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Preface

On behalf of the Steering and Organizing Committees, it is my great pleasure and privilege to welcome you to the International Conference on Education and Artificial Intelligence 2020. The main objective of this three-day conference is to provide an opportunity for scholars from around the world to share their ideas and research in all aspects of education and artificial intelligence. A total of 38 high-quality papers have been accepted for presentation at the conference, organized in 6 key themes and 12 parallel presentation sessions.

We are honored to have four distinguished keynote speakers who will offer their insights into education and AI from different perspectives. Professor Rose Luckin from University College London (UK) will speak about how we can build an AI for education ecosystem. Professor Xiao-Li Meng from Harvard University (USA) will present on the pedagogical challenges and opportunities for ensuring a healthy data science ecosystem. Professor Gwo-Jen Hwang from National Taiwan University of Science and Technology (Taiwan) will give a talk about the applications and research issues of artificial Intelligence in education. Professor Marcelo Milrad from Linnaeus University (Sweden) will share a historical view on the evolution of artificial intelligence in education. I believe that the keynote speeches will help us keep up to date with new developments and gain a deeper understanding of AI in education.

Much work has gone into preparing for this conference. I would like to extend my warmest thanks to the Conference General Chair, Dr. Gary Cheng, and the Organizing Committee. The conference would not have come about without their dedicated work. Last but not least, I would also like to extend my gratitude to all authors, reviewers, presenters and participants for their contributions and support.

I hope the next few days will inspire us all through exciting presentations and discussions, and we will all depart having enjoyed an enriching and memorable experience.

I am also looking forward to meeting with you all face to face after the pandemic.

Thank you very much.

Prof. Wai Keung LI

Steering Committee Chair of ICEAI 2020

The Education University of Hong Kong, Hong Kong

6 November 2020

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Keynote speakers

Prof. Rose Luckin

Professor of Learner Centred Design
UCL Knowledge Lab
University College London
UK

Biography:

Prof. Rosemary (Rose) Luckin is Professor of Learner Centred Design at UCL. Her research involves blending theories from the learning sciences and techniques from Artificial Intelligence (AI). Rose is author of 'Machine Learning and Human Intelligence: the future of education in the 21st century' (2018). Prof. Luckin is also Director of EDUCATE: a London hub for Educational Technology StartUps, researchers and educators to work together on the development of evidence-informed Educational Technology; Specialist Adviser to the UK House of Commons Education Select Committee for their inquiry into the Fourth Industrial Revolution, Co-founder of the Institute for Ethical AI in Education; a member of the UK Office for Students Horizon Scanning panel, an adviser to the Topol review into the future of the NHS workforce; a member of the European AI Alliance, holder of an International Franqui Chair at KU Leuven; one of the 20 most influential people in Education (Seldon List 2017).

Topic:

How can we build an AI for Education Ecosystem?

Abstract:

COVID-19 has precipitated a major experiment for education systems across the world and this provides an amazing opportunity for AI to assist in the beneficial transformation of teaching and learning that remote and hybrid approaches are likely to catalyse. However, how can educators be ready to leverage AI and how can AI developers be ready to support educators? Each community must help the other to learn and develop their thinking about what kinds of AI technology can best be used for education and training. The research community also has a vital role to play in helping the AIED ecosystem develop. In this talk, I will consider the current stage of AI's application in education and the ways in which AI has supported teachers and learners during the pandemic. I will then look towards the future and consider how AI could be used to support a COVID-compliant transformation for our education systems - a transformation that seeks to enable all learners to achieve their full potential. Throughout the talk I will draw on examples from different AI systems to illustrate what is happening in the present and what could happen in the future. I will suggest a way on which we can bring together educators, developer and researchers to create a healthy and vibrant AIED ecosystem and I will suggest ways in which education systems can become truly 'AI ready.'

Prof. Xiao-Li Meng

Whipple V. N. Jones Professor of Statistics
Department of Statistics
Harvard University
USA

Biography:

Prof. Xiao-Li Meng, the Whipple V. N. Jones Professor of Statistics, and the Founding Editor-in-Chief of *Harvard Data Science Review*, is well known for his depth and breadth in research, his innovation and passion in pedagogy, his vision and effectiveness in administration, as well as for his engaging and entertaining style as a speaker and writer. Prof. Meng was named the best statistician under the age of 40 by COPSS (Committee of Presidents of Statistical Societies) in 2001, and he is the recipient of numerous awards and honors for his more than 150 publications in at least a dozen theoretical and methodological areas, as well as in areas of pedagogy and professional development. He has delivered more than 400 research presentations and public speeches on these topics, and he is the author of "The XL-Files," a thought-provoking and entertaining column in the IMS (Institute of Mathematical Statistics) Bulletin. His interests range from the theoretical foundations of statistical inferences (e.g., the interplay among Bayesian, Fiducial, and frequentist perspectives; frameworks for multi-source, multi-phase and multi-resolution inferences) to statistical methods and computation (e.g., posterior predictive p-value; EM algorithm; Markov chain Monte Carlo; bridge and path sampling) to applications in natural, social, and medical sciences and engineering (e.g., complex statistical modeling in astronomy and astrophysics, assessing disparity in mental health services, and quantifying statistical information in genetic studies). Prof. Meng received his BS in mathematics from Fudan University in 1982 and his PhD in statistics from Harvard in 1990. He was on the faculty of the University of Chicago from 1991 to 2001 before returning to Harvard, where he served as the Chair of the Department of Statistics (2004-2012) and the Dean of Graduate School of Arts and Sciences (2012-2017).

Topic:

Ensuring a Healthy Data Science Ecosystem: Pedagogical Challenges and Opportunities

Prof. Gwo-Jen Hwang

Chair Professor
Graduate Institute of Digital Learning and Education
National Taiwan University of Science and Technology
Taiwan

Biography:

Prof. Gwo-Jen Hwang is Chair Professor of Graduate Institute of Digital Learning and Education in National Taiwan University of Science and Technology. He serves as an editorial board member and a reviewer for more than 40 academic journals of educational technology and e-learning. Currently, he is the Editor-in-Chief /Lead Editor of Australasia Journal of Educational Technology (SSCI), International Journal of Mobile Learning and Organisation (Scopus, Q1), Journal of Computers in Education (Scopus, ESCI) and Computers & Education: Artificial Intelligence (Elsevier). Prof. Hwang has published more than 700 academic papers, including more than 200 SSCI journal papers. Owing to his reputation in academic research and innovative inventions in e-learning, he received the annual most Outstanding Researcher Award from the National Science Council of Taiwan in the years 2007, 2010 and 2013. Moreover, in 2016, he was announced by Times Higher Education as being the most prolific and cited researcher in the world in the field of social sciences: https://www.timeshighereducation.com/news/ten-most-prolific-and-most-cited-researchers.

Topic:

Applications and Research Issues of Artificial Intelligence in Education

Abstract:

The advancement of artificial intelligence (AI) technologies has attracted the attention of researchers in the globe. However, it remains a challenging task for educational technology researchers to apply AI technologies to school settings, not to mention designing AIED (Artificial Intelligence in Education) studies. In this talk, Prof. Hwang is going to introduce the basic conceptions and applications of AI; following that, potential research issues of AIED are presented. In addition, several examples are given to demonstrate how AI can be used to promote teaching and learning outcomes.

Prof. Marcelo Milrad

Professor, Vice-Dean
Department of Computer Science and Media Technology
Linnaeus University
Sweden

Biography:

Prof. Marcelo Milrad is a Full Professor of Media Technology at Linnaeus University (LNU) in Sweden. His current research interests include the areas of Technology-Enhanced Learning (TEL), advanced human-computer interaction and novel uses of Big Data techniques and mobile technologies in the fields of Education & Health Care. Since March 2020, he acts as the main scientific coordinator of LNU´s complete knowledge environment Digital Transformations. Prof. Milrad is also actively involved also in a new initiative at LNU together with colleagues at the Faculty of Arts and Humanities called Digital Humanities. Professor Milrad conducts his research in very close collaboration with industrial partners and the public sector. He has published numerous articles in international journals, refereed conferences, books and technical reports. Prof. Milrad has also been presenting and giving lectures about his work in more than 45 countries worldwide.

Topic:

A historical view on the evolution of Artificial Intelligence in Education: perspectives, challenges and opportunities

Abstract:

The field of Artificial Intelligence in Education, usually referred to as AIED, can be defined as the use of AI (Artificial Intelligence) techniques and applications utilized in different educational contexts with the purpose of supporting learning, teaching and training. While recent advancements of information and communication technologies have accelerated the implementation of AIED applications, the field itself has existed for more than three decades. In this presentation I will give an overview of how the field of AIED has evolved over the last 30 years with the purpose of identifying the educational, technological and application areas that have been at the core of this evolution. The outcomes of this analysis will be presented and discussed in order to propose some initial considerations regarding current implementations of AI in educational settings. I will also outline some emerging challenges and research issues in this field that can help guide educational researchers interested in carrying out AIED studies. A few examples of work under way at Linnaeus University will be presented in order to illustrate some of these ideas.

Theme 1 ---- Research Trend and Future Directions of AI in Education

Thirty Years of Interactive Learning Environments: A Text Mining Based Bibliometric Analysis

Xieling Chen[1], Di Zou[2], Gary Cheng[1], Haoran Xie[3]

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BACKGROUND: Interactive Learning Environments (ILE) is one of the most active international journals in the field of educational technology, particularly in the field of interactive learning, which encompasses a wide range of the design and use of interactive learning environments for supporting both individual learners and collaboration amongst groups of learners. ILE published its first issue in 1990, and since then, its impact has increased significantly. Questions such as "in what kind of research topics were the ILE community interested?" "How did such research topics evolve?" "what were the main research concerns of the major contributors?" and "what were the potential inter-topic research directions?" are important to both the editorial board and ILE's readership.

METHODS: This study conducted a text mining based bibliometric analysis of 784 articles of the ILE from 1990 to 2019, to explore critical milestones in the ILE's 30-year history. Specifically, we analyzed article trends, identified influential countries/regions and institutions, and visualized the scientific collaboration. In addition, by using structural topic modeling, we uncovered significant research topics concerned within the ILE community. The evolution of topics and the correlation between topics were further explored by using a nonparametric Mann-Kendall trend test and a hierarchical clustering technique. Topic distributions across influential countries/regions and institutions were also investigated and visualized.

RESULTS: The annual articles of ILE had grown consistently across the past 30 years, particularly research articles, highlighting that ILE articles had become increasingly more impactful and influential. From the country/region perspective, it is found that the large increase in ILE articles was attributable to the growing interest and essential contributions of scholars from non-English speaking countries/regions. Collaborations between countries/regions and institutions demonstrated that actors in the same areas in geography were more likely to conduct scientific collaboration, particularly with close collaboration among Taiwan institutions. Results from topic modeling analysis highlighted several essential research issues such as flipped classroom, community of inquiry, technology acceptance models, e-book reading, augmented reality, and game-based learning.

CONCLUSIONS: The results obtained had led to informative and valuable implications, allowing readers to understand better the latent topical popularity, dynamics, correlation, and distribution in the research of interactive learning environments. Findings contributed to ILE by providing a comprehensive overview of its status and trends, which is beneficial to its decision-makers by allowing the authors and ILE editors to make a better and more reasonable decision about submissions and policies.

CORRESPONDING AUTHOR: Di Zou

KEYWORDS: Interactive Learning Environments; scientific collaboration; structural topic modeling; research foci

A Bibliometric Study on Artificial Intelligence in Education for Two Decades

Xieling Chen[1], Di Zou[2], Haoran Xie[3], Gary Cheng[1], Caixia Liu[4,1]

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BACKGROUND: Research on Artificial Intelligence in Education (AIEd) has become increasingly active during the past 20 years, with great interest, rich literature, and huge diversity. The diversity in research topics and technologies keeps increasing along with the tremendous growth in the application scope of AIEd research. A comprehensive overview of this field is necessary to understand what had been concerned in AIEd research, what is going on in the field of AIEd, and what might be the future of AIEd research.

METHODS: This paper combined the structural topic modeling (STM) with the bibliometric analysis to automatically identify prominent research topics from the large-scale AIEd literature in the past two decades. Specifically, by using STM, we uncovered important research topics concerned within the AIEd community. The evolution of these topics was explored by using a nonparametric Mann-Kendall (MK) trend test. In addition, the correlation between these topics was further explored and visualized based on a semi-parametric Gaussian procedure.

RESULTS: The annual trend of publications concerning AIEd had grown consistently across the past 20 years, indicating that research on AIEd had received a growing interest from academia Analyses on topical trends, correlations, and clusters reveal distinct developmental trends of these topics and promising research orientations. Specifically, the top six topics having the highest proportions in the dataset were cognition and perception, programming education, prediction, MOOCs, semantic Web and recommender systems, assessment and feedback, and emotion detection. Results of the MK test highlighted five topics receiving an increase in research interest, including prediction, assessment and feedback, flipped classroom and biosignal data, STEM education, and English language learning. In addition, several inter-topic research directions were identified, including 1) flipped classroom and biosignal data, emotion detection, and game-based learning, 2) artificial intelligence algorithms and prediction, 3) mobile and robotics-based learning and STEM education, as well as 4) English language learning, MOOCs, semantic Web and recommender systems, assessment and feedback, and natural language processing.

CONCLUSIONS: The topic-based bibliometric analysis contributed to the community of AIEd by providing a comprehensive overview. The exploration of important topics, topic prevalence and developments, and emerging inter-topic directions helps identify and compare current and potential scientific strengths. These findings help educators and researchers promote current and potential competitive research areas and enhance scientific communication and collaborations with promising countries/regions or institutions in specific research areas to bolster the scientific activities of AIEd.

CORRESPONDING AUTHOR: Di Zou

KEYWORDS: Artificial intelligence in education; structural topic modeling; bibliometric analysis; research topics; research evolution

Emotional Issues in Collaborative Learning: Bibliometrics with Topic Modeling

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BACKGROUND: Collaborative learning has been widely researched in education. The roles of motivation and emotions have been found to be central to collaborative learning. Research on emotional issues in collaborative learning has increasingly become an active field. However, no attempt has been made to evaluate the literature concerning emotional issues in collaborative learning. This study is thus conducted to fill this gap by summarizing its status and development trend.

METHODS: This paper presents a quantitative overview of the research concerning emotional issues in collaborative learning. The study is based on articles published in the Science Citation Index Expanded (SCIE) and Social Sciences Citation Index (SSCI) databases of the Web of Science between 2010 and 2019. In total, 824 articles are identified and quantitatively analyzed by using topic modeling and bibliometric analysis. Specifically, this study identifies the major research topics and their developmental trends, leading countries/regions and institutions around the world that have conducted relevant research on emotional issues in collaborative learning. Additionally, this study also identifies the journals that include the most articles, and the scientific collaborations between top countries/regions and institutions.

RESULTS: There is a generally increasing trend of annual articles and citations in the research concerning emotional issues in collaborative learning. Results from topic modeling provide important insights into current research hotspots as well as future research directions. For example, learners' technology acceptance and perception in collaborative learning are worth highlighting. Second, emotional issues such as learners' motivation, perceptions, and self-regulation are increasingly concerned by scholars conducting research concerning flipped or blended learning-based collaborative learning. Third, the anxiety of learners with special educational needs is increasingly concerned by scholars conducting research on collaborative learning. Furthermore, researchers should keep up with issues concerning learners' collaboration learning anxiety, learning perceptions and satisfaction, perceived usefulness of wikis when conducting studies concerning wiki-based collaborative language learning. Additionally, from a methodological perspective, in addition to statistical methods such as learning analytics and structural equation modeling, artificial intelligence techniques such as machine learning and sentiment mining and analysis have shown an increase in applications in the research field.

CONCLUSIONS: It is worth highlighting the potentially informative and valuable implications of this study, which may help scholars, policymakers, and practitioners understand the past, present, and future scientific structure of research concerning emotional issues in collaborative learning. Findings concerning influential institutions, countries/regions, and journals help scholars in identifying influential actors in the research field from whom they may learn and explore potential scientific collaborations.

CORRESPONDING AUTHOR: Di Zou

KEYWORDS: emotion, collaborative learning, research topics, research evolution, scientific collaboration, structural topic modeling

Interaction Between Primary Teachers' Teaching Conceptions and Practices in AI Curriculum Development: An Interactional Ethnographic Study

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BACKGROUND: Developing a new and non-traditional curriculum is a complex and challenging process. Since the last decade, the rapid development of artificial intelligence (AI) has called for piloting AI-related educational programs. Nevertheless, integrating AI into K-12 education as a sort of content knowledge, as well as developing the corresponding curricula, has been in slow progress. Yet few studies have been conducted to examine the practice and process of curriculum development. To fill in the research gap, this research aims to study primary teachers' engagement in developing an AI curriculum, focusing on how and in what ways they (re)frame their teaching conceptions and practices. Such knowledge will provide the field with a better understanding of how to support AI curriculum development.

METHODS: Interactional Ethnography (IE) will be adopted as the methodology to guide the whole research. The study will be conducted in two primary schools in Beijing, mainland China. From these two primary schools, six teachers are chosen as the research subjects who are representative of different (i) grades of teaching and (ii) years of teaching experience. The researchers are going to trace these six teachers' instructional practices and teaching conceptions over one year, with teaching observations and individual interviews. For the data analysis, sociolinguistic discourse analysis and intertextual analysis will be employed to investigate the dynamic interaction between teachers' instructional perceptions and practices in developing the AI curriculum.

RESULTS: The research findings will unfold a developmental process of teaching conceptions and practices which is in complex, dynamic and evolving natures. Firstly, the teachers' conceptions of AI education appear to be evolved along with the improvement of their instructional practices and strategies. Secondly, teachers' teaching conceptions might be powerful motivation agents for teaching practices. If teachers believe something to be true, they are likely to act accordingly. Thirdly, the interaction between teachers' teaching conceptions and practices seems to be mediated by some other factors. For instance, to what extent students can absorb new knowledge and what teachers perceive as importance in their school contexts might mediate the interaction.

CONCLUSIONS: This research will figure out the process of how teachers' conceptions are constructed and interacted with the design and implementation of the AI curriculum over time in the corresponding socio-cultural context. In this evolving process, the dynamic mechanism behind an emerging curriculum development will be uncovered, in which we can better interpret the relationship between teachers' conceptions and practices. Especially under the background of curriculum innovation, such research will contribute to reveal and better understand the course of developing a new and novel curriculum. For teacher education, this research will provide valuable and practical instructions for pre-service teachers to support their professional growth with regard to designing a new curriculum. For educational policy making, some standards and guidance can be promoted to create a supportive environment for nontraditional curriculum development.

CORRESPONDING AUTHOR: Miao Yue

KEYWORDS: Teachers' conceptions; Teachers' practices; Interactional ethnography; AI curriculum

Revisiting Searlean Mathematical Room Argument and its Meaning to Mathematics Education

Ka-wo Chan

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BACKGROUND: The Chinese Room Argument (CRA) propounded by the American philosopher J. R. Searle first fin Searle (1980) is one of momentous philosophical arguments against certain claims associated with artificial intelligence (AI), particularly the so-called strong AI thesis. In Ng (1994), the author adapted CRA to mathematics and propounded an argument called the Mathematical Room Argument (MRA) to argue that the computer could not understand mathematics, in contrast with his another contention, which he called CAM, that the computer can do all the mathematics that the human beings can do. The conclusion of MRA, according to Ng (1994), have certain implications to mathematics education in secondary schools. Given this backdrop, I will re-scrutinize CAM and MRA to see what it can inform us about the education of mathematics, particularly the so-called pure mathematics, at university level. I hope that through this examination my discussion can shed some light on the following two problems:

(1) What understanding in mathematics should consist in?

(2) Could AI supersede mathematicians in mathematical research?

METHODS: This discussion pertains to the area "Conceptual frameworks for integrating education and AI" which involves conceptual clarification of certain ideas in AI. Such kind of clarification is usually subject to philosophical analysis of relevant key concepts in the area concerned.

CONCLUSIONS: The concept of understanding is hierarchical in nature which comes into degrees rather than a simply yes-or-no one. So, the original CRA and thus MRA, given certain standard model of computation like the Turing machine, can at most indicate that the computer may not be able to attain certain level of understanding of mathematical concepts or grasp certain abilities which mathematicians should have. This cognitive inadequacy could be manifested by certain indicators associated with such mathematical prowess as generalization or abstraction of mathematical concepts frequently appear in contemporary mathematical studies. Furthermore, meta-mathematical decisions pertaining to processes like mathematicalization of various concepts in different areas of human pursuit of truth or judgements pertaining to evaluation of holistic coherence of mathematical enterprise *per se* should also be entertained in appraising the capability of AI in mathematics education.

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CORRESPONDING AUTHOR: Ka-wo Chan

KEYWORDS: Chinese Room Argument, Mathematical Room Argument, Understanding in Mathematics, Metamathematics, Mathematics Education

Theme 2 ---- Leveraging Chatbot to Support Learning

Providing Personalized Learning Support with AI Chatbot

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[2]*Department of Computing, The Hong Kong Polytechnic University, Hong Kong SAR*
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BACKGROUND: The use of chatbots has proliferated in education. Many successful cases of applying Artificial Intelligence (AI) chatbots were published. Georgia State University implemented a chatbot (AdmitHub, 2015) to help new students to make a smooth transition to college. A recent application of inclusive chatbot (Heo, J. & Lee, J., 2019) to enable international students and academics to effectively acquire essential information regarding their academic and campus life. In this project, we proposed to use AI chatbot to provide personalized feedback to students to meet their diverse needs. One-on-one individualized tutoring can help to provide specific study tips to enhance students' learning performance and experience if timely feedback can be received, but it is difficult to be employed in large class size or intensive courses. Using chatbots to create intelligent tutors is a potential solution. In this project, the AI chatbot system will be integrated into a Moodle-based online learning platform called GMoodle (https://gmoodle.eduhk.hk) to provide timely fact-based feedback, retrieve real-time learning progress and provide personalized advice for students. On the other hand, teachers can also use it to build their knowledge database to improve teaching productivity, reduce repetitive tasks and identify common learning problems. To study the effect of using AI chatbots as intelligent tutors on the learning and teaching experiences of students and teachers in higher education, experiments will be conducted in four different undergraduate courses.

METHODS: The framework of integrating AI chatbot into GMoodle online learning platform is shown in Figure 1. In the existing learning platform, students can collaborate and discuss with the other students to generate new knowledge. All these activities will be stored in the database of online activity logs that contains different tables. In this project, AI chatbot has been implemented with conversational interaction and NLP to facilitate effective communication with students. Students can ask questions related to the course as shown in Figure 2, and corresponding link(s) will be provided for getting further information.

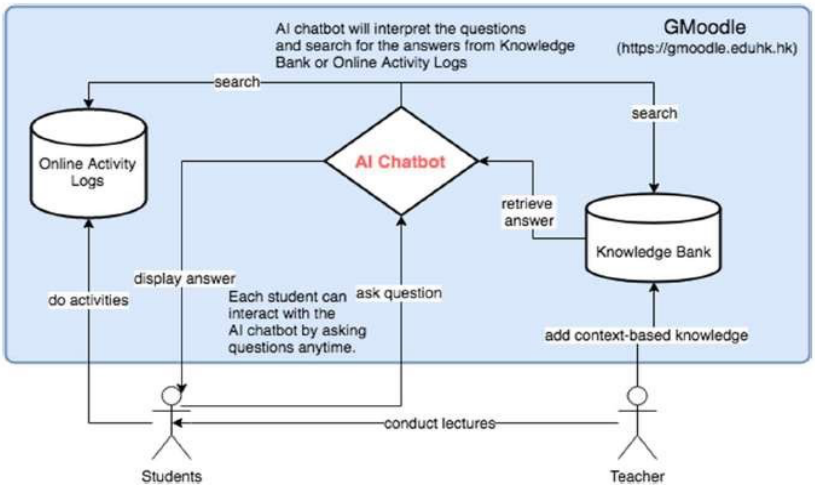

Figure 1. Framework of AI Chatbot in GMoodle

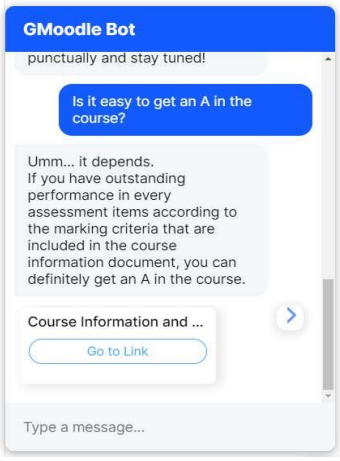

Figure 2. AI Chatbot response

RESULTS: The impact of applying AI chatbot on students' learning outcomes will be evaluated by questionnaires and semi-structured focus group interviews from four undergraduate courses. We expected that students will ask more questions comparing to regular class without the AI chatbot. Through the interactions between the students and the AI chatbot, we can promote active learning behaviour and promote self-learning with personalised recommendations from the AI chatbot. We foresee that there may have many questions that the chatbot cannot answer due to small training data set. However, this system will arouse students' curiosity of learning and motivate them to explore the course through the AI chatbot.

CONCLUSIONS: In these few years, the AI chatbots technology has gained more attention and become a new trend in many fields including educational context. AI chatbots can potentially help students and teachers to streamline the learning process to maximize the learning outcomes and promote active learning. There were a number of successful cases of applying chatbots in education (Clarizia et al., 2018; Dutta, 2017, Kim et al., 2018), but no study has been conducted to study the effect of integrating AI chatbots in regular courses of higher education in Hong Kong. In this project, we will offer a personalized education to foster students' learning to prove AI chatbots are the means to facilitate this outcome.

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KEYWORDS: AI chatbot, personalized learning, timely feedback, active learning

Impacts of AI-based Chatbot on College Students' After-Class Review, Academic Performance, Learning Motivation and Attitude towards Public Health Courses

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BACKGROUND: After-class review is an important and commonly adopted strategy to strengthen students' learning performances. After learning new knowledge, review activities to consolidate the mastering new knowledge, analyze that the learning topic contains certain aspects, and make an overview of the learning content (Shinogaya, 2012). Scholars have pointed out that without review, students are likely to forget nearly 42% of the learning content in 20 minutes after the class (Barrouillet, Bernardin, & Camos, 2004). Therefore, timely review after unit teaching is important for knowledge retention. However, educators found that some students might hesitate to ask questions no matter in the class or after the class owing to various reasons. This makes it difficult for the teacher, during the review process, to provide effective feedback to individual students to resolve their problems. Researcher have pointed out that the quality and quantity of feedback to students in the teaching and learning process is often insufficient (Carless, 2006; Higgins, Hartley, & Skelton, 2002). To enable students to receive quality and instant feedback during the learning process and to enhance their motivation to learn as well as facilitating their knowledge construction, it is imperative to use modern technology for after-class review.

Public health courses mainly teach about health protection, risk control of infectious disease, and environmental hazards. Rich knowledge and practical experience are needed. Research shows that students are often disappointed with the public health courses offered in medical schools and hope to have more public health practitioners with practical experience involved in the curriculum(Blank & McElmurry, 1988; Tyler et al., 2009) to clarify all the possible doubts during the course review process. Many studies show that the knowledge in the previous stage is learning the foundation of post-stage knowledge (Lawson, 1983; Peklaj, Podlesek, & Pečjak, 2015). If problems students encounter in the class cannot be solved in time, not only their prior knowledge could be poorly mastered, but also the new knowledge could not be well learned. Without proper assistance, this problem could become more serious (Binder et al., 2019; Hailikari, Katajavuori, & Lindblom-Ylanne, 2008).

To enable practitioners with hands-on public health experience to be involved in the curriculum, so that students can understand the continuity of theory and practice, an application (APP) for professional content creation and train through artificial intelligence (AI)-based chatbots, through The advantages of a good dialogue interface give full play to the ability of immediacy and response, give personalized answers, solve the problems encountered by students in the review, and get appropriate feedback, enhance learning achievement and attitude (Beaudry, Consigli, Clark, & Robinson, 2019; Bhargava et al., 2020; Go & Sundar, 2019; Lee et al., 2020). Therefore, the main purpose of this research is to study the use of AI-based chatbots in the public health curriculum of college students, particularly the units on infectious diseases by analyzing their learning achievement, motivation, and attitude. The research questions of the study are as follows:

1. Does the use of AI-based chatbots in public health curriculum review affect students' performance?
2. Does the use of AI-based chatbots in public health curriculum review affect students' learning motivation?

3. Does the use of AI-based chatbots in public health curriculum review affect students' learning attitude?

METHODS:

1. Research tools: Manufactured by Taiwan's Centers for Disease Control and Prevention and HTC Co., Ltd., the AI-based chatbot used in this study incorporates medical language processing (MLP) and artificial intelligence. Its functions, shown below in Figure 1, include interactive consultation on notifiable infectious diseases, such as their means of transmission, symptoms, and treatment methods. The chatbot was developed on LINE, a social communication application, since students in Taiwan generally have experience of using this application, which makes it easier to promote the use of the chatbot without additional cost.

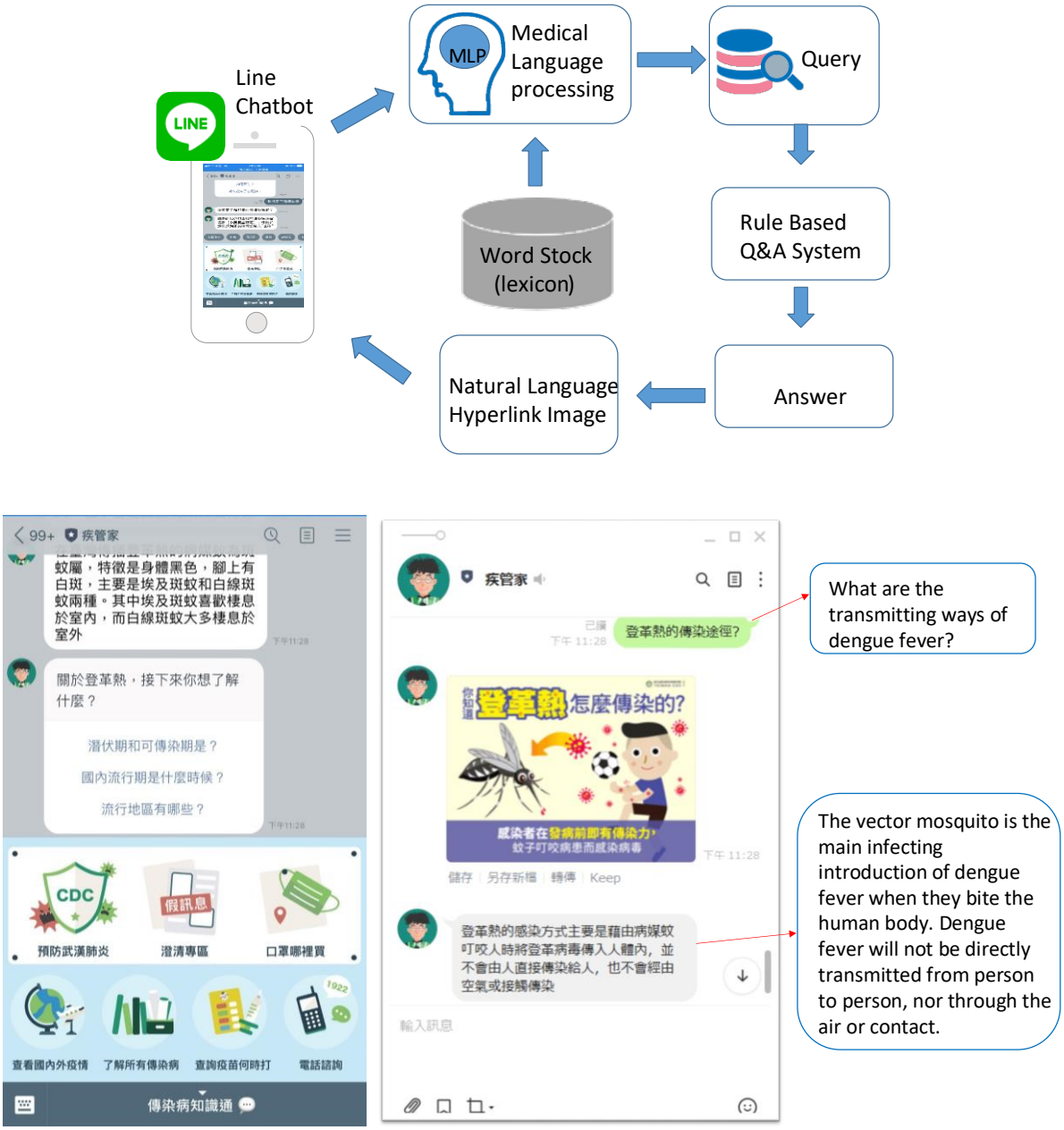

Figure 1: Diseases Stewardship APP

2. Research object: This research is carried out using the Quasi-experimental research method. The experimental group consisted of 18 students reviewing a printed textbook with an AI-based chatbot, while the control group was 20 students reviewing a printed textbook and interacting with the teacher.

3. Research design: This study explores the impact of AI-based chatbot via conducting an experiment on the "review of infectious disease" unit in a college public health course. The experiment was conducted for two weeks. In each week, the teacher gave lectures to the students in two 50-minute sessions. After finishing each unit and provide a worksheet to help students summarize the key points of learning, as shown in Figure 2 and 3.

And the experimental group reviewed with the chatbot, while the control group reviewed with the help from the teacher. The students' academic performance, learning motivation, and learning attitude were evaluated before and after the activity. In addition, open-ended questions, such as "How does this way of learning and review differ from the way you have experienced (or expected) before? (For example, using chat robots to assist in learning and reviewing, and how is it compared to previous learning and reviewing? Do you think it is effective? Why?)" were used to collect the students' perceptions for in-depth analysis after the learning activity.

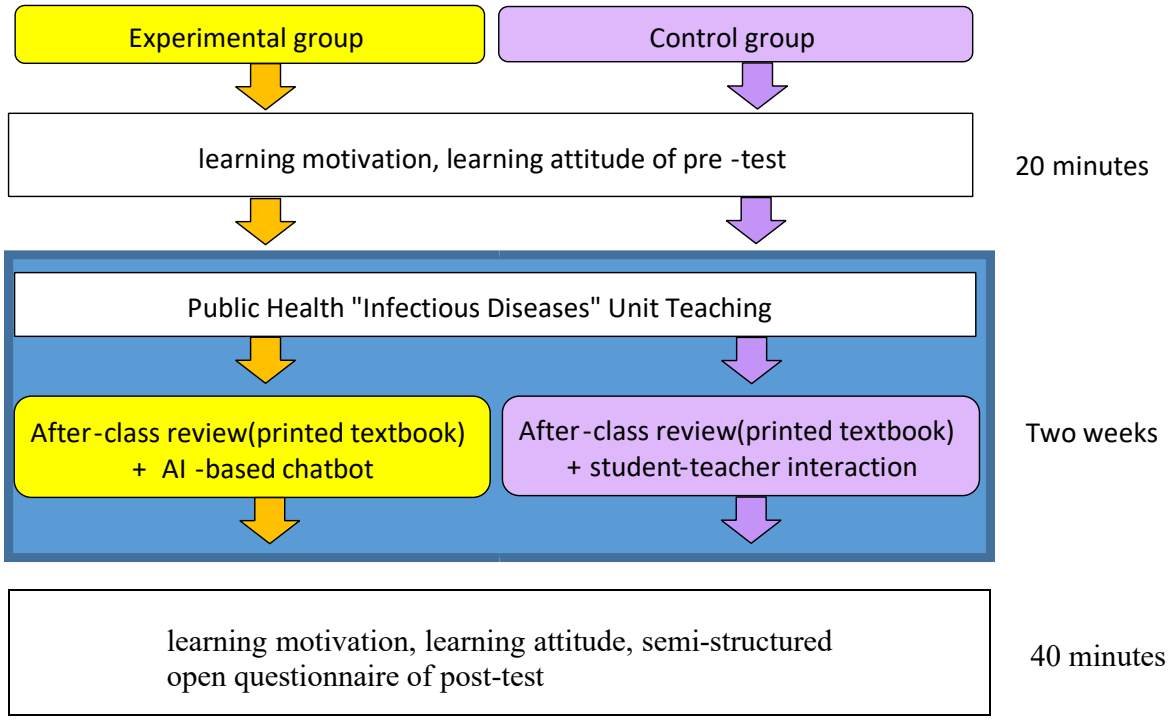

Figure 2: Experimental procedure

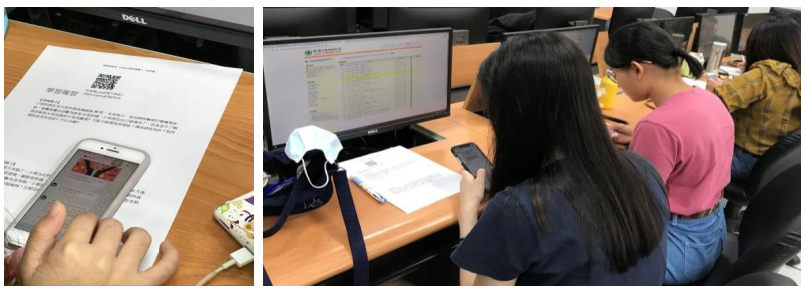

Figure 3: Reviewed with the chatbot

RESULTS: A quasi-experiment was conducted in this research, with the subject being the review process of the infectious disease units in our public health course. The experiment lasted for two weeks. The experimental group used AI-based chatbot and printed textbook to review, while the control group used traditional review where interactions with the teachers and printed textbook are involved. The experiment conducted a post-test to detect changes in learners' academic performance, learning motivation, learning attitude, and classroom participation.

Use ANCOVA analysis and qualitative analysis. The expected results are as follows:

1. By incorporating AI-based chatbot in the review process, the experimental group's average academic performance was 66.33, with standard deviation being 10.39. Comparatively, the control group's average was 57.40 with the standard deviation being 12.33. The ANCOVA analysis showed significant differences between the two groups ($F = 7.70$, $p < .01$, $\eta 2 = 0.18$), meaning that the experimental group and the control group have different learning results because of different review methods. This shows that the addition of AI-based chatbot to the learning review is helpful for students' performance.

2. In terms of learning motivation, the average for the experimental group is 4.22 with the standard deviation being 0.52, while the average for the control group is 3.67 with the standard deviation being 0.36. The ANCOVA analysis shows significantly different results for the two groups ($F=5.39$, $p < .05$, $\eta 2=0.13$), which means that the experimental group and the control group have different learning motivations because of different review methods. For the experimental group, the addition of AI-based chatbot greatly improves the students' motivation.

3. In terms of learning attitude, the average of the one-way ANCOVA learning attitude for the experimental group was 4.36, with the standard deviation being 0.59, while the average for the control group was 3.67 with the standard deviation being 0.47. The ANCOVA analysis again showed a significant difference ($F = 8.60$, $P < .01$, $\eta 2 = 0.197$), which means that the experimental group and the control group have different attitudes towards learning due to different review methods. The experimental group has a better learning attitude due to the addition of AI-based chatbot in the review process.

CONCLUSIONS: The results of the study show that the application of AI-based chatbot in the review process of public health courses improved the students' learning motivation and attitudes. Through the semi-structured open questionnaire to interview students' feelings about the learning mode, some students pointed out that "In previous activities I experienced, printed learning sheets were adopted, which was boring, and I needed to find a way to review the learning sheets on my own. Using the chatbot is more interesting and it is easier for us to remember the content than using the traditional approach." "The chatbot responds to my questions immediately and I feel I have been given attention," and "There is no time limit, I can seek help from chatbot at any time and in anywhere." In short, the chatbot helps the students to become more active about their study and provide them with sufficient feedback during the review process, thereby improving students' academic performance.

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KEYWORDS: chatbot, review, artificial intelligence, feedback

Smart Assistant for Academic Advising

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BACKGROUND: Academic advising is an important but easily overlooked service to many students, especially to the freshmen and underperformed students. In tertiary education, students take a more active role in their study planning and personal development. They may not aware their needs for advising as it is usually designed for those problematic students in high schools. Furthermore, some students may feel reluctant to setup face-to-face meetings with their academic advisors for seeking advice.

Recent advances in chatbot technologies provide an alternative for students to seek academic advising online. Chatbot is a computer program that provides an interactive conversation with user after training. It does not only automatically engage in a conversation but also learns from each conversation to provide a better response next time. In many applications, chatbot is more welcome than a real-person interaction due to its high availability (24x7) and large knowledge based.

METHODS: In this paper, we studied the feasibility and suitability of using chatbot in assisting academic advising. Academic chatbot should be flexible and adaptive. It should be flexible in interpreting student questions and provides answer that fits the conversation context. Canned response should be avoided as far as possible. On the other hand, consider the variety and volatility of academic guideline and requirement from different academic units and periods, the chatbot should be easily updated by administrative staff with no technical background. To achieve these goals, we build the chatbot with two components. The first component is the standard chatbot module with different questions and answer patterns. Another component is an web-configurable database which provides necessary information, criteria and actions to the chatbot for answering students' questions.

Furthermore, the chatbot should also able to sort out the unsettle questions and forward them to the related staff for following up. To train the chatbot, we setup a questionnaire to collect the common questions from year 1 students.

RESULTS: We have studies several chatbot platforms and select IBM Watson Assistant to build our prototype. The chatbot is capable to provide answers for questions in 3 major categories: (1) programme selection, e.g. which academic department the students should study based on their career plan, interest and job nature. (2) Courses selection: course can be / should be taken based on their programme and study progress. (3) Useful resource for newly admitted students. A web interface was built to facilitate the administrative staff to update the information such as the department and programme provided by the faculty, career list, available course and their dependency (prerequisite and precursor of different courses), and academic requirement of programme selection.

CONCLUSIONS: This study provides a fundamental work on applying chatbot in academic advising. We found that the accuracy of the chatbot is largely relied on training data which is not quite ready. In order to make the chatbot smarter, the system should allow administrate staff to review the dialog between chatbot and students, and the accuracy of the answer provided by the system. In the future, we would like to extend the chatbot to the administrative staff so that they can update the information via chatbot instead of web interface.

KEYWORDS: Artificial intelligence applications; Chatbot; Dialogue Systems; Academic Advising

Designing a Chatbot to Teach English: Transforming Learning Spaces

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BACKGROUND: The potential of natural language processing tools such as chatbots in learning a second or foreign language has not yet been fully realised (Dale, 2016; Fryer et al., 2019). Language learning occurs through interaction with classmates and teachers, which provides comprehensible input, feedback on output and the opportunity to modify output (Mackey, 2012). Chatbots can serve as an always-on source of interaction. In this study, a chatbot was designed and deployed using Dialogflow Messenger. It acts as a conversational interface for English learners and is available on our website or as a mobile application (app). Language learning is most effective when it is immediate and contextual, so this chatbot not only 'chats' but also guides learners to appropriate language study resources. It puts students in control of their learning by answering specific questions (e.g., How do I refer to sources in written texts and oral presentations?, Where can I find IELTS materials?, What is the present perfect?); providing customised learning options; and allowing students to learn at their own level, pace, and at a time of their choosing. This study investigates English language students' attitudes, beliefs, and perceptions towards using a customised chatbot to enhance language learning.

METHODS: Participants consisted of students and teachers (n=4) from a compulsory English for Academic Purposes course at the largest public university in Hong Kong. In this study, the students (n=76) had access to the chatbot for two months. Data on attitudes, beliefs and perceptions regarding the chatbot were collected using a questionnaire and focus groups; transcripts were collected to identify questions put to the chatbot. This mix of methods was chosen to provide rich, detailed, and complex accounts of users' experiences.

RESULTS: Findings from the questionnaire and focus groups are consistent with previous research that reported positive learning experiences with chatbots (Fryer & Carpenter, 2006; Lin & Chang, 2020). Of the student participants, 85% said it was an enjoyable learning experience and 71% said it answered their questions and directed them to suitable study resources. Transcripts revealed that the most common questions were about IELTS materials (e.g., Where can I find a sample Task 1 essay?, How do I get a high score on Task 2 of the speaking part?) and subject-specific questions about assignments (e.g. How many in-text citations are required?, How do I write an integral citation?). In the interviews, a majority of the participants (students and teachers) highlighted the detailed, concise answers/feedback and suggestions as beneficial and informative for language learning.

CONCLUSIONS: The results indicate the chatbot provided rapid access to rich language learning content and encouraged students to find solutions to their questions through self-directed study. These results show that chatbots are a valuable, viable tool for language acquisition.

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KEYWORDS: Chatbot, Natural language processing, language learning, self-directed

Stimulating and Sustaining Language Acquisition: Chatbots as a Pedagogical Possibility

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BACKGROUND: This study introduces the English Language Centre's Personal Learning Assistant, namely chatbot, an innovative language teaching and study tool for independent and effective language learning. This relatively new and under-researched area of study will, through the use of chatbots, open new and exciting teaching opportunities (Kessler, 2018). Chatbots necessitate communicative exchange, thus enhancing dialogue-based learning (Fryer et al., 2017; Thompson, Gallacher, & Howarth, 2018). In English language acquisition, teachers traditionally adopt a facilitator role. In contrast, chatbots, as conversational agents, provide students with a natural language interface. In many contexts, including English as a second language (ESL) and English as a foreign language (EFL), technology has been developed to assist language learners. However, there is still a need to practice the language with an on-demand 'conversational partner' (Kim, 2017), and chatbots can address this requirement (Shawar, 2017; Wang & Petrina, 2013). This study investigates how students perceive the Personal Learning Assistant as a supplement to direct teacher input in language learning.

METHODS: Participants consisted of students from a general English course at the largest public university in Hong Kong. The study adopted an exploratory qualitative approach, collecting two types of data in two phases. The first phase, a questionnaire (n=47), provided an overall picture of the research problem and informed the second phase of data collection, which comprised semi-structured interviews (n=12) (Ivankova, Creswell, & Stick, 2006). Thematic analysis of the interviews allowed the researcher to interpret participants' voices and gain a holistic understanding of their views.

RESULTS: The questionnaires and semi-structured interviews revealed that participants preferred the chatbot to traditional study methods such as visiting a library or asking a teacher. They benefited from unlimited opportunities to ask questions and repeat words, phrases, and sentence structures (Fryer & Carpenter, 2006). Several participants reported that using the chatbot was less time-consuming and more convenient, as they were able to get immediate replies. As the chatbot provides language interaction and practice through questions and answers, participants perceived it as a 'conversational partner' (Kim, 2017). Overall, by facilitating conversation, it heightened participants' language learning motivation.

CONCLUSIONS: The study investigated the potential of a chatbot (developed in-house) to act as a conversational interface to supplement direct teacher input. The data suggest the chatbot suits English learners' individual needs. Its question-and-answer interaction is potentially a better aid to language learning than traditional methods. The introduction of this innovative tool improved students' learning opportunities, helped them become self-regulated learners, and empowered them to improve their question-formulating skills, thus fostering positive attitudes towards language acquisition.

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CORRESPONDING AUTHOR: Lucas Kohnke

Keywords: Chatbot, English language learning, Self-regulated, Interaction

Theme 3 ---- Developing AI Literacy

Developing Teachers' Technological Literacy in AI, Data and Learning Analytics: A New Blueprint for Australian Schools.

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BACKGROUND: Teachers' interest in the affordances of artificial intelligence (AI), data and learning analytics in school education from the early years to the latter years of schooling across the world is growing. This paper introduces a new ten direction 'blueprint' for education in schools from research conducted in Australia in the early, elementary and middle years where the focus was on building teacher capacity in STEM using a pedagogical framework for digital learning.

One key direction that arose from the findings of three studies conducted over four years and now heralded in the 'blueprint' has an emphasis on developing technological literacies where virtual reality, augmented reality, robotics, coding, and computer programing are important, but so too is the inclusion of AI, data science, and learning analytics.

The relatively new challenges for schools around AI, data, and learning analytics include online personalised learning programs; the role of facial recognition software; teacher dashboards that track progress in real-time; data storage polices; and who has access to records of professional development activities, accreditations, and the test results of students. These and other issues identified in the Australian research concern ethical issues and the need for such matters to be prepared for, widely debated, and better understood in schools. Caution in this space is required and although AI is taking over a great deal of what has previously been viewed as the human domain, we need to change the way we view intelligence to ensure our education systems enable human intelligence to remain the smartest on earth (Luckin, 2018).

Teachers at all levels of professional experience need to know what questions to ask about the opacity of systems, the identification of algorithmic bias, and ethical practices in regard to policy, governance, and data. Addressing these apprehensions will strengthen all sectors of society. In schools, students require stage-appropriate introductions from the early years alongside discussions such as cyber-safety and optimal screen-time, progressing towards awareness of digital nutrition (Brewer, 2020) and digital citizenship (Basha, 2018).

METHODS: The Australian research involved a mixed-methods design that was facilitated by an academic partner at 14 primary schools. Conducted with 59 teachers and more than 1500 students it used action research principles where teams of teachers' co-taught using the *High Possibility Classrooms* framework (Hunter, 2015) with various technologies and content from curriculum in the STEM subjects in inquiry learning sequences, project-based learning and design challenges.

RESULTS: Results of the studies demonstrate that teacher capacity and confidence is significantly enhanced in using AI, data and learning analytics when they co-plan, experiment and co-teach in small teams supported by an academic partner. Critical to building personal technological literacy is future focused school leadership, the provision of time for professional development and the adoption of ethical educational technology polices in classrooms.

CONCLUSIONS: Evidence in an Australian 'blueprint' for High Possibility STEM Schools suggests that effectively developing the technological literacy of teachers arises out of their engagement with integrated approaches to STEM in teaching and learning. A sense of collective urgency in the minds of some communities on the role of AI, data and learning analytics in education suggests the discussion has never been more important.

CORRESPONDING AUTHOR: Jane Hunter

KEYWORDS: STEM, High Possibility Classrooms, pedagogy, teacher professional learning, AI in school education,

Incorporating the Audio Instruction Classifier into the Computational Thinking Board Game

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BACKGROUND: This study attempted to design an instructional material of computational thinking (CT). This CT learning material is a board game which applied the personal audio classifier. With the vigorous development of artificial intelligence, the application of AI has significantly impacted on not only our daily lives but also the technology education in K-12. The interdisciplinary application, such as Science, Technology, Engineering, Mathematics (i.e., STEM) is also emphasized in K-12 right now. The cultivation of computational thinking and the application experience of artificial intelligent are considered to be the essential information literacy for the new generations. The application of the image classifier has been widely used in stem education and maker education, but the application of the audio classifier has not. Therefore, our study employed personal audio classifier into the secondary school education. The purpose of the study was to train an artificial intelligence model by transforming the audio signals into the sound images first. The artificial intelligence model recording the spectrograms is utilized to classify the instructions you said orally, and then the controlled objects in the computational thinking bard game will react the corresponding actions. In the learning process with the AI instructional tool we designed, the students will experience the process of machine learning and cultivate the competence of computational thinking.

METHODS: This study designed a computational thinking instructional tool with personal audio classifier. The system is shown as Figure 1. In the instructional material, the students speak the words of instructions and the sound will be recorded. The personal audio classifier platform developed by MIT App Inventor will then transform the recorded audio signals to the spectrograms of the sound. The students have to give three different tags which are forward, turn right and turn left on the personal image classifier platform. In the training step of experiencing machine learning, the students provide the instruction in sound and classify each oral instruction to its corresponding tag. After training the artificial intelligence model, it will become a classifier model and the students can embed it into the smart phone app. The users can utilize their sound to control objects in the computational thinking board game with the app.

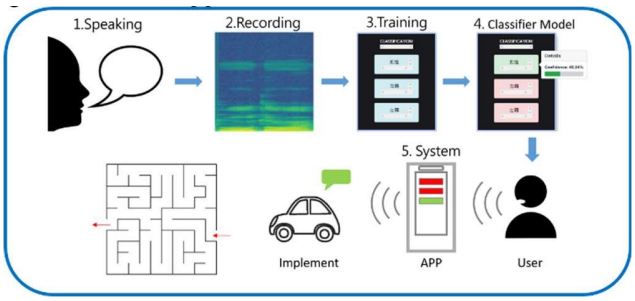

Figure 1. The students experience from the first step to the final board game.

RESULTS: From experiencing the process of making the classifier and controlling the objects with the application to finish the game, the study expected that the computational thinking competence of the students will be increased and the anxiety of artificial intelligence will be decreased.

CONCLUSIONS: A quasi-experimental design with pre-test and post-test will be conducted in the secondary school. The effectiveness of the instructional design will be proved.

CORRESPONDING AUTHOR: Ting-Chia Hsu

KEYWORDS: Machine Learning, Classifier, Audio, Computational thinking, Board game

Thinking Aloud and Progressing Together: Cultivating Communities of Practice for Supporting Hong Kong K-12 Schools in Embracing Artificial Intelligence

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BACKGROUND: In recent years, there has been considerable interest in taking up the opportunities of Artificial Intelligence (AI) in education. As an emerging concept and a driving technological force, AI is changing the kind of knowledge and skills students need for success in the forthcoming *Industrial Revolution 4.0*, and at the same time, enabling novel, powerful methods of teaching and learning. Although many school leaders, policy-makers and frontline teachers understand the need for embracing AI, they may lack clarity on what to teach students in the era of AI; how to harness the power of AI tools; and where to start given their own school contexts. This paper describes an ongoing study that uses Communities of Practice (CoPs) as a knowledge management strategy to support Hong Kong K-12 schools in embracing AI. CoPs comprise members who genuinely care about a mutual interest and seek to solve a common problem. The premise underlying this study is that the cultivation of CoPs may present enabling conditions and pave the way for AI adoptions. In these CoPs, members would engage in reflective discussions on the opportunities and challenges of embracing AI in their schools and collaboratively support each other through meaningful knowledge exchange.

METHODS: A collective case study is being conducted with members from 20 K-12 schools in Hong Kong to substantiate and illustrate the power of CoPs that aim to support schools in embracing AI. Qualitative data are gathered via semi-structured interviews and focus-group meetings with participants. Thematic analysis is adopted for analysing the data.

RESULTS: The preliminary results of this ongoing study have shown that CoPs, if successfully launched, can play an uplifting role for Hong Kong K-12 schools embracing AI. More specifically, the collaborative learning process in CoPs has helped members make sense of AI core concepts and the pedagogical implications as they access authentic, relevant and updated information. The collective reflections have further allowed them to distinguish between reality and hype of AI technologies, and between the valid AI affordances and unfounded worries of AI in education. While this progress has been encouraging, the effectiveness of CoPs can be influenced by school-specific contextual factors concerning AI such as infrastructure readiness, teacher capacity, student demographic characteristics, which can vary significantly. We therefore argue that meaningful CoPs be designed to allow all participants to critically review and internalise promising practices and lessons learned before they apply these into their unique educational contexts.

CONCLUSIONS: Cultivating CoPs can support Hong Kong K-12 schools to collectively embrace AI. Effective CoPs can help inform educational practitioners to plot a course for AI in education, which is especially important in the early days of AI era.

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KEYWORDS: Artificial Intelligence in Education; Communities of Practice; Innovation Adoption; K-12 Education

Understanding Students' Artificial Intelligence Literacy and Career Aspirations: Students, Teachers, and Experts Views in Indonesian Context

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BACKGROUND: The significant improvement of Artificial Intelligence (AI) technology in human lives triggered the researchers to find out whether or not understanding AI literacy become a new important literacy in the future. The views regarding AI literacy and Indonesian students' current learning environments and experiences in utilizing AI technologies for learning as well as the role of the primary school teachers are important in shaping students' ideas of their future career. Understanding career aspirations of students could help teachers to prepare the students for their future by helping them to acquire the important skills needed.

METHODS: This is a case study towards primary school students in Central Java, Indonesia. The data collected were drawings of their future jobs and AI technologies they are familiar with, and the result of interviews from teachers, students and AI experts. Students drew their imagination of their future jobs in the next 15 or 20 years when they grown-up. In the drawing they included also the technologies that probably be used in their future jobs. Then students were asked to draw what AI technologies they are familiar with. After that, interviews were conducted to find out students, teachers, and experts understanding of AI literacy as a new literacy for future career.

RESULTS: The results portrayed primary students' familiarity of AI technologies in relation with their early career aspirations, and teachers as well as experts understanding of AI literacy. The comparisons between students, teachers, and experts understanding of AI literacy were further discussed in this research.

CONCLUSIONS: This study is a preliminary study of Artificial Intelligence Literacy of Primary school students in Indonesia. This will be the basis for further studies in developing best practice of teaching AI literacy in the context of primary school in Indonesia.

KEYWORDS: Artificial Intelligence Literacy, career aspirations, primary students, Indonesia

University Teachers' Perceptions of Artificial Intelligence Transformations at Higher Education in Pakistan

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BACKGROUND: In recent years, artificial intelligence (AI) has undergone significant development and is an emerging technology to revolutionize the way people live and learn. This technology has already been introduced in higher education, although many teachers are unaware of its scope and, above all, of its composition (HinojoLucena et al., 2019). Colleges and universities currently confront a plethora of challenges, and an appropriate application of AI can help to solve specific challenges (Rouhiainen, 2019). In developing and developed countries, the overall effect of technology in education is studied and debated, particularly in the past decade (Skenderi & Skenderi, 2017). Since Pakistan is still a developing country, the purpose of this study was to gain a better understanding of what challenges we are facing to transform AI at higher education in Pakistan.

METHODS: A mixed-method research design was used for this study. A total of 238 IPFP fellows (Assistant Professors) in different universities of Pakistan filled an online questionnaire developed from previous studies (e.g., Gherheș, 2018; Holder et al., 2018; Pinto dos Santos et al., 2019; Rouhiainen, 2019; Skenderi & Skenderi, 2017); furthermore, six interviews were also conducted. Higher Education Commission (HEC) Pakistan initiated the IPFP (Interim Placement of Fresh PhDs) Program in 2009, both to employ fresh PhDs and support universities in attracting qualified faculty. IPFP provides all Pakistani fresh Ph.D. graduates an opportunity to be placed as Assistant Professors on a tenure track system for one year (HEC Pakistan, 2020). All of the participants were involved in teaching and research. Moreover, all participants recently completed one month ''National Faculty Development Program 2020.''

A few of the following questions were part of the questionnaire (1-4) and interviews (5-8): 1- Do you consider yourself a tech-savvy person? 2-Were you already aware of AI-related topics in education? 3- Do you have a basic understanding of the technologies used in AI and education? 4- Do you think that AI will revolutionize education? 5- How aware you think you are in terms of using AI-enabled devices and services? 6- What do you think are the areas in Education where AI has a significant impact? 7- What Challenges are facing universities in the present era? 8- How AI will help universities to overcome these challenges?

RESULTS: The survey results indicated awareness of AI in Pakistan is low; awareness of the possibilities of using AI in education needs to be disseminated further. A little less than half (48.2%) of all respondents were aware that AI was a hot topic in education. There has been a broad consensus that AI could be implemented in higher education. Furthermore, interviews revealed that a combination of human abilities and AI could generate productive results in higher education. AI-based technology platforms will be able to provide universities with insightful knowledge regarding students' learning. However, pilot programs are needed to introduce the AI and its role in higher education.

CONCLUSIONS: Though artificial intelligence is a reality, however, it still is lacking its practical application in higher education. AI and technology are an essential component for the development of developing countries. However, to transform AI at higher education levels as a primary initiative, considerable financial and technical assistance is required. Furthermore, experts are needed to train and enhance the professional skills of faculty members.

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KEYWORDS: AI, Technology, Transformation, Higher Education

Artificial Intelligence (AI) Literacy Readiness for Pre-Service Teachers through the Course Evaluation of Computer Vision, Design Thinking, and 3D Technologies

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BACKGROUND: Computer vision (CV) of artificial intelligence (AI) is pervasive in daily life. One example is the multiple face security system stemming from face recognition technology (Kasar et al., 2016). In the current situation of COVID-19, CV applications have been medically employed; for instance, the face recognition temperature measurement system, which applies face recognition and tracking technology (of CV), is installed at the main entrance of many restaurants to capture real-time body temperature (Ting et al., 2020). AI has evolved since the 1950s when John McCarthy proposed an Al project and attempted to make a machine for using language, forming abstractions and concepts, solving problems for humans, and improving themselves (Rajaraman, 2014). Nonetheless, AI is still a novel topic and innovative for exploration. Among the key fields of AI, the common focus of applications goes to CV, natural language processing (NLP), and robotics (Wiriyathammabhum et al., 2016). With respect to practical project situations, some key fields are integrated, such as robotics with CV for pick-and-place, pick-and-stack operations in factories, or controls driven by CV, etc. In view of the recent development of STEAM education in Hong Kong, AI draws more prominent attention. Students at different levels are now expected to be equipped with AI experience in school (Yeung, 2019). In our university, which is responsible for training teachers in information technology, it is important to nurture our student-teachers to be future teachers to understand the use of AI and its potential applications in the classroom as the AI experts. In this pilot study, we aim at integrating CV and 3D modelling and printing technologies to increase teacher awareness of AI, so at to further formulate our course development with AI elements for STEAM education.

METHODS: This study aims at exploring both pre-service and in-service teachers' understanding of AI in education focusing on CV in STEAM education. This study concentrates on basic robotic operations, namely the CV sensor features with face recognition, colour recognition, and object tracking. The robotic operations are realised with 3D modelling and printing technology with a high degree of freedom. The main micro-controller is BBC micro:bit with additional sensors as an integrative system of the miniature safe box. There were several units of learning prepared while the materials were disseminated for student-teachers' evaluation and learning. The study will include both undergraduate and postgraduate students majoring Information and Communication Technology (ICT) and Design and Technology (DAT) at the Education University of Hong Kong (EdUHK). A questionnaire related to the introduction of AI, 3D modelling and printing technologies, and design thinking were used in the pretest and post-test for the student-teachers. At the same time, the documentation for the learning unit development was also used for data analysis. Through this pilot study, some student-teachers were also invited for the focusgroup interview to elicit a more comprehensive conclusion of the study.

RESULTS: The study explored various computer vision (CV) hardware, sensors, and coding environments such as Jetson Nano, HuskyLens, BBC micro:bit, Mind+, and MadeCode

environments. It found that some sensors, in theory, are compatible but minor adjustments will be necessary. Specifically, the experiences in various coding environments will introduce different success rates of compilation which are worth sharing for the educators with similar interests or needs for the teaching and learning of AI. The data reveal student-teachers' critical reflections on the practical use of learning units, such as the arrangement of topics, practical concerns of coding environments, and hardware settings.

CONCLUSIONS: This pilot study sets the direction for the preliminary curriculum development related to AI in education. It is built on the previous project experiences in STEAM education with coding elements by infusing the new AI elements into computer vision. With the initiative of integrating practical 3D modelling and printing technology, the integrative system as project-based learning of AI and STEAM education also reduces the cognitive load and realises the possibility of learning and teaching of AI in senior primary to junior secondary schools.

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KEYWORDS: 3D technologies, artificial intelligence literacy, computer vision, design thinking, teacher readiness

Theme 4 ---- Leveraging AI to Promote Education

Effects of Incorporating Concept Mapping into an Image-Recognition App on Students' Learning Achievement and Motivation in Environmental Education Activities

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BACKGROUND: "Environmental education" aims to guide students to learn from the nature as well as knowing natural resources, such as various kinds of plants. In environmental courses, students need to learn to identify those natural resources as well as knowing the importance of predicting the resources. “Green life map” is an activity started in 1992, in which participants visit green resources in their daily life environments and learn the environmental protection knowledge. Owing to the advancement of artificial intelligence (AI) image recognition (IR) technologies, image-recognition apps have been employed in the “Green life map” or similar activities to help students identify plants in the field trip.

To know the details of the plants, students need to identify the plants and then search for the relevant information using the names of the plants as keywords. However, identifying plants generally requires long-term experience with the assistance of books or mobile computers. In recent years, with the development of computer technologies, IR has been applied to plant recognition, allowing people to quickly retrieve plant names and related content. However, researchers have reported that, during the field trip, students not only need to identify and find the information of individual plants, but also need to learn to organize the data they acquire. That is, without additional assistance from a knowledge organization tool, students’ learning outcomes could be limited.

There is also a lot of evidence that concept map, as a learning tool, can promote meaningful learning by helping them organize the acquired knowledge (Novak & Gowin, 1984). Several previous studies have reported that the use of concept maps can improve students' comprehension and memory ability, and help to cultivate their logical thinking and creative thinking (Hwang, Kuo, Chen, & Ho, 2014; Sun et al., 2018). Therefore, a concept mapping-based IR learning approach is proposed in this study. Moreover, an experiment is conducted to evaluate the performance of the approach by answering the following questions:

1. Do the students learning with the concept mapping-based IR learning approach have better learning achievement than those learning with the conventional IR learning approach?
2. Do the students learning with the concept mapping-based IR learning approach have higher learning motivation than those learning with the conventional IR learning approach?
3. Do the students learning with the concept mapping-based IR learning approach have lower cognitive load than those learning with the conventional IR learning approach?
4. Do the students learning with the concept mapping-based IR learning approach have better approaches to learning science than those learning with the conventional IR learning approach?

METHODS:

1. Research tools: The IR system is an app developed by the Hangzhou Dana Technology using the deep learning algorithm. When the users take photos of flowers or leaves using the app, relevant information is provided, as shown in Figure 1.

Figure 1: Interface of the IR app

2. Research object: in this study, the environmental education course of green life map was conducted. The subjects were 56 tenth graders from two classes of a senior high school in Northern Taiwan. The experimental group (N = 27) learned with the concept mapping-based IR approach, while the control group (N = 29) learned with the conventional IR approach.

3. Research design: The adopted the unit is the "green life map" of the natural science course, in which the teacher taught students how to classify plants by identifying the features of the plants, A quasi-experiment was conducted to compare the learning achievement, learning motivation, cognitive load, technology acceptance, and learning satisfaction of the students in the experimental group and control group. As shown in Figure 2, during the learning process, both the experimental and control groups used IR app to recognize the plants and find relevant information, The only difference was that the experimental group students needed to complete a concept map based on the collected data, while the control group was asked to answer a learning sheet. In addition to the pretest, pre-questionnaires, post-test and post-questionnaires, an interview was conducted to know the students' perceptions in depth.

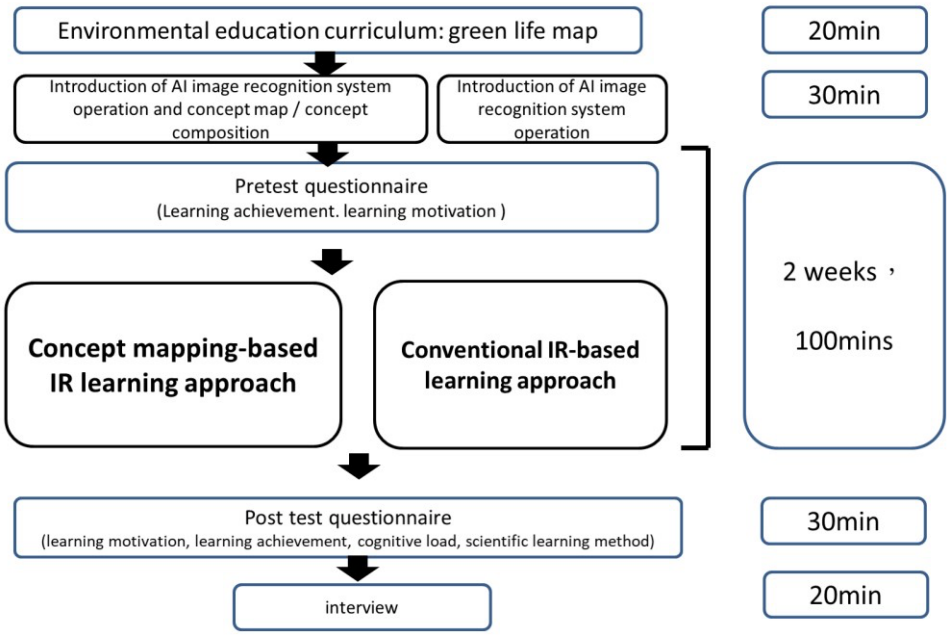

Figure 2:-Experimental procedure

RESULTS: The experiment is still on-going. The expected results are as follows:

1. It is expected that the students learning with the concept mapping-based IR approach have better learning achievement than those learning with the conventional IR-based learning approach.

2. It is expected that the students learning with the concept mapping-based IR approach have higher learning motivation than those learning with the conventional IR-based learning approach.
3. It is expected that the students learning with the concept mapping-based IR approach have lower cognitive load than those learning with the conventional IR-based learning approach.
4. It is expected that the students learning with the concept mapping-based IR approach have better approaches to learning science than those learning with the conventional IR-based learning approach.

CONCLUSIONS: The research results show that the IR-based system can improve students' motivation for environmental education activities. Combined with the concept mapping strategy, it can not only improve students' learning achievement, but also expand students' attitude towards scientific inquiry, from plant identification in the activities to observation of living environment. Therefore, appropriate learning strategies can be introduced into the activities using other AI or IR-based systems to improve students' learning and make them become more active and autonomous learners in the future.

CORRESPONDING AUTHOR: Hsiu-Ling Huang

KEYWORDS: Concept mapping, identification technology, artificial intelligence, environmental education

Toward an AI-Enabled Gamified Online Learning Application to Improve Students' Perception to University Physics

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ABSTRACT: This study discusses the current progress of the on-going design efforts in creating an AI-enabled gamified web-based online learning application in the undergraduate introductory classical mechanics and thermodynamics course in SUTD, Physical World. Physical World is one of the compulsory courses that the students must take upon enrolment to SUTD. However, given the diversity of the background of the students enrolled, the proficiency in Physics varies greatly among students, thus posing a huge challenge for the effective delivery of the course to achieve same level of learning outcomes for all students. The overall design architecture and principles will be discussed in this work, and the existing benchmark using resources available in our existing learning management system to emulate some of our design principles will be described.

METHODS: To tackle the problem of lack of self-efficacy of very weak students towards physics, a learning application is designed and complemented with ideas of gamification within the web application. The designed gamified algorithm will reward students not only when the students are able to answer the assessment correctly, but also based on positive progress made, as long as continuous improvement is achieved. Another intended feature of the platform would be to incorporate AI analytics to track the progress of the students, and to provide reminders and encouragement for them to continue trying by providing suggestions and recommendations to various resources that could help. Also, this functionality can be further expanded to perform analysis on the areas of improvement that the students should work on and provide timely feedback.

RESULTS: The key outputs at current stage are as follows: the integration and implementation of the game mechanics within the web application, the design and implementation of the gamified UI to enhance attractiveness of the application, a working prototype that can be deployed in classrooms.

CONCLUSIONS: The overall design architecture and principles represent the potential enactment of positive learning experience for the students to tackle a subject that is traditionally perceived to be challenging. With the working prototype completed, the next stage would be its implementation and the evaluation of students' experience in using the web application.

CORRESPONDING AUTHOR: Da Yang Tan

KEYWORDS: Gamification, Online Learning, Web Application

Exploring the Politeness Strategies in Online Human-Human Tutoring

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BACKGROUND: The politeness displayed by instructors has been demonstrated as important in facilitating student learning. The study presented in this paper proposes a computational method to analyze the politeness strategies used by both instructors and students in online human-human tutoring and show the potential for application in the future design of Intelligent Tutoring System (ITS).

METHODS: We used a large-scale dataset, which consisted of over 15K dialogues created by 5,462 students and 116 tutors in online human-human tutoring sessions. The dataset was collected with the aid of a mobile phone application, where students can work with instructors to solve problems in subjects such as math, chemistry, and physics. We used a tool called Convokit[a] to extract 21 politeness strategies, e.g., *HasPositive*, which refers to the sentence with positive sentiment words.

RESULTS: The top 10 most frequent politeness strategies observed in our dataset are listed in Table 1. It is worth noting that an utterance in dialogue could contain multiple politeness strategies, and thus the total fraction of utterances associated with these strategies was larger than the total number of utterances. Table 1 shows that 3 out of the top 10 strategies were likely to incur a sense of direct or impolite statements, i.e., *HasNegative*, *Direct_Start*, and *Direct_Question*, while the remaining strategies were all polite. This indicates that, in the setting of human-human online tutoring, a range of polite strategies were more frequently employed than direct ones.

Table 1. The top 10 most frequent politeness strategies in our dataset. Strategies marked with * are likely to incur a sense of being direct and impolite, while the others are polite.

Strategy	Example	% Utterances
HasPositive	I am glad to hear that	26.74
2nd_Person	As you can see, it would be outside the triangle	19.62
1st_Person_PL	Next, we will pick a pair of factors	14.35
HasNegative*	Why are you unsure about what you did?	11.70
Direct_Start*	But it's already given	10.38
1st_Person	Yes, I will start working on it	8.32
1st_Person Start	I will try how I'm doing	8.07
HasHedge	Probably being careful	6.85
Direct_Question*	What is the subscript on it?	6.69
Deference	Awesome!	4.98

[a] https://github.com/sudhof/politeness

CONCLUSIONS: Politeness strategies are commonly used in online human-human tutoring, and multiple types of politeness strategies can appear in the same utterance. By considering the prevalence of the politeness strategies in online human-human tutoring, it is worth to study in future research the effects of such politeness strategies on the learning performance of the students and exploring whether ITS should be equipped with the capability to have polite conversations with students so as to facilitate their learning outcomes.

KEYWORDS: Educational Dialogue Analysis, Politeness Strategies, Learning Analytics

An Intelligent Virtual Reality Interactive System for Learning Pour-Over Coffee Brewing

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BACKGROUND: This study aimed to examine the effect of an intelligent virtual reality interactive system on university students' learning performance in a pour-over coffee brewing lesson. Virtual reality allows users to observe things in a three-dimensional virtual environment. When the user moves the position, the computer can execute calculations immediately and transmit the intelligent feedbacks. Using virtual reality and intelligent feedbacks in education can improve learners' learning efficiency. In addition, the past research indicated that moderate drinking coffee is good for people's spirit and health. Most coffee lovers prepare their coffee at home. Therefore, people may have the demand to learn how to make coffee themselves. The septs of pour-over coffee brewing relate to manipulative ability. This research attempt to develop an intelligent virtual reality interactive system which can record learners' learning behaviors and provide them intelligent feedbacks to adjust the movement of pouring coffee. It also can help learners to improve their knowledge of making pour-over coffee brewing.

METHODS: To evaluate our intelligent virtual reality interactive system, a total of 103 university students participated in this experiment. They used the system to learn the steps of making pour-over coffee. The learning system is presented on HTC Vive and is divided into four learning stages. The first stage is to introduce the basic operations. Learners can practice the features of this system. The second stage is to introduce the equipment for making pour-over coffee and play an instructional video. When learners use controllers to click a tool, the system provides intelligent feedbacks to explain the functions of the equipment. After all equipment was clicked, the instructional video would be displayed. The third stage is to practice making coffee through the intelligent feedbacks we designed. This system divides the steps of making pour-over coffee into multiple parts. Learners can learn how to make coffee step by step and practice without any restriction. In the process of learner practicing, if the system detects wrong learning behaviors, it would immediately signal the error information and indicate the correct place of movement. This part can assist learners in acquiring manipulative ability and knowledge at the same time. The final stage is to complete all the steps of pour-over coffee brewing independently without instructions. The system recorded the error and deducted points. At the end of the operations, the system calculates the final score based on learners' behavior and shows the criteria of deducted points. After completing the above stages, the learners were asked to finish a learning performance test.

RESULTS: The result of the study revealed that the intelligent virtual reality interactive system can improve learners' skill and learning performance.

CONCLUSIONS: This study indicated the intelligent virtual reality interactive system could improve university students' manipulative ability and learning performance. In the future, it is suggested that teachers can use the intelligent virtual reality interactive system to teach multiple-step lessons and skills. In our future work, we plan to compare different pedagogies and feedback types to analyze the effects of intelligent virtual reality interactive system.

CORRESPONDING AUTHOR: Jerry Chih-Yuan Sun

KEYWORDS: Virtual reality, Intelligent system, Coffee brewing, Manipulative ability, Learning performance

Hierarchical Attention on Weighted Graph Network for Course Recommendation

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BACKGROUND: It is a challenging task to select a suitable course from a large online course pool like Coursera or EdX due to the diverse educational backgrounds and learning needs of learners. To clarify learner's true needs and ensure the quality of the course recommendation, it is crucial to exploit additional information about learners, courses and their relationships. These data sources are essentially non-Euclidean data structures, which should be represented in a graph data model. Heterogeneous information network (HIN) plays a central role in these graph data models due to its rich structural information. Meta-paths have been proposed to make use of this rich information. However, defining effective meta-paths requires domain knowledge, which will be quite labor-intensive and time-consuming. This paper integrates the multi-typed relationships between learners and courses without involving meta-paths based on rating prediction tasks.

METHODS: This paper proposes a two-level Hierarchical Attention on Weighted Graph (HAWG) Network for course recommendations. First, we construct a hierarchical attention on weighted graph network to explicitly model learner high-order preferences with one or multiple linked attributes. Weighted graph neural network recursively propagates the node's embedding representations based on the local neighbors (learners or courses). Hierarchical attention mechanism discriminates the importance of node's local neighbors. More specially, the first-level attention demonstrates which types of item attributes will be more important, and the second-level attention discriminates the importance of the courses' neighbors with different linked attributes. To properly leverage the non-local information beyond the local neighborhood, we propose to integrate the random walk strategy through a multi-task learning framework to enhance the recommendation performance.

RESULTS: In this paper, we apply our framework to a real-world course dataset selected from XuetangX, which is one of the biggest MOOC platforms in China. We compare our framework HAWG with some state-of-the-art baselines, including methods based on meta-paths and the random walk. The experimental results on real-world dataset demonstrate that the proposed HAWG outperforms several state-of-the-art recommendation methods. Furthermore, the experimental results illustrate that high-order relations, which establish the connections between two items with linked attributes, are valuable for successful recommendation, and the hierarchical attention mechanism improves the representations of users and items. Compared to traditional recommendations based on graph-based neural network techniques (e.g., Graph Convolution Network) which mainly focus on local information, our method leverages local and non-local information simultaneously to improve the recommendation performance.

CONCLUSIONS: Due to the fast–growing number of online courses, it is still challenging and potential to effectively utilize learner-course interactions and auxiliary information related to learners and/or courses to clarify learners' true needs. An accurate user profile can not only help to reveal the user's point of interest, but also be essential factors in other tasks such as learning path recommendations.

CORRESPONDING AUTHOR: Fu Lee Wang

KEYWORDS: Heterogeneous network, Hierarchical Attention, Course Recommendation

An AI-based Oregon-Style Debate Automatic Text Feedback Learning System

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BACKGROUND: Debating is considered to be one of the best teaching methods for training critical thinking, and is also regarded as the teaching goal of science education and social science education. However, finding a suitable text for debaters is often seen as the most challenging aspect when guiding students in debate training sessions. Recognition is one of the characteristics of AI, including speech and text recognition. Thus, with the support of AI recognition, the possibility of using AI as text recognition in debate training for students has greatly increased due to the instant feedback mechanism. Therefore, this research aimed to develop an AI-based debate learning system with a speech and text recognition mechanism that provides instant text feedback.

METHODS: One of the machine learning methods, the decision tree, was adopted in the study. Quality rules about debate text were discussed by three experts to make rules in a decision tree for the machine learning. Finally, to investigate the effectiveness of the proposed training system, Pearson's correlation and the quadratic-weighted kappa (QWK) method were employed to evaluate the scores of the experts and the system.

RESULTS: The study attempts to integrate AI into a debating course for social sciences, taking the topic "My country's criminal law should abolish the death penalty" as an example based on Taiwan's policy to develop an AI automatic text feedback system that assists the cross-examination debate. A quasi-experimental design was conducted to verify the effectiveness of the debate training system.

CONCLUSIONS: The study finding shows that the debate training system with automatic and timely text feedback could be helpful for students when taking debating courses, due to the certain degree of accuracy and validity of the text feedback. It is expected that a quasi-experimental design can be adopted to verify the effectiveness of the text feedback, and to understand the effectiveness of automatic feedback mechanisms on policy debates. In the future, this system can be considered to develop simulated debating scenarios by combining AR and VR techniques, making AI debate teaching scenarios a reality, and even developing either a game-based scenario or a debating experience system in the near future.

KEYWORDS: artificial intelligence, classification and regression tree, argumentation theory, automated text scoring, instant feedback

Intelligent Mathematics Teaching with Augmented Reality (AR) Manipulatives for Primary Students

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BACKGROUND: Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, the technique is widely used in teaching. Numicon is a set of manipulatives for teaching mathematics, which helps to deliver abstract idea of numbers to children by their visual impressions. While Numicon is widely used worldwide, there is no such teaching aids could be easily downloaded by the educators, or the children, to enhance the internalization of Numicon in Hong Kong. By designing and developing the teaching packages for primary students, we would also encourage the young generation to explore the components for increasing not only the number sense but also the spatial sense of children.

METHODS: We are designing a qualitative methods research on the learning and teaching of number sense and spatial sense of primary students.

RESULTS: We believe that the AR manipulatives would help students learning abstract idea with the concrete manipulatives.

CONCLUSIONS:

CORRESPONDING AUTHOR: Methew Mau

KEYWORDS: Augmented Reality, AR, pedagogy, Numicon

Effect of MR-Based Wearable Guide System with Adaptive Learning Model on University Students' Learning Interest

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BACKGROUND: With the mobile technology becoming more and more mature, many manufacturers are trying to break through the restriction that mobile devices need to be taken by hand. According to the global wearable device report published by IDC in 2019, the total sales volume of wearable devices in 2019 would reach 336.5 million units, an increase of 89% over last year. However, if the guide activities only pursue the introduction of new technologies but fail to arouse people's interest in the theme of the guide, such assistant systems still cannot help people's learning, thus leading to the result of changing in the form but not the content. Therefore, some scholars have proposed to introduce the concept of adaptive learning and combine the advantages of IoT (Internet of Things) and AI (Artificial Intelligence) technology of wearable devices to understand which exhibits the public are more interested in as well as the related content needs and reading time through data collection and analysis, so as to effectively improve people's learning interest and enhance their impression of learning objects.

METHODS: In this study, a wearable guide learning system was designed applying MR (Mixed Reality) and adaptive technology, which imports virtual-real interactive teaching materials into the guide activities in the real world, collects and records the wearer's reading habits and information through wearable devices, and records their learning behavior on the cloud system. Then, through the adaptive recommendation mechanism in the system, machine learning technology is used to establish the learning behavior model and recommend the learning materials, thereby creating personalized guide models.

RESULTS: In order to explore whether the proposed system can effectively enhance college students' learning interest in the guide activities of historic sites, the situational interest scale developed by Chen et al. (1999)[a] was adopted and revised to understand the overall learning interest from five dimensions: "novelty", "challenge", "focus on needs", "continuous enjoyment" and "exploration intention", including 24 questions. A five-point Likert scale was used for scoring purpose. The results showed that the average values of the above dimensions were 4.50, 3.86, 3.88, 3.98, 3.76 and 4.26 respectively, while the overall average is above 3, indicating that the guide system has a positive impact on college students' learning interest in the guide activities of historic sites. In addition, This results also found that some college students confirmed that the recommendation mechanism in the system could help them quickly find the exhibits they felt interesting and shorten their viewing and searching time, which also enabled them to continuously promote their learning activities, thus inducing and improving their overall situational interest.

CONCLUSIONS: This study applied the developed learning system was applied to guide activities of historic sites, and proved that the system can bring users feelings such as "exploration", "novelty" and "enjoyment" and effectively enhance their learning. It is expected that such research results could open up a wider exploration space for the application of wearable devices in the guide and learning topics in real contexts.

[a] Chen, A., Darst, P.W., & Pangrazi, R.P. (1999). What constitutes situational interest? Validating a construct in physical education. Measurement in physical education and exercise science, 3(3), 157–180.

CORRESPONDING AUTHOR: Kai-Yi Chin

KEYWORDS: Learning Interest, wearable device, mixed reality, adaptive learning, guide learning system

Leveraging AI for Growth in Dance Education

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BACKGROUND: This paper introduces how artificial intelligence (AI) has been used in performing arts, particularly in dance education. The integration of technology in teaching and learning is lagging behind in performing arts than in other subjects. On the other hand, performance on stage, television, and via social media channels is filled with high tech components, including the use of AI. This study aims to encourage tertiary performing arts educators to embrace technology and to use it not only to enhance teaching and learning but also to expose students to the world that they will face upon graduation.

METHODS: A thorough literature review was conducted only to discover that the use of artificial intelligence in performing arts, particularly in dance teaching and learning is extremely scarce. The researcher collected data from experts, including renowned choreographers who applied AI in dance creation and those professors who collaborated with performing artists in various capacities. To further strengthen the research, the author went to a multimedia lab in Central China and tested out a series of tools and applications that simulates the integration of AI and performance.

RESULTS: The use of AI in dance can be traced back to 1964 when University of Pittsburgh professors utilized a computer to generate irregular yet performable movement sequences. An architect attempted to create an instant representation of the human body in 1978. In the late 1980s and into 90s, Merce Cunningham's LifeForms, a dance notation system, caught attention from animators, film directors, and sport coaches because it let users to develop, modify, and archive 3D stick figure movement combinations on a computer. Moving forward, renowned choreographer Wayne McGregor and the Google Arts and Culture Lab utilized AI to aid choreography. In the experiment, the computer was taught movements from

McGregor's dancers' countless hours of video recording and eventually the device was able to generate "predictive" movement sequences. We describe it as 1+1, as AI used the learned movement vocabulary to predict what'd be the next move. This model used a similar algorithm that is commonly seen in texting suggestions nowadays. In recent years, Georgia Institute of Technology's *LuminAI* project enabled virtual dancers to learn, analyze, retrieve, process, and generate new movement sequences in response. In 2019, University of California - Berkeley's project *Everybody Dance Now,* enabled AI to learn the movement and then, convert the motion from a skilled dancer to a non-dancer. In other words, AI transforms the skill and makes a non-dancer look like a skillful dancer. In China Academy of Art, the researcher wore wireless sensors connected to the circuit, which generated movements and other stimuli. All these effects were then simultaneously synchronized and projected on the surrounding walls while the person moved.

CONCLUSIONS: With technology being more pervasive, affordable, and ubiquitous, the integration and experimentation between technology and dance as well as other performing arts subjects will continue. As educators at tertiary level, we have to not only embrace AI in teaching and learning, we should also learn how to use it scientifically to maximize learning outcomes and to inspire our students – future leaders to continue to explore the unknown.

CORRESPONDING AUTHOR: Michael Li

KEYWORDS: Dance education, technology, artificial intelligence, algorism, performing arts

Towards the Application of Action Recognition for Physical Education with Regular Video Cameras

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BACKGROUND: Action recognition refers to the task of detecting and classifying certain types of actions in videos. The accuracy of this task has been improved considerably in recent years thanks to deep learning. The video input of action recognition is usually captured by specialised equipment, such as Microsoft Kinet-like depth sensor, LED markers for 3D positions or optical markers for joint locations (Du, Wang, & Wang, 2015). The need for such specialised equipment hinders the wider use of action recognition particularly in schools. In this study, we propose to use action recognition with videos captured by regular video cameras. We aim to investigate the feasibility for applying action recognition for physical education under more general settings.

METHODS: We videotaped a session of physical education taken in a kindergarten in Hong Kong. The video was captured by a regular camera at a fixed location and the whole video lasted for 75 minutes. During the session, students were asked to perform actions such as jumping, hopping, sliding and running. Each action was first demonstrated by a teacher and the students were then asked to perform the same action.

We adopt the skeleton-based action recognition approach in this study. From a video, we first used OpenPose[a] to detect the joint locations of the persons (Cao, Hidalgo Martinez, Simon, Wei, & Sheikh, 2019). Two video frames from the original video and the video with the joints tagged are shown in the two figures above. After having the joint locations, we used Recurrent Spatio-Temporal Affinity Field (STAF)[b] to track the multiple persons detected a video sequence (Raaj, Idrees, Hidalgo, & Sheikh, 2019). Then, we extract sequences of joint locations for a distinct person in a 10-frame video segment and use the extracted sequences as data samples. To recognise actions taken in the 10-frame video, we use DD-Net[c] as a classifier (Yang, Sakti, Wu, & Nakamura, 2019). We chose two sample actions in the video and manually label the 10-frame sequences as positive and negative for each of the actions. We evaluate the accuracy of action recognition with cross validation.

RESULTS: Our initial results show that we can achieve at least 70% of accuracy in the action recognition task. The accuracy was adversely affected by the noise inherent in the videos. For example, some student actions may be blocked by other students or even other persons walking by in the street. We expect the that results can be improved by better tuning of the training process.

[a] https://github.com/CMU-Perceptual-Computing-Lab/openpose
[b] https://github.com/soulslicer/openpose/tree/staf
[c] https://github.com/fandulu/DD-Net

CONCLUSIONS: The study shows promising performance in action recognition can be achieved even with regular cameras. The results suggest that such techniques can be applied in normal school settings for physical education. The action recognition results can possibly be used to indicate the video segments relevant to certain actions that are of interest to the teachers for faster retrieval. They can also possibly be used to keep track of the amount of exercise done by different students. Furthermore, the technique can be applied for real-time detection.

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CORRESPONDING AUTHOR: Leonard K. M. Poon

KEYWORDS: Skeleton-based action recognition; physical education; computer vision; AI in education

Identifying Aspects of Comments in Peer Assessment by Clustering with Word Embeddings

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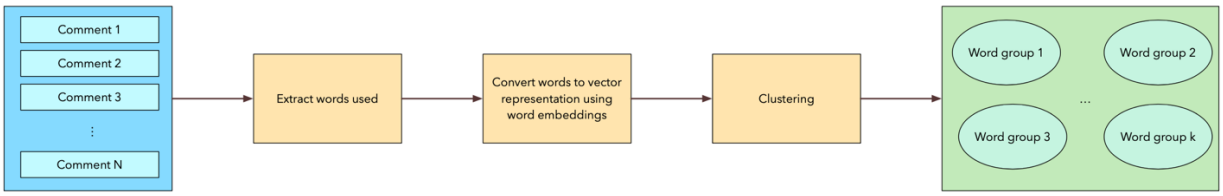
BACKGROUND: Student presentation is commonly used in undergraduate courses for assessment. It can also promote collaborative learning by allow students to share their work with and receiving feedback from their peers. However, due to COVID-19, many face-to-face class meetings have been cancelled. A majority of student presentation has to be conducted online and even in asynchronous mode, thus worsening the rate of participation of students. To mitigate that, peer assessment (Topping, 2009) can be used as an effective way to encourage students to watch the presentation attentively and to contribute to the discussions.

Students are often required to write comments in their peer assessment as feedback to the presentation. And scores may be given based on the merit of the comments as incentives for students to give quality feedback. However, when there are a large number of students, number of comments may become unmanageable for both students and teachers to comprehend and grade the comments. In this study, we consider using natural language processing techniques to facilitate the feedback and evaluation process.

METHODS: We conducted the study in a programming course at undergraduate level. Students were required to work in groups for their course projects and to upload their group presentation online. They were then asked to individually give scores and write comments to each of the other groups. There were 10 group videos and 23 students gave responses to each of those videos except their own. In total, 208 comments were used in the data set for analysis. We propose to represent the words written in the students' comments using word embeddings. We can then perform cluster analysis on the vector representation of the words that had been used in the comments. The process of the cluster analysis is depicted in the figure below.



In addition, we will compare our proposed method with other baseline methods, including cluster analysis on words directly and obtaining topics through topic modelling methods.

RESULTS: We expect that the groups of words identified through cluster analysis can indicate different aspects of the opinions students had towards the presentation. The clusters of words can be used for two main purposes. For the teacher, they can be used to reveal the what aspects of opinions had been raised for each student. For the students, the comments can be categorized based on the aspects of opinions for quicker understanding of the feedback given by the peers. Furthermore, we expect that our proposed method can produce better grouping of words than the two other baseline methods.

CONCLUSIONS: Our findings suggest that cluster analysis with word embeddings can produce meaningful groups of words used in the students' comments in peer assessment. The groups of words can be used to assist teachers in grading the students' comments and for students to comprehend the feedback given by their peers.

REFERENCES:

Topping, K. J. (2009). Peer Assessment. *Theory Into Practice*, *48*(1), 20–27.

CORRESPONDING AUTHOR: Leonard K. M. Poon

KEYWORDS: Peer assessment; Clustering with word embeddings; Natural language processing; Text analytics; AI in education

Towards Designing an Adaptive System for Providing Feedback to Students at Scale

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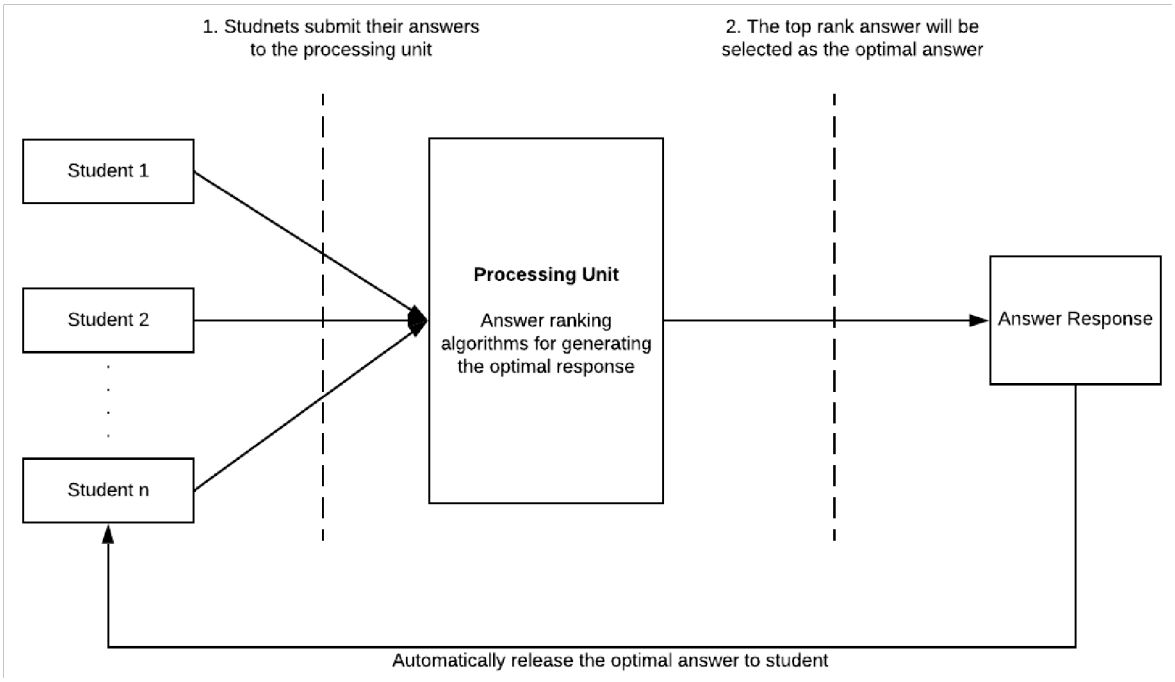
BACKGROUND: Questioning is an effective strategy for instructors to engage students by provoking in-depth thinking about their learning progress and knowledge gaps. In the educational field, Piazza or Moodle forums are the most popular place to post questions and answers. It should be noted that questioning alone, oftentimes, is not enough. It is also very important for the instructors to provide feedback to the students during the questioning process, e.g., whether their answers to the questions are correct or not. In classroom-based education, instructors can effectively provide feedback to students' answers because of the limited number of students. However, when it comes to online education (e.g., MOOCs), the number of students can be up to tens of thousands, which poses a great challenge for the instructors to provide quality feedback to students in a timely manner. Therefore, the study presented in this abstract aimed to propose a system for instructors to automate the feedback-providing process, so as to effectively and efficiently accommodate the needs of students in the setting of online education.

METHODS: We designed a system to automatically process the answers from many students, whose processing flow is depicted in Figure 1. The answer ranking algorithms, e.g., PHP[1] model, can be used to select the optimal answer in online learning. The model will be trained on the question-answering data from forums. The pre-trained model is then tuned parameters on our forum dataset and finally the optimal answer is used as the feedback for all students.

Figure 1. The processing flow of the adaptive system for providing feedback to students



RESULTS: We expect that all students will be given opportunities to answer questions proposed by instructors in online learning, which will greatly motivate the students to answer the questions and improve their learning engagement.

CONCLUSIONS: This system is designed to help instructors to handle the large amount of answers from students in the online learning environment. Additionally, students will be given the opportunity to engage with the question-answering process, which will motivate them to make more effort in the learning process and improve the students' learning outcomes.

KEYWORDS: E-learning, Learning system, Educational Feedback

Theme 5 ---- Applying AI in Assessment and Evaluation

Using AI Apps with Concept Mapping to Improve Students' Self-Efficacy and Communicative Tendency in a Social-Cultural Communicative Project

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BACKGROUND: This study examines the use of an artificial intelligence (AI) app with concept mapping. We focused on its impact on students' learning performances from the perspective of pragmatic competence and knowledge building in a social-cultural communicative learning a. A total of 36 high school students were randomly assigned into experimental (n = 18) and control (n = 18) groups. The experimental group used the AI app "Google Assistant" for the project information to organize in integral and inclusive forms with concept mapping, whereas the control group used the same AI app for the project information organized in a traditional note-taking format. Our research questions are:

1. Is the self-efficacy of the students learning with the concept mapping-integrated AI app better than that of the students learning only with the AI app?
2. Is the learning achievement of the students learning with concept mapping-integrated AI app better than that of the students learning only with the AI app?
3. Is the learning motivation of the students learning with the concept mapping-integrated AI app better

   than that of the students learning only with the AI app?

METHODS:

1. Instructional tool: The AI app "Google Assistant," which is an app built by Google that can offer more local and integral multi-modal information in an instance by both voice and text requesting channels.

2. Research objective: This study explores the differences in students' self-efficacy, learning achievement, and learning motivation in the intercultural communicative learning project with or without using concept mapping on the basis of the AI app.

3. Research design: The quasi-experiment lasted for 3 weeks on a project-based intercultural communicative learning of a famous temple. 36 high school students in Northern Taiwan were randomly assigned into two groups: (1) the experimental group used the AI app "Google Assistant" with concept mapping and (2) the control group used the same AI apps without concept mapping. Tests and questionnaires were held for further analysis. Qualitative analysis according to students' interviews was analyzed in depth.

RESULTS: There were significant differences between the two groups in their self-efficacy ($F=5.50$, $p=0.03$) and inner-motivation ($F=6.52$, $p=0.02$), while the result of outer-motivation ($F=0.26$, $p=0.62$) is not significant, which indicated the experimental group is more likely to have higher self-efficacy and inner-motivation than the control group. The qualitative analysis of the participants' interviews indicated that the students in the experimental group have more organized introduction for the project, although they might have deviated from the topic occasionally.

CONCLUSIONS: The study contributed to the existing literature on developing students' autonomous learning competence in aspect of self-efficacy and motivation by proposing the concept mapping-integrated AI apps for a social-cultural communicative learning project. The main findings reveal that appropriate learning strategies would be supportive in aspect of autonomous learning and also reflect learners' personal trajectories with different pathways and paces which allows for analyzing students learning outcomes in a more integral and balanced way.

CORRESPONDING AUTHOR: Chin-Yu Chen

KEYWORDS: Concept mapping, artificial intelligence, pragmatics, autonomous learning

A Handwriting Evaluation System with Multi-modal Sensors

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BACKGROUND: Handwriting is an important and common activity for students, which may occupy around 50% time in school life. Handwriting is a kind of fine movement, which requires the coordination of eyes, hands and body. Traditional assessment of handwriting are more dependent on the final handwriting output, while the coordination skills of eye, hand and posture are rarely considered and quantitated, due to the limitations of clinical observation. The rapid development of sensor and computer vision technology provides sharp tools to record, track and recognize the movement of eyes, hands and body, which makes it possible to build an automated system for handwriting evaluation with various sensors. In this paper, we proposed a multi-modal sensing system to record the gazes, strikes and limb body movement, and developed data processing and analysis algorithms.

METHODS: First, we built a data acquisition device including an eye tracker, a tablet and a camera, which is used to record the gaze, writing and body movement respectively. Second, we used both traditional data processing and machine learning method to process the collected data, including statistical feature extraction, automatic time stamp matching, automatic segmentation of characters, feature extraction and rule-based classification. Finally, we recruited a small group of subjects to test the system and the algorithms.

RESULTS: In this preliminary study, five participants were recruited, including two kids and three adults. We used the proposed data acquisition device and processing method to process the data collected by multi-modal sensors. The experimental results show that there are noticeable differences in the features of head up frequency, pen tip pressure and head movement between kids and adults, when they are writing Chinese characters. The effectiveness of the handwriting evaluation system with multi-modal sensors is verified by the experiments designed in this study.

CONCLUSIONS: The handwriting evaluation system with multi-modal sensors based on artificial intelligence can evaluate individual performance in the process of handwriting. The system has the advantages of convenient data acquisition, distinguishing subtle actions, and objective and fine granular analysis results. In addition, the system can be applied to other studies related to attention control or fine motor.

KEYWORDS: artificial intelligence, handwriting evaluation system, multi-modal sensors, fine motion.

The Effect of Robot Feedback Frequency on Children's Learning with Respect to Age

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BACKGROUND: Many educators and parents believe that social robots create engaging learning experiences for children. Indeed, social robots are often bought by schools and families to teach younger ones mathematics, new words and so on. However, despite their growing popularity, there is still limited understanding as to how social robots should interact in order to foster effective learning in children. This study investigates how social cues, in the form of robotic facial and verbal feedback, affect children's learning outcomes and situational interest. It looks at children of two different ages and is guided by the following research questions:

Q1. Does robot feedback frequency affect learning outcomes and situational interest in children?
Q2. Are children of different ages affected differently by robot feedback frequency in terms of learning outcomes and situational interest?

Q3. Is there anyone interaction between children of different ages and robot feedback frequency in terms of learning outcomes and situational interest?

METHODS: The study employed a 4 x 2 mixed design. The two independent variables were robot feedback frequency (i.e. the number of times the social robot displayed both a facial motion and verbal response) and children's age. Robot feedback frequency used a within-subject design and had four levels: 0, 1, 3, and 5. Children's age used a between-subject design and had two levels: 7–8 years and 11–12 years. Two dependent variables were also used. These were children's learning outcome and situational interest.

The experiment involved 30 girls and 30 boys individually interacting with a social robot that had a touchscreen as a face. Each child watched short four-section film on the screen and after each section answered an on-screen multiple-choice question about what they had seen. The social robot then told each child whether he/she had got the answer right, after which, depending on the experimental parameters being tested, offered 0, 1, 3 or 5 pieces of feedback. To assess situational interest, each child completed the Study Interest Questionnaire (SIQ) after each interaction with the social robot.

RESULTS: The results showed that there was no correlation between robot feedback frequency and learning outcome for either age group. However, with respect to situational interest, robot feedback frequency did correlate with situational interest for the 7–8 year-olds: as feedback increased, their situational interest increased. This was not the case for the 11–12 year-olds, their interest increased with robot feedback up to a frequency of 3 but then decreased.

CONCLUSIONS: The findings of this study show that the amount of feedback an educational social robot offers impacts on the situational interest of children. They also reveal that the same amount of feedback affects children differently depending on their age. Because of this, the authors suggest that designers should take feedback frequency and age into account when developing educational social robots for children.

KEYWORDS: social robot; children; feedback frequency; situational interest; age difference

Deep Heart Rate Variability analysis for VR-Learning

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BACKGROUND: Emotions are a fundamental means of communication for human beings to inform others of their feelings. Unfortunately, some people cannot or do not accurately express their emotions, e.g., people with autism spectrum disorder (ASD), attention-deficit hyperacti i di de (ADHD), Pa i disease, depression that we commonly encounter in school, or community settings. However, assessing emotions is hard in clinical settings where patients' periodic self-reports as such reporting is subject to intra-subject variations in reporting due to other circumstantial factors like environment, people, situation, etc. There is an increasing interest in investigating ways to assess emotions from various fields of study, especially in education. This project novelty is the application of the physiological principle of the human autonomic nervous system and the use of both time and frequency domain parameters of heart rate variability (HRV) for the emotions of learning status identification objectively. As biosignals, the changing emotions can be measured by changes in heartbeats which can be precisely represented by HRV using deep analysis. Immersive VR-learning places individuals in an interactive learning environment to replicate possible scenarios or teach particular skills or techniques. Considering the potential learning enhancement through VR use, it is understandable why educators nowadays scrutinize this technology intensively, looking to add an extra dimension to the classroom concerning both teaching and learning. With today wearable technology, it is feasible to ascertain the emotion in real-time and provide effective VR-learning for users.

METHODS: The project aims at assessing emotions of happiness, sadness, surprise and anger objectively. The study attempts to determine the distributions of various HRV parameters for happiness, sadness, surprise and anger respectively, and ascertain whether emotions can be predicted with high performance in terms of sensitivity and specificity based on HRV parameters. There will be two stages of the study. Stage 1 is the preparation of video clips for emotion stimulation, while Stage 2 is the main part of the experimentation. The inclusion criteria will be the same for both stages. Healthy adults from the local community with no known medical diagnosis will be recruited. Those with a history of mental health problems, mood disorders, and cardiovascular and pulmonary problems will be excluded. A tailor-made wrist band for collecting HRV parameters will be used. HRV parameters will be extracted and machine learning algorithms will be used to develop the model for emotion prediction.

RESULTS: The performance of the use of machine learning algorithms for assessing emotions using HRV will be discussed. The study attempts to find out the distributions of various HRV parameters for happiness, sadness, surprise and anger, respectively and to ascertain whether emotions can be predicted with high performance in terms of sensitivity and specificity basing on HRV parameters.

CONCLUSIONS: The study is an introductory study of using artificial intelligence to classify emotions based on HRV for VRlearning. This study will be the basis for further studies. The finding in this project will indicate that using HRV as a biomarker and the machine learning as an emotion classifier to assess emotions is feasible for VR-learning.

CORRESPONDING AUTHOR: C.F. So

KEYWORDS: Artificial Intelligence (AI), Machine Learning, Heart Rate Variability (HRV), VR-learning

Analyzing Classroom Talk:
An Integration of Artificial Intelligence and Statistics

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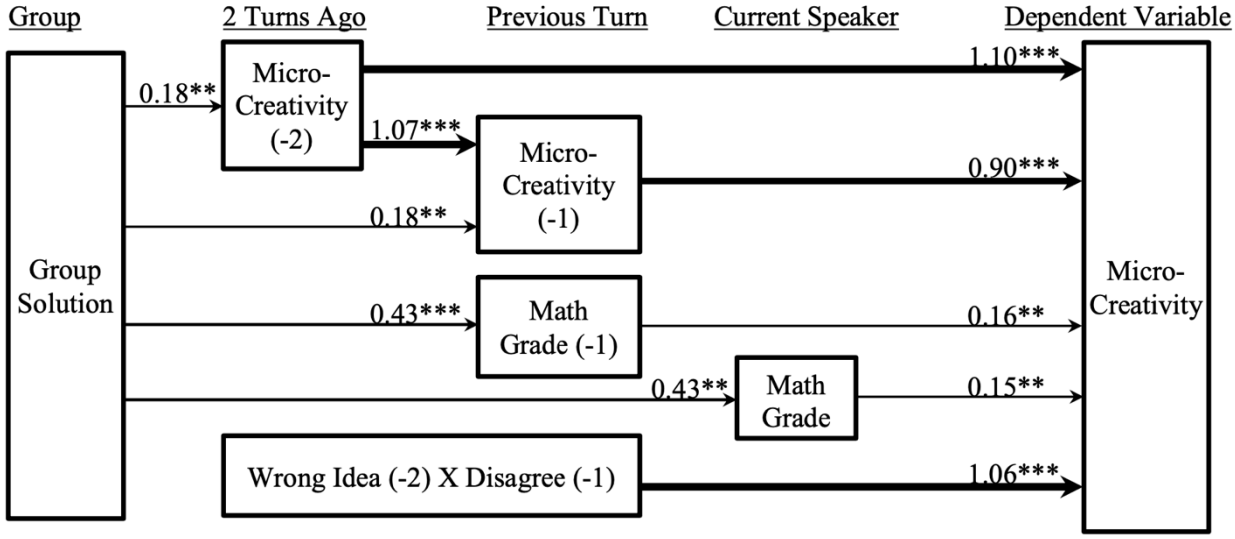
BACKGROUND: Educators seek to understand how students' learning processes affect both one another and learning outcomes, and current technology enables collection of vast quantities of complex data (e.g., videotaped classroom conversations, online forums, Twitter tweets). Hence, my *statistics artificial intelligence expert system* (SAIES) analyzes face-to-face or online classroom conversations by checking the data, translating a theoretical model into a statistical model, running the statistical analyses, checking satisfaction criteria, and if needed, re-writing itself to run further analyses.

METHODS: The 80 secondary 3 (9th grade) students completed a survey (gender, age social status) and worked in 20 groups of 4 on an algebra word problem for 30 minutes, talking for 3,296 turns (videotaped). *Otter* software transcribed the videotapes, and a research assistant corrected 2% of the words. I wrote a computer program to categorize turns of transcribed talk as *disagree*, *wrong*, or *correct*, based on the *linguistic inquiry* and *word count* classification. A research assistant corrected less than 1% of the categorizations. The program converts all words involving number and arithmetic operations into computations (e.g., "ten minus one is nine" □ 10 – 1 = 9) and assessed them as right, wrong, or neither (e.g., 3 + 4?). Two research assistants identified turns of talk with *new* ideas (vs. old ideas vs. off-task). A turn of talk that is *new* and *correct* is *micro-creativity*. SAIES applied *statistical discourse analysis* to (a) statistically identify breakpoints that significantly elevate or reduce micro-creativity, thereby dividing each group's problem solving session into distinct time periods and (b) determine which attributes of classrooms, groups, students, or recent sequences of talks affect the likelihood of micro-creativity in each turn of talk.



RESULTS: Of the differences in likelihood of *micro-creativity*, 21.1% occurred within time periods, 78.8% across time periods, 0.1% across groups, and less than 0.1% across classrooms. The groups averaged 2.65 micro-creativity breakpoints and 3.65 time periods. The likelihood of micro-creativity was higher (a) among groups that solved the algebra problem, (b) for speakers with higher mathematics grades, (c) when responding to a speaker with a higher mathematics grade, (d) after

micro-creativity in the previous turn (-1) or two turns ago (-2), and (e) after a wrong idea (-2) followed by a disagreement (-1). Hence, the results showed two significant sequences:

Mathematics grade (-1)➡*Mathematics grade*➡*Micro-creativity*

Wrong idea (-2)➡*Disagreement* (-1) ➡ *Micro-creativity*

CONCLUSIONS: This study showed the growing feasibility of SAIES to integrate automatic transcription, categorization, and analysis. As commercial transcription software become increasingly accurate, assistants can simply check and correct. While automatic categorization can identify disagreements and arithmetic validity, it cannot easily distinguish between new versus old ideas, so humans are still needed for such categorizations. Lastly, SAIES can fully incorporate a statistician's analyses and decision-making to greatly accelerate analyses.

CORRESPONDING AUTHOR: Ming Ming Chiu

KEYWORDS: Automatic categorization, Automatic statistical analysis, Statistical conversation analysis, Group problem solving processes

Theme 6 ---- Applying AI in Language Learning

Artificial Intelligence in Language Education

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BACKGROUND: Artificial intelligence (AI) is defined as "a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations or decisions influencing real or virtual environments" (Organisation for Economic Co-operation and Development, 2019, p.7). It is often used to provide learning analytics, recommendations and diagnosis tools in education, common applications of which for instruction include personalized learning systems, chatbots, and sensors and cameras that can analyse classroom dynamics and student engagement learners (Vincent-Lancrin & van der Vlies, 2020). The algorithmic power of AI can also generate predictive and diagnosis models for precision education, which is effective in visualising students at risk, providing timely intervention, and reducing dropout (Lu et al., 2018). Moreover, AI enhanced assessment can provide algorithm-based decisions and conduct interesting and effective real-time assessments of complex skills and knowledge (Vincent-Lancrin & van der Vlies, 2020). Unique language-related AI include natural language processing, speech recognition and analysis, and pronunciation correction.

METHODS: This study conducted a review and discussed how AI has been integrated in language education and the advantages and challenges associated with AI-assisted language learning.

RESULTS: Our results showed five common approaches to applying AI in language education.

(1) Personalized language learning refers to the tailored education that aims to satisfy students with different needs (You, Li, Xiao, & Liu, 2019). With personalized language learning systems, learners with different language proficiency levels are provided with appropriate learning materials and instructional approaches, which allows them to study at their own pace and hence optimizes the learning process (Pokrivcakova, 2019).

(2) Chatbot is a software tool AI enables users to interact on certain topics via text and voice (Smutny & Schreiberova, 2020). These conversational agents can be used to explain teaching material, provide answers instantly and deliver pedagogical content (Alin Andrei, 2018). It helps to solve the problems raised by the students on an immediate basis which serves as a virtual advisor.

(3) With the help of AI, timely feedback could be generated automatically after students completed a learning activity (Calvo & Ellis, 2010). The automated feedback identifies the learning gaps and enables students to take immediate action to promote learning.

(4) Natural Language Processing (NLP) is a branch of AI that uses computers to parse human language (Maddox & Matheny, 2015). NLP tools make sense of human language through identifying the linguistic features from large amounts of data. With NLP, language learners could understand the words, sentences and concepts in the text comprehensively.

(5) Speech-to-text recognition (STR) and text-to-speech recognition (TSR) refer to the automatic generation of the textual or audio counterparts of learners' speech (or writing) (Zhang & Zou, 2020). They can deepen learners' knowledge processing and memorization by strengthening the connections between audio and textual forms of language knowledge (Shadiev, Hwang, & Liu, 2018).

CONCLUSIONS: This research has identified the ways in which AI assists language learning. It helps researchers and practitioners understand AI and reveals the potential of digital humans in language education.

KEYWORDS: artificial intelligence, language education, personalized learning, chatbots, computer-assisted language learning

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Design of an Augmented Reality App for Pupils' Vocabulary Learning in a Seamless Learning Environment

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BACKGROUND: Despite studies on design and development of argument reality (AR) apps for learning are on the rise, the majority of studies have developed the AR apps for enhancing students' learning motivation and engagement in higher education for prescribed learning tasks in either formal or informal learning environments, few studies have been conducted to develop the AR app that serves to bridge in-class and real-life English as a second language (ESL) vocabulary learning based on the curriculum in primary education.

Against this background, this study developed an AR app termed "VocabGo" (refer to Fig. 1) that can be applied in a seamless learning environment to enhance pupils' vocabulary learning in line with the English curriculum and improve their learning motivation. Premised on Mayer (1997)'s generative theory of vocabulary learning with technology and the concept of seamless learning (Wong & Looi, 2011), the design of the AR app focuses on enhancing learners' learning using AR identified real-world objects/picture with triggered vocabulary in authentic learning environments across different settings. In the meantime, premised on Vygotsky's (1978) socio-cultural theory that children enhance their learning in different socio-cultural contexts and through social interactions with more skilled individuals, the AR app also provides opportunities for learners to comment on each other's learning logs and strengthen their cognitive development in vocabulary learning.

The features of the AR app composed four modes (refer to Fig. 2): (a) Find Mode where students can scan the real objects with identified newly learned English words included in the current curriculum unit (refer to Fig. 3), (b) Go Mode where students can do location-based learning tasks using the newly learned words in the current curriculum unit (refer to Fig. 4), (c) Explore Mode where students can do free scanning of objects with words beyond the curriculum unit, and (d) Challenge Mode where students can do game-based learning activities via computer-generated quizzes about the words learned in Find Mode and Explore Mode (refer to Fig. 5).

Fig. 1. Interface

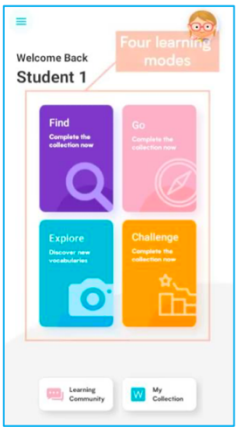

Fig. 2 Four learning modes

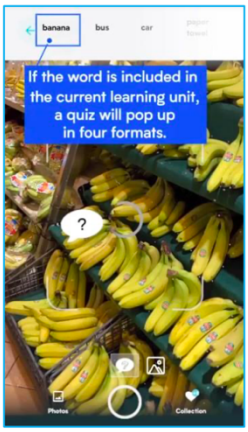

Fig. 3 Scan objects

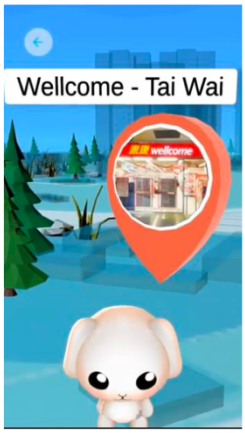

Fig. 4 A location-based task

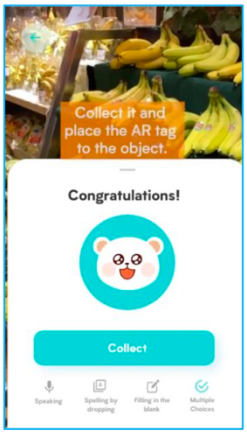

Fig.5 An auto-generated quiz

In addition, in the Learning Community, students can share their collected object pictures with words, comment on each other's shared artifacts and give "likes". In My Collection, the scanned objects will be automatically saved in two categories: one includes pictures with newly learned

words in the current learning unit; and the other includes pictures with words beyond the current learning unit.

METHODS: A usability test was carried out to evaluate the features of the VocabGo for vocabulary learning.

RESULTS: The results show that the features of the VocabGo app worked well in general although some issues and bugs were identified.

CONCLUSIONS: This study reported the design of an AR app –VocabGo to improve pupils' vocabulary learning outcomes and motivation. A usability test was conducted, and proved to function well in general. Future work will focus on improving the usability of the app features in order to apply the app to English vocabulary learning in primary schools in Hong Kong in a seamless learning environment.

CORRESPONDING AUTHOR: Yanjie Song

KEYWORDS: Augmented Reality (AR) app, VocabGo, seamless learning environment, vocabulary learning

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English Learning with Duolingo: A Case Study of Three EFL Learners

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BACKGROUND: Duolingo, as a popular language learning application, have approximately 200 million active users worldwide (Loewen et al., 2019). With artificial intelligence (AI) support, it can model and recommend courses for learners according to their performance in the placement test. This personalized learning experience makes learning relevant and lead to effective learning (Zou, Wang, Xie, Cheng, Wang, & Lee, 2020). Several studies compared Duolingo with regular classes and reported favorable learning outcomes (e.g., Rachels & Rockinson-Szapkiw, 2018). However, little research has been conducted to investigate the learning experiences of learners with different language proficiency levels.

METHODS: The current study conducted a case study on three EFL learners' English learning with Duolingo. The three participants were of low, middle, and high proficiency levels respectively. Methods of think aloud, learning logs, and interviews were applied to investigate their learning experience. The participants learned with Duolingo for one month and reported their learning experiences by conducting thinking aloud protocols and writing learning logs twice a week. One month later, they were interviewed to further reflect on their learning experiences.

RESULTS: The results showed that the learners generally enjoyed learning with Duolingo, as it enabled them to learn, practice, and review language knowledge at their own paces. The AI algorithim embedded in it also assisted them in reviewing what they have learned previously at scientifically timed intervals. Take vocabulary learning as an example, if learners remembered target words correctly in consecutive two days, the system would prolong the review interval till the 4th day. Four days later, if they remembered it again, the review interval would be extended to 8th day, etc. If learners answered incorrectly, the words would be demoted to a shorter review interval. The learner with high proficiency also considered the gamified learning mode useful for grammar learning. The learners with low and middle proficiency reported that they benefited greatly from the personalized arrangements of the recommended courses (e.g., vocabulary, speaking, grammar).

CONCLUSIONS: Duolingo is conducive to successful language learning as it provides learners with personalized learning experiences and makes good use of spacing effect through AI algorithm.

CORRESPONDING AUTHOR: Di Zou

KEYWORDS: Duolingo, EFL, learning experience, AI

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The Influence of University Teachers' Knowledge and Attitudes on Implementation of Innovative Technologies in EFL Teaching

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BACKGROUND: Computer assisted language learning (CALL) has entered a new phase characterized by various Web 2.0 technologies and artificial intelligence (Kessler, 2018). Integrating those innovative technologies into English as a Foreign Language (EFL) teaching as a policy-driven educational strategy has been strongly advocated in China. Nevertheless, the low level use of technologies by Chinese EFL teachers was common (Teo, Huang & Hoi, 2018). Effective technology use in teaching has long been a sophisticated issue relating to multiple-faceted factors (Zhao & Frank, 2003). Among the various factors, the knowledge and attitudes of teachers who are the planners and implementers of teaching with technology are undoubtedly the major ones. In order to better understand the influence of teachers' knowledge and attitudes on their technology uses, this study proposed and examined a hypothetical model of relationships among five study variables, namely, technological pedagogical and content knowledge (TPACK), affect-based (ATT) and evaluation-based attitudes towards technology (EAT), classroom-based (CTU) and Web-based technology use (WTU) based on a sample of 261 Chinese university EFL teachers.

METHODS: A quantitative research design was employed. Data were collected from 261 EFL teachers at 17 universities across eastern, central and western China via self-reported questionnaire. The questionnaire comprised of a battery of psychometric scales measuring the study variables (i.e., TPACK, ATT, EAT, CTU and WTU). Structural equation modeling (SEM) was conducted by using AMOS 24.0 to examine the hypothesized relationships among different variables.

RESULTS: A good model fit was achieved (TLI=0.925, CFI=0.937, RMSEA=0.071), in which CTU (β=0.31, p<0.001) and WTU (β=0.44, p < 0.001) were both significantly influenced by TPACK, and CTU was also significantly influenced by EAT (β=0.26, p<0.01), while neither type of technology use was influenced by ATT. In addition, TPACK was found to be significantly correlated with EAT (β=0.64, p<0.001) rather than AAT.

CONCLUSIONS: This study broadened the extant knowledge of theoretical models of technology integration by providing insights into the interrelations among several key teacher-related variables. It also contributed to the current TPACK research by focusing on a domain-specific construct (i.e., CALL) as well as improving its applicability in Asian cultures. The practical implications to CALL policy-makers and EFL faculty professional development in China can also be found in this study.

CORRESPONDING AUTHOR: Meng Zhang

KEYWORDS: CALL; TPACK; EFL; Technology integration; Teacher professional development

A Self-Regulated Speech Recognition Approach to Enhancing EFL Students' Speaking and Listening Performances

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ABSTRACT: In non-English speaking countries, many college students have limited oral practice in English; even they have invested over 10 years in learning English since they were in elementary schools. An automatic speech recognition (ASR) system has been developed to support speech learning in computer-aided speech practice. However, learners tend to lack the self-regulated learning (SRL) skills to manage and monitor their learning behaviors in e-learning. To actively engage in e-learning activities, students need to set learning goals, adopt proper learning approaches, and be capable of monitoring and reflecting their learning behaviors. Thus, integrating the ASR system in the SRL approach was designed to assist students' EFL speaking fluency and accuracy. A quasi-experiment was conducted in a university in northern Taiwan. The sample of the study was 19 college students. A class of 12 students was the experimental group, and another class of 7 students was the control group. The findings suggested that integrating the ASR in the SRL approach was helpful to students in guiding them to learn in a more effective way of improving their fluency and accuracy while speaking in English. Teaching students the skills of SRL is a need to use technology for better learning.

CORRESPONDING AUTHOR: MeiRong Alice Chen

KEYWORDS: Self-regulated learning, automatic speech recognition, EFL speaking fluency, EFL speaking accuracy, self-directed learning behaviors