

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Workshop Proceedings

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The 1st International Workshop on Metaverse and Artificial Companions in Education and Society (MetaACES 2022)

Workshop Proceedings

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MESSAGE FROM THE WORKSHOP CHAIR

Workshop Chair
Tak-Wai CHAN,
National Central University, Taiwan

The 1st International Workshop on Metaverse and Artificial Companions in Education and Society (MetaACES 2022) aims to provide an interactive platform for academics, researchers, practitioners, and professionals in the education sector to share and exchange research agenda, innovative ideas as well as practices of promoting and exploring metaverse, artificial companions, and related technologies. MetaACES 2022 comprises keynote speech and parallel sessions delivered by internationally renowned scholars, researchers, and practitioners. Catalysed and facilitated by emerging technologies, the metaverse and related artificial companions will affect us in every aspect of our lives.

(MetaACES 2022) focuses on the themes related to education and society. The main themes of MetaACES 2022 include but not limit to the followings (in alphabetical order):

- Artificial Companion in Education
- Artificial Companion in Society
- Artificial Intelligence (AI)
- Assessment in Games and Virtual Worlds
- Authentic Environments and Worlds
- Automated Feedback
- Avatars or Player Characters for Learning
- Behaviour and/or Interaction Modeling, Detection and Visualization
- Big Data Analyzed and Processed by Computers
- Bridging Informal and Formal Learning Outcome
- Chatbot
- Computational Models of Knowledge and Expertise
- Computer Supported Discussion Analysis and Assessment
- Educational Applications of Metaverses
- Educational Robots and Toys
- Emotion (Affective State) Modeling, Recognition and Detection
- Emotive Agents
- Enhancing Grading, Scoring and Feedback
- Game Analytics
- Human Computer Interaction (HCI)
- Human Robot Interaction (HRI)
- Intelligent Agents

- Intelligent Tutors and Mentors
- Internet of Things (IoT), Internet of Everything (IoE), and/or Sensors
- Learning Companion Robots (Robotic Learning Companions)
- Languages, Thinking Skills, Meta-cognitive Skills, Cognitive Skills, and STE(A)M
- Learning Analytics in Educational Games
- Learning Companions
- Metaverse in Education
- Metaverse in Society
- Motivational and Affective Factors on Learning with Technology
- Natural Language Processing supported Tools, Systems, Applications, Mobile Apps, and Chatbots
- Non-Player Characters for Learning
- Personal Learning Environments (PLE)
- Roles of Artificial Companions in Metaverse
- Role Playing Games for Learning
- Security and Privacy Issues
- Sentiment Analysis
- Simulation and Training (Skill, Competence, Vocational Learning)
- Social Network Analysis (SNA)
- Speech Recognition and Synthesis
- Stealth Assessment
- Unstructured and Semi-structured Data for Computer to Read and Learn
- User Experience (UX) Evaluation
- Virtual and Augmented Learning Environments
- Virtual Animal Learning Companions
- Virtual Characters in Learning and Life
- Virtual Companions in Learning and Life
- VR, AR and Simulation Technology

The 2nd International Workshop on Metaverse and Artificial Companions in Education and Society (MetaACES 2022Nov) will be held in November in ICCE 2022.

We look forward to your participation.

Tak-Wai CHAN
National Central University, Taiwan

MESSAGE FROM THE INTERNATIONAL PROGRAM CHAIR

Program Chair
Maiga CHANG,
Athabasca University, Canada

The 1st International Workshop on Metaverse and Artificial Companions in Education and Society (MetaACES 2022), organized by The Education University of Hong Kong, will be held on 24 June 2022 in a fully online mode. I am honored to serve as the Program Chair of the first MetaACES.

The International Program Committee is led by a strong and dedicated team, which includes the Workshop Chair, the International Program Chair and Co-Chairs, Local Organizing Chair and 129 PC members in the field of Metaverse and Artificial Companions in Education and Society as well as related fields from 28 different countries or economies.

MetaACES 2022 calls for abstracts from scholars around the world, this year, the workshop received a total of 46 submissions by 101 authors from 12 countries/economies include Canada, China, Finland, Germany, Greece, Hong Kong, India, Japan, Philippines, Taiwan, Tunisia, and Turkey. Table 1 shows the statistics of regions of origin of the authors.

Table 1. Author statistics by country or economy

Country or Economy			
Hong Kong	41	Greece	5
Taiwan	16	Japan	4
China	9	Turkey	4
Philippines	7	India	3
Canada	5	Finland	1
Germany	5	Tunisia	1

Three (3) of the 46 abstracts were pre-screen rejected due to not following author guidelines format and/or not meeting the page limit requirements. The remaining 43 abstracts were subjected to a rigorous review process by at least three reviewers from the workshop program committee. In total, 194 reviews were received. This resulted in 29 accepted abstracts and the overall acceptance rate is 63.04%, which reflects our efforts to the maintenance of the quality of presentations at MetaACES 2022. The complete statistics of paper acceptance is shown in Table 2.

Table 2. Statistics of abstract acceptance in MetaACES 2022

Submissions	Accepted	Rejected	Pre-Screen Reject	Acceptance Rate
46	29	14	3	63.04%

We are grateful to all who contributed to MetaACES 2022's success. We thank all the authors for choosing MetaACES 2022 as the venue to present their research. We would also like to thank the PC co-chairs and members, who undertook the responsibility of reviewing and selecting abstract that represent research of high quality. We want to thank the local organizing committee of members from The Educaton Univerisity of Hong Kong to make MetaACES 2022 happen. Specially thanks to our Keynote and session chairs for accepting our invitations and sharing their insights in the world of MetaACES.

Thank you for your participation and unfailing support.

See you in the next MetaACES!

Maiga CHANG
Athabasca University, Canada

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Local Organizer: The Education University of Hong Kong

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PROGRAM

June 24, 2022 (Friday) * https://time.is/Hong_Kong	
09:20 – 09:30	**Check-in to Zoom Meeting**
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10:00 – 10:15	**Break**
10:15 – 11:15	**Session 2A: Artificial Intelligence (AI)** **Session Chair: Jeff Chak Fu Wong, The Chinese University of Hong Kong** 014 Building Up an Online Training Platform for Enhancing Communication and Presentation Skills of Undergraduate Students by Using AI: Design, Challenges, And Solutions Eric King-Man Chong and Roland Leung 020 Development and Preliminary Research of Artificial Intelligence Learning System Using Quadcopter as Learning Scaffold Li Pin-Yen and Chu Chih-Ming 025 Visualized Environment to Build Chatbot for Learning and Training Maiga Chang and Scott McQuoid

	037 New ways in information retrieval for Children: voice and image recognition with human-computer interaction Yanyan Pan and Yingyi Zheng
10:15 – 11:15	**Session 2B: Language Analytics and Knowledge (LAK)** **Session Chair: Jeremy Tzi-Dong Ng** **The University of Hong Kong** 029 An Analysis of Learner Traversals and Observation Behaviors in Minecraft Jonathan Dl. Casano and Maria Mercedes T. Rodrigo 034 An Exploratory Analysis of Learner Traversals in Minecraft Worlds Maricel A. Esclamado, Maria Mercedes T. Rodrigo and Jenilyn A. Casano 047 Analytics in Sports Using Social Network Analysis Tools and Linear Discriminant Analysis Jeff Chak Fu Wong and Tony Chun Yin Yip
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11:30 – 12:30	**Opening Ceremony** **and** **Keynote** **Education Today and Tomorrow: Exploring the Metaverse with AWS** **Chair: Siu-Cheung Kong, The Education University of Hong Kong** **Speaker: Chris Wang, AWS**
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14:00 – 15:00	**Session 3A: Metaverse** **Session Chair**: **Wen-Chu Hu,** **Ming Chuan University** 010 Math Teachers' Digital Instructional Resources Using Metaverse Technology: A New Trend Guoqiang Dang and Hongke Feng 017 What is Metaverse? A Scoping Review Davy Tsz Kit Ng 041 Learning and Teaching in Higher Education in the Era of Metaverse for Future-Readiness of Learners: Research Issues and Policy Implications Siu-Cheung Kong

	044 The Metaverse in Education – A Proposed Case Study in Primary Schools on Sustainable Development Ecology Kam Yuen Law and Sha Li Shirley Duthie Chuang
14:00 – 15:00	**Session 3B: Augmented Reality/ Virtual Reality (AR/VR)** **Session Chair**: **Ka-Shing Chui,** **Fukien Secondary School Affiliated School, Hong Kong** 003 Using Virtual Reality in teaching Crisis Management Course Tai Ming Wut and Mei-Lan Peggy Ng 023 Pedagogical Conversion of Tangible Augmented Reality Sandbox into mobile Augmented Reality Sandbox App for Learning Geography Aaron Liu and Percy Kwok 031 Exploring the Outcomes of Learning Analytic Supported VR Content Creation in Cultural Heritage Education Jeremy Tzi-Dong Ng, Zuo Wang, Ruilun Liu and Xiao Hu 038 Augmented Reality Books and Smart Glasses: A Case Study on In-Service Teachers' Views Georgia Kazakou and George Koutromanos
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16:30 – 16:45	**Closing Ceremony** **and** **2nd MetaACES Announcement**

PRESENTATION GUIDELINES

- All presentations will be conducted live via Zoom and Gather Town.
- All presentation date/time is in Hong Kong time (GMT+8). Please refer to https://time.is/Hong_Kong or click here for finding the time difference that your local time may have.
- Presentation time will be 10 minutes plus 5 minutes for questions,15 minutes in total.

KEYNOTE

Title: Education Today and Tomorrow: Exploring the Metaverse with AWS

Date: 24 June 2022 (Friday)

Time: 11:30 – 12:30

Speaker: Chris Wang
Business Development Manager, Startups,
Amazon Web Services

Abstract:

For the first time ever, we are entering the metaverse—an interconnected digital world that seamlessly integrates physical and virtual spaces. As we are still on the cusp of discovering all the different ways that the metaverse will revolutionize education, it's an intriguing moment to explore the advantages, opportunities, and challenges that the metaverse will bring to education. In this keynote address, Amazon Web Services (AWS) will share: (1) What the metaverse means for education; (2) AWS's involvement in the current metaverse; and (3) Envisioning the future of the metaverse for education.

PROCEEDINGS

Chan, T.-W., Chang, M., Hwang, G.-J., Ogata, H., Kong, S. C. (2022). Proceedings of The 1st International Workshop on Metaverse and Artificial Companions in Education and Society (MetaACES 2022). Hong Kong: The Education University of Hong Kong.

A Virtual Environment for Learning English with Metaverse and Natural Language Processing

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Abstract: Teaching English in non-native English-speaking countries, teachers often rely on extra-curricular materials to arouse student's motivation in learning English. In recent years, due to the impact of COVID-19, students around the world have to attend classes remotely, which might reduce student's learning efficiency and willingness to learn. Therefore, this research proposes an English learning system with a natural language processing engine based on Metaverse. This system makes use of the content of storybooks so that learners can interact with chatting robots in virtual space. A teacher will first tell learners about the story. After knowing the flow of the story, a learner can practice oral English according to the plot selected by the learner. The learner can enter the virtual world of the metaverse through a mobile phone APP to practice English conversation. In this way, the learner can practice English speaking at school or at home.

Many of current educational dialogue robots lack natural understanding capability. To address this issue, the open source chatbot framework Rasa is adopted in the virtual world. Rasa is divided into Rasa NLU (Natural Language Understanding) and Rasa Core. Rasa NLU uses a default machine learning model DietClassifier for the analysis of intent and entity recognition. For example, in "I want to go to the park", "go" in this sentence is the action of the intent, and "park" is the location of the entity. DietClassifier can combine with the plug-and-play functions of various pre-trained embeddings, such as BERT, GPT-2, etc. in order to improve the accuracy of the results. Moreover, Rasa provides a function to do slot-filling, which saves the entity of the current conversation in the memory. The value of this slot can be used to predict the user's next action.

Chatbot designers still need to provide a story to make the dialogue proceed smoothly. Rasa Core is the dialogue management module provided by the Rasa framework. Being the brain of the chatbot, Rasa Core tries to maintain and update the dialog state and action selection, and then respond to user's input.

Let us consider a typical processing flow of Rasa Core. First, the message input by the user is passed to the Interpreter (NLU module), which is responsible for identifying the intent in the message and extracting entity data. Second, Rasa Core will pass the data extracted by the Interpreter to the Tracker object, which is mainly used to track the conversation state. Third, according to the current state of the Tracker object, the policy executes the corresponding action, which is recorded in the Tracker object. Finally, the output of the result is returned by the executed action, and then a conversation turn is taken and completed.

At the beginning of the story, learners will be asked where they want to go. There are three places in the story, the library, the school and the park. The story will display a street map and the learner's line. When the learner selects a location, say the park, the virtual robot will move to the park and the street map will be replaced by the park's map. The learner must tell the robot, which is equipped with a manipulator, what objects to pick up in the park. Then the screen will on the virtual robot, which will move to pick up the object. Then the robot will return to the starting point and the learner will get an achievement medal.

Because the learner subjects were from elementary schools, the learning activitieswere designed so that researchers can evaluate whether the learners would be motivated by the medal exchange event. The number of turns each learner takes to speak, and their pronunciation will be analyzed. Some of the research questions are:

1. The learners enjoy using the app to learn English communication.
2. The learners like exchanging medals.
3. The learners improve their pronunciation after using the app.
4. The learners' performance improves more when they practice speaking more times.

For the implementation of the virtual world robot of metaverse, the JavaScript library Three.js is used to construct the metaverse virtual space, and the function of zooming in, zooming out and moving the screen with finger swipe is added., Learners not only can watch the robot move, but also can view the robot in 360 degrees. This increases the overall degree of freedom.

One purpose of this research is to focus on mobile learning instead of 3D experiences. For example, learners can use the app on a smartphone at school or at home. Future studies might focus on using hardware of headsets of Augmented Reality and Virtual Reality.

Keywords: Educational Applications of Metaverses, Natural Language Processing, English Learning, Robot Assisted Learning

Wing-Kwong Wong

Chia-Ching Wu

Yu-Fen Yang

An Analysis of Learner Traversals and Observation Behaviors in Minecraft

Jonathan DL. Casano[1], Maria Mercedes T. Rodrigo[2],

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Abstract: What-If Hypothetical Implementations using Minecraft (WHIMC) is a set of Minecraft worlds that learners can explore to learn more about science, mathematics, engineering, and technology. This collection of worlds immerses learners in simulations of conditions on certain exoplanets and on alternate versions of Earth, logging both the ways in which learners traverse these worlds and the observations that learners make during their explorations.

Because Minecraft is open-ended by design, assessing whether students are learning is always a challenge. In addition to using methods such as post-tests and self-reports, how can we use in-game data to measure learning?

We created a custom visualization tool that graphically organizes player traversals and in-game observations made inside WHIMC. The observations were arranged into word clouds and were superimposed on a top-view map of the WHIMC worlds, taking into account the context in which the observations were made. Additional symbols and annotations were used to further draw the connection between in-game behaviors and outcomes. To demonstrate the tool's utility, 329 grade school learners coming from four Filipino schools were invited to play WHIMC following the instructions in learning modules created by their teachers. The learner traversals and observations gathered were then compared against canonical answers from experts to determine the extent to which students achieved the desired learning outcomes and the ways in which outcomes varied. In addition, we grouped the students into high- and low-performing categories based on an out-of-game posttest included in the learning modules created. Using the visualization tool's output, we analyzed the observation frequency, observation relevance and traversals between these performance categories. Figure 1 shows an example output of the visualization tool comparing the word clouds of high- (red boxes) and average- performing (blue boxes) students.

Six (6) comparison attempts were made across 3 WHIMC maps and 3 performance categories (high-, average- and low-performers) for a total of 18 comparison attempts. Out of the 18 attempts, we share key insights from the 6 successful comparison attempts. We found that:

High-performing students make more observations. When there were insufficient observations for the clustering step, the visualization was not generated. Hence, we see that making more observations across all maps visited is characteristic of high-performing students. Low-performing students made no observations at all.

Observations of high-performing students matched the canonical observations from experts. Most of the observation matches occur in comparisons where the high-performing students were included. The matching observations were mostly from the high-performing group.

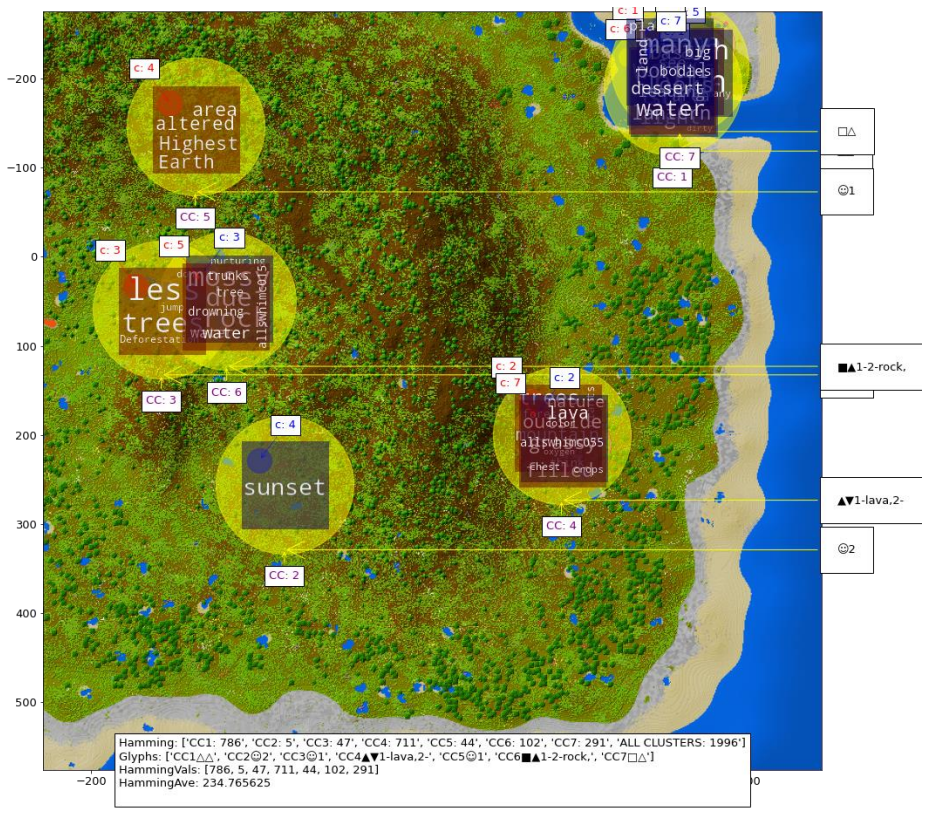

Figure 1. Sample output of the custom visualization tool. The annotations on the right represent match with canonical data (▲, ▼, ■), *wanderer clusters* (☺), and similarity between the most important words between the two groups being compared (△, ▽, □).

High-performing students tend to wander. It was noted that for the successful comparisons, there are more wanderer clusters, or clusters that deviated away from the areas where NPC's were located, generated by the data coming from the high-performing group. Wandering around the Minecraft map and making observations beyond the prompts of the NPC seems characteristic of high-performing students.

Low-performing students did not make any observations. None of the low-performing students made any observations. Hence, we speculate that active observation-making, might be an indicator of positive performance.

Keywords: Minecraft, WHIMC, Visualization

Jonathan DL. Casano

Maria Mercedes T. Rodrigo

An Exploratory Analysis of Learner Traversals in Minecraft Worlds

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Abstract: In this paper, we analyze in-game data and knowledge assessment outcomes from 21 Grade 7 students from the Philippines who were completing a learning task with the What-If Hypothetical Implementations using Minecraft (WHIMC). We examine how learners' traversals in Minecraft worlds relate to their assessment outcomes and determine if Minecraft explorations have canonical answers. To do these, we determine how distance traveled, area covered, total time of exploration, the number of WHIMC worlds explored, and the number of observations relate to assessment outcomes. We also computed the Jaccard Index and Maximum Similarity Index (MSI) to determine if there is a canonical traversal in an open-ended environment. We find no significant correlation between assessment scores and overall distance, area, or MSI. However, when we break the data down into five-minute intervals, we find a significant negative correlation between assessment scores and distance traveled and area covered during certain time periods. These findings suggest that wandering off early in game play may be indicative of low learning outcomes later on. The absence of a significant relationship between MSI and assessment scores suggests the absence of a canonical traversal in an open-ended environment. We also find a significant positive correlation between the assessment scores and the total time of exploration which indicates that those learners who spent more time exploring the WHIMC worlds have high learning outcomes. There is also a significant positive correlation between assessment scores and the number of WHIMC worlds explored which indicates that learners who have explored more worlds in WHIMC have high performance. There is also a significant positive correlation between the assessment scores and the number of observations the students made which indicates that high-performing learners make more scientific observations compared to low-performing learners.

Keywords: Minecraft, Exploration Behaviors, Assessment, Philippines

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Analytics in Sports Using Social Network Analysis Tools and Linear Discriminant Analysis

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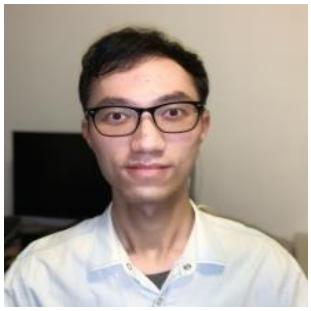
Abstract: Analyzing soccer team data is an emerging research area with several applications in a variety of fields, for example, quantifying a team's performance and identifying important players on a team. In this work, we present our home-made online learning platform for finding/ranking a set of important players, e.g., forwards, midfielders and defenders, using a real life soccer game dataset. We first use the linear discriminant analysis algorithm for a supervised learning technique to cluster three groups of players as a validation test. We then use the mutual information based method to measure player performance (correlation) relationships based on their unique professional skills and develop a soccer player network using the minimum spanning tree (MST) method. Finally, we consider further study for analyzing the topological properties of these networks using social network analysis (SNA) tools, where for analyzing individual players in the MST network, local centrality measures, e.g., the degree, closeness, and betweenness centralities, are used, while for understanding the entire pattern of the MST network and finding the most central role in the network, the global centrality measure, e.g., the eigenvector centrality, is used. Our findings indicate that when performing an unsupervised learning technique, the important/key players in one of the three groups in a team are identified using SNA. Most importantly, the tools presented here can be used in classroom teaching to benefit our undergraduate students and further bridge the gap between the applications of sports analytics and SNA learning.

Keywords: Sports Analytics, Social Network Analysis, Machine Learning, Information Theory, Education Technology

Jeff Chak Fu Wong

Tony Chun Yin Yip



Augmented Reality Books and Smart Glasses: A Case Study on In-service Teachers' views

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Abstract: Augmented reality books achieve the combination of printed matter with virtual and digital objects on the book in real time. They can be viewed with smart glasses that give more immersion capability than one given by mobile devices. The research that combines these books with augmented reality smart glasses (ARSGs) is still limited. More specifically, there is no research examining the creation of augmentation in textbooks and their acceptance through smart glasses by teachers themselves. The purpose of this study is to examine the attitudes and perceptions of in-service teachers regarding the augmentation of textbooks and to identify the factors that could contribute to the use of these books in teaching through smart glasses. The study was conducted in spring 2022 on a sample of 16 in-service teachers at a secondary school in Greece. Data were collected through interviews that focused on variables: perceived ease of use, perceived relative advantage, perceived enjoyment, and facilitating conditions. The research was conducted in three phases: in the first phase, teachers were trained in the use of indicative augmentations with the ZapWorks platform, in the second, teachers augmented various sections of textbooks which were viewed through ARSGs, and in the third, interviews with teachers were conducted. The results of the study showed that teachers found it easy both to create augmented reality books and to view them through smart glasses, useful for teaching and learning, and enjoyable for themselves and the students. Results also showed that there are many advantages to using augmented reality books through smart glasses compared to smartphones and tablets. However, they have expressed various concerns about the existing facilitating conditions at schools, such as the high cost of glasses. The results of the study are expected to have significant implications for both augmented reality book creators and educational technology researchers.

Keywords: augmented reality books, augmented reality smart glasses, teaching, learning, teachers

Georgia Kazakou

George Koutromanos

Building up An Online Training Platform for Enhancing Communication and Presentation Skills of Undergraduate Students by Using AI: Design, Challenges, and Solutions

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Abstract:

This presentation will present the design, challenges and solutions of setting up an online training platform of presentation and communication skills for undergraduate students by using AI. The Faculty of Liberal Arts and Social Sciences (FLASS) of the Education University Hong Kong has collaborated with Moodie.ai to build up an online training platform by using AI in communication and presentation analysis and scoring system, which utilized various language and speech processing applications. Student users can record their online presentations at this self-directed online AI training platform. Their performances will be assessed by receiving scores on aspects such as emotion, energy, sentiment, body, voice, confidence, fluency, and credibility. Initial purposes behind this online training platform include comparing programme-based and cross-programme student online performances, and leaderboard functions. The first phase started in February 2022. The participating undergraduate programmes include full-time final year and those full-time education major students who need to deliver teaching practice in schools. They need to enhance their various aspects of communication and presentation skills upon graduation. However, owing to the COVID-19 pandemic in early 2022, only about 70 students responded to the invitation email, thus making comparison of student performance across 6 different departments difficult. Yet the average scores tell some aspects of performances that should be enhanced. Alternatively, various measures have been used such as creating both written and video-format (both Cantonese and English) user guides, giving assignment marks for student participation, and issuing a certificate of recognition, etc. Suggestions shall be made to individual programmes to help their student improving communication and presentation skills. Upon gathering more data on student performance and obtaining feedback from each participating department, the second phase will start in September 2022. Further exploration can be made on how to encourage creativity and differences/ uniqueness in performances in an online training platform.

Keywords: AI, online training platform, presentation and communication skills, measurement, undergraduate students

Eric King-man Chong

Roland Leung

Deploying Operational Companion-based Learning Activities in the Metaverse: A Realistic-enough Approach

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Abstract: The metaverse is an old concept that can be defined simply as an interconnection of virtual worlds. It has recently come back to the forefront due to the renewed interest of major industry players such as Facebook, whose efforts and money could help make it the next iteration of the Internet. In our presentation, we point out that interests of these for-profit stakeholders (e.g., making users captive of specific ecosystems to collect and monetize data, and/or sell hardware and services) may differ from those of the educational world. We then question whether the search for a greater degree of realism that they call for systematically leads to the improvement of learning ecosystems.

To support our presentation, we describe the Deteriorating Patient App (DPA) project, and the participatory approach used to design, develop and operationally deploy this companion-based learning ecosystem that trains medical students using virtual patients iteratively created by expert physicians, professionals who are notoriously busy. According to exchanges with the medical community, greater realism in educational systems increases cost, complexity, and development time without necessarily enhancing its educational value. Furthermore, the more realistic the simulation the greater the demand made of domain experts, which slows down case development and improvements. The DPA ecosystem comprises an editor software for case creation, a simulation module that can be adapted for different contexts such as virtual worlds or mobile apps, an Amazon AWS-powered cloud module for data management (medical case storage and distribution, and analytics), and a website for more easily managing the previously mentioned data. Screenshots of the DPA editor and of its simulation module are provided in Figure 1.

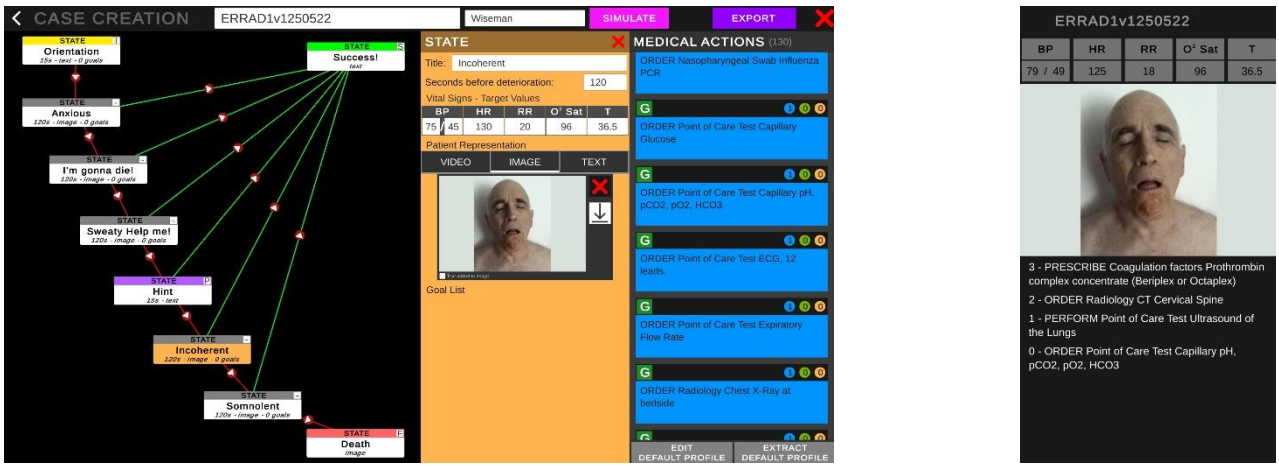

Figure 1. Two modules of the DPA ecosystem: the Editor showing the "case creation" frame (left), and the simulation app module with an activated "image-based patient representation" (right).

In our presentation, we discuss our ongoing efforts to determine how realistic a learning platform needs to be in order to be effective. We initially aim to investigate two dimensions of realism:

- Realism of the expert model used in the simulation. Three professionals in computer science, in internal medicine, and in educational psychology respectively (two of them being long term members of the ITS/AIED research community) worked iteratively to develop a simplified representation of time-evolving medical conditions as a model consisting of (i) a graph of deterioration states, and (ii) an overlay of reactions to medical actions for a patient with the condition as compared to those of a healthy person.
- Realism of virtual companion representations. Each state of a DPA case requires a patient representation. It is a critical part of the simulation since it is expected to provide clinical cues to help students diagnose the simulated medical condition. The DPA editor allows case creators to select the kind of resource (text, image, video) to be used to represent the patient in a certain state. Support for animated 3D models is also possible (the platform is based on the Unity3D engine) but has not been implemented so far considering the lack of physicians with adequate expertise. Table 1 summarizes observations and assumptions regarding these various representational approaches for DPA case creation, that we developed through exchanges with the medical community.

Table 1. *Observations on creators' use of various companion representations*

	Text	**Image**	**Video**	**3D Model**
Complexity of use for creators	Very easy	Easy	Moderate	Hard
Development speed for creators	Very fast	Fast	Moderate	Very Long
Ease of cue integration for creators	Very easy	Moderate	Easy	Hard
Number of creators with expertise and times	Many	Several	Some	Very few

According to table 1, we expect expert physicians to more readily engage in case creation if the educational effectiveness of text-based or image-based simulations is confirmed. On the contrary, simulations involving 3D Model representations will most of the time require 3rd party expertise, which lowers the autonomy of physicians and increases cost and development time, and would eventually make the DPA platform less appealing to targeted case creators. Video-based simulations, despite being overall more demanding than text and image, could also be considered if they bring a greater feeling of immersion because of the more dynamic nature of their representation.

A team of medical experts is currently preparing three variants of the same medical case where only the patient representation method differs. The DPA platform is about to be operationally deployed (with restricted access) and, in the course of 2022, we will assess the overall learning potential of DPA simulations, and the educational effectiveness of text-based, image-based, and video-based simulations respectively. To do so, we will investigate user immersion perception, motivation, and learning gain for each condition by jointly analyzing user activity logs and user answers to validated questionnaires. On a longer timeframe, we also plan to assess how skills and knowledge acquired virtually effectively transfer to real-world medical practices, and if the type of companion representation used has an impact on these transfers.

Keywords: Virtual Patient Simulation, Medical Education, Realism, Operational Deployment

Design and Implementation of a Location-based and Collaborative Real-time Multiplayer Application Framework for Virtual Teaching and Learning

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Abstract: Virtual reality (VR) is a promising technology that can facilitate teaching and learning over cyberspace, relaxing the limitations of time, space, and other precious resources such as laboratory equipment. Specifically, a virtual environment provides learners readily available access to uncomfortable scenarios or dangerous exposures and allows them to repeatedly engage in activities/processes that are irreversible. While current VR applications can provide a first-person immersive learning environment for learners, the experience is largely limited to individual learners because significant application development efforts are required to allow learners to interact with their peers and teachers in the virtual space. In this work we propose a location-based and collaborative real-time multiplayer application framework to facilitate educators and practitioners to build virtual learning applications that support real-time user collaboration and interaction in a virtual space. The design of the application framework consists of two parts, namely a location tracking system and a user interaction module. The location tracking system relies on base stations to collect users' location information in the physical space via some location trackers mounted on VR headsets such as Oculus Quest and Microsoft HoloLens devices. In our experiment with HTC Vive base stations and trackers, a physical playground of 2.5m x 2.5m to 10m x 10m with at most 11 users is supported. By mapping the physical location to relative position in the virtual space, the user interaction module is a Unity module which governs the types of interaction that can happen among the users, such as passing objects from one to another, completing a task together, audio chat, etc. In this work we also share the development experience of using the proposed framework to build two prototypes, nursing practical skills training and crime scene investigation.

Keywords: virtual reality, virtual learning, collaborative learning, online learning, skills training simulation

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Developing an Avatar Generation System for the Metaverse in Education

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Abstract: The metaverse is a network of digital worlds with a focus on social connection where people can act as avatars to gather to socialise, collaborate, learn and play. Although some digital worlds provide people with immersive 3D experiences, most of them require high-performance devices to render 3D graphics, or need external or wearable devices (e.g., sensors, headsets and controllers), which cause many restrictions for daily use and may also result in health problems. Against this backdrop, we designed an avatar generation system with a common webcam to enable learners' easy participation in the metaverse for educational purpose. The developed avatar generation system bears four main features: (1) integrating multiple artificial intelligence (AI) models (e.g., pose tracking, hand tracking and expression recognition) to identify and extract essential behaviours on devices locally (no video or image is recorded or stored to protect users' privacy) for generating avatar synchronously just with a common webcam; (2) adopting inverse kinematics (IK) engine to compute more body joints of generated avatars to make their motions smoother and more natural; (3) being developed on a physics engine so that avatars can interact with each other without clipping, and (4) working on a personal computer without the need for high performance CPU and GPU. The designed avatars can be more widely used in virtual learning environments. It will provide immersive, interactive and joyful learning experiences for learners at different education levels, and for educators to understand better learners' learning engagement as well as issues associated with their behaviours for just-in-time pedagogical refinement. Based on the developed avatar generation system, further development of the metaverse will focus on realising customised design of virtual environments by users. In this environment, avatars can move freely, interact with virtual objects, and collaborate with other avatars for interactive learning.

Keywords: metaverse, avatar, artificial intelligence, inverse kinematics engine, physics engine

Development and Preliminary Research of Artificial Intelligence Learning System Using Quadcopter as Learning Scaffold

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Abstract: This research uses a quadcopter as a teaching aid to develop a learning system suitable for primary and secondary school students to learn artificial intelligence-related applications. It is hoped that after the use and learning of this system, students can have a complete and clear understanding of the principle, structure, and programming of quadcopters as well as artificial intelligence-related algorithms and applications. The learning system consists of three parts: "Augmented Reality Educational Board Game Based on Artificial Intelligence Path Algorithm", "Data Collection and Machine Learning of Quadcopter Scenario Simulation", and "Computer Data Analysis and Visual Graphics". The first part is "Augmented Reality Educational Board Game with Artificial Intelligence Path Algorithm". This educational board game allows students to think and judge how to complete the specified tasks in the game in the best way. In the game, a highly interactive augmented reality mechanism is designed so that students can easily understand the relevant knowledge and application of artificial intelligence. And lay a good learning foundation for the second part of the learning system. The second part of "Data Collection and Machine Learning of Quadcopter Scenario Simulation" is to let the quadcopter go to the best path programmed by the learner under the preset color, shape, text, picture, and image simulation situation. Collect relevant data for the analysis of the third part of the learning system. The third part of "Computer Data Analysis and Visual Graphics" is to conduct computer analysis on the data collected in the second part and present the results in the form of visual graphics. Let the learners understand the meaning of the information simply and clearly.

Keywords: artificial intelligence, algorithm, quadcopter, machine learning

Pin-Yen Li

Chih-Ming Chu

Exploring the Outcomes of Learning Analytic Supported VR Content Creation in Cultural Heritage Education

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Abstract: Virtual reality (VR) is an important implementation and component of the metaverse. With the rise of the Maker Movement in education and the increased affordability of digital content creation tools, VR content creation has been democratized to learners from non-technical backgrounds. This also shows potential in allowing end-users in creating a metaverse of VR content. Applying design-based research, we have recently developed our own VR content creation platform, where student-creators can 1) create VR tours using mobile-captured spherical panoramas, 2) add multimedia objects via a "what-you-see-is-what-you-get" user interface, and 3) view these products using a low-cost head-mounted display (e.g., Google Cardboard). Based on a qualitative needs analysis, we identified students' needs for self-regulated learning and automated feedback in the process of VR creation. Therefore, we designed and implemented learning analytics (LA) features in this platform, including a checklist of tasks, progress reports and statistics, and text analytic feedback on students' narratives. As an ongoing implementation, the platform has been deployed in an undergraduate general education course on digitizing cultural heritage, in which about 100 students are currently creating VR stories to showcase heritage sites from around the world. In the literature on VR content creation, there is a paucity of studies on how LA-supported VR content creation facilitates the achievement of learning outcomes, particularly in the cultural heritage domain. To address this gap, survey responses, performance scores, learning journal entries, and student-created VR artefacts are being collected for analysis. Results of statistical tests, text mining, and qualitative coding will reveal to what extent VR content creation and LA can help students achieve the outcomes of learning about and beyond knowledge of cultural heritage. Theoretical implications and pedagogical suggestions will be discussed based on the results.

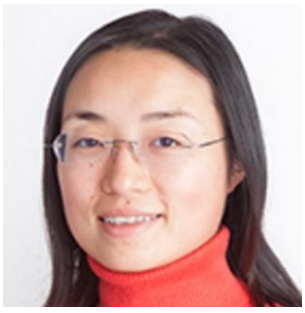
Keywords: virtual reality, learning analytics, maker education, cultural heritage, design-based research

Jeremy T. D. Ng

Zuo Wang

Ruilun Liu

Xiao Hu



Helping Freshmen Students Understand Mathematical Inequalities Using An Online-based Learning Platform

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Abstract: Knowledge of mathematical inequalities, which are based on the comparison of two quantities, is an indispensable tool for students because they are required for various mathematics topics such as pre-calculus, calculus and mathematical modelling. However, students often learn inequalities under the framework of algebraic rules and operations and acquire knowledge about the concepts using graphical visualization computing software. The visual geometric concepts of the Jensen, Arithmetic Mean-Geometric Mean, Bernoulli, Young, Hölder, Minkowski, Cauchy-Schwarz and Chebyshev inequalities are embedded in an online-based learning platform. This study aims to first use a conceptual and procedural approach by introducing inequalities with abstract formulations and then use a dynamic visual approach for illustrating different inequalities by adjusting a set of known parameters. Shifting from algebraic concepts to the dynamism of a graphical representation will not only benefit undergraduate students through their use of cognitive connections in understanding the inequalities but also further bridge the gap between the applications of mathematics and "learning by doing" online learning by enriching the learning process, e.g., completing multiple choice tests, matching items and visualizing the graph of an inequality by using animation and a sliding bar.

Keywords: Mathematical inequalities, Online-based learning platform, Mathematical thinking, Education technology

Po-Chai Wong

Jeff Chak-Fu Wong

Impact of Immersive Virtual Environments on Primary Mathematics Learning

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Abstract: The transformation in education towards the 21st Century is not only in curriculum but also in teaching pedagogies. Mathematics education plays an essential role in STEM education, in which enable students to acquire subject knowledge and develop skills in an innovative and practical way. Students are motivated in experiential learning to gain inspiration in linking up knowledge across subjects and relate to daily life applications. Virtual immersive technology applications empower learning and teaching to echo the 21st Century education needs. In this study, the impact of immersive virtual environments on primary mathematics learning will be examined through the four case studies across the strands "Numbers and Algebra", "Measures, Shape and Space" and "Data Handling". The experiential learning designs are based on immersive virtual environments, or 4-Dimensional immersive space, that transform classrooms into dynamic learning environment. Students immersive into the virtual environment with animations, sound effects and movement. The lesson design of using immersive virtual technology in mathematics learning and teaching will be discussed in the study: (1) Applications of arithmetic operations of numbers included shopping experience in a virtual supermarket environment; (2) Measure of circumference related to triangulation in GPS with immersive Google Maps space; (3) Explore the features of 3-D shapes with the virtual technology; (4) A storyline relates solve simple equations with data handling immersed detective situation. The results insights into the use of immersive virtual environments on primary mathematics learning. Overall, the findings suggest a practical design framework for impact immersive lessons and relevant assessments for studies.

Keywords: Immersive virtual environment, primary mathematics education, innovation teaching approaches

Ka Shing Chui

Learning and Teaching in Higher Education in the Era of Metaverse for Future-Readiness of Learners: Research Issues and Policy Implications

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Abstract: One of the goals of learning and teaching in higher education is to develop learners to be future-ready. This study aims to discuss the research issues and policy implications for achieving such a goal in higher education in the era of the metaverse. One of the broad views of metaverse is a digital environment mimicking the real world and ultimately will be an interoperable network of human and technology. A review of literature of core fields related to metaverse is augmented reality (AR) and virtual reality (VR), artificial intelligence (AI), blockchain and cryptocurrency, and the Internet of Things (IoT). As the shape of metaverse is still evolving, higher education institutions should start by introducing core digital technologies to be used in metaverse to maximize learning and teaching opportunities of learners and ride on these learning experiences to prepare them to be future-ready and live in harmony in the era of metaverse. We identify research issues essential for learning and teaching in higher education in this context. There is a need to research into the effectiveness of learning and teaching using virtual presence such as intelligent AI avatars in course delivery. Blockchain technology can help learners acquire structure and content skills and connect them with sustainability. There should be research into curriculum development in higher education connecting the blockchain technology with the teaching of sustainability. There should be research into the effectiveness of promoting AI literacy in higher education and the crossover of the AI literacy with the professional skills of learners in their expert domains. In this regard, literacy of AI in machine learning, deep learning, and their use in application development should be promoted to all students in higher education institutions. IoT is the Internet of physical objects. The metaverse brings the physical and virtual worlds together. The core concept of IoT is sensing-reasoning-reacting as parts as well as a whole and it is applied in Digital Twins. There is a need to research not only digital twins of real-world objects such as factories and buildings for more thoughtful and cost-effective planning and implementation but also digital twins of learners for effective learning such as artificial companions. We recommend stakeholders of higher education consider policies riding on research results in the above areas to enhance learning and teaching in higher education institutions and prepare their learners to be ready to live in the era of metaverse with metaverse literacy.

Keywords: artificial companions, higher education, learning and teaching, metaverse literacy, virtual presence

Siu-Cheung Kong

Math Teachers' Digital Instructional Resources Using Metaverse Technology: A New Trend

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Abstract: The education metaverse will greatly expand the limits of time and space of education and change the general teaching concepts and modes. The education metaverse technology such as virtual reality, augmented reality, mirror worlds, lifelogging, and mixed reality are interactive, immersive, and multiple, with the potential for social interaction during immersion. The education metaverse technologies can be widely used in situational teaching and learning, personalized learning, online teaching and learning, and game-based learning scenarios. Digital instructional resources (DIRs) refer to resources designed and appropriated to support instruction, including curriculum materials. Taking some Chinese elementary and secondary math teachers as subjects of this study, to examine mathematics teachers on how to apply metaverse technologies in teaching, we designed the questionnaire to investigate DIRs used by teachers and pose three questions: first, how do mathematics teachers get DIRs? Second, in which way are DIRs used by teachers' teaching and students' learning? The third is to evaluate the impact of DIRs on the qualities and quantities of teachers' teaching and students' learning. The results of the survey show that most of the teachers' DIRs come from their development and the Internet. These DIRs are mostly made by using mathematical or office software such as GeoGebra, Sketchpad, PowerPoint, smart whiteboard, and Seevo platform, etc. Most resources are two-dimensional graphics, rarely three-dimensional, including video, audio, pictures, and text. Furthermore, these traditional instructional resources are not interactive, not open, and not real, with a single change and patchwork; therefore, students cannot participate in interaction and experience knowledge. Traditional DIRs cause teachers to demonstrate these materials only in classes, while students can only see and cannot experience the generation of knowledge. Conversely, the mathematics classroom supported by educational metaverse technology has the characteristics of "interactive, immersive, interesting, real, and open". 71.4% of the subjects expressed willingness to use educational meta-universe technology in mathematics classroom instruction. DIRs involving educational metaverse technology should be applied in mathematics classes. Educational metaverse technology will bring new vitality and vision to the traditional classroom and will have a positive impact on teaching and learning.

Keywords: digital instructional resources, mathematics teaching, metaverse technology, education metaverse, mathematics teacher

Metaverse Learning Agents for Early Childhood e-Learning

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Abstract: e-Learning, in the form of virtual classrooms and various digital learning devices, is often considered as an inferior teaching medium for early childhood education due to weak motivation, limited interaction and poor environment control. However, the covid pandemic has turned e-learning into an indispensable education medium even for younger children. To resolve e-learning issues in younger children, a metaverse learning agent design is proposed to resolve the above core issues. We present our prototype system based on the combination of metaverse design and artificial intelligence techniques: including facial feature emotion recognition with computer vision, gesture recognition, ambient understanding and natural language understanding. Analysis on how learning agents can help gauge learning progress, learning focus, learning difficulties and learning well-being will also be presented. Special focuses will also be given to measuring concentration in learning activities as well as measuring emotion response in learning via face emotion detection. To enhance learning motivation, metaverse agents are equipped with reward abilities that extend beyond verbal and scores based achievements to include: physical games, electronic games, various children's favorite media and other metaverse interactions.

Keywords: early childhood e-learning, emotion recognition, learning agent, ambient sensing, metaverse reward and motivation

New ways in information retrieval for Children: voice and image recognition with human-computer interaction

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Abstract: Nowadays, children are using various types of devices and platforms to retrieve information for both educational and social purposes. Especially, due to the impact of the COVID-19, children experience a rapid transition to online homeschooling. Although a lot of efforts have been made to explore ideal Information Retrieval (IR) models for children, many challenges can not be ignored. These challenges include interface design, input methods and retrieval preference. In addition, children have different thinking patterns and interest preferences which have influences on their retrieval behaviour. This study investigated 58 pieces of literature about children's IR, voice and image recognition, multimedia information retrieval and Human-Computer Interaction (HCI) in IR. The objective is to explore the value of voice and image recognition with HCI in IR for Children. Findings from six databases: ACM Digital Library, IEEE Xplore, Springer Link, ScienceDirect, Web of Science and CNKI are discussed highlighting the core elements of this study. Some articles indicated that children have special query behaviour compared with other generations. Findings showed that multimedia retrieval technology integrated some methods including pattern recognition, similarity retrieval, Artificial Intelligence (AI), image understanding and computer vision, which makes IR via voice and image feasible. Voice and image recognition has a positive effect on the learning performance of children based on the concept of Search as Learning (SAL). Because extracting features and recognizing elements from images and voice information could present not only the best matching results but useful information or knowledge to children. HCI gives children feedback, visualized retrieval plans and flexible selections. These selections will help children to delete irrelevant information and to extend ignored range. As a result, this type of IR system could become children's artificial companions in learning, making children's IR more effective and interesting. It can be predicted that voice and image recognition with HCI are effective ways to help children to retrieve information. Yet the technologies were immature, it would need more time and effort to optimize.

Keywords: Information retrieval, Multimedia retrieval, Voice recognition, Image recognition, Human-Computer Interaction

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Oral Practice Language Learning by Speech Synthesis and Pronunciation Assessment

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Abstract: For non-native English language speaker, we usually worried about our pronunciation, speaking speed and grammar, etc. With mature voice recognition and speech synthesis technology, we can use it as our artificial intelligence language learning tutor. This platform is implemented by integrating cognitive service and represented as a website. In IDC Theory, the creation loop has three steps: Imitating, Combining and Staging. In this website, at first, students can input sentences which they would like to practice. The system will provide the AI synthesis voice for the sentence like demonstration. Students can listen and learn, that's imitating. After that, students can try to practice it by his own speed and tone, that's combining. At last, students can turn on microphone to speak the sentence to system, that's staging. After submitted to the platform, it will input student's voice data to machine learning model which is pretrained by numerous native English speakers' voice data, then returns the assessment scores for pronunciation accuracy, fluency, and completeness. It will also show you which vocabularies you are doing good or not. The platform also shows you which vocabularies you ignored or did redundant. Once you have this report, you can know which part you can practice more and make it better. Clear goals make you know how to improve yourself; it also turns out to your motivation to let you are willing to go forward. We use this platform to English drama rehearsal in experiment elementary school. Most students ask to practice more on this platform to get better scores. This paper takes this platform as AI language tutor and students can practice by themselves without getting one-to-one real English native speaker partner. The results also reveal that clear grades report can lead students to practice precisely and improve effectively.

Keywords: Language Learning, Intelligent Tutor, Voice Recognition, Speech to Text, IDC Theory

Hsiang-Jen Chung

Pedagogical Conversion of Tangible Augmented Reality Sandbox into Mobile Augmented Reality Sandbox App for Learning Geography

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Abstract: The technologies of mixed reality have become ubiquitous in classroom teaching. The AR sandbox is one of the best examples of applying AR technologies to the innovative Geography learning environment. The AR Sandbox has been utilized through augmented contour lines projection on the authentic sand. The projection in the tangible sandbox changes with "hands-on" movement. Students need to learn the 3D landscape by touching to visualize some sophisticated concepts and their interrelationships in learning Geography. However, due to school suspension of face-to-face classes, the strict COVID prevention instructions place obstacles to the physical contact between students. Therefore, the action researcher and the university academic have converted the display and functions of the tangible AR sandbox into mobile AR app. The mobile AR function provides the same topographic display in a virtual mobile AR view. Students can keep their "hands-on" experiences in the mobile app-based virtual environment. The AR sandbox app acts as a seamless learning tool which provides a high-mobility AR display in a field-oriented subject like Geography. Despite the technological breakthrough, a new pedagogy is needed for adopting the technologies into teaching. Some overseas research bodies have found that the best use of the AR sandbox requires good learning instructions. This presentation will discuss proper usage of the AR sandbox through a pedagogical design and a conceptual model of the AR sandbox with a seamless approach in teaching some geospatial concepts of Geography in Hong Kong's K-12 classrooms. Then we will discuss those learning and teaching differences between the tangible AR sandbox and the mobile AR sandbox. Nevertheless, we are going to address possible pedagogical obstacles in the large class-size teaching environment and try to figure out the implementation of the pedagogical needs on these new technologies to Hong Kong education system using the example of the AR sandbox.

Keywords: augmented reality, AR sandbox, tangible AR, mobile AR, pedagogy

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Research on Classroom Playful Learning from the Perspective of Students

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Abstract: This study discusses playful learning in classroom from the perspective of primary students based on grounded theory, and aims to extract the connotation of classroom playful learning from the perspective of students. 120 K-4 primary school students from China, aged 9-10, participated in the study by conducting an in-depth interview on their understanding of playful learning in classroom. All the participants were asked to describe their ideal playful learning in classroom by writing a paragraph and drawing. 90 pupil's paragraphs were coded and analyzed, and the key features and implications of an ideal playful learning in classroom based on their ideas were developed. The study reveals that an ideal playful learning in classroom should have a clear learning goal, explicit play rules, elaborate design combining with daily games or computer game elements, with impartial evaluation and long-term incentive mechanism. The participating students, as classroom learning stakeholders, are well aware of playful learning in classroom, and their conceptual framework of playful learning in classroom should be understood.

Keywords: playful learning; student perspective; grounded theory; interview

Xiaoyan Li

Kangas Marjaana

Teaching the Creation and Distribution of Digital Artworks within the Metaverse during the Pandemic

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Abstract: The concept of the Metaverse has recently been adopted in order to express the potential future of the internet to become a largely three-dimensional spatial (virtual, physical or hybrid) context, within which most online activities may take place. This concept and the technologies that support it, however, are more than 30 years old. Terms like Collaborative Virtual Environments (CVEs), Virtual Worlds and Social Virtual Environments etc. have also been used to express the same concept during the last decades. The Metaverse concept expands the idea of CVEs by relating them with a series of other 3D types of interfaces supporting interaction in a 3D context (augmented reality, mixed reality, geolocated systems projection-based systems etc.) as well as with Blockchain technologies.

Teaching the creation of visual (2D/3D), audio-visual and other spatial compositions or assemblages, is a process that involves face-to-face communication amongst students and teaching personnel, in an artistic laboratory context, in order to convey the empirical and tacit aspect of knowledge involved in the creation of these artworks, in the best possible manner. Due to the outbreak of COVID-19 pandemic, higher education institutes quickly turned to the use of online tools, radically transforming the modes of teaching and communication with students. This educational shift significantly affected the conduct of artistic laboratory courses, where physical presence is essential for students and teaching staff. In order to address this shift, the authors adopted a project-based learning methodology and used a combination of Social Virtual Environments and teleconferencing tools, as a context within which they taught the creation of interactive assemblages and spatial compositions. This paper presents a research study which investigated the result of this teaching process with regards to the educational impact and the experience of the students.

More specifically, the aforementioned research focuses on the evaluation of the teaching methods adopted for the undergraduate laboratory course “Digital Artistic Creation 2”, which was remotely offered during the spring semester of the academic year 2020-2021 by the Department of Digital Arts and Cinema (National and Kapodistrian University of Athens). Following the project-based learning methodology paradigm, the objective of the laboratory course was the design and development of digital interactive artworks, consisting of 3D elements and multimedia, presented within virtual environments. In this assignment, students were prompted to elaborate on their own artistic ideas and collaboratively work within small groups of 4-5 members. The teaching staff employed a hybrid scheme of teaching, including the simultaneous use of a multi-user platform for online, shared, persistent virtual worlds (OpenSim) and a teleconferencing platform (Webex).

Following the end of the semester, the students were invited to describe their experience and provide valuable feedback to the teaching staff providing quantative and qualitative data pertaining to their learning experiences and outcomes, as well as improvisation suggestions. The results gave valuable insights to the efficiency of social virtual environments as educational tools for collaborative artistic creation, as well as their productive coexistence with teleconferencing tools, in a purely distance learning academic context.

Following this course, the teaching personnel further investigated the possible streams of exhibition, distribution and revenue for the produced artworks, in order to encourage the efforts of the students as young artists. This investigation focused on the possibilities afforded by the convergence of CVEs with Blockchain technologies, such as Non-Fungible Tokens (NFTs), for managing 3D artistic content in a Metaverse context. The paper discusses the ways in which this convergence may empower young artists by providing them the opportunity to present, exhibit and distribute their artistic compositions, without necessarily following the traditional processes and channels of distribution, dictated via the art market.

Keywords: Metaverse, digital art, artistic laboratory, social virtual reality, Blockchain

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The Analysis of Multimodal Communication in the Metaverse and Its Implications in Language Education

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Abstract: The Metaverse has been a technology buzzword since Mark Zuckerberg renamed his company Meta in 2021. If the Metaverse is the future of mobile Internet as Zuckerberg predicted, there is a need to equip our students with new competences, not only in terms of ICT (Information Communication Technology) but also language skills, for them to be able to navigate smoothly in the Metaverse. The literature on this issue is still sparse. This paper aims to compare and contrast the differences between real world and the Metaverse communication from a multimodal point of view. Horizon Venues, an immersive virtual reality (VR) environment developed by Meta Company is selected as the representative environment of Metaverse. The multimodal analysis in communication comprises two parts: human-to-VR interaction and human-to-VR-to-human interaction. In each part, various modes in communication, such as text, speech, facial expression, gesture, graphic and emoji modes are analyzed. The findings show that the real world and the Metaverse communication share most modalities but with different affordances and limitations. In addition, the emoji mode is unique in the Metaverse because no counterpart can be found in the real world communication. In conclusion, the implications for language education is that, apart from human interaction, human-to-Metaverse-interface interaction is also an important language practice that need to be addressed. Moreover, communication in the Metaverse is in some ways different from real word communication, therefore proper training needs to be provided to help our students become competent citizens in the Metaverse. Suggestions for language educators, both first and second languages, with the interest in Metaverse technology will then be provided.

Keywords: Metaverse, Virtual reality, Multimodal analysis, Language education

Wen-Chu Hu

The Metaverse in Education – A Proposed Case Study in Primary Schools on Sustainable Development Ecology

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Abstract:

Through closely linking virtual reality to different aspects of everyday life, the Metaverse is evolving as a brand new ecosystem. Scientists believe that the Metaverse will gradually mature in ten years, and current elementary school students will grow up in a future world full of metaverses. While the developmental direction of the education metaverse is still under discussion, we believe creating a virtual platform where students can engage learning meaningfully in an immersive atmosphere would be an indispensable element of an education metaverse. Students can also explore, create, socialize and acquire various experiences on the platform. A properly managed platform should also be able to nurture students' information literacy in the metaverse. Therefore, our school is seeking to establish an education metaverse with various partners and create a regulated metaverse with Microsoft Minecraft Education. Using the theme of sustainable development ecology, we are aiming to create a virtual environment with learnability and malleability. This project will invite different schools to participate and collaborate, and the number of participating schools will gradually increase throughout the different developmental stages. The core of our Metaverse will be enriched with learning material under the theme of sustainable ecological development. Supplemented with face-to-face lessons, teachers will guide students to conduct themed project studies as well as understand the challenges and difficulties faced by endangered creatures and offer potential solutions. Students will present their research results in the Metaverse with fellow students of participating schools. Through socialised interaction and creation, the education metaverse will be formed. Upon laying a good foundation of the platform, the diverse experiences gained in the Metaverse will help develop students' information literacy and moral values of the Metaverse.

Keywords: Education Metaverse, Minecraft, Sustainable development, Information literacy, Primary School

Kam Yuen, Law

Sha Li Shirley, Duthie Chuang

Using Virtual Reality in Teaching Crisis Management Course

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Abstract: Full time students in crisis management courses find material difficult to understand. Most of them do not have relevant working experience. It is unrealistic or unlikely to experience a real crisis during the study period. Thus, making use Virtual Reality (VR) in the crisis management course is important. The purpose of the study is to investigate the effectiveness of using Virtual reality in the course.

There are some studies on using virtual reality in teaching and learning. Chan et al. (2022) found that VR could provide architectural details and give sense of presence to students in order to have better learning outcomes in architectural courses. VR might enhance the fieldwork observation technique using simulation and finally employability (Bos et al., 2021). VR was used in the crisis management training with low cost. Also, mistakes could be made without negative drawback (Conges et al., 2019). The environment for the drill is totally separated from the actual operation site. Thus, it could reduce the disruption of the service and business operation (Kwok et al., 2019).

In our study, students need to have a "real" experience in the crisis events in the first lesson of the crisis management course. They were asked to watch a video to feel a sense of earthquake in their homes. Students could make use 360 degree button to move around surroundings. In the second video, students were presented a video of tsunami. In the video, a full description of how strong of tsunami was explained by the same function.

Virtual Reality is defined as a three dimensional computer-generated environment which can be interacted to create a sense of presence for the students as quasi-real environment (Diemer et al., 2015; Che, 2016). Crisis management courses consists of crisis prevention, crisis preparation, crisis response and crisis revision (Coombs, 2019). There are two case studies in crisis preparation. In the first case study, VR was used for the crisis preparation for the fire. A Fire Drill was used to test the crisis management plan when fire is broken in a rehearsal manner. The second case study is fire drill simulation. Suppose you worked in an office and heard a fire alarm. You have to follow the fire exit sign and go to the designated safe place.

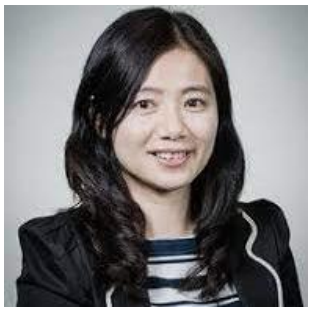
Two crisis management classes were conducted in a parallel manner. VR videos was employed in one of the classes and ordinary video/textual description was used in the other class. Before the class, students were asked about the crisis management knowledge and/or experience. Student were asked to fill in the survey after the class whether they learn something for the course. It was found that students in the second class were much more satisfied for the course.

The paper identified several ways in which VR technology can be used as a resource to foster the teaching and learning in crisis management. Cases was shown that VR was used to motivate students' interest and engage students in the fieldwork practice.

Keywords: Virtual Reality; Crisis Management; Student experience

Tai Ming Wut

Peggy Mei-lan Ng



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Virtual and Robotic Learning Companions: Some Research Issues

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Abstract: Since Chan and Baskin (1988) proposed that a computer acts as a learning companion for students, various learning companions are designed and implemented in virtual and robotic forms. A learning companion is an artificial character, which has human-like characteristics to promote student learning in a social learning environment (Chou *et al.* 2003). The development of technologies, such as virtual reality (VR), augment reality (AR), mixed reality (MR), Metaverse, and robotics, enables students to learn with multiple connected artificial companions of different roles and forms. A future scenario is that students have a set of lifelong learning companions that have different roles and stay with students from childhood to adulthood (Chan *et al.* 2001; Chou *et al.* 2003). We propose four emergent research issues and our suggestions as follows.

1. What are the current and emergent technologies for supporting learning companions?
2. What are the roles of learning companions?
3. Are there learning theories suitable for designing learning companions?
4. What are the expected outcomes and related evaluations of learning companions?

Acceleration Studies Foundation (Smart, Cascio & Paffendorf, 2007) pointed out that Metaverse can be divided into four quadrants according to the direction of technology projects information (i.e., in the real world or a new virtual world). The focus of technology improves the quality of life: lifelogging, augmented reality, mirror worlds, and virtual worlds. We believe that learning companions can be designed as "connectors" to connect the virtual world with the real world, especially as the recently popular Metaverse platforms, such as Zepeto, Roblox, Gather.town, and Fortnite. These platforms provide a user experience based on a 3D multimedia environment which serves as a learning environment. Besides, many current and emergent technologies, such as AR, VR, MR, and IoT, will be integrated into the real world and a new virtual world. These technologies could support a better learning experience, but they also allow us to have more effective, diverse, and complete learning process materials. This students' learning information will be used to improve technology adoption, learning content development, and learning activity design.

Learning theories are important for design learning companions. For example, based on the interest-driven creator (IDC) theory (Chan et al. 2019), the design of learning companions could be emphasized in terms of the three aspects: interest, creation, and habits. For interest aspect, learning companions could be designed as "storytellers" to help students explore and develop their interest in different subjects. Specifically, students' interest could be initiated by the deprivation curiosity, and then deepened by the interest curiosity. Thus, making students always feel curious to develop their interest is suggested as an embedded mechanism for IDC learning companions. For creation aspect,

learning companions could be designed as "co-makers" to help students remix and combine their products/projects in different subjects. Making students always feel possible to develop their creation is suggested as an embedded mechanism for IDC learning companions. For habit aspect, learning companions could be designed as "mentors" to help students develop and make their habits in different subjects, since the development of habit involves the long-term goal setting, monitoring, and effort regulation. Making students always feel perseverant to have their habit is suggested as an embedded mechanism for IDC learning companions.

We also believe that the role of learning companions in the Metaverse will be to promote happiness and well-being in student learning, such as Seligman (2012) described a visionary new understanding of happiness and well-being, including positive emotion, engagement, relationships, meaning, and accomplishment. Learning companions can be designed as "facilitators" of students' cognition, interest, behaviors, habit, happiness and well-being. We could evaluate the effectiveness of learning companions on students' learning outcomes, including performance, interest, behaviors, habit, and happiness. In interacting with students in learning companions, we could continuously collect and accumulate data on students' learning outcomes and combine formal and summative assessments to master students' learning patterns and preferences.

Keywords: virtual and robotic learning companions, interest-driven creator (IDC) theory, Metaverse

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Virtual Mentor Agents as Companions in Higher Education

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Abstract: Designing and evaluating intelligent user interfaces is part of human-computer interaction (HCI) research. The use of extended (XR) or mixed reality (MR) and artificial intelligence (AI) is widening this design space. Avatars, virtual agents and bots are changing the awareness and agency of users, e.g., large language models are driving natural language processing towards daily conversations. Moreover, we can add interaction possibilities with digital and real artifacts, opening artificial spaces from a variety of perspectives. However, we have also to deal with known problems in these spaces like motion sickness in virtual reality and the uncanny valley of avatar presentation. In particular, the deployment of new interaction design in pedagogical scenarios like mentoring in higher education needs evidence of advantages for learners and instructors. Previous research has, e.g., faced the challenge of suitable agent designs that gain the learner's trust and that increase the engagement with the medium. The usage of algorithms, the design of intelligent natural language interfaces and the interaction in augmented or virtual spaces can evoke different user reactions, as we know from recent research results. This contribution describes the design of a combined virtual agent and chatbot approach for creating AI-based mentors in higher education in a running interdisciplinary research project. Based on open-source software deployed in a cloud-based cluster connecting a number of universities in Germany, we have designed a solution, where students can interact with virtual mentor agents in XR environments using different devices and platforms. In this context, we have also created tutorials on YouTube for generating model-based chatbots and virtual agents. We are convinced that our open-source and open content approach will facilitate the spread of virtual mentor agents in many higher education institutes worldwide.

Keywords: mentoring, higher education, mixed/extended reality, chatbot, virtual agent

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Visualized Environment to Build Chatbot for Learning and Training

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Abstract: Chatbots are a powerful tool in training and their usage as automated first-level support is ubiquitous, but leveraging chatbots requires learning the language that chatbots speak including the syntax, semantics, and other intricacies. Our research team has proposed a block-based, visual editing environment as Figure 1 shows below to alleviate the burden of knowledge imposed on users wishing to implement chatbots in their use of training and/or as an automated first-level of support. Users can use the block-based, visual editing environment to create RiveScript-powered chatbots without needing to know any RiveScript thanks to visual and text cues. See the following presentation recording for more details on the use of the platform:

https://www.youtube.com/watch?v=G9TbwaNgW0s&list=PLOvm0EU5Q72iVx5hSa35BNj7z9ka01kO7&index=7

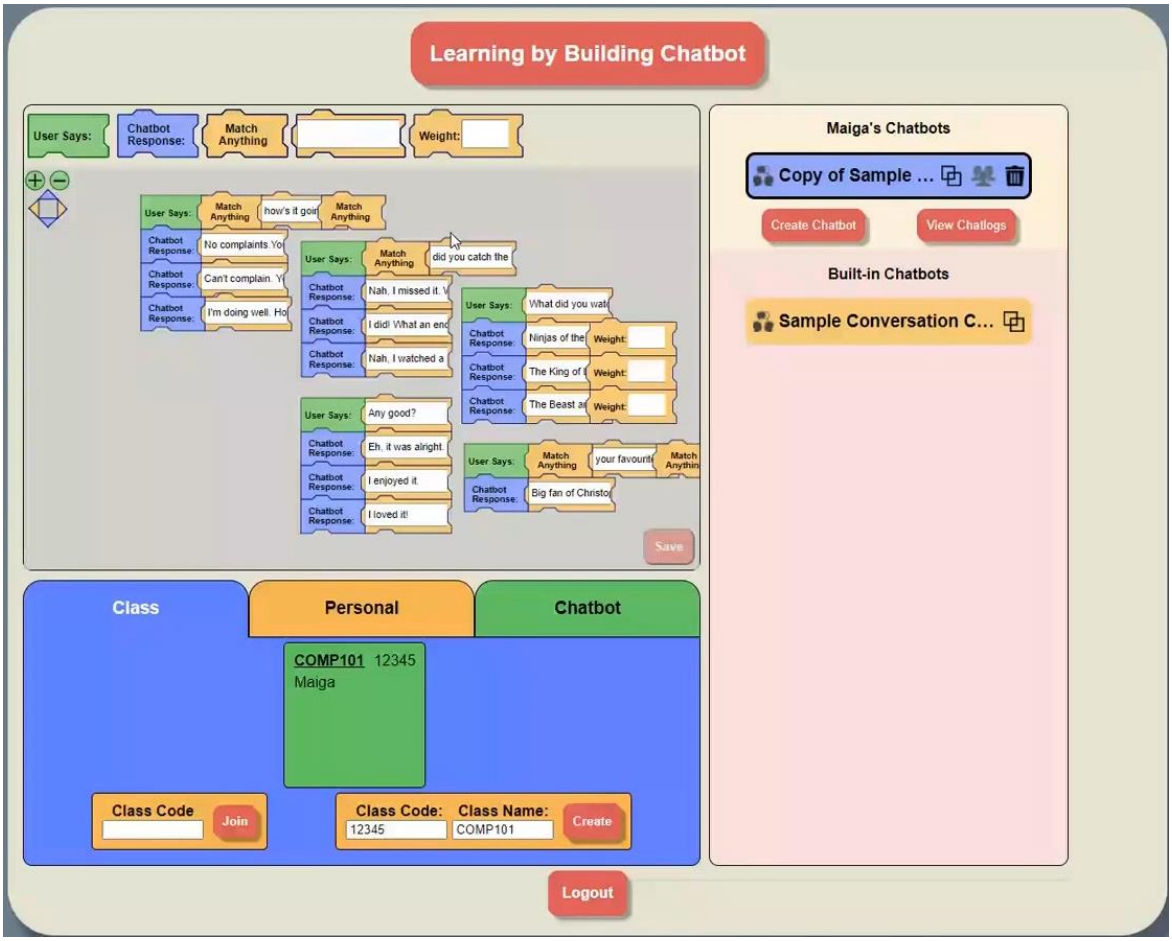

Figure 1. The Visualized Editing Environment for Building Chatbot (https://vp.vipresearch.ca/)

The platform the chatbots are hosted on also allows for teachers to share chatbots and review student chatbot interactions from a single website without the need to self-host a chatbot or distribute a program. Teachers can create chatbots as virtual person or patient for their students to practice the communication skills with customers, language speaking and writing skills with a waiter/waitress in the restaurant, bedside manner and skills with a patient in the clinic/hospital or an elder in the long-term care facility. Students can choose a pre-created or shared chatbot and then talk (via typing at this moment) to the chosen one. Via the interaction with the chatbots, they can practice at any time while having lunch, waiting at a bus stop, or during their commute to work/home.

Besides that, students can also create chatbots based on the knowledge they learned in the class; for instances, they can create a chatbot based on the grammars and words they have been taught in a second or foreign language course; or they can create a chatbot based on the taught policies and procedures, conversation practices, or drilling activities or in a customer relationship, a nursing education, or a language learning class. Teachers can assess students' mastery level of the specific knowledge or concept via "talking" to their chatbots.

Keywords: Block, RiveScript, Second Language, Foreign Language, Communication Skill, Grammar, Virtual Person, Virtual Patient, Virtual Customer, Practice

Maiga Chang

What is Metaverse? A Scoping Review

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Abstract: The term "Metaverse" appeared for the first time in the novel published in 1992. In the recent decade, researchers started to use this term to engage learners through digital technologies to interact with other users with avatars. The term began to revolutionize the world again in 2020. The world's largest online social network Facebook rebranded itself to Meta that indicates a great shift of how students engaged in the digital world. However, researchers interpret and use the term in a diverse way. Of this interest, an exploratory review identified 20 articles from the Web of Science database, and examined how educators conceptualize the term in the educational fields. This discussion aims to explore how researchers in the past and present conceptualized the term with examples and applications in different contexts. Furthermore, this discussion identifies the major types of technologies used in the Metaverse studies and offers a sound theoretical foundation in terms of cognitive, social and teacher presence to understand what future potential of these technologies could bring to online learning. Seven types of technologies were found: learning management system, avatar-based Second Life software, mirror and virtual world, simulation and multimedia, immersive technology, artificial intelligence. This study examined how these (pre-)Metaverse technologies bring digital affordances, educational values and new features to support pedagogical and educational innovations. Further, I discuss how these technologies and their integrations with artificial companion could make great impact on students' learning performance or potential of the collaborative learning. It is foreseen that Metaverse would reshape education through technologies in the post-pandemic world.

Keywords: Metaverse, online learning, Second Life, virtual reality, avatar, artificial intelligence, simulation

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