GCCCE 2021

重塑計算機教育

Reimagine Computers in Education

SEPTEMBER 11-15 2021

二零二一年九月十一至十五日

第25屆全球華人計算機教育應用大會

The 25th Global Chinese Conference on Computers in Education

大會論文集（英文論文）

Main Conference Proceedings
(English Paper)

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(English Paper)

Editors:

KONG Siu Cheung, The Education University of Hong Kong, Hong Kong

WANG Qiyun, National Institute of Education, Nanyang Technological University, Singapore

HUANG Ronghuai, Beijing Normal University, Mainland China

LI Yanyan, Beijing Normal University, Mainland China

HSU Ting-Chia, Taiwan Normal University, Taiwan

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Main Conference English Paper Track

1. Message from the Organiser

The Global Chinese Conference on Computers in Education (GCCCE) is a premier annual international bilingual (Chinese and English) forum. In GCCCE, researchers, practitioners and policymakers within and beyond the ethnic Chinese communities around the world disseminate and exchange ideas and advancements for research on and practice of technology-enhanced learning. The 25th GCCCE (GCCCE 2021) will be organised by The Education University of Hong Kong, Beijing Normal University, Taiwan Normal University and the National Institute of Education of Nanyang Technological University on 11-15 September 2021. This year's conference theme is "Reimagine Computers in Education".

It is worth noting that, this is the second year of conference since the English Paper Track (EPT) has been found, inviting both ethnic Chinese and non-ethnic Chinese leading international scholars to form a Program Committee in attempt to attract papers from non-Chinese authors around the world. The EPT comes with an individual English-only sharing session, welcoming all conference participants to attend and interact with international scholars. All papers accepted by EPT will be independently edited and published as the GCCCE 2021 English Paper Track Proceedings. In addition, like last year, two English keynote speeches will be delivered by two leading scholars.

Unfortunately, the COVID-19 pandemic continues to rage around the world amid the year-long preparation of GCCCE. Both the International Program Committee and the Local Organizing Committee have been monitoring the situation and therefore decided to turn GCCCE 2021 into a hybrid (online and physical) conference. The conference has been postponed from May to September to better prepare for the event and to respond to the pandemic by adjusting to changing circumstances, in order to ensure both online and offline meetings can be held successfully.

Apart from the inaugurated EPT, nine theme-based sub-conferences are featured in this GCCCE as usual, namely,

C1: Learning Sciences & Computer-Supported Collaborative Learning
C2: Mobile, Ubiquitous & Contextual Learning
C3: Joyful Learning, Educational Games & Digital Toys
C4: Technology in Higher Education & Adult Learning, and Teachers' Professional Development
C5: Technology-Enhanced Language and Humanities Learning
C6: Artificial Intelligence in Education & Smart Learning Environments
C7: Learning Analytics & Assessments
C8: STEM & Maker Education
C9: Educational Technology: Innovations, Policies & Practice

Within EPT and each sub-conference, an Executive Chair, Co-Chairs and Program Committee (PC) Members were appointed to shoulder the review and programming process. Each sub-conference was also set up with additional evaluation. GCCCE 2021 calls for papers from scholars around the world (not limited to ethnic Chinese), this year, the conference received a total of 276 submissions by 533 authors from mainland China, Hong Kong, Taiwan, Singapore, USA, the United Kingdom, Kazakhstan, and some other regions. Table 1 shows the statistics of regions of origin of the authors.

Table 1. Statistics of regions of origin of GCCCE 2021 authors in the nine sub-conferences and EPT

Region	Mainland China	Taiwan	HK	USA	Singapore	UK	Kazakhstan	Tunisia	Total
No. of author	427	72	24	4	3	1	1	1	533

Each submission was assigned to at least 3 PC members for the first round of review. The results were then meta-reviewed by the chair and co-chairs of the corresponding sub-conference or EPT before a

final decision was made. Through the rigorous review process, 213 papers were accepted (see Table 2). Among them, 7 papers were nominated for Best Chinese Research Paper Award (limited to long papers accepted by the sub-conferences), 2 were nominated for Best English Research Paper Award (limited to long papers accepted by the EPT), 10 were nominated for Best Student Paper Award (limited to long papers accepted by the sub-conferences and the EPT), 6 were nominated for Best Technical Design Paper Award (limited to long or short papers accepted by the sub-conferences and the EPT), and 10 were nominated for Best K-12 Teachers' Paper Award (limited to long or short papers accepted by K-12 Teachers' Forum).

Table 2. Statistics of paper acceptance of each sub-conference and the EPT in GCCCE 2021

Sub-conference	Long paper	Short paper	Poster	Elimination	Acceptance Rate	Subtotal
C1: Learning Sciences & Computer-Supported Collaborative Learning	4	9	2	6	71%	21
C2: Mobile, Ubiquitous & Contextual Learning	4	7	1	2	80%	14
C3: Joyful Learning, Educational Games & Digital Toys	4	6	5	3	71%	18
C4: Technology in Higher Education & Adult Learning, and Teachers' Professional Development	8	11	12	9	78%	40
C5: Technology-Enhanced Language and Humanities Learning	3	7	0	2	83%	12
C6: Artificial Intelligence in Education & Smart Learning Environments	7	15	1	7	77%	30
C7: Learning Analytics & Assessments	7	13	7	6	82%	33
C8: STEM & Maker Education	6	12	8	7	79%	33
C9: Educational Technology: Innovations, Policies & Practice	9	15	1	9	74%	34
English Paper Track	5	10	9	7	75%	31
Total	**57**	**105**	**46**	**58**	**78%**	**266**

This year, four academic experts and scholars are invited to be the keynote speakers. These keynotes are,

Keynote 1：**Investigations into Deep Knowledge Tracing: From Cold-Start to Real Life**
Speakers: Dr Ryan Baker, Associate Professor at the University of Pennsylvania, and Director of the Penn Center for Learning Analytics, US

Keynote 2：**具親子共讀策略之擴增實境繪本**
Speakers: Professor Chang Kuo-En, Professor at the Graduate Institute of Information and Computer Education, Taiwan Normal University, Taiwan

Keynote 3：**The Future of Education: New Space, New Knowledge and New Ontology**
Speakers: Professor Chen Li, Vice President of the Beijing Normal University, Mainland China

Keynote 4：**Awarding Skill Improvements based on Behaviour Pattern Extraction and Analysis**
Speakers: Professor Maiga Chang, Full Professor at Athabasca University, Canada

The four keynotes, the nine sub-conferences, the EPT and two topical discussion panels form the main conference of GCCCE 2021. Other than that, like previous years, there will be three pre-conference events, including K-12 Teachers' Forum, workshops and Doctoral Student Forum. In particular, the Teachers' Forum accepted 44 teachers' papers from mainland China, Taiwan and Hong Kong, 2 of which were nominated for Best K-12 Teachers' Paper Award.

A total of 8 workshops on various research topics were featured this year, which accepted 66 workshop papers in total, namely,

Workshop 1: ICT 輔助成人與繼續教育
Workshop 2: 新科技應用於提升學習成效工作坊
Workshop 3: 學習科學與遊戲化學習
Workshop 4: 學習投入與學習行為建模
Workshop 5: 創新互動回饋科技提升學習動機
Workshop 6: 知識建構與教育創新
Workshop 7: 電腦支援個人化與合作學習工作坊
Workshop 8: 第三屆「親身體驗，好就用」：教育玩具與遊戲式學習工作坊

Besides, Doctoral Student Forum will be established in the conference and 5 doctoral candidates will participate. A total of 8 experts and scholars will be invited to make comments and review.

We would like to express our deepest gratitude to all the chairs, co-chairs, committee members and volunteers of the sub-conferences, EPT, workshops, Teachers' Forum, Doctoral Student Forum, and the Local Organizing Committee. We thank them for their contributions and assistance to the conference, particularly their swift adaptability in responding to the emergent challenges posed by the ever-evolving COVID-19 pandemic.

We are running GCCCE 2021 at unprecedented times. Yet we sincerely hope that our conference will bring inspirations and a magnificent experience to all the online or physically attending participants. Together, we shall build a stronger, resilient and more internationalized GCCCE community, and continue to relay the GCCCE torch to successive hosts and new generations of scholars in the coming years.

HUANG Ronghuai, Beijing Normal University, Mainland China
Conference Chair

KONG Siu Cheung, The Education University of Hong Kong, Hong Kong
International Programme Coordination Chair

WANG Qiyun, National Institute of Education, Nanyang Technological University, Singapore
International Programme Coordination Co-Chair

Li Yanyan, Beijing Normal University, Mainland China
Local Organising Committee Co-Chair, Beijing

HSU Ting-Chia, Taiwan Normal University, Taiwan
Local Organising Committee Co-Chair, Taipei

2. Conference Organisation

Organiser:
Global Chinese Society for Computers in Education (GCSCE)

Hosts:
The Education University of Hong Kong
Beijing Normal University
Taiwan Normal University
National Institute of Education, Nanyang Technological University

Conference Chair:
HUANG Ronghuai, Beijing Normal University, Mainland China

Conference Co-Chairs:
CHAN Tak Wai, Central University, Taiwan
LOOI Chee Kit, National Institute of Education, Nanyang Technological University, Singapore

International Programme Coordination Chair:
KONG Siu Cheung, The Education University of Hong Kong, Hong Kong

International Programme Coordination Co-Chair:
WANG Qiyun, National Institute of Education, Nanyang Technological University, Singapore

Local Organising Committee Co-Chair:
LI Yanyan, Beijing Normal University, Mainland China

HSU Ting-Chia, Taiwan Normal University, Taiwan

Consultant:
WONG Lung-Hsiang, National Institute of Education, Nanyang Technological University, Singapore

Conference Lead Secretary:
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ZHANG Muhua, Beijing Normal University, Mainland China
CHANG Ching, Taiwan Normal University, Taiwan
HSIEH Sung-Ying, Taiwan Normal University, Taiwan
ZHANG Yuk Yui Katrina, The Education University of Hong Kong, Hong Kong

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Executive Chair:

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Co-Chairs:

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WEN Yun, Nanyang Technological University

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WU Longkai, Nanyang Technological University

WU Jing, Nanyang Technological University

ZHONG Baichang, South China Normal University

MA Zhiqiang, Jiangnan University

YANG Jinzhong, Qingdao University

3. Keynotes

主旨演講 1　Keynote Speech 1

2021 年 9 月 13 日(星期一) 10:00 - 10:45　　13 September 2021 (Monday)

Investigations into Deep Knowledge Tracing: From Cold-Start to Real Life

Dr Ryan Baker　　**Associate Professor at the University of Pennsylvania, and Director of the Penn Center for Learning Analytics, US**

Speech Abstract

In the last several years, there has been increasing interest in studying different variants of deep knowledge tracing (DKT). However, deep knowledge tracing has remained largely an algorithm studied rather than an algorithm used. Real-world adaptive learning systems generally still use algorithms developed over a decade ago, or even simpler heuristics. In this talk, I discuss our research group's investigations into key issues relevant to the use of deep knowledge tracing, complementary to other research efforts going on around the world and in particular in East Asia. I will talk about two tracks of research in my group. In the first track of research, we investigate the use of DKT to estimate latent knowledge in terms of interpretable skills that can be carried outside the adaptive learning system. We propose a simple extension, applicable to all DKT family algorithms, and evaluate the degree to which DKT family algorithms can predict latent knowledge demonstrated on tests outside the learning system. In the second track of research, we study the degree to which DKT family algorithms can solve cold-start problems, producing acceptable knowledge tracing estimates earlier in student work on a new skill. I conclude with a discussion of directions needed for DKT family algorithms to achieve their full potential and scale in real-world use.

Speaker Bio

Ryan Baker is Associate Professor at the University of Pennsylvania, and Director of the Penn Center for Learning Analytics. His lab conducts research on engagement and robust learning within online and blended learning, seeking to find actionable indicators that can be used today but which predict future student outcomes. Baker has developed models that can automatically detect student engagement in over a dozen online learning environments, and has led the development of an observational protocol and app for field observation of student engagement that has been used by over 150 researchers in 7 countries. Predictive analytics models he helped develop have been used to benefit over a million students, over a hundred thousand people have taken MOOCs he ran, and he has coordinated longitudinal studies that spanned over a decade. He was the founding president of the International Educational Data Mining Society, is currently serving as Editor of the journal Computer-Based Learning in Context, is Associate Editor of the Journal of Educational Data Mining, was the first technical director of the Pittsburgh Science of Learning Center DataShop, and currently serves as Co-Director of the MOOC Replication Framework (MORF). Baker has co-authored published papers with over 300 colleagues.

主旨演講 2　Keynote Speech 2

2021 年 9 月 13 日(星期一) 14:45 - 15:30　　13 September 2021 (Monday)

具親子共讀策略之擴增實境繪本

Professor Chang Kuo-En
張國恩教授

Professor, Graduate Institute of Information and Computer Education, Taiwan Normal University
臺灣師範大學資訊教育研究所教授

Speech Abstract 摘要

親子共讀是父母、幼兒教育者和其他照料者幫助兒童獲得語言與文字認知發展與學習行為技能的一種方式。 對話式閱讀 (Dialog Reading)是一種以證據為基礎的常用親子共讀策略，其中 PEER(Prompt, Evaluate, Expand, Repeat)更能促進親子互動之學習行為。然而由於父母並未受過對話式閱讀策略之訓練，因此並未表現出親子共讀效果。另外因父母需兼顧工作，較沒有充裕的時間陪伴兒童進行閱讀。為了能夠改善父母不會運用 PEER 策略與沒有時間陪兒童做親子共讀等問題，故運用 AR 技術發展具 PEER 親子共讀策略的 AR 繪本。在此 AR 繪本上，能引導兒童利用行動載具進行 PEER 之共讀，也探討此 AR 繪本對兒童學習成效與行為分析的影響。

Speaker Bio 個人簡介

張國恩從台灣大學獲電機博士後，在臺師大任教超過三十年，擔任過電算中心主任、資訊教育研究所所長、圖書館館長、副校長等職，2010 年接下校長一職，帶領臺師大全面發展。期間創辦「數位學習與內容學會」與「新媒體科技與教育協會」，並擔任首屆理事長，納入「數位學習科技期刊」與「TWELF 學術會議」，也完成「新聞媒體識讀素養指標與量表」與發展相關課程，培養全民具備 「識讀能力」。此外，他也曾擔任國科會科教處資訊教育學門召集人，創設 SIG 研究群與薪火相傳會議，持續推動台灣數位學習研究。台師大校長任期屆滿後，現為台師大資訊教育研究所與運動科學系合聘講座教授。

張國恩從事數位學習相關研究，從早期的概念圖輔助教學、電腦模擬輔助學習、與行動學習外，也建立用於企業的數位學習品質認證指標，並於 2011 年建立了「華語文與科技研究中心」，整合團隊，從事華語文資訊科技在寫作、閱讀、語音辨識等研究。目前的研究工作集中在擴增實境(Augmented Reality)的教育應用，探討如何將擴增實境技術應用於輔助紙本書籍的閱讀上，結合精熟學習策略，在實體書籍上擴增輔助學習資訊，建構新的書本型態，稱為麻布書 (MAR Book，Mastery learning-based AR Book)，同時也將 AR 技術應用在親子共讀與角色扮演的桌遊學習上。在後疫情時代，有鑑於遠距教學的重要，張國恩將人力資源發展與知識管理策略結合到數位學習中，並協助台灣上市企業發展內部的數位化訓練系統與建立企業數位大學。

主旨演講 3　Keynote Speech 3

2021 年 9 月 14 日(星期二) 9:15 - 10:00　　14 September 2021 (Tuesday)

The Future of Education: New Space, New Knowledge and New Ontology

Professor Chen Li　　Vice President, Beijing Normal University
陳麗教授　　北京師範大學副校長

Speech Abstract

Prof. Li Chen will deeply elaborate how cyber space is transforming education on essence in three aspects. Firstly, Prof. Chen will explain the impact on education of disruptive technology. The cyberspace is a kind of disruptive technology which is an information space with different characteristics from physical space and social relation space. Now cyber space is transforming from two spaces to three spaces. Secondly, Prof. Chen will issue that in the cyber space knowledge is extending to all kind of experience and different from traditional knowledge the book. Prof. Chen will present her research findings on knowledge in the cyberspace. Thirdly, Prof. Chen will issue that education ontology is changing to connection. Prof. Chen is going to present the experimental study on cMOOC. At the end of the speech, Prof. Chen will call on the researchers in education technology to pay attention on revealing new foundation of education during applying new technology into education.

Speaker Bio

Prof Li Chen a PhD supervisor. She is vice president of Beijing Normal University. She is the leader of master program and PhD program of Distance Education in Beijing Normal University. Her research is mainly focusing on Education Transformation by Internet, online teaching & learning, and internet plus education strategy. She is deep engaged in policy consulting in Distance Education and lifelong learning. She has authored and published more than 10 books and 100 papers.

陳麗，博士、博士生導師。現任北京師範大學副校長。陳麗是北京師範大學遠端教育碩士點和博士點的學科帶頭人。陳麗教授的主要研究領域為：1.互聯網推動教育變革的趨勢；2. 線上教育教與學的規律；3.“互聯網+教育”戰略。陳麗教授是中國終身教育和遠端教育領域的重要諮詢專家。她已經出版了十餘部著作和百篇以上的學術論文。

主旨演講 4　Keynote Speech 4

2021 年 9 月 15 日(星期三) 10:00 - 10:45　　15 September 2021 (Wednesday)

Awarding Skill Improvements based on Behaviour Pattern Extraction and Analysis

Professor Maiga Chang　　Full Professor, Athabasca University, Canada
張明治教授　　教授，阿薩巴斯卡大學（加拿大）

Speech Abstract

Educational games and gamification learning systems usually provide learners rewards when they have progress on solving learning quests and/or doing learning activities. But how to give learners an appropriate reward that reflects the efforts they have taken and the skill improvements they have made? This talk will start with the showcases of couple of educational games that can help learners improve their meta-cognitive skills (e.g., problem solving, associative reasoning, evaluation and accuracy, and planning and organization) and language speaking skill. These educational games record learners actions taken in the games and give learners points, virtual currency and virtual items to award their learning achievements and progress (i.e., skill improvements). This talk will then use the real game-play data collected from a commercial mobile educational game as example to explain the process of identifying and extracting learners' bahaviour patterns and calculating a learning quest/activity's general difficulty for most of learners as well as its difficulty for the particular learner. At the end of the process, the educational games and gamification learning systems is capable of awarding the learners proper rewards based on their efforts, improvements, and achievements.

Speaker Bio

Dr. Maiga Chang is a Full Professor in the School of Computing Information and Systems at Athabasca University, Canada. His research mainly focus on game-based learning, training and assessment, learning analytics and academic analytics, intelligent agent technology, etc. He is Chair (2018~2023) of IEEE Technical Committee of Learning Technology (TCLT), Chair (2021) of Educational Activities Committee & Awards/Recognition Committee, IEEE Northern Canada Section, and Secretary and Treasurer of International Association of Smart Learning Environments (IASLE) (2019~). He also serves as Executive Committee member for IEEE Computer Society Special Technical Communities (2021), Asia-Pacific Society for Computers in Education (APSCE) (2017~2024) and Global Chinese Society for Computing in Education (GCSCE) (2016~2021).

Dr. Chang is editor-in-chief of Journal of Educational Technology & Society (an Open Access SSCI journal), International Journal of Distance Education Technologies (an ESCI, SCOPUS, EI journal), and Bulletin of Technical Committee of Learning Technology (an Open Access ESCI journal). He serves as a Steering Committee member for International Conference on Intelligent Tutoring Systems (ITS) (2020~), program chair of International Conference on Smart Learning Environments (2015, 2018~2020), program committee chair of International Conference on Intelligent Tutoring Systems (2019), executive chair of inaugural English Paper Track of 24th Global Chinese Conference on Computers in Education (2020), IPC Coordination chair of International Conference on Computers in Education (2019). He has given more than 110 talks and lectures and (co-)authored more than 227 edited books, book chapters, journal and international conference papers.

Kong, S.C., Wang, Q., Huang, R., Li, Y., & Hsu, T. C. (Eds.) (2021). *Conference Proceedings (English Paper) of the 25th Global Chinese Conference on Computers in Education (GCCCE 2021).*
Hong Kong: The Education University of Hong Kong.

A Systematic Literature Review of the Challenges of the COVID-19 Pandemic for K–12 Education

Carla Huck[1] and Jingshun Zhang[2]
[1,2] Florida Gulf Coast University
chuck@fgcu.edu

Abstract: *In this study we investigate educational research conducted in the United States during the COVID-19 school closures to increase our understanding of student, parent, teacher, and school leader experiences with remote learning in a K–12 context. With the application of a concept mapping tool to harmonize and prioritize outcomes among relevant studies, this systematic review includes data collected during the pandemic when instruction transitioned to a remote environment in the spring of 2020. By including research relevant to all stakeholders, we can ensure the scope and focus of this review address essential issues to support practice and policy. Findings include the need to develop frameworks that emphasize equity, support teacher preparation in remote teaching, and produce clear communications of expectations for multiple target audiences. While it is currently unknown how long students will engage in remote learning, we present data-informed recommendations that school district personnel and state education officials might implement to improve stakeholder experiences and minimize potential achievement gaps.*
Keywords: systematic review, COVID-19, remote teaching, equity, concept mapping

1. Introduction

The COVID-19 pandemic has had far-reaching effects on nearly every aspect of society, including education. Schools in the United States, and in most countries in the world, were closed in March 2020 as nations developed lockdown measures to prevent further spread of the virus. While educators transitioned from traditional face-to-face learning to digital platforms for remote teaching, many challenges arose that required quick solutions and changes to policy and procedures in order to provide equitable and appropriate remote learning to all students. Through a process of systematic literature review and an elaborated concept mapping strategy, we will present a deeper understanding of how remote instruction was experienced during the mandatory school closures for sample populations of K–12 students, teachers, parents, and school leaders. Scholarly sources include journal articles, reports, policy briefs, and dissertations that address the focus research question, "What challenges has the COVID-19 pandemic created for K–12 education?" The application of a concept mapping strategy enabled us to present common issues, concerns, and recommendations; prioritize outcomes across studies; and identify gaps in the literature for further investigation. As mandated remote learning is a recent and ongoing phenomenon, it is essential that we also outline the following aspects of these studies: (1) In what ways do the primary components of these studies, such as research questions, datasets, research methods, samples, relevant theories, results, and limitations overlap, and in what ways do they differ? (2) What are the common results beneficial to understanding challenges and implementing successful strategies to support all stakeholders? This study will make a scholarly contribution as a systematic review helps us locate and understand relevant scholarship, along with sub-themes, populations, and geographic areas that require further exploration.

2. Brief Literature Review

While educators' lack of experience in teaching remotely was brought to the forefront during the pandemic, with numerous media reports of teachers feeling overwhelmed and unprepared as they tried to navigate distance learning for the first time, demand for these learning models has in fact been increasing in the K–12 sector (Archambault & Kennedy, 2014; Rice & Deschaine, 2020). Researchers of remote teaching and virtual school instruction have consistently recommended high quality pedagogical and technical preparation for educators to prevent significant widening of opportunity and achievement gaps for traditionally marginalized student populations (Xu & Jaggars, 2014). The global pandemic and mandated schoolwide closures have no precedent; while the United States has historically experienced many natural disasters and economic crises, none have required widespread transition to remote learning. The ability to use technology to teach learners at a distance has been especially important in times of emergency (Hinson et al., 2014) but fully functioning online schools are possible only through thoughtful planning and development before a disaster strikes. Researchers have cited previous studies on crisis management of school leaders (Smith & Riley, 2012) and organizational cultures that promote continuous improvement for teachers (Reinhorn et al., 2017) as frameworks for examining the efficacy of educational practices during the pandemic.

3. Data Source

This study began by locating published research addressing the main research question. A range of quantitative, qualitative, and mixed-methods studies were screened for quality and eligibility using an abstract screening tool and revisited multiple times during the coding process. To select an effective sample we applied the following standards to our selection criteria:

a. Time: Studies conducted during period of COVID 19 school closures
b. Demographics: Studies conducted in United States, K–12 sample (March – July 2020)
c. Sources: EBSCO, ERIC, ProQuest, and Google Scholar
d. Keywords: "K12" AND "research" AND "pandemic" AND "United States"
e. Impact: Academic journal articles (peer-reviewed); high-quality reports and policy briefs from established organizations with well-cited references; dissertations and working papers

Table 1. Type of studies included in systematic review

Type of studies	Total studies (2020-2021)	
	Frequency	Percent
Dissertation	2	4%
Journal	30	61%
Policy Brief	7	14%
Report	7	14%
Other	3	6%
Total	49	100%

4. Research Methods

To analyze the sample of studies, we developed a classification scheme and data extraction table in Excel. A systematic literature review is an attempt to make sense of a body of existing literature through the aggregation, interpretation, explanation, or integration of existing research (Rousseau et al., 2008). For this study, we applied graphical representation for organizing and representing knowledge, concepts, and their relationships through concept mapping. Concept maps utilize circles or boxes that indicate the connecting links between concepts (Novak & Canas, 2006) and help researchers and students visualize and learn information by using nodes and links that reflect a domain knowledge and application (Alias & Suradi, 2008; Carnot et al., 2008). We used the concept mapping approach (Zhang, 2011; Zhang et al., 2021) which follows three stages: collecting and cataloguing studies through systematic literature review and creating preliminary visual mapping structure; synthesizing key information from studies and coding by theme; and deeply analyzing the maps to identify frequencies, interconnections, and knowledge gaps. Our map has the primary research question at the center with five sub-groups as shown in Figure 1. We utilized the program Inspiration 10 to draw a thematic mapping structure, enter data from our reviewed literature to create color-coded levels, revise after multiple full-text readings of articles, and add article numbers that addressed each concept (coded 01,02,03. . . on the map). The concept map provided us with visual cues to aid in our analysis of the data clusters.

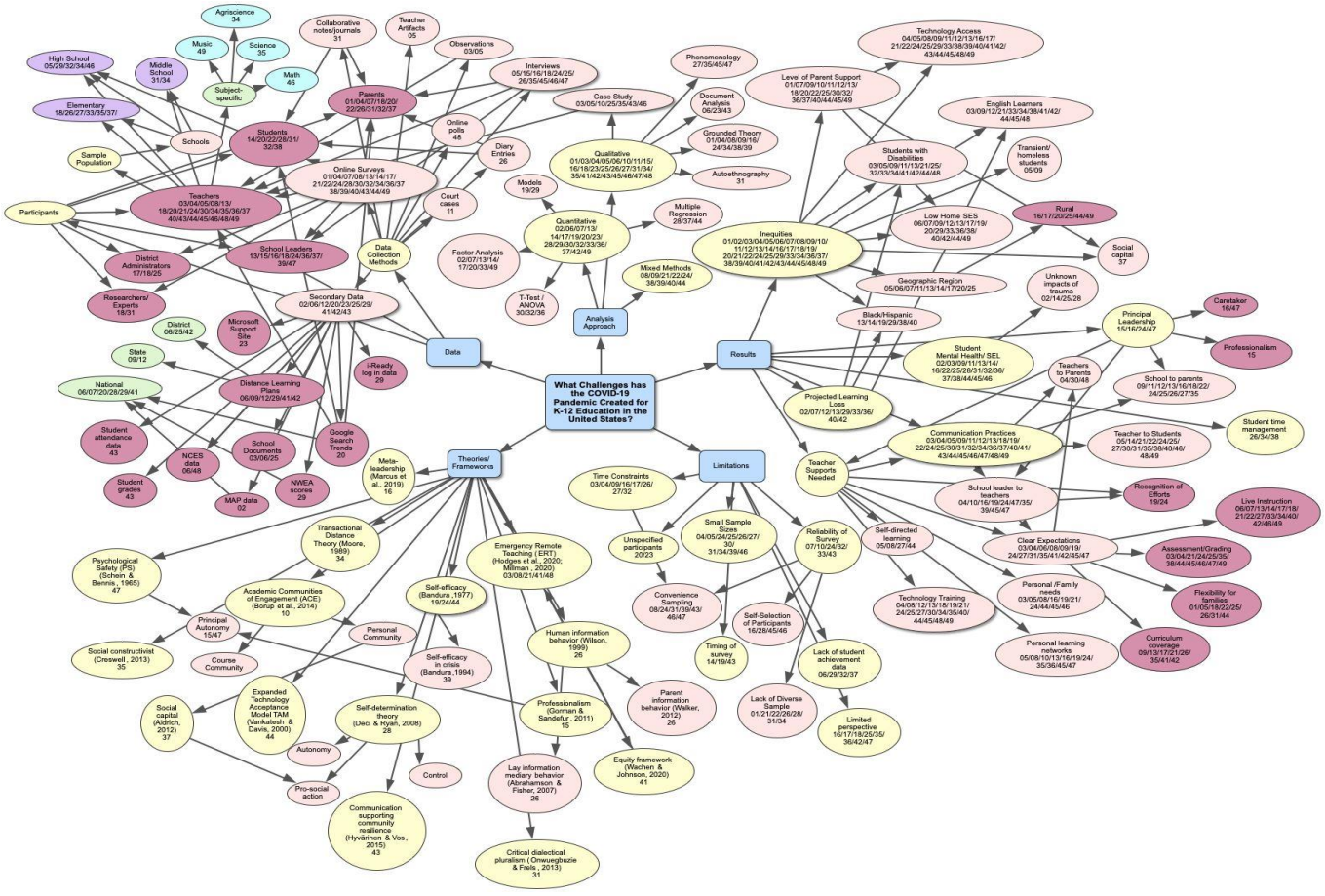

Figure 1. Concept map of literature

5. Preliminary Results

This systematic review synthesizes and summarizes key findings among multiple studies conducted during the COVID-19 pandemic in the United States. While we have analyzed findings from the five sub-groups in our study—data, approach, theories/frameworks, limitations, and results—our key findings in this paper will address the common challenges in the results sub-group about equity, teacher preparation, and school-home communication.

5.1. Equity Issues

Concerns about students' equitable access to resources were reported in 38 studies in this review (77.5%). Student engagement in remote learning can be influenced by family social capital including household material, technological resources, and parents' networks. Students with access to high-speed internet and internet-enabled devices consistently reported higher levels of engagement (Domina et al., 2021). Dorn et al. (2020) analyzed real-time log-in data from i-Ready digital-instruction and assessment software to find only 60 percent of low-SES students were regularly logging into online instruction compared to 90 percent of high-SES students. Students with disabilities and English learners faced additional challenges learning in remote environments without classroom supports required for their full participation (Hamilton et al., 2020; Sugarman & Lazarin, 2020). The widely reported barrier to infrastructure access, particularly in rural areas, is an issue that needs to be addressed by policy makers in collaboration with utility providers and telecommunications companies.

5.2. Teacher Preparation for Remote Instruction

Although many educators enjoy teaching online, those new to this practice faced increased workloads and difficulties utilizing technology, communicating with students, and measuring student outcomes (Kraft et al., 2020; Trust & Whalen, 2020). When schools closed and education transitioned to "emergency remote instruction," many teachers were learning new technology platforms and delivery modes at the same time as their students. Participants in 18 out of 21 studies sampling teachers (85.7%) reported needing significant support with shifting their practice. Those who did not teach online before the pandemic described how their professional job functions such as lesson planning, assessment, and differentiation were much more challenging in a remote environment and they had a lower sense of success and self-efficacy (Cardullo et al., 2021; Kraft et al., 2020). In contrast, teachers who felt confident in their remote teaching skills reported work environments with pre-established scheduled professional learning networks and collaboration with colleagues, supportive school leadership, and meaningful professional development (Kaden, 2020). As students return to traditional classrooms, we suggest school leaders provide teacher training to enhance technology integration and incorporate successful pedagogical strategies such as flexible pacing and individualized instruction (Cardullo et al., 2021; Lindner et al., 2020).

5.3. School-Home Communication

The need for heightened teaching presence and increased instructor support and feedback was emphasized as important by both student and parent respondents (Pesnell, 2020; Simpson, 2020). In surveys of youth well-being, researchers found that 29% of adolescents did not feel connected to an adult at school (Margolius et al., 2020) and motivation and engagement varied by grade level, SES, and race (Youth Truth, 2020). In a large survey of parents conducted by the Pew Research Center (Horowitz, 2020), 64% of parents reported concern about their children falling behind, with live, online instruction from teachers more prevalent in higher SES areas. Garbe et al. (2020) similarly studied parents' experiences with remote learning and focused on challenges to parental involvement such as economic

resources, lack of internet access, and low digital self-efficacy. While there is a large body of literature addressing the use of technology in schools, most of this research has referred to pedagogical implementation rather than the use of technology as a tool to fulfill communication needs (Lewin & Luckin, 2010). We find this area merits further scholarship as schools and families are increasingly dependent on digital communication methods.

6. Limitations

One limitation of our study was the range of our literature review, since we were studying a recent and ongoing event. Several researchers cited their own time constraints in developing and administering surveys or collecting data, which could affect the reliability of those studies. We could continue to expand this study by extending the time period in our search and providing a deep content analysis applying an equity framework.

7. Significant Contributions

The present study highlights the need for teachers and school leaders to center equity concerns to inform decision-making and effective communication with students and families. There has been a gap in the research on the effects of prolonged school closure and remote instruction on students and their parents, and this systematic review examined the first set of studies addressing this topic while it was happening. The results of this study are expected to help guide further research for scholars in the field who are studying the effects of COVID-19 on K–12 education, as well as those who are interested in conducting systematic reviews.

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Examining 12th Grade English Learners' Choice of Instructional Models During the COVID-19 Pandemic

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Abstract: *In this quantitative study, researchers examined the factors that correlate to Grade 12 English learners' (ELs) selection of instructional delivery models during the school year 2020-2021 and the COVID-19 pandemic. Secondary data from one large school district in South Florida were analyzed related to background and contextual factors that may have influenced EL students' choice of model to successfully complete their senior year of high school and meet graduation requirements. These factors include student background, achievement scores, and school demographics. Local education agencies must ensure ELs continue to have equal access to academic grade-level content through high-quality instruction, and state agencies should develop guidance on how to best do this in remote teaching contexts.*
Keywords: English learners, graduation, COVID-19, remote teaching, instructional model

1. Introduction

The graduation rate of ELs has increased nationally from 57% in 2010-11 to 67% in 2015-16 (National Center for Education Statistics, 2016) but still lags behind the non-EL rate of 84%. In Florida, the rate in 2018-19 was 75% for ELs compared to 86.9% for non-ELs (Florida Department of Education, 2020). Secondary level teachers are challenged to help students persist to graduation despite pressure and anxiety these adolescents feel to pass assessments for graduation that they are not yet linguistically prepared to master. In this study, researchers analyzed available data to determine which background and contextual factors may have influenced a 12th grade EL's selection of instructional delivery model from the options offered in one school district in Florida: face-to-face, home connect, or virtual school. The research questions were: (1) Is there a statistically significant difference in EL student choice of instructional model according to achievement entering senior year? (2) How do background factors correlate to an EL student's choice of instructional model? (3) Do school context variables correlate to an EL student's choice of instructional model?

2. Brief Literature Review

There are already broad interests to explore how education is being impacted by COVID-19, though limited research is available on the specific implications for ELs. Reich et al. (2020) compiled recommendations from 50 states, finding only a few states have explicitly noted that school districts must ensure English learners continue to have equal access to academic grade-level content in remote learning environments. When considering the effects of remote instruction on ELs, the digital divide and "digital use divide" is frequently cited as an obstacle for many families (Sugarman & Lazarin, 2020). According to Altavilla (2020), ELs are often assigned to use computers for vocabulary drills, phonics practice, and rote lessons rather than higher level thinking tasks. Unfortunately, few teachers have the resources and training to use technology in ways that provide ELs with meaningful learning opportunities (Siefert et al., 2019). Teachers and students may need carefully planned approaches to effective use of technology that ensure instructional activities are specifically designed to facilitate language development (Hartshorn & McMurry, 2020).

3. Research Method

3.1. Sample and Population

This study used a convenience sample of all students in one large school district in Southwest Florida coded as English learners in Grade 12 for the 2020-21 school year (n=861). The secondary school data was obtained directly from the district student learning management system with IRB approval, and additional information regarding school demographics was obtained from public websites for the Florida Department of Education.

3.2. Design

First, student and school data were analyzed with descriptive statistics that indicate general tendencies in the data (mean, median, mode) and the spread of scores (variance, standard deviation, and range). Next, we applied inferential statistics through correlational analyses to describe and measure the degree of association between two or more variables. We used Pearson's r correlation, t-test, ANOVA, and multiple regression analysis to try to determine one or more predictor variables that could positively predict an outcome (choice of instructional model).

3.3. Variables

The aggregate student data from the district information system included the following variables: choice of instructional model, student gender, number of years in a U.S. school, home language, years of interrupted schooling, scores on WIDA ACCESS for ELs (AFE) language and reading assessments and Florida Postsecondary Education Readiness Tests (PERT) in mathematics. The school data compiled from public websites includes school grade, zone, district or charter, and Title 1 designation.

4. Preliminary Results

We focused on three instructional models for analysis: face-to-face (n=326), home connect (n=504), and virtual school (n=24). Students who opted into home connect joined classes being taught simultaneously in a classroom via Zoom from their homes. Students in virtual school completed all coursework online in a largely asynchronous platform. In response to our first research question regarding the relationship between choice of instructional model and student achievement, we found that when we disaggregate GPA, AFE scores, and PERT math scores by instructional model the mean of each is higher for students in the virtual school. In fact, all 24 students in the virtual school model had the required GPA for graduation of 2.0 or higher. When we examined the frequency of overall scores on the AFE language proficiency assessment available from participants in our sample, we determined a mean score of 3.0. The highest number of students fell in the 1.6 - 2 range, which indicates entering to emerging levels of proficiency. This lower level of proficiency could result in challenges for students trying to meet graduation requirements, including passing state standardized assessments that are the same as those of their native-English speaking peers.

While examining choice of instructional model and student background factors, a Phi correlation test indicated a strong correlation between students with interrupted schooling and their choice of instructional model ($r = 1$). The majority of these students selected face-to-face, which is the recommended mode of instruction for English learners providing social interaction needed for English language development (Altavilla, 2020; Hartshorn & McMurry, 2020).

5. Conclusions

There is a gap in the literature on the implications of these models on student learning, particularly for ELs. This study was conducted using secondary data available from a school district information system; therefore, the statistical analyses cannot capture the motivations behind student choice of model, challenges and benefits for students who selected remote options, and other differences in school cultures and environments. This study was conducted in a single school district; similar studies in the future could benefit from including multiple districts across many regions.

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A Conceptual Framework for Designing Artificial Intelligence Literacy Programmes for Educated Citizens

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Abstract: *In the digital era, as the application of Artificial Intelligence (AI) permeates every corner of the world, public AI literacy is becoming essential. This study aims to promote AI literacy for citizens of digital-era societies. We propose a three-dimensional conceptual framework of AI literacy: the cognitive dimension involves educating people about basic AI concepts, and developing their competencies in using AI concepts for evaluating and understanding the real world; the affective dimension focuses on the empowerment of participants to enable them to react to the widespread use of AI in their daily lives and workplaces; and the sociocultural dimension encourages the ethical use of AI for sustainable global development. The aim of this paper is to start a conversation about and guide future research on a conceptual framework for designing AI literacy programmes. It is hoped that the proposed conceptual framework will provide researchers, educators, and policymakers with a solid foundation as they attempt to nurture and engage educated citizens who can capitalise on the opportunities and benefits AI offers.*
Keywords: artificial intelligence literacy; concepts; conceptual framework; empowerment; ethics

1. Background of the Study

As Artificial Intelligence (AI) becomes increasingly integrated into technology in the digital era, it is becoming an important part of all aspects of life. Some knowledge of AI becomes essential for the public to be able to react appropriately when engaging with AI. Besides, cultivating AI literacy among citizens is necessary for a contemporary city to thrive, considering the great potential of AI in reshaping the competitive landscape and bringing tremendous economic benefits (The Legislative Council Commission, 2019). That is, for both the benefits of individuals and society at large, cultivating AI literacy among citizens is necessary. In this study, we propose a conceptual framework for designing AI literacy programmes for the public, including young adults such as university students, and those working across different sectors such as journalists, schoolteachers, salespeople, medical staff, financial advisers, housewives, and so on who show an interest in understanding AI and regard it as related to their careers and daily lives.

2. Aim and Objectives of the Study

Echoing the significance of AI literacy for all individuals involved with AI, this study aims to promote AI literacy for interested citizens. The objectives of the study are to promote AI literacy for citizens, to empower them with AI literacy, and to promote the ethical use of AI.

3. What is AI literacy?

The term literacy was originally defined as the ability to read and write. In today's digital world, the concept has been extended to include 'new' or 'multiple' literacies (Buckingham, 1993) such as visual, digital information, and AI literacy (Kong, 2008; Kong et al, in press). There is no widely accepted definition of AI literacy at present. Kong and

others (in press) defined AI literacy as understanding of AI concepts and competencies in using AI concepts for evaluation and using AI concepts for understanding the real world, which we consider comprehensively address what AI literacy comprises and can be a proper starting point. We will detail this definition in the following section.

As previously indicated, educating individuals about AI is becoming crucial. As a result, our research aims to provide educated citizens with the capabilities they need to succeed in today's digital society. Educated citizens are defined as those who are skilled and can contribute to society in general (Sullivan, 1988). In line with this definition, we propose that fostering AI literacy is a way to equip educated citizens with the knowledge and competencies to protect their benefits as members of society and to employ AI to benefit their communities.

4. Conceptual Framework of AI Literacy

The conceptual framework for AI literacy we propose in this study involves three dimensions: the cognitive dimension, focusing on educating people about basic AI concepts and developing their competencies in using AI concepts for evaluation and understanding the real world; the affective dimension, with an emphasis on the empowerment of participants, enabling them to react to the widespread use of AI in their daily lives and workplaces; and the sociocultural dimension, aimed at encouraging the ethical use of AI for sustainable global development.

4.1. Cognitive Dimension

The cognitive dimension focuses on individuals' mental processing and is an integral part of AI literacy. As suggested by Kong and others (in press), AI literacy incorporates AI concepts, using AI concepts for evaluation, and using AI concepts for understanding the real world.

Understanding AI concepts is fundamental for leaners in developing AI literacy. Basic AI concepts are also highlighted in the OECD guidelines (2018) and curriculum guidelines suggested by Touretzky and others (2019). In this study, machine learning and deep learning will be the foci of the content of AI literacy. Regarding machine learning, participants will be introduced to basic concepts such as supervised learning, unsupervised learning, regression, classification, and K-means clustering. For deep learning, participants will learn concepts such as data cleaning, data augmentation, neural network, computer vision, deep learning, and convolution neural network.

Secondly, using AI concepts for evaluation means learners form their own judgement using the AI concepts they learned. As AI systems are becoming ubiquitous, evaluating them via the accurate knowledge can help everyday users make informed decisions about how to use and when to trust AI (OECD, 2019). Seeing that AI is rapidly changing the world, it is important for educated citizens to consider the values inherent in the technology, and critically evaluate the long-term effects the technology may have on the world (Long and Margeko, 2020).

Lastly, an AI literate person should be able to use AI concepts for understanding the real world. Understanding the real world means individuals are situational aware and perceive the environment and situation correctly (Fukuda, 2019). This understanding is vital for individuals in the fast-changing digital era. Fukuda (2019) holds that concepts alone are not enough for individuals to understand the real world exactly; what they need is experience, an action to explore our world. We thus propose that AI literacy programmes include developing AI applications, thereby offering learners with problem solving experience via employing the AI concepts acquired. The AI concepts, together with the explorative experience may help learners understand more about the real world and adapt to an AI-pervaded future.

4.2. Affective Dimension

The affective dimension mainly focuses on individuals' emotional and perceptual processing throughout the learning process. Our concern is whether participants feel empowered by becoming more AI literate and can confidently engage in the community. We argue that AI literacy should include an affective dimension.

The empowerment of individuals means giving them increased control over their lives and coping skills (Makinen, 2006). Kong and others (in press) initiated the concept of AI empowerment, which means that with AI literacy, people gain new abilities and ways to participate in digital society. Borrowing the framework of programming empowerment (Kong et al, 2018), Kong and others (in press) proposed that AI empowerment incorporates four components: AI self-efficacy, meaningfulness, impact and creative self-efficacy.

The primary component, AI self-efficacy, relates to how well participants believe they are doing when engaging with AI. When participants have greater self-efficacy, they have greater confidence in their competence to perform an AI-related task and are more likely both to start doing it and to continue working on it. The second component, meaningfulness, refers to the perceived relevance and importance that AI has for learners in their daily lives. The importance of AI literacy is generally recognised. Participants who perceive AI as meaningful are likely to make more efforts and to succeed, and are more likely to be empowered. Impact is the degree to which the accomplishment of a task is perceived to make a difference in the scheme of things (Frymier et al., 1996). Here it is concerned with learners' perceptions of AI literacy and their recognition of the societal impact of AI, following one of the five 'big ideas' proposed by Touretzky and others (2019). The final component, creative self-efficacy, is a person's belief in his or her ability to come up with new ideas and solutions (Kong et al., 2018; Kong et al, in press). When faced with a difficult task, someone with a higher level of creative self-efficacy is more likely to try different means and to be empowered.

4.3. Sociocultural Dimension

Incorporating AI ethics in the curriculum is emphasised by Touretzky and others (2019) and OECD (2018); this item falls into the sociocultural dimension. We argue that AI literacy should include such a sociocultural dimension to capture how individuals approach the changing environment as AI becomes popular. As the widespread use of AI can lead to either beneficence or maleficence, the ethical use of AI in society (OECD, 2018) is vital to sustainable global development (UNESCO, 2020; United Nations, 2015) and should be the focus of this dimension in our framework.

In the 'Recommendation on the Ethics of Artificial Intelligence' (UNESCO, 2020), sustainability is one of the important guiding principles of AI ethics. As the advent of AI technologies can either contribute to or hinder the realisation of sustainability objectives, continuous assessment of impact of AI technologies should be implemented. The United Nations Sustainable Development Goals (SDGs) (United Nations, 2015) provide concrete guidelines on this assessment.

In ensuring ethical standards in AI applications, the principles stated in the Belmont Report (NCPHS, 1978) can be considered as a starting point (Luckin, 2017; Yu et al., 2018), and these principles echo the SDGs (United Nations, 2015). There are three key requirements of these principles: (1) the violation of personal autonomy should be avoided; (2) the benefits of decisions should outweigh the risks; and (3) fairness should be ensured (NCPHS, 1978; Yu et al., 2018). Accordingly, these principles applied in the use of AI will be as follows: (1) the use of AI should not violate human autonomy; (2) the benefits brought by AI should outweigh the risks; and 3) the benefits and risks brought by AI should be distributed equally. These three principles, together with the SDGs, are the effective guidelines to follow.

This multidimensional conceptual framework addresses the knowledge set, competencies, and awareness one should possess to be an educated, AI-literate citizen in the digital era. It will serve as the foundation for and provide effective and clear guidance on the design and development of AI literacy programmes in the future.

5. Conclusion and Future Work

This paper proposes a conceptual framework for designing AI literacy programmes based on an operational definition of AI literacy. The conceptual framework outlined in this paper lays a solid ground to move forward for researchers, educators, and the government in research, curriculum development, and probably the improvement of education policies to cultivate and engage educated citizens. We are aware that our conceptual framework for AI literacy needs to be validated through empirical studies. To provide more sound underlying data to document the success of the conceptual framework for designing AI literary programmes, we plan to design and conduct an AI literacy programme and evaluate the implementation among university students across disciplines. Furthermore, we encourage researchers and educators in the community to engage in conversation around the framework in this study and to use it to guide and inspire their future research on education in AI literacy.

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The effects of captions on verbal and visual learners when learning from videos

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Abstract: *This study was conducted on 232 high school students to explore the effect of caption type (no caption vs. keyword captions vs. full captions) and learning style (verbal vs. visual) when learning from declarative and procedural knowledge videos. The results found that the interaction effect of caption type, learning style, and knowledge type on cognitive load was significant. When learning declarative knowledge videos, keyword captions reduced visual learners' cognitive load, but when learning procedural knowledge videos, keyword captions were more beneficial to visual learners. In addition, keyword captions and full captions both improved visual learners' memory, but only keyword captions were more beneficial to verbal learners. Therefore, when designing instructional videos of different knowledge types, learners should be provided with appropriate types of captions based on their learning style.*
Keywords: instructional videos, captions, learning style, knowledge type, cognitive load

1. Introduction

Designing instructional videos based on the characteristics of learners is an important problem to be solved urgently. Studies showed that the presence or absence of captions in instructional videos and different types of captions may have different effects on learning effects (Cockburn, Quinn, & Gutwin, 2017; Perez, Peters, & Desmet, 2018). The cognitive processing methods for verbal and visual learners were distinct, so their learning effects with different captioned videos were dissimilar. In addition, when learning declarative and procedural knowledge instructional videos, learners used different metacognitive strategies, which may lead to different learning effects (Hong, Pi, & Yang, 2018).

1.1. Effects of captions on instructional videos learning

The captions in instructional videos referred to the text translation of the explanation speech presented in synchronization with the video and audio (Danan, 2004). As learning support, captions in instructional videos helped learners establish a connection with the learning content, reduced cognitive load, and improved learning performance, which was in line with the dual coding theory (Matthew, 2020). An earlier study found that learners in captioning group outperformed those in the no captioning group, and the learning performance was better when the captions and speech were presented at the same time (Bernard, 1990).

However, when text and spoken information were presented at the same time, the repeated information may cause redundant effects, which can increase learner's cognitive load, and harmed their learning performance (Tarchi, Zaccoletti, & Mason, 2021; Rop et al., 2018). According to the cognitive load theory, learning occurred by establishing a connection between the visual and verbal channels, while the processing ability of the two channels was limited (Paas, Van Gog, & Sweller, 2010). Thus, adding captions may cause redundancy, thereby reducing learning effects.

The above studies had different opinions on whether to add captions or not. Therefore, many empirical studies classified captions according to the amount of information and found the effectiveness of keyword captions, which seemed

to indicate the boundary conditions of the redundancy effects. Compared to no caption and full captions, keyword captions provided the least but most important information, which helped learners focus on the key points, thereby reduced cognitive load and improved learning performance (Perez, Peters, & Desmet, 2018).

1.2. The role of learning style in instructional videos learning

Learning style referred to the learner's personal and preferred way in the process of organizing and processing information (Messick, 1984). Verbal information and images are important components of videos, so learning style was classified as verbal and visual in this study (Felder & Silverman, 1988). Verbal learners tended to obtain knowledge through symbols, text, and speech explanations. Their thinking styles mostly involved abstract symbols and they preferred verbal information; in contrast, visual learners tended to use images or physical objects. Their thinking activities were more specifically with a strong ability to process and form images (Massa & Mayer; 2006).

Verbal and visual learners had different tendencies when learning different types of multimedia materials, which may cause differences in cognitive load and learning performance (Chen & Wu, 2015). For visual learners, multimedia materials combined with text and pictures were more conducive to learning than text-only; while learning materials containing videos and animations were more suitable for visual learners than those containing text and animation (Chen & Sun, 2012).

1.3. Declarative knowledge and procedural knowledge

Knowledge is the understanding of the attributes and connections of things, manifested in the mental forms of perception, representation, and concepts, which could be divided into procedural knowledge and declarative knowledge according to the content of knowledge (Anderson, 1983). Declarative knowledge is factual knowledge about "what" and "why". The learning of declarative knowledge needs to go through six steps: perceiving material, activating previous knowledge, choosing to perceive new knowledge, interacting with old and new knowledge, establishing connection points, and forming a new cognitive structure (Crooks & Alibali, 2014). Procedural knowledge is a kind of process knowledge about "how to do", emphasizing that learners practice rules according to case operation steps, to achieve practical applications that are relatively automated with skills (Star, 2007).

Studies have proved that during the learning process of declarative knowledge and procedural knowledge, learners used different metacognitive strategies, which led to different learning effects and cognitive load (Hong, Pi, & Yang, 2018; Lenz et al., 2020). For example, a study found that when learning declarative knowledge videos with full captions, learners gained more knowledge, while learners in the summary captions group performed better. when learning procedural knowledge, learners in the summary captions group gained the most knowledge and performed the best (Wang, Wang, & Hou, 2016).

1.4. The present study

In the present study, we explored the effect of caption type and learning style when learning from declarative and procedural knowledge videos. Based on the previous studies, we supposed that there will be significant interaction effects of knowledge type, learning style, and caption types on cognitive load and learning performance. The hypotheses are as follows.

H1a: For declarative knowledge, verbal learners who view the videos with keyword captions will report the lowest cognitive load, followed by no caption, and finally by full captions; while visual learners who view the videos with keyword captions will report the lowest cognitive load, followed by full captions, and finally by no caption.

H1b: For procedural knowledge, verbal learners who view the videos with keyword captions will report the lowest cognitive load, followed by full captions, and finally by no caption; while visual learners who view the videos with keyword captions will report the lowest cognitive load, followed by no caption, and finally by full captions.

H2a: For declarative knowledge, verbal learners who view the videos with keyword captions will perform best, followed by no caption, and finally by full captions; while visual learners who view the videos with keyword captions will perform best, followed by full captions, and finally by no caption.

H2b: For procedural knowledge, verbal learners who view the videos with keyword captions will perform best, followed by full captions, and finally by no caption; while visual learners who view the videos with keyword captions will perform best, followed by no caption, and finally by full captions.

2. Method

2.1. Participants and design

Two hundred and thirty-two participants were recruited from a Chinese high school. Their age ranged from 16 to 17 years old (Mage = 16.47, SDage = 0.50; 156 males). This study was approved by the local ethics committee and all participants signed informed consent.

A 2 (Knowledge type: declarative vs. procedural) × 2 (Learning style: verbal vs. visual) × 3 (Caption type: no caption vs. keyword cations vs. full captions) between-subjects design was used in this experiment. Each participant with a verbal or visual learning style was assigned to view one of the six videos (2 Knowledge types × 3 Caption types).

2.2. Instructional videos

There were 3 instructional videos for declarative knowledge with the topic of "Composition method in photography". The three 4-min videos were the same except for the captions (Figure 1). Also, there were three 6-min videos for procedural knowledge themed "Delete the background of a picture" (Figure 2). No captioned videos had no captions throughout the whole video. Keyword captioned videos only presented the keywords at the bottom of the screen. Full captioned videos presented captions the same as the speech at the bottom of the screen.

(a) No caption (b) Keyword captions (c) Full captions

Figure 1. Declarative knowledge instructional videos of different caption types.

(a) No caption (b) Keyword captions (c) Full captions

Figure 2. Procedural knowledge instructional videos of different caption types.

2.3. Measurements

2.3.1. Learning style questionnaire

This study adopted the verbal and visual learning style classification from Silverman (1988). The questionnaire consisted of 11 multiple-choice items (A or B). If the amount of A was less than B, they were classified as verbal learners; otherwise, they were visual learners.

2.3.2. Prior knowledge test

Two prior knowledge tests were developed by the instructor in videos. The declarative knowledge test included three multiple-choice items (4 choices for each item and only one was correct; 2 points for the correct answer), one multiple-choice item with more than one answer (4 points for all correct answers), and two open-answer items (15 points). The total possible score was 25 points (M = 8.11, SD = 3.66). The procedural knowledge test consisted of three multiple-choice items (total 8 points), two multiple-choice items with more than one answer (total 8 points), one open-answer item (9 points), and the total possible score was 20 points (M = 8.78, SD = 3.05).

2.3.3. Cognitive load scale

The cognitive load scale developed by Paas et al. (1994) was used in this experiment. The scale included two 9-point Likert items to investigate participants' mental effort and perception of difficulty. The reliability of the scale was high (Cronbach's $\alpha = 0.74$).

2.3.4. Learning performance test

Learning performance tests included a retention test and a transfer test. For declarative knowledge, the retention test included two multiple-choice items, two multiple-choice items with more than one answer, two open-answer items (13 points), and the full score was 25 points (M = 12.85, SD = 5.31). The transfer test consisted of two open-answer items (total 25 points; M = 12.85, SD = 5.31), which aimed to assess participants' understanding and utilization of composition rules.

For procedural knowledge, the retention test included three multiple-choice items, one multiple-choice item with more than one answer, one fill-in-black item (1 point for each blank, total 10 points), one open-answer item (5 points), and the full score was 25 points (M = 15.98, SD = 4.72). The transfer test required participants to use Photoshop software to process a picture (total 25 points; M = 17.71, SD = 3.61).

2.3.5. Semi-structured interview

A semi-structured interview was conducted to investigate participants' preference of the captions when learning declarative or procedural videos, which included two questions: (1) Do you want to add captions to the instructional videos? (2) If yes, what kind of captions do you want? And why?

2.4. Procedure

This experiment was carried out in a computer laboratory and lasted about 40 min. Firstly, the researcher introduced the basic information of the experiment to participants (5 min). Secondly, participants were required to fill out the learning style questionnaire and were assigned to one of the six conditions randomly to complete the corresponding prior knowledge test (declarative vs. procedural, 10 min). Then the researcher published the instructional videos to the student computers through the teacher computer, each participant under the same condition watched the video on the student computer at the same time. After viewing videos, the participants filled in the cognitive load questionnaire and corresponding learning performance test (20 min). Finally, a semi-structured interview was conducted (5 min). After the experiment, the participants received a gift as a reward.

3. Results

To examine the difference between the 12 groups, the scores for all prior knowledge and learning performance tests were standardized. A series of three-way analysis of covariance (ANCOVAs) were conducted with the between-subjects factors of Knowledge type (declarative vs. procedural) × Learning style (verbal vs. visual) × Caption type (no vs. keyword vs. full), and the score on the prior knowledge test was used as the covariate. The dependent variables were cognitive load, retention and transfer scores. Descriptive statistics and the results of the ANCOVAs are respectively shown in Table 1.

Table 1. Means (*M*) and standard deviations (*SD*) of all dependent variables.

Knowledge type	Learning style	Caption type	*N*	Cognitive load		Retention		Transfer	
				M	*SD*	*M*	*SD*	*M*	*SD*
Declarative	Verbal	No	15	11.13	0.78	0.53	0.24	0.30	0.25
		Keyword	12	8.00	0.88	0.14	0.27	0.34	0.28
		Full	12	11.17	0.88	-0.22	0.27	-0.13	0.28
	Visual	No	17	8.65	0.74	-0.84	0.23	-0.90	0.23
		Keyword	30	9.80	0.55	0.18	0.17	0.26	0.17
		Full	27	10.56	0.58	0.07	0.18	0.01	0.18
Procedural	Verbal	No	14	11.36	0.81	-0.07	0.25	0.60	0.25
		Keyword	8	9.25	1.07	0.80	0.34	0.60	0.34
		Full	12	8.67	0.88	0.20	0.27	-0.15	0.28
	Visual	No	27	11.63	0.58	-0.52	0.18	0.10	0.18
		Keyword	28	10.75	0.57	0.26	0.18	-0.15	0.18
		Full	30	12.77	0.55	-0.03	0.17	-0.33	0.17

3.1. Cognitive load

ANCOVA on cognitive load revealed that significant main effects were found in Knowledge type ($F(1, 219) = 3.78$, $p = .053$, $\eta p2 = 0.017$) and Caption type ($F(2, 219) = 3.64$, $p = .028$, $\eta p2 = 0.032$), but the Learning style was not. The two-factor interaction effects of Knowledge type × Learning style ($F(1, 219) = 7.47$, $p = .007$, $\eta p2 = 0.033$) and Learning style × Caption type ($F(2, 219) = 1.49$, $p = .011$, $\eta p2 = 0.041$) were significant. Importantly, the interactive effect of Knowledge type × Learning style × Caption type was slightly significant ($F(2, 219) = 2.66$, $p = .072$, $\eta p2 = 0.024$). Further simple effect test was conducted (Figure 1).

For declarative knowledge, verbal learners in no caption and full captions conditions reported higher cognitive load than those in keyword captions condition (respectively, MD = 3.13, $p = .009$; MD = 3.17, $p = .009$), but no difference was found between no caption and full captions conditions ($ps < .05$); while for visual learners, only significant difference between the no caption and full captions conditions was present (MD = 1.91, $p = .048$).

For procedural knowledge, verbal learners in no caption group reported higher cognitive load than those who in the full captions group (MD = 2.69, $p = .026$); visual learners who in full captions group reported higher cognitive load than those who in the keyword captions group (MD = 2.02, $p = .012$). The above results partly support H1.

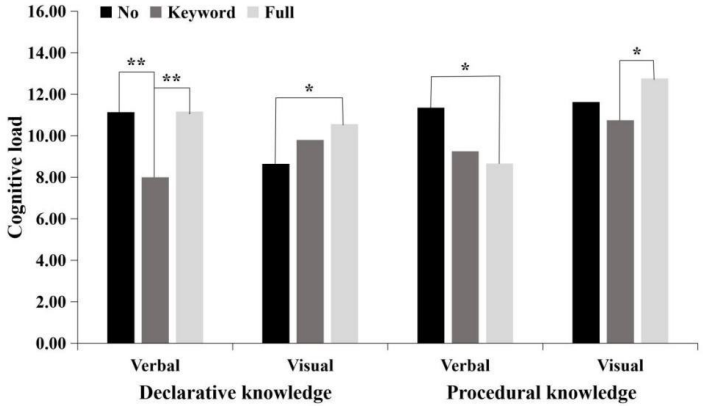

Figure 1. The differences of cognitive load across 12 groups. ($^{**}p < .01$, $^{*}p < .05$)

3.2. Learning performance

3.2.1. Retention

ANCOVA on retention scores indicated significant main effects of Learning style ($F(1, 219) = 8.49$, $p = .004$, $\eta p2 = 0.037$) and Caption type ($F(2, 219) = 6.14$, $p = .003$, $\eta p2 = 0.053$), and interaction effect of Learning style × Caption type ($F(2, 219) = 3.89$, $p = .022$, $\eta p2 = 0.034$). No other significant effects were found (ps > .05). Further simple effect test on Learning style × Caption type was conducted.

Verbal learners who in keyword captions condition showed higher retention scores than those in full captions condition (MD = 0.61, p = .053); while visual learners who in keyword captions and full captions conditions showed significantly higher retention scores than those in no caption condition (respectively, MD = 0.45, p < .001; MD = 0.24, p = .003). No other significant difference was found.

3.2.2. Transfer

ANCOVA on transfer scores revealed that the main effects of Learning style ($F(1, 220) = 9.73$, $p = .002$, $\eta p2 = 0.042$) and Caption type ($F(2, 220) = 2.95$, $p = .054$, $\eta p2 = 0.026$) were significant, but Knowledge type was not. Significant interaction effects were found in Knowledge type × Caption type ($F(2, 220) = 3.76$, $p = .025$, $\eta p2 = 0.033$) and Learning style × Caption type ($F(2, 220) = 3.21$, $p = .042$, $\eta p2 = 0.028$). No other significant interaction effects were observed.

Further simple effect test on Knowledge type × Caption type was conducted. When viewing declarative knowledge videos, learners who in keyword captions condition showed higher retention scores than those in no caption condition (MD = 0.60, p = .009). However, when viewing procedural knowledge, learning who in no caption condition outperformed those in full caption condition (MD = 0.59, p = .007). No other significant difference was found.

Simple effect test on Learning style × Caption type showed that verbal learners who in no caption and keyword captions conditions showed significant higher transfer scores than those in full captions condition (respectively, MD = 0.59, p = .028; MD = 0.61, p = .038). For visual learners, there was no significant difference across the three caption types.

3.3. Preference of captions

In order to understand the participants' preference for captions in different knowledge videos. The semi-structured interview data was analyzed.

As shown in Figure 2 Q1, the majority of learners preferred to watching videos with captions, especially when learning declarative knowledge (81.82%). Compared with declarative knowledge, more learners didn't mind whether to add captions to procedural knowledge videos (18.03%).

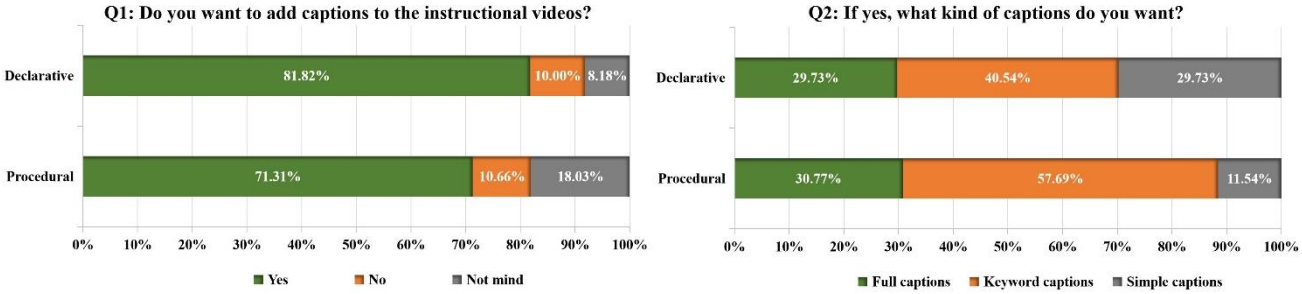

Figure 2. Participants' preference of captions

We further interviewed learners who preferred to add captions to understand what kind of captions they preferred. After coded, their comments focused on three types of captions: full captions, keyword captions, and simple captions (Figure 2 Q2). Regardless of declarative knowledge or procedural knowledge, about 30% of learners preferred full captions. Secondly, many learners preferred keyword captions to full captions. Compared with procedural knowledge, more learners preferred procedural knowledge videos with keyword captions (57.69%). Finally, compared with procedural knowledge, more learners paid attention to the conciseness of captions in declarative knowledge videos (29.75%).

4. Discussion

This study explored the effects of three types of captions on visual and verbal learners when watching declarative knowledge and procedural knowledge videos. The results indicated that the interaction effect of the three factors on cognitive load was significant. When learning declarative knowledge, compared with no caption and full captions, keyword captions helped to reduce the cognitive load of verbal learners. The possible reason was that the cognitive load generated by the processing of captions by verbal learners was not overloaded, and its processing may be automated. Besides, the keyword captions reduced the interference of irrelevant information and highlighted key points, thereby reducing the cognitive load of learners, which is conducive to learning. For visual learners, those who watched full-captioned videos reported the highest cognitive load, which was consistent with cognitive load theory (Rop et al., 2018).

When learning procedural knowledge, the absence of captions increased the cognitive load of verbal learners, which was quite consistent with the results of learners' preference, that was, learners who preferred the captions claimed that the combination of sound and captions can enhance memory, and the results were supported by double coding theory (Cuevas & Dawson, 2018). For visual learners, full captions increased their cognitive load. When full captions were added, part of the learner's attention would be drawn to the captions, making it difficult to allocate more cognitive resources to the demonstration of the operation in the videos (Star, 2007).

Regarding the learning performance test, the interaction effect between learning style and caption type was significant. For verbal learners, the retention and transfer performance of verbal learners who watched keyword captions videos were significantly higher than those who watched videos without captions, which just proved the boundary effect of the redundancy principle (Perez et al., 2018). Captions were better for improving the learning performance of visual learners. For visual learners, processing abstract knowledge was difficult, so the presence of captions can improve learner's construction of the image and be helpful for learning (Chen & Sun, 2012).

This study has some limitations. Firstly, this research focused on learners' cognitive load and learning performance and did not evaluate learners' attention. The research found that captions influenced learners' visual attention (Wang et al., 2016), so eye-tracking technology can be used for further research. In addition, the topics of the videos were Photography and Photoshop, and further research is needed to explore whether the results can be generalized to other learning topics.

Notwithstanding these limitations, our findings have implications for designing instructional videos. This study found the boundary conditions of the redundancy principle. Specifically, for verbal learners who learn declarative knowledge and visual learners who learn procedural knowledge, the presence of keyword captions is beneficial to reduce cognitive load and promote learning performance. Therefore, when designing captions for instructional videos of different types of knowledge, the differences in learning styles of learners should be considered.

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The Experiences of a Chinese Family with Online Learning During the COVID-19 Pandemic in The United States

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Abstract: *The COVID-19 pandemic brought global challenges to educators, parents, and students transitioning to online learning during the school closure measures to protect the spread of the virus. In addition to these challenges, Chinese immigrant families living in the United States were also confronted with increased discrimination that impacted their children's learning experiences. This paper focuses on a qualitative case study of a Chinese immigrant family's experiences in the United States adapting to online learning during the COVID-19 pandemic school closures. Data collected from narrative interviews with the Chinese mother and her twin children were analyzed through content analysis and resulted in two themes that revealed disengaged learning experiences and disconnected relationships that significantly impacted the children's learning experiences during the pandemic. The case highlights the importance of the school's infrastructure to support online learning, teachers' readiness to incorporate technology into their lessons, and parents' and children's relationships to discuss their schooling experiences, including those related to discrimination. Implications and recommendations to educators, scholars, and parents are included.*
Keywords: Chinese immigrants, online learning, COVID-19, education, USA, case study

1. Introduction

Since March 2020, the COVID-19 pandemic brought global challenges to educators, parents, and students adapting to online learning due to school closure measures that affected 90% of students of 190 countries to protect them from getting infected and transmitting the virus (Viner et al., 2020). Uncertainties concerning school calendars and unknown consequences of online learning surrounded parents, students, and educators worldwide (UNESCO, 2020). However, the need for online learning revealed that schools and teachers lacked fundamental technological support, know-how, and skills or experience to teach online (Lynch, 2020). Also, the rise of anti-Asian discrimination in the United States was an additional burden to Chinese families and their children's education during the pandemic (Human Rights Watch, 2020; Kambhampaty, 2020). Recent publications regarding the COVID-19 pandemic explored Asian Americans' experiences within university settings and were conducted in South Korea, China, India, and Pakistan (e.g., Baber, 2020; Kim & Shah, 2020). Thus, research was needed to investigate the experiences of Chinese immigrant families with online learning in the United States.

2. Literature Review

Online or distance learning in K-12 settings has been offered throughout the United States in the past twenty years; however, little had been done before the COVID-19 pandemic to implement technology into school lessons (Gemin & Pape, 2016). Several factors contribute to resistance to technological changes in the American school system due to political, financial, organizational, and parental pressures. While teachers and administrators seem to be technologically illiterate and resistant to implementing the emerging technologies into their lessons (Anctil, 2014), limited opportunities are offered in teacher education programs to develop 21st-century technology skills (Archambault et al., 2016).

Many arguments support online learning advantages, including accessibility, flexibility, and affordability, like allowing students to study anywhere, using any portable device—computers/notebooks, tables, or mobile phones—and being accessible to students of urban, suburban, and rural areas. Also, students can choose when and where to study and avoid commuting to schools and face other costs of face-to-face schooling (Singh & Thurman, 2019). However, in the context of the COVID-19 pandemic, online learning became a necessity rather than an alternative to education worldwide (Dhawan, 2020). Consequently, the debates about the advantages and challenges of online learning implementation shifted to how educational institutions, educators, parents, and students would rapidly adapt to it during the pandemic (Carey, 2020). Besides adapting to online learning during the pandemic, Asian Americans were confronted with other challenges like increased discrimination and anti-Chinese rhetoric (Human Rights Watch, 2020; Kambhampaty, 2020; Kim & Shah, 2020). Thus, this study investigated a Chinese immigrant family's experiences and perspectives on the transition to online learning in the United States during the COVID-19 pandemic. This project is to answer to following research question: What were the experiences of a Chinese immigrant family living in the U.S. with online learning during the COVID-19 pandemic school closure?

3. Method

A case study investigated the contemporary, real-life context of a Chinese immigrant family's online learning experiences during the COVID-19 pandemic school closures (Stake, 1995). The case comprised a Chinese single mother (48) who immigrated to the United States in 1998 and worked as a senior executive for a multinational technology company and 11-year-old first-generation Chinese American twins. The twins—a boy and a girl—were middle-school students at a Northern California school district transitioning to online learning in March 2020. The case of the volunteer Chinese immigrant family represented the phenomenon of interest.

3.1. Data Collection and Analysis

The study was approved under Protocol #S2020-103. The family signed informed consent and assent forms authorizing their participation in the study, ensuring their right to non-participation and non-response, and describing measures to protect their identities and information using pseudonyms (Patton, 2015). The data was collected via narrative interviews with the participants, conducted by telephone and via Zoom (online meetings), and field notes taken during the interviews. The participants selected the events and experiences they had with online learning during the pandemic and ordered them as they wished, including their feelings and attitudes (Jovchelovitch & Bauer, 2000).

The interviews were conducted in September 2020 and lasted an average of two hours, mainly relevant as two participants were children. The extended time helped create a warm and safe environment that helped them feel comfortable sharing their experiences during the interview process (Griffin, Lahman, & Opitz, 2016). The audio-recorded interviews were conducted in English, transcribed, organized, and coded. Two themes emerged from the content analysis. The data were analyzed separately to reduce bias, and external audits increased the credibility and validated the consistency of the findings (Patton, 2015).

4. Findings

Two themes emerged from the content analysis: (1) disengaged learning and (2) disconnected relationships. The findings pointed out challenges in engaging students in online learning, which impacted their relationships with classmates and teachers, affecting their learning experiences.

4.1. Disengaged Learning

The first theme emerged from the children's perspectives that going to school was more engaging and provided them a better overall learning experience than online learning. They felt frustrated with online learning and said they were constantly distracted and disengaged from their online learning classes. Ling said, "now, school it's all about going through all these open tabs. At home, you don't really care about learning; we get easily distracted, watch YouTube videos and entertain. In school, we had to study all day." Cheng added,

> Things were easier and busier when we just had to go to school. It's much harder to focus and manage homework when I have to sit on my chair all day, and all you have to do is click on things. It's just painful to do everything online!

The mother's perspective agreed with the children: "Sometimes the kids play games while in class which also impacted their grades. Their final scores dropped to B in the past semester" (Jinjing). However, Jinjing pondered that because of the distractions with online learning and the lack of teacher support during and after class, the twins were more tired than usual and could not keep up with the amount of homework assigned that piled up over the weekend.

The family perceived their online learning as a disengaging experience because of frequent technical issues during the classes. Ling explained, "The website we were using [for classes] crashed, and we didn't get to do anything last week! No classes! It crashed because of all the people online at the same time. They didn't know what to do about that." The unprecedented times of COVID-19 caused schools and educators to shift rapidly to online learning and find solutions to continue the classes online, having to deal with unexpected technical issues and students' needs. Therefore, the children associated online learning with a lack of planning due to the unforeseen times of school closures. Because online learning became necessary to maintain children's schooling during the pandemic (Dharwan, 2020), its implementation exacerbated the teachers' unpreparedness and limited resources to engage students online (Anctil, 2014; Lynch, 2020).

4.2. Disconnected Relationships

The second theme emerged from the children experiencing the lack of social and learning interactions online during their online classes that affected their learning and motivation. Ling commented, "I liked going to school because my friends were right there physically. The environment and the teachers were better. Now, the teachers don't care; they leave it up to us to study and do stuff." Similarly, Cheng talked about feeling disconnected from his teachers: "Though I feel somewhat comfortable sending emails to my teacher asking for help, I'm pretty sure she's getting annoyed at me." While Cheng and Ling felt disconnected from their teachers, they did not seem to make efforts to engage in their classes with friends or teachers, complaining about the requirement of having to turn on their cameras and microphones to participate in online classes. For example, Cheng did not like turning on his camera because of his introverted nature. "In school, I was the quiet kid in the back, reading his book under the desk. I barely spoke to anyone then, and I wouldn't do it now on camera." Indeed, keeping their cameras and microphones off was an experience shared by teachers and students worldwide during the pandemic, which significantly contributed to disconnected relationships and enlarged the distance between teachers and students (Halpern, 2021).

Furthermore, one significant aspect that impacted the children's disconnected learning relationships was that online learning was not restricted to each school in the district but combined all children who chose online learning over traditional face-to-face classes in the same virtual environment. Ling said, "online school is for the whole district. So, we have people from other schools in [our class in] online school. That's why [Zoom] breakout rooms are so awkward." The lack of familiarity with classmates from other schools inhibited the children from engaging with different students and contributed to their frustrations with their learning experiences.

5. Significant Contributions

This study contributed to the understanding that online and distance learning requires adaptation and flexibility, from curricula, administration, and organization, to instruction, student engagement, and assessment (Dhawan, 2020). In addition to the challenges of adapting to online learning, the unpredictability and unprecedented times of a global pandemic added extra pressure to schools, administrators, teachers, students, and parents that deeply impacted students' social experiences and interactions and, ultimately, their learning (Halpern, 2021).

One of the limitations of this study is the case itself; despite case studies allowing readers to learn lessons from the case, they may not represent other Chinese immigrant families living in the United States and their experiences with online learning during the COVID-19 pandemic. Moreover, the findings may not be generalizable but may offer lessons that can be applied to similar contexts and settings (Stake, 1995).

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Research on College Students' Online Learning Motivation

——Based on the Perspective of Flow Theory

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Abstract: *Based on the flow theory, the article adopts the investigation method to explore the influencing factors of college students' online learning motivation. Research has shown that there is a correlation between the flow experience level of students in online learning and the various influencing factors. The average level of each factor of the flow experience of students is different from the level of the students. There is no significant difference in the average scores of students of different genders experience "distortion of the sense of time" and "happy experience ", yet there are extremely significant differences in the scores of the three elements of "the disappearance of self-awareness", "integration of action and consciousness"and "challenge and skill balance". These findings help us to carry out case design of pedagogical practices to enhance students' learning flow experience in the future.*

Keywords: Flow theory, Learning motivation, Online learning

1. Introduction

American psychologist Mihaly Csikszentmihalyi pointed out that people may experience a unique experience when they are engaged in the work they love. It often makes people forget about sleep and food, devote themselves to work regardless of return, and enjoy it. People often experience this kind of experience in activities. An amazing burst of creativity, he called this unique experience----Flow(Deng Peng, 2006). Follow-up research on flow theory shows that flow experience may occur in any field of work and activities, and this experience can significantly improve the subject's concentration, satisfaction and even happiness in work activities, and can also enhance the subject's activities efficacy(Csikszentmihalyi,2011).The Ministry of Education recommended the Python language as the first programming language in the "Basic Requirements for University Computer Basic Course Teaching" released in 2016. The "Python Programming" is a course that cultivates students' logical thinking and practical operation ability as a bridge of language programming. With the help of the theoretical framework and research methods of flow theory, the article focuses on the classroom experience of students' online learning, and explores how the flow experience promotes the students' desire to learn in the "Python Programming" class and what are the main elements that affect the flow experience of students .

2. Research Design, Instruments and Data Analysis

The survey instruments used in this article is Dispositional FlowScale-2 (DFS-2). The Chinese scholar Yu Peihong conducted experimental tests on the relevance, consistency, reliability, and validity of the Chinese scale.The results show that the cumulative variance contribution rate of the nine component dimensions formulated by the scale is 68.58%, and the test indicators are normal, which proves that the reliability and validity of the Chinese version of the flow experience scale are good, and it is suitable for promotion in different fields(Yu Peihong, 2009).

The subjects of this research are the 2019 undergraduate and junior college students of Nanchang N University. The article uses a simple random sampling method to select 21 classes from all students in the class of 2019, and randomly select 20 student numbers from each class. The teacher in each class will arrange for these 20 students to fill in the questionnaire. There were totally 420 questionnaires and 393 valid questionnaires were finally obtained with an effective response rate of about 93.6%.

2.1. Analysis of the average degree of each element of flow theory

The DFS-2 scale divides the factors that affect the production of flow into nine categories, and each factor is set with four questions as test items. The corresponding relationship between each element and the test items is shown in Table 1.

Table 1. Corresponding test items for influencing factors of flow

Serial number	Influencing factors	Corresponding test items
1	Challenge and skill balance	1 10 19 28
2	Integration of action and consciousness	2 11 20 29
3	Clear goals	3 12 21 30
4	Accurate and timely feedback	4 13 22 31
5	Concentration	5 14 23 32
6	Potential control	6 15 24 33
7	The disappearance of self-awareness	7 16 25 34
8	Distortion of the sense of time	8 17 26 35
9	Happy experience	9 18 27 36

By using SPSS software combined with Excel to perform statistical analysis on the obtained data, it is found the influencing factor "happy experience" in the students' scores is the highest (4.90 points), and the lowest average score is "integration of action and consciousness" with 3.69 points. "Happy experience" is the most important factor that affects the flow of students. Not only in the happy and safe situation, but also in the face of difficulties and dangers, as long as the conditions for the occurrence of flow experience are satisfied, the body can experience this kind of happiness.This kind of happiness does not have to rely on any external factors, and it is the affirmation of the subject's own abilities from the heart, which Csikszentmihalyi called "the joy of not fake foreign objects." (Csikszentmihalyi, 2020)

"Integration of action and consciousness" mainly examines the subject's degree of autonomy when performing homework activities, and at the same time reflects the subject's proficiency to a certain extent(Jackson, S. A. & Marsh，H. W.1996). Compared with other items, the average score of this item is lower. Students of different genders have discrepancy average degree of their flow factors. Boys are higher than girls in all items except "distortion of the sense of time".It was found that junior college students were slightly higher than that of undergraduates as for the average scores of factor 1 to 4. However, the other terms showed the opposite result.

2.2. Correlation analysis

In order to study which of the nine elements of flow theory play a more direct role in the overall state of flow, the article uses Karl Pearson's correlation coefficient analysis method to analyze each flow element and explain the relevance of each element to the total score of flow.The formula used in this part of the analysis is as follows, X is the total score of flow of each sample in the survey, Y is the score of each of the nine flow elements, and the interval of r2 is (0, 1). The closer r2 is to 1, the stronger correlation between variable X and variable Y is(Zhang Wentong, 2019).

$$r = \frac{1}{n-1}\sum_{i=1}^{n}\left(\frac{Xi-\bar{X}}{\sigma X}\right)\left(\frac{Yi-\bar{Y}}{\sigma Y}\right)$$

As shown in Table 2 below, the three factors that have the highest correlation with the overall level of the survey sample's flow status, and they are factor 3, factor 5and factor 6. Through data analysis, it can be seen that the nine elements are positively correlated with the total level of flow. The remaining five factors are ranked from strong to weak in terms of correlation with the total level of flow: factor1>factor2>factor4>factor9>factor7>factor8.

Table 2. Correlation coefficient between factors and total score of flow

	Total score		factor1	factor2	factor3	factor4	factor5	factor6	factor7	factor8	factor9
Total score	Pearson Correlation	1	.870**	.856**	.891**	.832**	.891**	.886**	.608**	.593**	.790**
	Significance （Double tail）		.000	.000	.000	.000	.000	.000	.000	.000	.000
	Number of cases	393	393	393	393	393	393	393	393	393	393

Note: **Significant at the 0.01 level (two-tail detection)

2.3. Relationship between gender and the factors of flow

In order to explore the deep relationship between the gender of the students and the various factors of flow, the article uses a one-way analysis of variance method for data analysis. The specific results are shown in Table 3.

Table 3. Comparison of flow factors among students of different genders

		Number of cases	Average value	Standard deviation	**F**	**P**
Challenge and skill balance	Male	123	4.30	1.18	11.96**	.001
	Female	270	3.89	1.05		
	Total	393	4.02	1.10		
Integration of action and Consciousness	Male	123	3.99	1.20	14.15**	.000
	Female	270	3.56	0.98		
	Total	393	3.69	1.07		
Clear goals	Male	123	4.53	1.21	7.47**	.007
	Female	270	4.21	1.02		
	Total	393	4.31	1.09		
Accurate and timely feedback	Male	123	4.92	0.92	4.56**	.033
	Female	270	4.73	0.78		
	Total	393	4.79	0.83		
Concentration	Male	123	4.61	1.18	4.51**	.034
	Female	270	4.36	1.06		
	Total	393	4.44	1.10		
Potential control	Male	123	4.78	1.11	6.10**	.014
	Female	270	4.49	1.04		
	Total	393	4.58	1.07		

The disappearance of self-awareness	Male	123	4.49	1.13	17.61**	.000
	Female	270	3.94	1.23		
	Total	393	4.11	1.23		
Distortion of the sense of time	Male	123	4.82	1.04	0.05**	.819
	Female	270	4.84	0.84		
	Total	393	4.83	0.91		
Happy experience	Male	123	4.99	1.18	1.05**	.305
	Female	270	4.86	1.07		
	Total	393	4.90	1.11		

Note: **Significant at the 0.01 level (two-tail detection)

As for Table 3, there was no significant difference between factor 8 and factor 9. However, the scores of factor1,factor 2 and factor 7 have extremely significant differences. In terms of factor 3 to 6, the average scores of male and female are significantly different. These results suggest that in the course design, more attention should be paid to the different performances of boys and girls in various factors.

3. Results and Discussion

On the whole, the flow theory has a certain guiding role and significance in stimulating students' online learning motivation. Judging from the overall average degree of flow of the survey subjects, boys and girls have different average scores on various factors of flow. Boys' flow experience level is generally higher than that of girls. From the perspective of student level, most undergraduates have higher average scores of flow than that of junior college students. In terms of the correlation between the various factors of flow and the overall level of flow, the factors that have a large to small impact on the student's flow experience are arranged as follows: factor3 > factor5> factor6> factor1> factor2> factor4 > factor9>factor7> factor8. In addition, students of different genders have extremely significant differences in factor1,2 and 7. And except factor 8 and 9, the others have significant differences.

4. Conclusion

Just as Csikszentmihalyi said the flow is the source of happiness(Csikszentmihalyi, 2020). Happy experience has become the most concerned element in students' learning. Teachers in the new era should use new concepts and ideas to improve teaching methods and optimize teaching strategies. The flow theory, as the cornerstone of the field of positive psychology, has a broad application prospect in the field of education(Zhou Hailong & An Zhen, 2021). This study explores the flow experience level of students in online learning through questionnaires. The results show that there are certain differences between the average level of flow experience of students and analyze the core elements that affect the flow experience of students. In the future, we will carry out case design of pedagogical practices based on this research to enhance students' learning flow experience.

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Investigation of College Teachers' Online Roles During the Epidemic Situation: Taking Chu Kochen Honors College, Zhejiang University as an Example

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Abstract: *Affected by COVID-19, online teaching has been carried out in all of Chinese universities between March and July, 2020, college teachers might encounter some challenges for the adaption of online teaching in a short time. This study aimed to investigate the roles of college teachers online during the epidemic situation, 91 teachers from Chu Kochen Honors College, Zhejiang University filled the questionnaire. The findings indicated that: (1) teachers' satisfaction with online teaching still needs to be improved. (2) teachers scored highest as course designer and organizer, while got the lowest scores as technology facilitator. (3) gender had no significant impact on surveyed teachers' online roles, while age had significant impact on several dimensions of teachers' roles, those aged 40-50 performed better than those aged over 50 as discussion facilitator, social supporter and technology facilitator. Based on the findings, this study provided reference and enlightenment to the more effective online teaching or blended teaching practice in the follow-up of domestic universities*.

Keywords: COVID-19, online teaching, college teachers, teachers' roles

1. Introduction

COVID-19 has a significant impact on educational system around the world, and an important deployment named "Classes Suspended while Learning Continues" was issued by Chinese Ministry of Education during Spring Semester, 2020. Therefore, online teaching has become the main way to make up for the inability to carry out face-to-face teaching. However, online teaching is not merely using video to deliver instructional materials, it different from traditional face-to-face teaching in many aspects, including interaction between teacher and students, teaching medium and technology, and course evaluation. From this perspective, teachers' knowledge and skills related to online teaching were very key to the quality and effectiveness of online teaching.

Teachers play important roles in promoting students learning online, such as educator, manager, socializer and technician (Berge, 1995), who were benefit to stimulate students learning motivation, improve student performance, maintain the harmony teacher-student relationships and transfer knowledge and skills (Lauermann & Karabenick, 2013). Notably, compared with traditional face-to-face teaching, a distinctive feature of online teaching is the geographical separation of teachers and students, although Roblyer and McKenzie (2000) argued that there was no significant difference between online and offline performance of good teachers, teachers faced more difficulties in adjusting teaching strategies to meet students' need that could be easily achieved in traditional classroom according to the oral or non-verbal suggestions of students. Therefore, teachers need more competencies to cope with online contents, pedagogical and technological issues.

In particular, understanding the behaviors of teachers played online was valuable to improve the quality of large-scale online teaching caused by COVID-19, for example, Johnson et al. (2020) reported the findings of a survey

investigated faculty experiences and approaches in early weeks of COVID-19 in USA, including previous online experience, teaching techniques used in online class, assistance that would be most helpful to online teaching. With such background, this study aimed to investigate teachers' online roles during the epidemic situation through questionnaires. In summary, the two research questions were:

RQ1: How teachers feel about online teaching compared with traditional face-to-face teaching?

RQ2: What are the roles played by teachers in online teaching, are there differences in gender and age?

2. Methodology

2.1. Sample

Teachers from Chu Kochen Honors College of Zhejiang University (ZJU) was selected as the sample. Totally, about 200 teachers were involved in the college. Chu Kochen Honors College is an honorary college aims to cultivate the elite of undergraduate students, and is equipped with high-quality teachers selected by the whole school.

2.2. Instrument

The survey instrument was constituted by two parts. The first part was to collect teachers' basic information, such as gender, age, online teaching experience. The second part was consisted of 16 items including five types of roles teachers played in online environment, namely, course designer and organizer, discussion facilitator, social supporter, technology facilitator and assessment designer (Hung & Chou, 2015), and a 5-point Likert scale (1 =very poor; 5 =very good) was used.

2.3. Data collection and analysis

From May 18 to June 4, 2020, questionnaires were distributed to teachers' online groups through the online questionnaire platform named Questionnaire Star, and a total of 91 questionnaires were collected. Data were compiled and analyzed using the Statistical Package for Social Sciences (SPSS 24.0).

3. Findings

Among the 91 ZJU teachers participated the survey, 69 (75.8%) were male and 22 were female (24.2%). 41 teachers (44.6%) were over the age of 50, followed by teachers aged 40-50 (33, 35.9%) and teachers aged 30-40 (17, 18.5%). 62 (68.1%) surveyed teachers indicated that they had no online teaching experience before the epidemic, 21(23.1%) indicated limited online teaching experience, while 8 (8.8%) had rich online teaching experience prior to the epidemic.

When compared online teaching with face-to-face teaching, 11 (12.1%) surveyed teachers expressed that online teaching was better, 55 (60.4%) thought was worse, while 25 (27.5%) thought they were the same. In terms of interaction time in class, 14 (15.4%) thought was increased, 55 (60.4%) indicated the reduction, while 22 (24.2%) expressed as the same. For the time of interaction after class, 26 (28.6%) thought was increased, 25 (27.5%) thought was decreased, while 40 (44%) indicated the same.

As for teachers' roles in online environment, the Cronbach's α of five dimensions were higher than .70, indicating good reliability of all scales. Specifically, surveyed teachers scored highest as course designer and organizer (M=4.17, SD=0.53), followed by discussion facilitator (M=4.15, SD=0.57), assessment designer (M=4.14, SD=0.49) and social supporter (M=4.08, SD=0.55). Comparatively, the scores of surveyed teachers as technology facilitator (M=3.99, SD=0.53) was relatively low.

Table 1 showed that male and female teachers did not have statistically significant differences in five dimensions, which means that gender had no significant impact on surveyed college teachers' roles in online environment.

Table 1. Distribution of surveyed ZJU teachers' online roles by gender (n=91)

Dimensions	Gender	n	M	SD	df	T	p
Course designer and organizer	Male	69	4.12	0.54	89	1.76	0.08
	Female	22	4.35	0.49			
Discussion facilitator	Male	69	4.13	0.60		0.42	0.67
	Female	22	4.19	0.46			
Social supporter	Male	69	4.01	0.56		1.96	0.05
	Female	22	4.27	0.46			
Technology facilitator	Male	69	3.95	0.54		1.35	0.18
	Female	22	4.12	0.50			
Assessment designer	Male	69	4.11	0.48		0.84	0.40
	Female	22	4.21	0.53			

Teachers from different age groups did not have statistically significant differences as course designer and organizer and assessment designer, while they had significant difference as discussion facilitator, social supporter, and technology facilitator ($p<0.05$), for teachers aged between 40 and 50 performed better than those aged over 50 as discussion facilitator, social supporter and technology facilitator (Table 2).

Table 2. Distribution of surveyed ZJU teachers' online roles by age (n=91)

Dimensions	Age	n	M	SD	df	F	p	LSD' test
Course designer and organizer	30-40	17	4.16	0.61	89	0.41	0.66	
	40-50	33	4.24	0.58				
	>50	41	4.13	0.46				
Discussion facilitator	30-40	17	4.13	0.67	89	4.43*	0.02	40-50> over 50
	40-50	33	4.36	0.51				
	>50	41	3.98	0.53				
Social supporter	30-40	17	4.00	0.63	89	2.46*	0.04	40-50> over 50
	40-50	33	4.24	0.54				
	>50	41	3.98	0.50				
Technology facilitator	30-40	17	4.08	0.67	89	3.67*	0.03	40-50> over 50
	40-50	33	4.14	0.52				
	>50	41	3.83	0.43				
Assessment designer	30-40	17	3.98	0.48	89	1.39	0.26	
	40-50	33	4.22	0.50				
	>50	41	4.13	0.48				

Note, *p<0.05.

4. Discussion and suggestions

The first finding was that teachers' satisfaction with online teaching has yet to improve compared with face-to-face teaching. In this study, more than half (60.4%) of teachers said that the effect of online teaching was not as good as face-to-face teaching, and similarly, a lack of interest in teaching online for teachers was reported in the study of Blackboard (2013). As online teaching was different with face-to-face teaching in knowledge and skills to delivery contents and organize activities, teachers' lacking of online teaching experience may affect the quality of online teaching, only less than 10% of teachers indicated that they had rich online teaching experience in this study. Considering the honorary

college normally owns better instructional resources than other colleges, the finding implicated that online education was not popular in the whole university. During COVID-19, although schools and relevant departments have organized training and established professional answer groups by asynchronous communication tools before the implement of large-scale online teaching, teachers' understanding of online teaching was not really in-depth, previous study has shown that teacher training was an effective way to improve teachers' ability to integrate technology into teaching (Chai et al., 2011), so it is valuable to conduct teacher training to increase their access to and familiarity with online teaching.

The second finding was that surveyed teachers' scores in non-technological knowledge dimensions were averagely higher than their scores in technological knowledge dimensions. The finding keeps consistence with previous study of Hunt et al., (2014). On the one hand, most college teachers got their Ph.D. before enrolled in university and therefore, they were well trained in their disciplinary knowledge domain. In addition, years of teaching experience may increase their knowledge about instruction. Therefore, it is reasonable that they ranked higher in teaching-related dimension. On the other hand, although Information Technology Center of ZJU provided online teaching related training programs to all ZJU teachers, most of them had very limited previous online teaching experience, teachers still need time to get familiar with and to practice those online teaching skills. Additionally, teachers' attitude and acceptance of technology were also one of the factors affect their technical performance (Oomen-Early & Murphy, 2009).

Thirdly, gender had no significant impact on teachers' roles online, this was inconsistent with previous study of Kay (2006). One possible explanations for this different result might relate to the fact that teachers carried out online teaching freely and personalized in previous studies, while in this study, the special background of epidemic made teachers of different genders received the same training in a very short period of time and therefore, the "unified" training may lead to the similar online teaching behavior among surveyed teachers. However, for teachers aged 40-50 and over 50, significant difference was shown as discussion facilitator, social supporter, and technology facilitator ($p<0.05$), the older the teachers, the worse performance they behave. The reason may be that older teachers with poor technical foundation do not adapt to the short-term online teaching training, it is difficult for them to master some basic operations, which may have a negative effect on teaching activities based on technology. In addition, older teachers may be more accustomed to traditional face-to-face teaching, the sudden transformation to online teaching made them feel uncomfortable.

5. Limitation

This study was conducted in a university located in a developed urban city in China, therefore, results based on the limited sample could not represent general situations in China, and the explanation of findings should be cautious. In the near future, larger scale of investigation in different cities and countries are needed to know how teachers performed in online environment.

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Whether instructors' beat gestures in video lectures facilitate students' learning performance? A meta-analysis

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Abstract: *Video lectures are widely used in formal and informal learning, and instructors' presence which considered as an important factor of quality of video lectures attracted much attention. Instructors' beat gesture is one of the most frequently movements in instruction, which can synchronize the rhythm of instructors' speech. According to the signaling principal, instructors' beat gestures have great influence on students' learning. However, previous studies have not got a consistent conclusion on the question whether instructors' beat gestures can improve students' learning performance. Therefore, reviewed available empirical studies in the past five years, the current study conducted a meta-analysis to explored the question. Finally, we found that instructors' beat gestures can improve students' learning performance. The current study conducted a meta-analysis to explored the question. Results suggested that instructors' beat gestures can facilitate students' learning performance. Our finding provides practical suggestion: if an instructor presented in video lectures is encouraged to produce beat gestures to mark important information and to synchronize rhythm of verbal expression, then the students will get better learning performance.*

Keywords: Beat gestures; video lectures; learning performance; meta-analysis

1. Introduction

Recent years, the continuous progress of information technology has enabled MOOC platforms to develop into the second largest educational battlefield besides classroom education. According to the Class Central, the modern MOOC movement has crossed 180 million learners, and provide 163000 courses, which excluding China (Shah, 2020). In China, more than 34,000 MOOCs had been launched, and the number of students had reached 540 million. In addition, the global spread of COVID-19 has also injected a strong impetus to the development of video teaching and video lectures in 2020. In this situation, how to improve the quality of video lectures has attracted much attention of researchers (Pi et al., 2019; Yang et al., 2020). Among which, instructors' presence is an important factor (Fiorella et al., 2019).

Instructors' movements are often accompanied with their speech spontaneously, which can not only supplement semantic knowledge, but also express emotional information (McNeill, 1992). For example, if an instructor just standing still like a robot when he giving a speech, students can only seek information from his verbal expression. While if an instructor freely using body movements to assist his teaching, students can not only get knowledge from his words, but get information from his movement, and finally may get better learning. Among movements, instructors' gestures are most widely used, and attracted researchers' attention (Beege et al., 2020; Morett & Fraundorf, 2019; Pi et al., 2019; Yang et al., 2020). However, there are still unclear aspects about the effect of instructors' gestures on students' learning.

Beat gestures can be defined as a series of rapid flicks of hands. McNeill (1992) divided gestures into four types, that is pointing gestures, iconic gestures, metaphorical gestures and beat gestures. The first three can convey rich semantic

information, while the beat gestures only synchronize the rhythm and prosody of instructors' verbal expression without semantic information. According to the signaling principle of multimedia learning theory (Mayer, 2014), instructors' beat gestures have a benefit on students' learning through emphasizing important parts of verbal information (Gluhareva, & Prieto, 2017; Kartalkanat & Gksun, 2020; Morett & Fraundorf, 2019).

Previous research about the effects of instructors' beat gestures om students' learning have not yielded consistent conclusion. For example, Kushch et al. (2018) tested the effect of an instructor's beat gestures on students' second language learning, and found that students who viewed the video lecture with the instructor's beat gestures got better learning performance. While in the study of Beege et al. (2020), they investigated the effects of an instructor's beat gestures and head nods on students' learning experience and learning performance. They found that compared with students who in the no gesture condition, there were no significant improve on students' learning experience or learning performance in the beat gestures condition.

Thus, the current study aimed to summarize the existing work nearly five years on the effect of learning from video lectures with an instructor's beat gestures on students' learning performance.

2. Method

Literatures were selected from the Web of Science database (https://www.webofknowledge.com/) using the keyword "beat gesture", and the period was set ranged from January 2016 to February, 2021. Finally, 86 published articles were yielded. In order to selecting studies, six criteria were used to select articles for inclusion in the meta-analysis. First, definition of beat gestures was cited from McNeill (1992). Second, learning materials of the study participants viewed were based on the video lecture. Third, beat gestures provided by a human instructor, rather than an animation agent or a robot. Fourth, the study included conditions whereby participants observed an instructor's beat gestures during a learning task (e.g., while being explain a concept). Fifth, the study included a measure of learning performance as the dependent variable, including recall, retention, transfer, and memorization. Sixth, experimental manipulation of the study included whether a student viewed the video lectures with or without an instructor's beat gestures. We found that only 21 of the initial 86 articles explored the effect of beat gestures on learning, however, some of them neither based on video lectures, nor used a human instructor. As a consequence, only 6 articles met these criteria and were included in further analysis (Table 1).

Then, in order to tested the effect of instructors' beat gestures on students' learning performance, data were analyzed using RevMan v5.4 (https://training.cochrane.org/online-learning/core-software-cochrane-reviews/revman). A random effects model was used to calculate the mean effect sizes of selected studies, and the confidence intervals were set at 95%.

Table 1. Included articles used in the meta-analysis.

Articles	Task	Learning performance	Condition	*N*
Macoun & Sweller, 2016	Viewed a short videotaped with or without gesture.	Recall	Gestures type (No gesture vs. Beat vs. Iconic vs. Deictic)	101
Gluhareva & Prieto, 2017	Observed videos about second language pronunciation in beat and no beat condition	Memorization	Gestures (Beat vs. No beat) * Items (Easy vs. Difficult)	20
Igualada, Esteve-Gibert, & Prieto, 2017	Learned new words accompanied by beat gesture	Recall	Gestures (Beat vs. No beat) *Age (3 vs. 4 vs. 5)	106

	or not from videos.			
Morett & Fraundorf, 2019	Observed two cues conveying emphasis in video lectures (beat gesture and contrastive pitch accenting).	Recognition memory	Beat (Beat vs. No beat) * Pitch (contrastive accenting vs. presentational accenting)	32
Beege et al., 2020	Received an educational video about weather phenomena or the industrial revolution with a lecturer's gestures.	Retention Transfer	Gestures (beat gestures vs. deictic gestures vs. no gestures)	229
Kartalkanat & Göksun, 2020	Observed different types of gestures while listening to a story.	Recall	Age (Children vs. Adults) * Gestures (iconic gestures vs. beat gestures vs. no gesture)	118

3. Results and Discussion

A total of 6 articles yielding 14 pairwise comparisons for learning performance between beat gestures condition and no gestures conditions were analyzed. Results showed that instructors' beat gestures in video lectures did facilitate students' learning performance, 95% CI [-714.41, -341.41], $z = 5.55$, $p < 0.001$.

It is consistent with previous resaerch (Igualada et al., 2017; Kushch et al., 2018). Instructors' beat gestures not only benefit students' attention, but cognitive process by supplementing their speech to mark the parts of speech (McNeill, 1992; Zhu, 2020). On one hand, according to the signaling principle, beat gestures as a kind of visual cues have influence on students' attention (Dimitrova et al., 2013; Mayer, 2014; Zhu, 2020). Specifically, compared with the no gestures condition, students in the beat gestures condition are sensitive to instructors' verbal information corresponding to beat gestures, and more focus on the content of video lectures. On the other hand, beat gestures can promote students to process information which emphasized by the instructors' beat gestures actively, and deeply cognitive processing produces better learning performance (Wang & Chu, 2013). Specifically, instructors' beat gestures can induce some ERP components associated with semantic integration and processing, such as N1, P300, N400. Therefore, students in the beat gestures got better learning performance than the no gestures condition.

4. Conclusion and Implications

Through a small size of meta-analysis about the effect of an instructor's beat gestures on students' learning, we verified that an instructor's beat gestures can facilitate students' learning performance from video lectures, including recall, memorization, retention, and transfer performance.

The finding not only makes theoretical contribution to the multimedia learning theory (Mayer, 2014), but provide practical suggestions for instructors' instruction and video designing. Video lectures presenting an instructor are widely used in formal and informal online learning. However, how to design the instructor's movements to improve students learning is still unclear (Wang et al., 2020; Mayer, 2014). Some recent studies have suggested that the instructor's beat gestures have potential benefits on students' learning from video lectures. Our finding provides a definite answer for the question. In a word, the finding provide suggestion for designing video lectures: firstly, for instructors, if an instructor want to explain some knowledge (e.g., concepts, procedures) through recording video lectures, and her/his image is required be presenting on the screen, she or he can produce beat gestures to synchronize rhythm of verbal expression;

secondly, for students, if someone want to learn some new from video lectures, he can view the video lectures presenting an instructor's image and beat gestures, then he will get better learning performance.

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A Study of Smart Pedagogy Based on Intelligent Technology

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Abstract: *Smart pedagogy (SP) is the study of the methods and activities of teaching based on intelligent technology (IT), aiming to cultivate learners' diverse abilities with appropriate teaching strategies. SP is frequently mentioned and used by practitioners, but current there are few studies about the concept and typical types of SP. Therefore, this paper made a qualitative analysis by reviewing studies about SP in recent ten years, and discussed SP in different countries. Combining the characteristics of the post-pandemic era with the current development of IT, this paper identified and analyzed the role of IT in supporting the teaching processes. In addition, from the perspective of post-pandemic era and future education, this paper summarized four typical smart pedagogies: flexible learning and education, virtual simulation real-time training, design-based online collaborative learning, technology enhanced teaching and learning. In the future, these four typical smart pedagogies will improve the active learning and deep learning level of learners by creating smart learning environment.*

Keywords: smart pedagogy, flexible learning and education, design-based collaborative learning, virtual simulation real-time training, technology enhanced teaching and learning

1. Introduction

With the development of intelligent technology (IT), smart education has received more and more attention. It has built a technology-integrated learning environment, enabling teachers to implement effective pedagogies, enabling learners to obtain appropriate personalized learning services, and developed in activity, thinking and creativity (Gros, 2016). Smart education consists of three parts, namely the smart learning environment, smart learners and smart pedagogy (Zhu et al., 2016). With the development of 5G, Internet of Things (IoT), educational big data (EBD), smart pedagogy, represented by IT to promote teaching and learning, plays an increasingly prominent role in smart education.

The term smart pedagogy (SP) has been emphasized a lot to completely change the existing education model and framework (Iqbal et al., 2020). Moreover, different countries integrate technology into pedagogies. The government of Singapore announced the Intelligent Nation 2015 (iN2015) plan to implement smart education supported by information and communications technology (ICT). The difference is that the SP in South Korea focuses on SMART, namely Self-directed, Motivated, Adaptive, Resource-enriched and Technology-embedded. In addition, in the National Educational Technology Plan 2016 (NETP2016), the US reconstructed the role of technology in pedagogy, covering five areas: learning, teaching, leadership, assessment and infrastructure.

At the same time, there are many researches on SP. With the aid of effective learning strategies, the use of smart boards can overcome the learning difficulties of advanced thinking skills (Julius et al., 2018). And SP effectively promoted advanced thinking skills. In addition, SP using intelligent systems was regarded as an innovation pedagogy, which is used in STEM teaching (Uskov et al., 2018).

It can be seen that the SP is to promote the synergy between technology and pedagogy. But there are only fragmented studies on the didactic aspects of technology usage, that is why pedagogy as a science has to engage in a new research direction – smart pedagogy (Daniela & Lytras, 2018).

Therefore, based on the above research of SP, combined with the application of current IT, especially 5G, blockchain, big data in teaching, this paper, through reviewing studies about SP in recent ten years, summarized four typical smart pedagogies, which are flexible learning and education, virtual simulation real-time training, design-based online collaborative learning, technology enhanced teaching and learning, combined with the teaching characteristics of post-pandemic era. And in the actual teaching process, one or a combination of smart pedagogies may be used in the classroom.

2. Related work

Before 2010, cooperative learning was associated with SP, and regarded it as a kind of SP. SP, which takes cooperative learning as a typical example, brings convenience to teaching and develops students' multiple intelligences, such as having higher levels of self-esteem and being able to cooperate more actively with working partners (Gillies & Boyle, 2007; Gradel & Edson, 2010).

However, there are few explanations on the definition and connotation of SP in these studies. In Cambridge dictionary Pedagogy is defined as "the study of the methods and activities of teaching" (2020). As an internal factor of education, teaching method connects teachers and students, teaching and learning methods and strategies to support the development of students (Žogla, 2017). Smart education is to create intelligent environments by using IT, so that smart pedagogies can be facilitated as to provide personalized learning services and empower learners, and thus talents of wisdom who have better value orientation, higher thinking quality, and stronger conduct ability could be fostered (Zhu et al., 2016). SP, as an important part of it, can be understood as creative teaching strategies and teaching methods. It is in line with the law of education, learner centered, or supplemented by IT, and the purpose is to cultivate learners' ability to adapt to the changing and developing society. Under the background of the rapid development of ICT, this paper summarized four smart pedagogies from the perspective of individual, group and class learning based on the framework of smart pedagogy (Zhu et al., 2016; Meng et al., 2020).

3. Typical smart pedagogies

3.1. Flexible learning and education

After the outbreak of COVID-19, students study online, and large-scale online teaching and learning become normal at a certain time. In the post-pandemic era, in order to highlight the learner centered online and offline integrated learning mode and promote flexible individual learning, the research and exploration of flexible teaching and learning are very important. Flexible teaching can provide learners with diversified and learner centered learning methods in terms of learning time, learning place, teaching resources, teaching methods, learning activities and learning support, and provide learners with convenient and personalized teaching methods (Huang et al., 2020). In a variety of learning scenarios, the use of 5G and other IT, according to the needs of learners, choose appropriate pedagogy, so that learners from passive learning to active learning, so as to carry out goal oriented real learning. The collaborative effect of flexible teaching and 5G and other IT breaks through the shackles of traditional pedagogy in terms of time and space, so that learners can effectively learn direct and indirect experience.

3.2. Virtual simulation real-time training

Virtual simulation real-time training provides highly simulated and visualized teaching content, creates practical teaching situation with the sense of presence, immersion and interaction, and has the characteristics of multi perception, interaction and imagination (Howard & Gutworth, 2020; Morélot et al., 2021). In the virtual environment of 5G network, SP effectively improves the practical skills of learners.

3.3. Design-based collaborative learning

Cultivating students' creativity is a difficult problem to be solved in today's education. Design thinking is a kind of product design innovation method based on scene and user understanding, which is oriented to real complex problems (Rubens et al., 2005). It usually includes inspiration, idea and implementation. Design-based collaborative learning, which is oriented to cultivate design thinking and innovation ability, is usually carried out in the form of group cooperation (Lyons et al., 2021). And combined with IT such as 5G, Internet of things and extended reality, SP integrates design thinking into teaching activities such as maker, stem and extended curriculum, so as to promote the cultivation of students' innovation and creativity in the design process.

3.4. Technology enhanced teaching and learning (TET&L)

TET&L as a tool for pedagogical innovation, is changing what we need to know and how we understand it. Learners need to constantly update and develop their advanced skills, such as information processing, independent learning, critical thinking, reflective innovation, design and creativity. Especially, in the environment of TET&L, learners need more and more new smart pedagogies and knowledge models. Technology is generally seen as beneficial for students by eliminating didactic one-way transmission teaching (DeBourgh, 2008). Therefore, the research of TET&L involves natural sciences (for example, chemistry (MacArthur & Jones, 2008), mathematics (King & Robinson, 2009), medicine and geography (Duggan et al., 2007; Wood, 2020)). And through TET&L, learners improve their level of active learning and deep learning.

4. Conclusion and future works

In line with the intelligent era, this paper summarized four smart pedagogies flexible learning and education, virtual simulation real-time training, design-based collaborative learning, technology enhanced teaching and learning (TET&L). Compared with traditional pedagogies, the four typical smart pedagogies take the IT as the driving force, take the dynamic development of learners as the guidance, and improve the active learning and deep learning level of learners by creating smart learning environment.

In the future, research of SP constructed by IT such as 5G can focus on the integration of learning space, provide technical and environmental support for teaching and learning, explore new pedagogies and cultivate learners' 7C ability (Critical thinking and problem solving, Creativity and innovation, Collaboration and leadership, Cross-cultural understanding, Communication, ICT literacy, Career and life skills) (Jang, 2014). In addition, future studies should improve the quality and equity of education from the perspective of pedagogy.

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The Impact of Online Gamified Learning on Students' Scientific Attitudes and Conceptual Learning

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Abstract: *In this study, an online game-based learning platform was used to intervene in the science classroom of 74 senior high school students in order to reveal the impact of introducing online games in science education on students' scientific attitudes and conceptual learning, and thus provide some useful references for further developing students' scientific literacy. The empirical study showed that students who learned science through an online gamified learning platform performed best in learning performance (SAT, SCT scores), as evidenced by higher levels of awareness building and understanding of science concepts.*

Keywords: Online, Gamified learning, Science attitude, Scientific concept

1. Introduction

In recent years, low interest in learning among young people has been a common challenge in science education worldwide. Game-based learning has great potential to address such problems (Shang & Pei, 2015). Studies have shown that the organic integration of game-based thinking and online educational platforms can effectively promote learning effectiveness and will make learning more educational and entertaining (Alessi & Trollip, 2001).However, the content about online gamified learning has not been deeply involved in science classrooms in China, and there is limited research on the impact of online gamified learning platforms on students' science learning.

2. Literature Review

2.1. Current Status of Gamified Learning Development

Gamified learning refers to the process of teaching design by using the concept of games and integrating game elements and design into teaching activities so that students can learn through games.In the last decade, the concept of gamification has been enthusiastically discussed in the field of academic research (J. Hamari et al., 2014). Since 2012, the U.S. Horizon Report has listed "gamification and game-based learning" as one of the new technologies to be widely promoted in the future education field for three consecutive years (Chen, Qian& Li, 2017). The China Learning Initiative Report 2018, led by the School of Education of Peking University, suggests that gamified learning will become a new technology and concept for future learning. However, in the current situation, there are still many problems in the integration of gamified learning with classroom and other aspects, such as the raw combination of gameplay and education (Ma, Long, Du& Xu, 2016) and single, which need further research.

2.2. The Impact of Gamified Learning on Science Learning

Mohd. Elmagzoub Eltahir et al. (Mohd. Elmagzoub Eltahir et al., 2021) through an empirical study found that there is a positive effect of gamified learning on students' motivation, engagement and academic performance. Arif

Rachmatullah et al. (Arif Rachmatullah et al., 2021) confirmed that games had a significant impact on students' understanding of scientific concepts by having subjects interact with a game-based learning environment to learn genetics concepts, and that the positive role played by game-based learning environments in science classrooms has some practical implications.Gong Fangqin (Gong, 2020), on the other hand, suggested that the use of games in science education is of high value and significant for future integrated practice in teaching. However, the importance of online game-based learning for learners' scientific attitudes and conceptual learning remains to be confirmed by research.

3. Research Methodology

3.1. Procedure

The subjects of this study were 74 senior high school students in a school (37 in both classes), and they were randomly divided into 2 groups: an experimental group (n=37) and a control group (n=37). The two classes were taught by the same science teacher and had the same course progress. Before learning Science topic, students in the experimental group and the control group need to complete two sets of pre-test , namely Science Attitude Test (SAT) and Scientific Concept Test (SCT), to evaluate the initial level of students in each group.Students in the experimental group were required to complete five science topic courses in a school computer classroom through an online game-based learning platform, each topic course was divided into two 40-minute lessons, and the learning period was three months. For each learning topic, the online learning platform provides two types of game-based argumentative quiz games, namely the“Find the Error”and“Find the Difference”games. The 37 students in the control group studied the same topics of science content, but the difference was that they basically received traditional instruction with less communication.After learning the five Science topics, the teacher will provide two sets of measurement scales to investigate the learning effect of the students in the experimental group and the control group.

3.2. Data Analysis

The primary data for this study were obtained from the students' scores on the Science Attitude Test (SAT) and the Scientific Concept Test (SCT). SAT is a 5-point Likert scale (cronbach 's = 0.86) are used to measure students' feelings and attitudes towards studying science in school (Russell & Hollander, 1975). SCT is a multiple-choice diagnostic instrument that measures students' understanding of scientific concepts and knowledge (cronbach's = 0.83) and was designed and refined by a panel of reviewers consisting of several researchers designed and refined.

4. Research Results

4.1. Science Attitude Test (SAT)

As shown in Tables 1 and 2, the results show that there is no significant difference between the scores of the control and experimental groups in the pretest preatt ($p>0.05$). And in the posttest postatt, there is a highly significant difference between the two groups in the posttest scores ($p=0.000$).This indicates that teaching science through an online gamified learning platform will have a positive impact on students' attitudes toward science.

Table 1.SAT test - descriptive statistics

Group Statistics

	group	Number of cases	Mean	Standard Deviation	Standard Error Mean
preatt	1	38	52.74	10.549	1.711

	2	36	52.08	7.004	1.167
postatt	1	38	53.37	10.162	1.648
	2	36	80.61	9.107	1.518

Table 2. SAT test - independent sample test

	Levene's equivalence of variances test		Equivalence of means t-test						
	F	Significance	t	df	Sig.(two-tailed)	Mean Difference	Standard error difference	Difference 95% confidence interval	
								lower limit	upper limit
preatt	4.789	0.032	0.312	72	0.756	0.654	2.094	-3.52	4.827
			0.315	64.646	0.753	0.654	2.071	-3.484	4.791
postatt	0.44	0.509	-12.121	72	0	-27.243	2.248	-31.723	-22.762
			-12.158	71.785	0	-27.243	2.241	-31.71	-22.776

4.2. Scientific Concept Test (SCT)

The results in Tables 3 and 4 show that there is no significant difference between the control and experimental groups in the pre-test SCpqe in the pre-test scores ($p>0.05$). In the post-test SCPost, there is a highly significant difference between the two groups in the post-test scores ($p=0.000$). This suggests that teaching science through an online gamified learning platform will have a positive impact on students' mastery of science concepts.

*Table 3.*SCT test - descriptive statistics

Group Statistics

	group	Number of cases	Mean	Standard Deviation	Standard Error Mean
SCpqe	1	38	4.05	1.138	0.185
	2	36	4.17	1	0.167
SCpost	1	38	7.42	3.554	0.576
	2	36	11.11	3.232	0.539

Table 4. SCT test - independent sample test

	Levene's equivalence of variances test		Equivalence of means t-test						
	F	Significance	t	df	Sig.(two-tailed)	Mean Difference	Standard error difference	Difference 95% confidence interval	
								lower limit	upper limit
SCpqe	.161	.689	-.457	72	.649	-.114	.250	-.612	.383
			-.459	71.609	.648	-.114	.249	-.610	.382
SCpost	.713	.401	-4.665	72	.000	-3.690	.791	-5.267	-2.113
			-4.677	71.885	.000	-3.690	.789	-5.263	-2.117

Test results showed that the experimental group performed significantly better than the control group, as evidenced by higher levels of awareness building and understanding of science concepts, while demonstrating higher motivation to learn science than students in the control group who used traditional teaching strategies. Specifically, the online gamified learning platform embedded diverse resources for the experimental group's science classroom, designed interactive

discussions and knowledge tests as feasible and effective gamified activities, and integrated professional video, image, and text materials to stimulate students' learning motivation, for which students could actively participate in the teaching. Also through the online platform, students can follow their own learning path to master the learning pace. In other words, by integrating science into this online game-based learning, students' a priori knowledge can be effectively activated and learners are actively guided to complete the construction of their knowledge system on their own, which in turn improves their scientific attitudes and conceptual levels and generates motivation for continuous active learning.

5. Conclusion

In the field of gamified learning, most studies focused on the gamified teaching model design or the development of educational games, however, few studies involving online gamified learning platforms for the influence of students' science learning.Therefore, on the basis of previous studies, this study introduced online gamified learning platforms into middle school science classes, which revealed that online gamified learning platforms have a positive impact on students' attitude towards science and concept learning. The application of online gamified learning concept will make scientific learning more active and efficient, thus promoting the improvement of learners' knowledge, skills, value and emotion. Because game learning has great potential to stimulate learners' motivation to learn science and promote meaningful learning, this study has certain reference value to further develop students' scientific literacy.

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How did technologies "assist" self-regulated language learning?

- A systematic review of research from 2011 to 2020

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Abstract: *Despite the growing number of studies on technology-assisted self-regulated language learning (SRLL), little is known about the development of technology-assisted SRLL studies. In addition, there was a lack of updated review with the focus on the ways of technology-enhanced SRLL. This systematic literature review aims to address the research gap related to how technology "assisted" self-regulated language learning. The review covers 24 empirical studies focusing on technology-assisted SRLL published from 2011 to 2020. Content analysis shows (1) desktop computers were adopted in most cases;(2) four types of interventions that technologies provided, in which prompts and hints were mostly applied aiming at strengthening students' inherent SRLL skills; and (3) the role of technologies in supporting students' SRLL. The findings have implications for future research into applying more mobile applications and using technologies to facilitate the whole process of students' SRLL and support SRL strategies.*
Keywords: technology, interventions, self-regulated language learning (SRLL), self-regulated learning (SRL) strategies

1. Introduction

For the last decade, research in self-regulated language learning (SRLL) has proliferated. Recent studies have greatly contributed to the field of SRLL on the use of technologies. Studies such as Chen, Wang, and Chen (2014); Zheng, Li, and Chen (2018); Serrano, Vidal-Abarca, and Ferrer (2018) have shown that technologies were able to support students' SRLL. While in some studies, technology is not positively related to language learning outcomes (e.g. Chen & Lee, 2018) or SRL skills (e.g. Seifert & Har-Paz, 2020). The research results of the current technology-enhanced SRLL are mixed. In addition, understanding the role of technologies is necessary and important for resarchers to conduct empirical studies in the future. However, little research has been conducted to systematically review the technologies that have been used to support SRLL. Therefore, this study aims to conduct a literature review on technology-assisted SRLL, with foci on the features of educational technologies and the role of technologies in the process of SRLL. Specific research questions to be addressed are as follows:

(1) What technologies were investigated in the selected studies?
(2) What types of interventions did technologies provide in the selected studies?
(3) What was the role of technology in assisting self-regulated language learning in the selected studies?

2. Method

The review process followed the guideline of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2015) and Bano et al. (2018) to ensure the quality, which involves (1) development of search strategy, (2) identification of eligible studies, and (3) analysis of selected studies.

2.1. Development of search strategy

Firstly, Web of Science (WOS) and Educational Resources Information Centre (ERIC) were used as the primary database. The timespan of this review was the period of one decade from 2011 to 2020. Then, by identifying the relevant terms, the following search string was used to search on the relevant articles: ((technology OR computer OR mobile OR tablet OR phone) AND (self-regulated* OR self-regulation*) AND (language learning OR reading OR writing OR speaking OR grammar OR vocabulary OR speaking)). The search only involved the peer-viewed articles that could be retrieved online to review high-quality articles.

2.2. Identification of eligible studies

The searches on online databases resulted in a total of 284 articles. After removing duplications, the remaining 95 articles were scanned by their titles and abstracts. The inclusion criteria and exclusion criteria were applied to filter out irrelevant articles. The articles had to be (1) published in English, (2) dated from 2011 to 2020 inclusively, (3) empirical or case studies, and (4) with a detailed introduction to technology in supporting SRLL. Furthermore, studies were excluded if they were conceptual in nature and in non-experimental research designs. In addition, special needs education research was eliminated. As a result, a total of 24 articles were selected as eligible for the review which spread across different journals (see Figure 1).

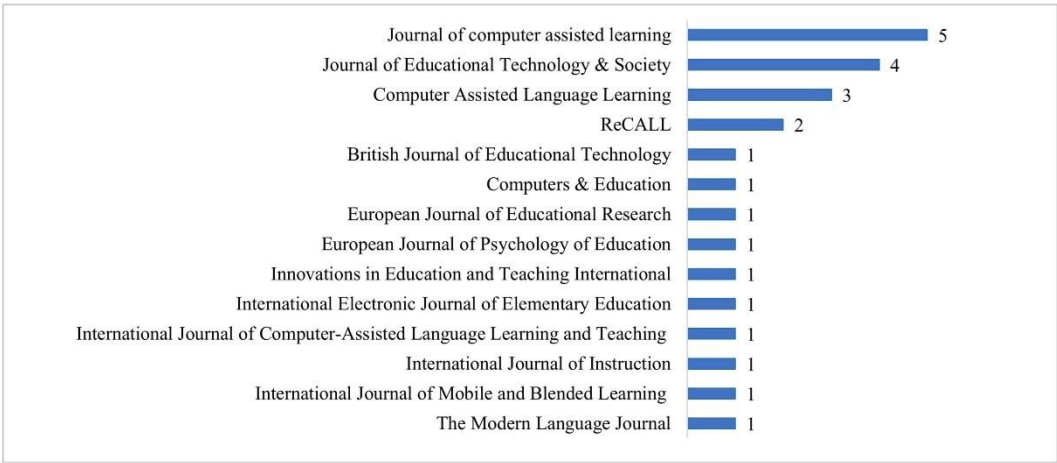

Figure 1. Distribution of eligible articles from referred journals.

The distribution of publication years of the selected 24 articles over past ten years (2011-2020) is shown in Figure 2. It indicates the steady increase of the studies, especially in the recent three years (2018-2020).

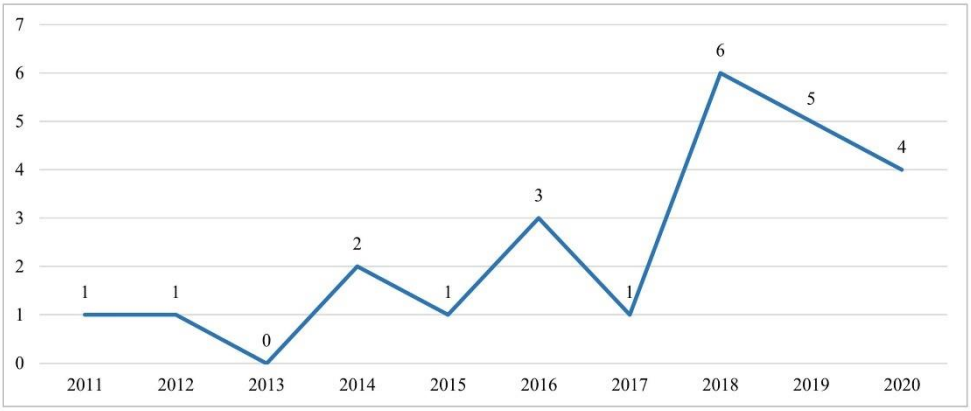

Figure 2. Distribution of publication years.

2.3. Analysis of selected studies

All the articles were examined and coded based on technologies and interventions that technologies provided in terms of visualisations, scaffolding, prompts/hints, and agents (Araka, Maina, Gitonga, & Oboko, 2020). Understanding the role of technology in SRLL was based on Zimmerman's (2002) three cyclical processes of SRL in terms of forethought, performance and self-reflection; and SRL strategies proposed by Zimmerman and Pons (1986) (see definition in Appendix I). Two reserachers were involved in the the coding phases, content analysis was conducted to analyse the selected papers. To measure the inter-rater reliability (IRR), five papers (21%) were selected and coded by two researchers independently and the results were compared. Finally, revisions to the coding scheme and agreements on the standards of coding were made through discussions.

3. Results and Discussion

3.1. Technology types

Regarding technologies adopted in the study (see Figure 3), desktops were employed the most (58%), followed by mobile devices (38%). Only one study used multiple devices (Torres, Salamanca, Cely, & Aguilar, 2020), which referred to more than one types of devices identified in the study.

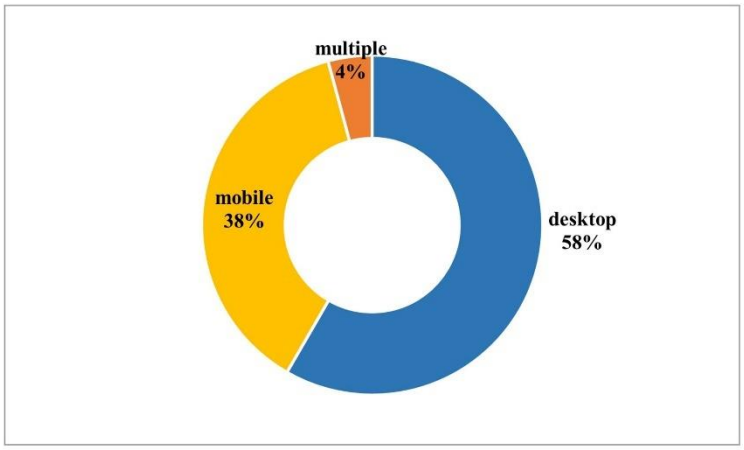

Figure 3. Distribution of technology types.

3.2. Types of interventions

The types of interventions that technologies provided were adapted from Araka et al.'s (2020) identifications of SRL tools. The detailed information on the types of interventions that technologies provided was analysed in terms of visualisations, scaffolding, prompts/hints and agents as follows:

(1) Visualisations: Two studies used visualised dashboards to keep students informed of the SRLL process. Chen et al. (2014) used a radar plot to represent students' SRLL status and support students to monitor their learning. Chen and Lee (2018) adopted a coloured-table to show primary students' vocabulary learning status.

(2) Scaffolding: Scaffolding acted as cognitive and social support, such as system-generated assessments for self-correcting or feedback from peers and teachers (Kim & Hannafin, 2011). Scaffolding provided by the technologies enabled students to not passively receiving assistance and guidance but actively engaged in the SRL process (Rogoff, 1990). The scaffolding for learners facilitated through technology was adopted in most studies in this review, namely, 19 studies.

(3) Prompts/hints: System-generated metacognitive or behavioural prompts or hints (Araka, Maina, Gitonga, & Oboko, 2020) that aimed to engage students to reflect on their learning and enhance SRL skills. In the reviewed studies, question prompts/hints have been applied in six studies (Hong et al., 2015; Lin, Liu, & Chen, 2020; Llorens, Vidal-Abarca, & Cerdán, 2016; Saks & Leijen, 2019; Serrano et al., 2018; Shyr & Chen, 2018) to help direct students to keep focused on the tasks and rethink the way they engaged in learning. Text-based prompts/hints were used to directly guide students as illustrated in the other six studies (Chen, Chen, & Yang, 2019; Chen et al., 2014; Chen & Lee, 2018; Ferreira, Simão, & da Silva, 2017; Ghufron, & Nurdianingsih, 2019; Liu, Lan, & Ho, 2014).

(4) Agents: Agents in this study referred to virtual instructors who provided support and guidelines to learners. Four studies (16.7%) employed agents to support students' SRLL: Ahn and Lee's study (2016) involved a virtual salesperson with whom students could have conversations and get personalised feedback to improve speaking skills. Chen and Hsu (2020) created a virtual reality (VR) game, which allowed students to improve listening, reading comprehension and learn vocabulary and self-regulate their learning by engaging students in the virtual environments with virtual instructors. Lin et al.'s (2020) study introduced a 3D instructor named Mr. Ice Age to engage students' writing. Serrano et al.'s (2018) study also involved virtual agents in scaffolding students' metacognition strategies in SRLL by monitoring the learning processes.

3.3. The role of technology in the process of self-regulated language learning

The analysis of the role of technology in self-regulated language learning included (1) whether technologies supported the whole process of SRLL and (2) how SRL strategies were addressed using technologies, aligning Zimmerman and Pons's taxonomy (1986).

As posited by Zimmerman (2002), self-regulated learning (SRL) included three cyclical phases, namely, forethought, performance, and self-reflection. To be more specific, the forethought phase involves task analysis (e.g., goal setting and strategic planning). In the performance phase, students monitor their processes. Finally, the self-reflection phase includes self-judgment and self-reactions to learning performance and outcomes. Based on the content analysis, the findings show that technologies in most studies supported the "performance" phase, allowing students to monitor learning status and process. However, only four studies supported the whole process of self-regulated language learning (Chen et al., 2014; Saks & Leijen, 2019; Shyr & Chen, 2018; Zheng et al., 2018).

To be more specific, the four studies were further analysed to understand how the technology supported self-regulated strategies by adopting Zimmerman and Pons's (1986) taxonomy as a framework. The framework has been used as a foundation for recent SRL research to understand students' SRL strategies (Kizilcec et al., 2017, Garcia, Falkner, & Vivian, 2018). The original definitions can be referred to Appendix I. Table 1 maps tools adopted in the four studies supporting 15 categories of SRL strategies. Category 1 (self-evaluation), category 3 (goal-setting & planning), category 5 (keeping records & monitoring), and category 13 (reviewing records notes) were the most predominantly supported SRL strategies using technologies in the selected studies. Strategies lacking technology-supported belonged to category 6 (environmental structuring), category 7 (self-consequences) and category 12 (reviewing records tests).

- Category 1 (self-evaluation): Automated assessment tools were used to help students evaluate their learning performance as conducted in Chen et al. (2014), Saks and Leijen (2019), Shyr and Chen (2018) and Zheng et al. (2018). In addition, two studies (Saks & Leijen, 2019; Shyr & Chen, 2018) also provided students with prompts to assess their understanding and evaluate learning effectiveness.
- Category 2 (organising & transforming): three studies allowed students to self-initiated learning tasks. For example, in the study conducted by Chen et al. (2014), students were able to schedule learning units on their own. The

Flip2Learn system encouraged students to freely chose learning tasks (Shyr & Chen, 2018). Finally, students could select different tasks based on their evaluation of the task in Zheng et al.'s study (2018).

- Category 3 (goal-setting & planning): technologies in the four studies helped students set learning goals. Chen et al.'s (2014) proposed system required students to set self-monitor table in terms of learning time, learning units, class ranking, degree of effort, degree of concentration and expected learning abilities. Similarly, Zheng et al.'s (2018) study helped students set goals and make plans as well as selecting appropriate learning strategies. Furthermore, a written learning plan was guided by the prompts in the guidelines of the assignments as conducted in the studies of Saks and Leijen (2019) and Shyr and Chen (2018).
- Category 4 (seeking information): dictionaries were embedded in the system of DRAS (Chen et al., 2014) and mobile self-regulated learning system (Zheng et al., 2018) to support student reading; multimedia resources were offered in the study of Shyr and Chen (2018).
- Category 5 (keeping records & monitoring): technology in the four studies in this category provided students with mechanisms to monitor learning status and progresses for later retrieval.
- Category 6 (environmental structuring): none of the technology in the four studies was found to support student-initiated efforts to arrange the physical environment to regulate language learning.
- Category 7 (self-consequences): this category referred to students working towards or imagining rewards for success, or punishment for failure during the learning processes; competition mechanism was adopted in Chen et al.'s (2014) study by ranking students' annotations in terms of numbers of translation-type, antonym-type, phrase- and grammar-type, related link-type annotations. Students would be encouraged to contribute high-quality annotations based on the ranking level.
- Category 8 (rehearsing & memorising): two systems were found to help students rehearse or memorise by practising. Chen et al.'s (2014) DRAS system provided annotation functionalities to students by highlighting text, selecting annotation types, searching meanings, and browsing all annotations. Saks and Leijen (2019) included peer-assessment and prompts to make students revise essays.
- Category 9-11 (seeking social assistance): technology in the two studies supported students to seek social assistance from peers (category 9) and adults (category 11) through peer-assessment (Saks & Leijen, 2019) and discussion forum (Shyr & Chen, 2018). In addition, Shyr and Chen (2018)'s study allowed students to ask help from teachers (category 10) using the forum embedded in the system or "through videoconferencing and online messengers" (Shyr & Chen, 2018, p. 58).
- Category 12-14 (reviewing records): category 12-14 referred to student-initiated efforts to reread tests (category 12), notes (category 13), or textbooks (category 14), Chen et al.'s (2014) DRAS system allowed students to revisit tests, notes and textbooks. Saks and Leijen (2019) and Zheng et al. (2018) allowed students to review learning notes. Furthermore, Flip2Learn system (Shyr & Chen 2018) enabled students to record notes and textbooks.
- Category 15 (others): this category acknowledged actions initiated by peers or teachers, during students' learning (Garcia, Falkner, & Vivian, 2018). Technologies adopted in the four studies all allowed outside influence to foster students' SRLL.

Table 1. Summary of technology support in the SRLL using Zimmerman and Pons's taxonomy (1986).

Technology (Author, Year) / SRL strategies	DRAS: a SRL mechanism combined with a digital reading annotation system (Chen et al., 2014).	The prompts: hyperlinks in the guidelines of the assignments (Saks & Leijen, 2019).	Flip2Learn system: provided facilitation and guidance for learning performance and	A mobile self-regulated learning system (Zheng et al., 2018).

			self-regulation (Shyr & Chen 2018).	
1. Self-evaluation	√	√	√	√
2. Organising & transforming	√		√	√
3. Goal-setting & planning	√	√	√	√
4. Seeking information	√		√	√
5. Keeping records & monitoring	√	√	√	√
6. Environmental structuring				
7. Self-consequences	√			
8. Rehearsing & memorising	√		√	
9. Seeking social assistance peers		√	√	
10. Seeking social assistance teachers			√	
11. Seeking social assistance adults		√	√	
12. Reviewing records tests	√			
13. Reviewing records notes	√	√	√	√
14. Reviewing records textbooks	√		√	
15. Others	√	√	√	√

4. Implications

To sum up, although this systematic literature review was not meant to be comprehensive, it provides important findings that can be useful for instructional designers and researchers. Firstly, in the 24 selected studies, desktops were the primary devices adopted. Therefore, it is advised that mobile applications to support SRLL should be given much attention in the future. Secondly, four types of interventions that technologies provided were identified in the selected studies. Prompts and hints were mostly applied aiming at strengthening students' inherent SRLL skills, while visulisations and agents were paid less attention. In the future, data-driven persoanlised feedback is encouraged to guide students' SSRL (Araka et al., 2020). Thirdly, the majority of technologies were designed to support the "performance" phase of SRLL, enabling students to monitor learning processes and status. However, only a few technologies facilitated the whole process of students' SRLL. Therefore, a more systematic tool is adovacated to support the whole phases of SRL in the context of language learning. Furthermore, four studies were analysed in detail with an attempt to understand how SRL strategies were applied in using technologies to support the whole process of SRLL. The findings uncovered that environmental structuring, self-consequences and reviewing records tests were less supported by technologies.

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Appendix

Appendix I Zimmerman and Pons' taxonomy (1986)

SRL Strategies	**Definitions**
1. Self-evaluation	Student-initiated evaluations of the quality or progress of their work.
2. Organising & transforming	Student-initiated overt or convert rearrangement of instructional materials to improve learning.
3. Goal-setting & planning	Statements indicating student setting of educational goals or subgoals and planning for sequencing, time, and completing activities related to those goals.
4. Seeking information	Student-initiated efforts to secure further task information from non-social sources when undertaking an assignment.
5. Keeping records & monitoring	Student-initiated efforts to record events or results.
6. Environmental structuring	Student-initiated efforts to select or arrange the physical setting to make learning easier.
7. Self-consequences	Statements indicating students arrangement or imagination of rewards or punishment for success or failure.
8. Rehearing & memorising	Student-initiated efforts to memorise material by overt or covert practice.
9-11. Seeking social	Statements indicating student-initiated efforts to solicit help from peers (9), teachers (10), and adults (11).
12-14. Reviewing records	Student-initiated efforts to reread tests (12), notes (13), or textbooks (14) to prepare for class or further testing.
15. Others	Statements indicating behaviour that is initiated by other persons such as teachers or parents and is unclear verbal responses.

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Exploring Middle School Students' In-moment Engagement with Online Problem-based Learning

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Abstract: *This study examines the relationship between technology-supported activities and middle school students' in-moment engagement during a problem-based learning "camp", which was conducted entirely remotely online. The instructional technology of Desmos was used to gather students' real-time feedback during the online camp sessions. Results show that certain technology-supported teaching and learning activities contribute to student different types of (dis)engagement (i.e., behavioral, cognitive, emotional engagement) during online problem-based learning.*

Keywords: online learning, problem-based learning, instructional technology, student engagement

1. Introduction

Online teaching and learning (T&L) has been called upon as an adaptable solution to maintaining the normal operation of teaching during this time of COVID-19 pandemic. Engagement is thought to be a more important mediator for online learning than in the traditional face-to-face environment. Interactivity is associated with effective and engaging online learning experiences. Moore (1989) proposed the interaction model, which comprises three types of interactions, namely student–student interaction (S-S), student–teacher interaction (S-T), and student–content interaction (S-C). However, much of related works targeted on college students, adopting a methodology of self-reported engagement via surveys. There is a need to extend these kinds of research to the K–12 education context and explore qualitative methods of inquiry into students' in-moment engagement during online learning activities.

In the present study, a PBL course targeted at middle school students was conducted entirely remotely online. Various technology-supported T&L activities were designed to facilitate different types (S-T, S-S, and S-C) of interaction. Among the technology-supported activities, the instructional technology *Desmos* was adopted, allowing the researchers to observe students' real-time engagement during the camp sessions. This enabled the researchers to investigate the relationship between the designed technology-supported activities and the students' in-moment engagement in the online environment. In particular, this study is intended to answer the following research question: What T&L activities contribute to student (dis)engagement during online PBL?

2. Methodology

A total of 62 participants were recruited to join two online enrichment courses of 30 and 32 students each. We selected participants with at least 60% (or 3 of the 5 sessions) attendance level, which were 54 in total for data analysis. The T&L activities took place over Zoom, a platform for online video-conferencing. We developed a series of T&L activities, and further characterized them in terms of S-S, S-T, and S-C interaction. For example, S-S interaction activities including pair-work problem solving and peer exchange by discussions and presentations; S-T interaction activities including progress check and reflection questions with Desmos; for S-C interaction activities, there were in-problem questions with Desmos and individual problem solving. Noting that some activities were characterized by more than one interaction. For

example, the activity of "In-problem questions" could be considered both S-T and S-C because the questions were designed and proposed by the teacher, and they were also highly content dependent.

3. Results

The most prevalent conceptualization of engagement in the literature suggests that it consists of three distinct yet interrelated components: behavioral, emotional, and cognitive engagement (Fredricks, Blumenfeld & Paris, 2004). We adopted this framework to present the results accordingly.

We assessed students' overall behavioral engagement in terms of students' response rate to the questions posed in Desmos. In particular, it can be found that "In-problem questions" yielded a higher response rate (83.53%) than "Progress check" (77.64%). On the other hand, we observed student disengagement during "Pair-work PS". This was due to various technical issues, including hardware (i.e. devices such as iPad did not feature remote-control) and an unstable network connection. We also observed that S–C impacted students' behavioral engagement in significant ways. This was evident in the students' spontaneous Zoom chat discussions related to the problem being tackled that were not prompted by the teacher. For example, when presented with the problem "what will be the sum if we throw six dice all at once?" a discussion spanning 60 turns unfolded among 6 students in Camp 1, and 63 turns among 8 students in Camp 2.

We mainly assessed emotional engagement through identifying textual statements that demonstrated affective aspects. In particular, when responding to the "Reflection questions" about aspects of the camp that were most enjoyable, 51% of student respondents commented on programming-related aspects (S–C), such as processes of programming, learning outcomes, and enhanced computational thinking. In addition, 24% of student respondents commented on peer learning-related aspects (S-S), such as peer discussions, sharing, and help. Very little was shown in S–T interaction.

The students' cognitive engagement was most evident in their mathematics- and programming-related responses during the activities. The activity of "In-problem questions" contained two types of questions. The first type of question was well-structured with an expected short answer within the scope of the problem while the other type of question was more open, aiming to prompt students' higher-order thinking as well as self-explanation. We observed that the answer rate of the short answer questions was lower (75.3%) than the higher-order thinking questions (83.6%). Moreover, the quality of the responses was consistently high for the latter type.

4. Conclusion

The current study investigated the relationship between different types of technology-supported activities and students' in-moment (dis)engagement in an online PBL environment. As shown in the results, students' in-moment engagement was most prevalent during S-C activities. Hence, it is argued that S-C interactions are especially important for facilitating online PBL. Future studies may further examine the kinds of S-C interactions in effectively promoting students' engagement in PBL in STEM subjects, in light of recent calls for better integration of problem solving and STEM education (Ng & Cui, 2020). In terms of S-S interactions, the spontaneous use of Zoom chat discussion was found to be productive in this study. Besides Zoom chat discussions, other S-S activities, such as individual student presentations yielded high levels of emotional engagement. The challenges experienced in this study's online T&L environment raised attentions to the practice of online collaborative PBL.

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Rural Teachers' Perceptions of Open Educational Resources and Practices: An Investigation in China

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Abstract: *The concept Open Educational Resources (OER) and Open Educational Practices (OEP) are becoming a research hotspot since the concept OER was first proposed in the 2012 Pairs Declaration. Several studies have been researched on the effectiveness and adoption of OER and OEP especially in universities. However, there are few studies on the perception, related policies and implementation awareness of OER among rural teachers, especially in China, as a country attaches great importance to education, including the government, society and each family. This study conducted a questionnaire to investigate the first-line primary and secondary rural school teachers in China towards the awareness of OER including perception towards OER, the OER use, empowering OER as well as accessibility also been taken into consideration. The findings show that most of the teachers hold positive perception towards OER. Unfortunately, a great deal of them do not clearly know the definition of OER rather than MOOCs. Finally, more actions are required to enhance the adoption of OER and OEP in China.*

Keywords: Open Educational Resources, Open Educational Practices, China, Rural teachers

1. Introduction

Since the concept of Open Educational Resources (OER) was first proposed in the 2012 Paris Declaration, OER and Open Educational Practices (OEP) have been developing rapidly to support the implementation of Sustainable Development Goal 4 (SDG4). Particularly, during the pandemic, UNESCO as well as researchers paid much attention on OER and OEP (Zhang et al. 2020). Consequently, OER can help achieve social justice between rural and urban areas (Ossiannilsson, 2019). China has started at an early stage, since 2003, to adopt OER by initiating several policies and strategies for that, including Chinese Quality Course (CQC) founded by Chinese Ministry of Education and Science Data Sharing Project (SDSP) invested by Chinese Ministry of Science and Technology. Additionally, since China's educational development is unequal especially in rural areas, the ministry of Education issued the rural teacher support plan (2015-2020) by the state council in 2015. Therefore, this study conducts a survey to investigate how rural teachers, the ones most familiar with the daily rural education challenges, perceive OER as a way to overcome these challenges.

2. Methodology

A questionnaire (please see the next subsequent section for more information) was developed and reviewed by several experts from China and the Arab League Educational, Cultural and Scientific Organization (ALECSO). Based on several reviewed OER questionnaires (see for instance (Rowell, 2015)), a Likert-scale questionnaire was developed. It focuses on several perspectives, namely: (1) Perception towards OER - investigates the opinions of teachers toward OER; (2) OER use - investigates the use of OER in rural areas; (3) Empowering OER - investigates the awareness of policies/strategies launched by the government to support OER; and, (4) Accessibility - investigates the perception of OER for disability.

3. Results and Discussion

It is important, at the beginning, to investigate the awareness of the teachers about OER. The obtained results are presented in Figure 1. The barriers for publishing OER and awareness of using open license are also investigated. Since there are different types of OER

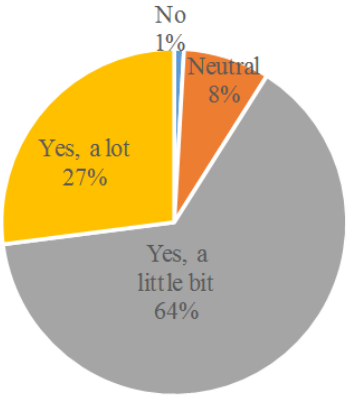

Figure 1. Perception of Advantages of OER

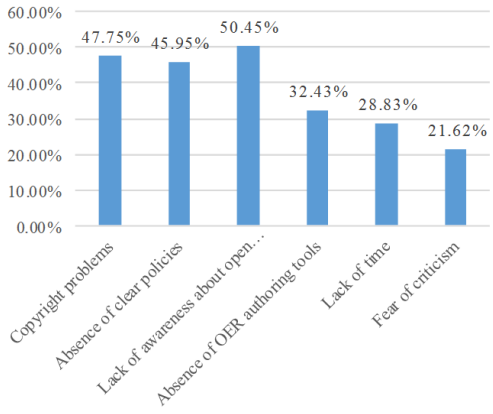

Figure 2. Barriers for publishing OER (Q6)

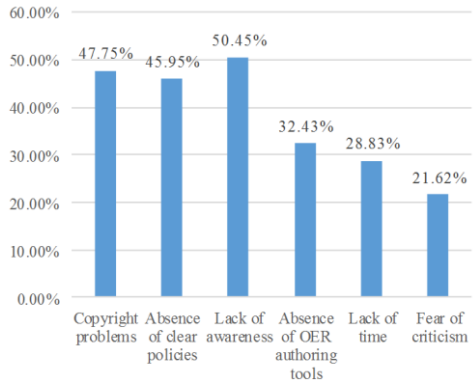

Figure 3. Awareness of using open licenses

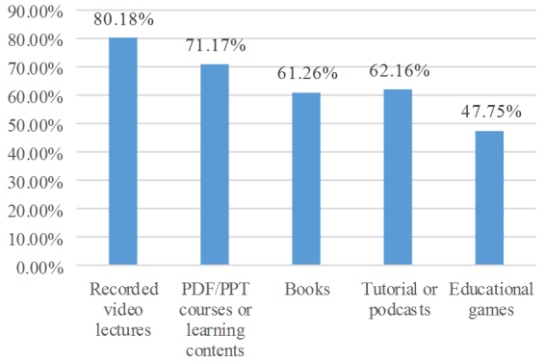

Figure 4. Type distribution of OER (Q8)

4. Conclusion, Recommendations and Future Directions

This study conducted a survey to investigate the OER perception and use in rural education in China. From the obtained results, several remarks can be found as follows: 1) While several policies have been initiated to support OER in China, lack of awareness about these policies and especially about the OER repositories in rural education can limit OER accessibility. 2) There should be a wider institutionalization of OER policy in rural areas where educators are using these resources to ensure full utilization. 3) More awareness and efforts about raising awareness in rural areas when it comes to open license should be conducted.

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Project-Based Teaching Based on STEAM for Programming Course in Universities of Applied Sciences

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Abstract: *Due to the disadvantages in the training for undergraduates in computer-related programs and the characteristics of universities of applied sciences, the project-based teaching based on STEAM (Science, Technology, Engineering, Art and Mathematics) (or, PJBT-STEAM) is introduced into programming courses. The teaching reform is carried out from the aspects of teaching project design, teaching activity design and evaluation design. The new mode aims to improve the current situation in programming courses, such as repetitive and monotonous practice, lack of interdisciplinary knowledge, etc., adopting the project-based teaching and diversified evaluation model to cultivate students' innovation ability. The result shows that the PJBT-STEAM enhances student's interest in attending the course, eagerness to innovate and multidisciplinary application ability, which plays a beneficial role in the teaching reform and innovation in universities of applied sciences.*

Keywords: STEAM, project-based teaching, universities of applied sciences, computer-related programs

1. Introduction

To meet the demand of strategic industries, Shenzhen, the core engine of Guangdong-Hong Kong-Macao Greater Bay Area, is striving to become a global City of Innovation. Shenzhen is the hardware heaven with the world's most complete supporting capability for emerging industries, whose demand for high-quality technical and innovative talents has been growing rapidly.

Software development is the basic ability of students in computer-related programs, which can be improved by learning programming languages. As a compulsory course for students in computer-related programs, Object-Oriented Programming in C++ is one of the main research objects of teaching exploration for many educators. In traditional programming teaching, repetitive practice could make students proficient in writing basic programming code. The monotonous repetition, however, reduces student's interest in the course and eagerness to innovate. Additionally, their comprehensive competitiveness is likely to be insufficient due to lack of interdisciplinary knowledge.

The project-based teaching, which is problem-oriented, multidisciplinary and instructive, is adopted to promote the current teaching mode, encouraging students to collaborate and innovate. The project-based teaching combines STEAM, maker education and course objective, so as to enhance students' learning interest and innovation ability. Therefore, the project-based teaching based on STEAM (or, PJBT-STEAM) is a feasible way to solve the problem mentioned above, and it is of great significance to explore how to apply the PJBT-STEAM to the compulsory courses in computer-related programs.

2. STEAM (Science, Technology, Engineering, Art and Mathematics)

STEAM integrates five aspects, namely science, technology, engineering, arts and mathematics. It combines independent and scattered disciplines through specific projects, aiming at improving students' comprehensive ability.

STEAM focuses on training hands-on innovative talents, which will actively promote the reform of practical teaching and further improve the teaching quality. The computer-related programs offered by universities of applied sciences are to cultivate high-quality talents who can meet the societal needs with practical and innovative ability.

STEAM originated from STEM education in the United States. STEM refers to science, technology, engineering and mathematics. Art was later added to form STEAM education, which has been developing into a new educational theory of cultivating talents by the way of multidisciplinary integration. After decades of exploration, educators generally recognize the following characteristics of STEAM education: (1) paying attention to the cross-border cultivation; (2) constructing interdisciplinary courses; and (3) attaching importance to diversified evaluation. It is important for college students to master multidisciplinary approaches, which include learning skills, innovative thinking, digital application and life skills. It shows that students should not only be proficient in a certain professional knowledge and skill, but also have integrated competence to better meet the societal needs. To enhance students' multidisciplinary application ability, educators should provide more opportunities for students to learn and apply interdisciplinary knowledge by making project-based teaching plans. To realize diversified evaluation, course grades should largely go to team projects and peer review rather than written examinations.

3. PJBT (Project-Based Teaching)

The theory of STEAM can be put into practice by carrying out project-based teaching (PJBT), which requires educators to change the traditional teaching methods to stimulate students' interest in learning and offer them more chances to showcase their achievements. It is proved that multidisciplinary knowledge can be made full use of in PJBT. With stage evaluation included, PJBT can help students find out the problems and adjust their plans effectively with clear expectations and definite goals. Educators are able to make the concept of interdisciplinary integration advocated by STEAM concrete and executable by implementing PJBT. There are generally two directions for PJBT. The first one is to guide students to figure out the problem-solving measures for selected projects by teamwork, the purpose of which is to enhance their sense of teamwork and improve their ability to use theoretical knowledge to solve problems. The other one is to provide a project bank for students, various types of open-ended projects in which are open to them. They are encouraged to participate in multiple projects, which helps them discover the directions they are interested in. In universities of applied sciences, there are plenty of senior technicians and chief engineers from famous enterprises recruited as full-time instructors or guest professors. With rich experience in technological application and innovation, they have the inherent advantage in implementing PJBT. The real project development scenarios in the enterprises can be introduced to the class, which enhances students' eagerness to innovate.

4. PJBT-STEAM Implementation

We implemented the PJBT-STEAM through "Object-Oriented Programming in C++", a compulsory course in computer-related programs. Students are supposed to pass "Introduction to Computer" and "Fundamentals of Programming (C Language)" or other basic programming courses before taking "Object-Oriented Programming in C++". According to the academic calendar, there are generally 18 weeks per semester. In accordance with the teaching plan, students need to learn the concepts of objects, classes, inheritance, interfaces, and packages, and independently finish some regular assignments from Week 1 to Week 8. In particular, they are required to finish team projects in a group of 3 to 5 from Week 9 to Week 16. All innovative designs and development results should be fully displayed from Week 17 to Week 18. Specifically, Table 1 shows the PJBT-STEAM implementation plan.

Table 1. PJBT-STEAM Implementation Plan

Phase	Tasks for Students	Report	Time

1. Kick-off	Discover the interest; Decide the type	Opening Report	Week 9-10
2. Project in progress	Requirement analysis; Function design; Task division; Software development; Interface design; Software Testing	Interim Report	Week 11-16
3. Summary	Present development results; Compose and submit final report	Final Report	Week 17-18

There are three phases for the PJBT-STEAM implementation, namely Phase 1: Kick-off from Week 9 to Week 10, Phase 2: Project in Progress from Week 11 to Week 16, and Phase 3: Summary from Week 17 to Week 18. The course instructor plays a role as an advisor in Phase 1 and Phase 2, and a judge in Phase 3. Since all the projects selected should be based on real market demand, teachers from the Business School are also invited as jurors in Phase 3, assessing the market value of the products developed by each team and giving advice on further commercialization. Each team must submit the opening report, interim report and final report at the end of Week 10, Week 14 and Week 18 respectively. The final group presentation starts at the beginning of Week 17. The three phases are specified as below.

- Kick-off: In this phase, a project bank is provided for students, who need to figure out the directions they are interested in and make a decision on the software to be developed and the core function(s) to be achieved after the discussion. Moreover, an opening report must be submitted by each team, describing the functions, highlights, customer groups, and prospects of the product to be developed based on the preliminary investigation and analysis.
- Project in progress: In this stage, requirement analysis, function design, task allocation, software development, interface design as well as software testing are carried out by each group. Likewise, an interim report must be submitted to show the stage achievements and problems to be solved.
- Summary: A detailed final report and slide show are required for each team, in which students need to explain how the concepts they have learned relate to the real world and fully present the design flow, project highlights, development process, test results and commercial value.

Both professional review and peer review are included in the final evaluation, accounting for 30% of the course grade respectively. The other 40% goes to the regular assignments, opening report and interim report. Not only the instructor and technician, but also students taking the course made their comments on all projects. As a bonus, the excellent teams with their projects have the opportunities to attend the Challenge Cup and other domestic collegiate technological innovation competitions or business plan contests.

Multidisciplinary application is indispensable in the PJBT-STEAM implementation. First of all, students need to have a preliminary understanding of project design, management approach, software development. Second, they need to figure out the commercialization prospects of the software to be developed and identify their customer group through market research. Third, solid programming skills are greatly needed in terms of software development and testing. Fourth, an interactive-friendly software interface should be included in a good development project, which requires team members with web design skills. In addition, articulate speech and colorful language can help a team earn extra points when showcasing the project. Moreover, a successful team is inseparable from the members with strong sense of teamwork and effective communication skills.

Before implementing the PJBT-STEAM, we generally instruct students in a traditional way in the course of "Object-Oriented Programming in C++", only requiring them to repeat similar practice and gain proficiency in writing regular code to get the answers we have already known. In this case, students' interest in learning programming language as well as their enthusiasm for innovation are largely reduced. Through the new attempt with the PJBT-STEAM, most of the students have improved their comprehensive abilities, mastering programming skills, raising awareness of teamwork,

engaging in project management, realizing effective communication and learning project commercialization. They could hardly obtain such experience in traditional lectures.

Specifically, 27 students were divided into 6 groups, who completed 6 projects with 11,868 code lines in total. According to our statistics, they created an average of 633 code lines per person per week, while the 30 students taking the same course without the PJBT-STEAM last year each produced an average of 394 code lines per week. In addition, the average attendance rate of the class with the new teaching mode is 90.3%. Under the same attendance regulation, however, the average attendance rate of the students who were instructed in a traditional way is 79.2%. It means that students are more willing to attend the class with the PJBT-STEAM than the conventional one to some degree. 9 students from 3 teams further optimized and improved the software functions based on the course projects. They were selected to attend the technological innovation competitions and won 1 award in nation-wide Intelligent Manufacturing Innovation Competition and 3 school-level innovation prizes. Moreover, we made a survey of the teaching effect of the course and all the 27 students were invited to fill out a questionnaire after their final presentations. The result shows as the Figure 1.

	同意 Agree	不同意 Disagree	不确定 Not Sure
在《C++面向对象程序设计》课程中，相较传统教学方式，你更认可PJBT-STEAM。 You prefer "Object-Oriented Programming in C++" using PJBT-STEAM to that taught in traditional way.	85.2%	3.7%	11.1%
参加本课程后，你的多学科应用能力得到了提高。 Your multidisciplinary application ability has been improved after taking the course.	92.6%	3.7%	3.7%
参加本课程后，你更愿意从事软件创新与开发。 You are more willing to engage in software innovation and development after taking the course.	77.8%	3.7%	18.5%
你认为PJBT-STEAM应该推广到其他计算机相关课程。 The PJBT-STEAM should also be applied to other courses in computer-related programs.	77.8%	7.4%	14.8%

Figure 1. Questionnaire statistics with the PJBT-STEAM implemented

In accordance with the survey, 85.2% of the students prefer "Object-Oriented Programming in C++" with the PJBT-STEAM to the traditional one and 92.6% of them agree that the new attempt has helped them improve their multidisciplinary application capabilities. Moreover, 77.8% of them think they are more willing to engage in software innovation and development after taking the course, and that other courses in computer-related programs should also get the PJBT-STEAM introduced. It means that the new attempt has achieved initial success and received great recognition from the students, which is a booster for further teaching reform of computer-related programs.

5. Conclusion

The result shows that the course with the PJBT-STEAM receives great recognition from the students, enhancing their willingness to attend the class and enthusiasm for software innovation and development, and improving their multidisciplinary application ability. It is more feasible to apply the PJBT-STEAM in universities of applied sciences because they pay more attention to students' capability in solving practical issues and with more experienced technicians and engineers from enterprises recruited, they have a clear advantage in implementing the PJBT-STEAM. The statistic implies that with the PJBT-STEAM implemented, the course of "Object-Oriented Programming in C++" is successful with fruitful achievements. Therefore, it is highly important to further explore the PJBT-STEAM application to other courses in computer-related programs.

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Teaching Critical Thinking in the Blended Learning Environment

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Abstract: *In the era of knowledge economy, learners need not only knowledge and answers, but also processes of exploration and thinking. In this environment, it is very important to actively explore the teaching mode of cultivating learners' critical thinking. Based on in-depth analysis of the current connotations and characteristics of critical thinking, this paper constructs a teaching mode to promote learners' critical thinking in a blended learning environment. Taking the course of educational technology as an example, three rounds of practical research are carried out, and the teaching process and learning process are introduced in detail. The effectiveness of the teaching mode is verified through the comparison of the data before and after the test. The research results show that targeted teaching mode can effectively enhance students' critical thinking ability and tendency. This paper will provide reference and reference for subsequent related research.*

Keywords: blended learning, critical thinking, teaching mode

1. Introduction

The information society is faced with complex and real problems, so as to extract effective information and ideas and form the ability of independent thinking. Researchers must make scientific and reasonable judgments through questioning, reasoning, judgement and interpretation. This puts forward higher requirements for researchers' critical thinking ability. It is also the expectation of society for educating and training talents.Educational is an important link and path for the development of critical thinking ability. Effective activities help to train learners' critical thinking. Traditional face-to-face learning limits the learning resources and learning space in the classroom, and the way students acquire knowledge comes from teachers and books, rather than real situations and practices. Such a single face-to-face instruction may solidify thinking and become a resistance to the development of students' critical thinking. Online learning and web based cognitive tools create diversified and flexible learning methods for students. Transforming a single, relatively static book learning resource into a dynamic, iterative and updated dynamic resource in the network environment, students can have more thinking and reflection space and practice opportunities in a resource rich and relatively free environment. In the face of complex real situations, we can discern and improve the scheme of information authenticity. More conducive to the development of critical thinking. Organic integration of classroom activities and online learning provide a good environment for training learners' critical thinking. This study will explore the construction of a teaching mode for promoting the development of learners' critical thinking in blended learning environment and carry out practical research, hoping to provide practical and practical research to solve the existing problems in critical thinking teaching.

2. The Concept of Critical Thinking

2.1. The Concept of Critical Thinking

The emergence of the concept of critical thinking can be traced back to Socrates' midwives' operation. It adopts dialogue and discussion and inspiring teaching, and attaches importance to the logical reasoning and speculative process of teaching. The earliest definition of critical thinking is educator John Dewey. He proposes that reflective thinking is

active, persistent and deliberate thinking, based on belief or presumptive knowledge and possible inferences (Dewey, 1993).With the development of social pluralism and complexity, informal logic has gradually replaced formal logic and symbolic logic. People have a new understanding of critical thinking. The American Philosophical Association published critical thinking related reports. They used Delphi Fa's research on critical thinking for two years, suggesting that critical thinking is a process of pointing and self-regulating judgment, including the interpretation, analysis, evaluation, reasoning of evidence, concepts, methods, standards, or the consideration of all situations based on judgment (Facione, 1990).

In summary, critical thinking is based on appropriate standards or norms, and has a process of self-regulation and judgment. This process includes interpretation, analysis, evaluation and inference of the conclusion. Critical thinking includes two dimensions of thinking tendency and thinking ability, with strong self-regulation and self-correction ability, emphasizing the utility of argumentation and the scientific nature of argumentation (Matthew, 1998).

2.2. Critical Thinking Training Process

Ennis proposed that Frisco single structure model divided critical thinking training into six stages, namely, focus, reasoning, conclusion, situation, clarification and evaluation; Delphi divided critical thinking into cognitive ability and emotional characteristics. In the training of cognitive ability, it puts forward six stages: understanding, analysis, evaluation, inference, explanation and self-regulation. Holzer's critical thinking mainly includes: linguistic reasoning, topic analysis, hypothesis testing, probability and statistics, decision making, problem solving and cognitive monitoring. The process of critical thinking training proposed by researchers from different angles has generality. Through generality and generality, we can see that the process of critical thinking training can be divided into six stages: discovery, viewpoint statement, argument evaluation, inference, monitoring and evaluation, and self-regulation.

2.3. Blended Learning Environment

Lefebvre's three-dimensional dialectical spatial epistemology put forward that spatial cognition involves three levels: material, spiritual and social (Xu, Ta, & Zhang, 2015). Blended learning makes learning no longer confined to closed physical space. Under the combination of information technology and teaching methods, the learning space is expanded to integrate traditional classroom physics space, online learning network space, learning participants' psychological space and blended learning space system composed of social interaction and situational space (Zhu, 2006).

3. Teaching Mode Design for Critical Thinking Training Under the Blended Learning Environment

According to the training process elements of critical thinking, this study designs the training process according to Newell and Simon general problem-solving program (see Fig. 1). Under the guidance of the procedure, the structure and core elements of critical thinking are combined with the corresponding learning behaviors of critical thinking. The study divides critical thinking training into five stages: discovery, representation, evaluation, monitoring and self-regulation.

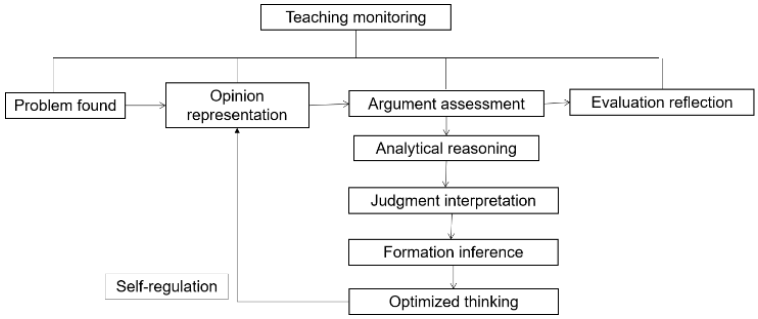

Figure 1. Critical thinking training process.

Based on the above critical thinking training process and blended learning teaching process, this study constructs a teaching mode to cultivate critical thinking under the blended learning environment, as shown in Fig. 2 in the appendix. The teaching mode can be divided into four parts. The first part is the teaching goal, the second part is the critical thinking training process based on the basic problem solving, and the third part is the migration application. The fourth part is participants and instructors of teaching activities, namely teachers and students. Each part integrates teaching mode and promotes the process of teaching and learning activities and the effective training of learners' critical thinking.

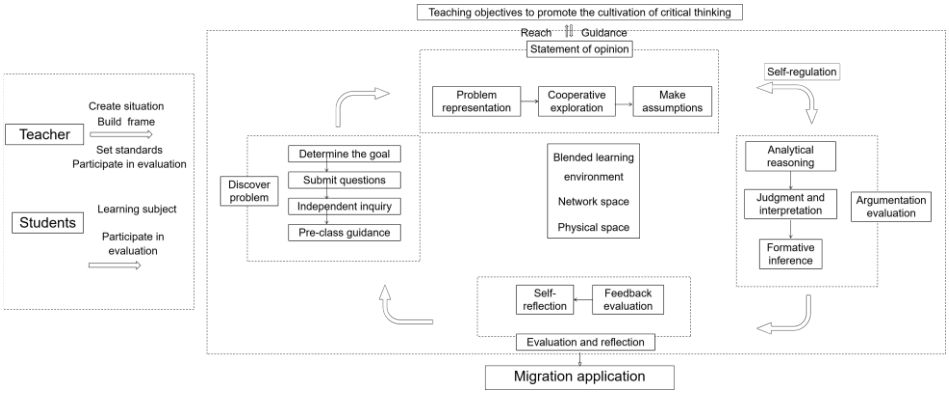

Figure 2. Teaching mode of critical thinking training under the blended learning environment.

4. The Process of Critical Thinking Training Under the Blended Learning Environment

The process of blended learning can be divided into three stages: introduction before class, research in the classroom, and extension after class, combined with critical thinking training process and mixed teaching process. In this study, the teaching process is divided into the introduction stage, the problem of discovery, the presentation and demonstration assessment in the research stage of the course, and the evaluation and reflection in the extension stage.

“the problem of discovery” in the introduction stage before class. The teacher sets up the teaching goal, issue teaching resources and tasks on the network platform in advance, provides teaching evaluation criteria and stimulates students' learning behavior. Students carry out pre-class guidance and self-exploration through online teaching platform to determine research contents and research objectives, and carry out the learning process. This stage mainly trains students to seek truth and curiosity. Students ask questions through independent inquiry, which is the result of knowledge processing. It is the starting point for students to try to learn and seek truth. At the same time, students can use resources and tools to clear up their thinking and put forward more valuable questions.

In the course of study, it is the focus of the study and appraisal. Learning takes place in the network teaching platform and classroom teaching. Classroom teaching is the main form. Students represent the problems on the basis of the guidance before class, make assumptions through cooperative inquiry, and deduce and verify, and form inferences. Teachers monitor the students' learning situation throughout the whole process. Provide the necessary guidance. This stage is to cultivate students' ability of open mind, analytical ability and systematization, so that students can respect different views, put forward their own views based on analysis, and organize and purposefully explore and solve problems. In the course of teaching, we can set up random tasks to observe and monitor students' learning process with the help of mobile phone end star school platform.

Evaluation reflection is to carry out teaching evaluation and student self-reflection according to the actual teaching situation after the end of classroom teaching. Teaching evaluation adopts process-oriented evaluation and multi-subject orientation evaluation method, including the analysis and arrangement of learning data in the whole learning process, and the way of student self-evaluation, mutual evaluation and teacher evaluation. Self-reflection is the process of self-

adjustment of students. Through teaching evaluation and feedback, we can reflect on our own learning process. This stage is mainly to cultivate students' critical thinking self-confidence and cognitive maturity. With the help of web-based learning platform, we can carry out the evaluation and reflection of student achievement evaluation and repeated submission of revision results.

Critical thinking requires students not only to develop critical thinking ability in setting up environment, but also to transfer critical thinking transfer to other situations. Critical thinking has commonality, so critical thinking cannot be confined to a certain field or topic. Students should have the ability to migrate to other situations. In teaching practice, multiple rounds of practical activities can be carried out according to different themes, and students can be trained repeatedly in practice to promote the development of critical thinking.

5. Summary and Prospect

Through the empirical study of the critical thinking teaching mode in the blended learning environment, this study believes that targeted teaching can effectively enhance students' critical thinking ability. Through the effective implementation of the teaching mode, the critical thinking ability and tendency of learners in all dimensions have been significantly improved, based on the teaching mode of problem-solving process design. This paper finds out that the blended learning environment can help learners to express their views more easily, and promote the emotional and aptitude of critical thinking.

However, this study only examined the validity of the teaching model proposed by a single set of critical thinking scales before and after the test, and whether there was natural effect after learning. Therefore, we should have a more in-depth discussion and analysis. In subsequent research, we need to improve and perfect it.

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Learners' Behavior of Reading Course Announcements on Their Academic Performance in Online-Merge-Offline (OMO) Learning

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Abstract: *Leaners' behavior analysis and its prediction of learners' performance has always been one of the important research fields of learning analytics. In previous study, students' behavior in online learning, especially MOOCs, gained lots of attention from the researchers. However, there is still a lack of research on learning behavior analysis in Online-Merge-Offline (OMO) learning. This study focused on college students' behavior of reading course announcements (CA) and its impact on their academic performance in OMO setting. An intelligent instructional tool named the Rain Classroom was employed to support OMO learning and 175 students' log data was automatically collected. Descriptive statistical analysis found that students' behavior of reading CA showed great difference. However, the time interval distribution of their behavior of reading CA showed certain regularity. The correlation analysis found that there were a significantly correlation between the timeliness of students' reading CA and their academic performance, including the score of the assignments (SA) and the score of module test (SMT). Based on above findings, some implications were provided for teachers to implement OMO learning in the post-COVID-19 era.*

Keywords: learning behavior, course announcements (CA), academic performance, learning analytics, Online-Merge-Offline (OMO) Learning

1. Introduction

The COVID-19 pandemic has brought great challenges to the field of education worldwide. To maintain school education during the time of crisis, Online-Merge-Offline (OMO) learning approach has become more and more popular in school education. As an emerging learning mode, OMO learning relies on hybrid infrastructure and open educational practices to merge online and offline (i.e., physical classrooms) learning spaces together in real-time while simultaneously seamlessly teaching students in both the physical classroom and online (Huang et al., 2021). Different from traditional classroom learning, learner's behavior in the OMO learning can be tracked more easily due to the use of a variety of advanced technology (Xiao, Sun-Lin, & Cheng, 2019). During the post-COVID-19 era in China, various intelligent learning management systems (LMS) (e.g., ClassIn X, Rain Classroom) have been applied to support the OMO learning (Huang et al., 2021). However, there is still a lack of research on learning behavior analysis in Online-Merge-Offline (OMO) learning. Although various proxy variables from recorded log data within a LMS was explored to predicted learners' performance in previous studies (Conijn et al., 2017; Jo & Yoon, 2014), few studies focused on students' learning behavior of reading course announcements and its effect on their learning performance in OMO setting.

In OMO setting, teachers and students are not always located in the same physical classroom space. So, the communication between teachers and students has to been expended online, which makes the teachers' work become more challenge. As an essential components of OMO learning, the course announcements (CA) play an important role in

maintaining the daily communication between teachers and students. By checking and reading the CA, students can clearly know the arrangement of each learning activities, easily find the supplement learning materials after class, and obtain teachers' feedback on their homework at the first time. By checking the log data of students' behavior of reading the CA, teachers can draw their attention to the students who may need more focus in OMO learning. Hence, this study aims to explore students' behavior of reading course announcements and inquire its impact on student academic performance in OMO learning. The result of this study can shed light on the implementation of OMO learning in the post-COVID-19 era.

2. The related work

Prediction of students' performance is one of the important applications of learning analytics (LA). LA refers to techniques that analyze the existing, learner-produced data for assessing academic progress, predicting future performance, giving suggestions, and spotting potential issues (Lan, Chen, & Sung, 2017).

Learners' personal qualities in online learning were confirmed to affect their academic performance. Jo's study found that adult learners' time management strategies manifested by several proxy variables had the potential to predict students' performance (Jo, Kim, & Yoon, 2015). The study of Brooks et al. (2015) explored the impact of interactions between learners and resources on their final performance. Tseng et al. (2016) examined learning outcomes in MOOCs by different types of learners and found that learners who participated in online discussion forum reported a higher rate of passing the course and a better score than those inactive classmates. Dvorak and Jia (2016) found that the regularity of study habits examined by data from logs recorded from online assignments during the first half of the term is a valuable source to predict grades in the course.

Besides, the assessment on students was also confirmed to affect their academic performance. A study found that student academic performance was tailored by disciplinary rules in the timing of assessments by exploiting a data set of weekly performance classifications for first year students in a pre-major advising program (Brown et al., 2016). Douglas et al. (2016) investigated patterns of learners' behavior and performance in a highly technical MOOC engineering course and found that some of the high dropout numbers in advanced MOOCs may be related to learners' performance on course assessment. Obviously, there were more complex factors affecting learners' academic performance in online learning. Learners' behavior shown during online learning influenced their academic performance, where regularity, timeliness, and intensity were just evidences (Dvorak & Jia, 2016).

Above studies mainly explored the potential factors that had impact on the academic performance in online learning environment rather than OMO learning environment. Furthermore, few studies focused on students' behavior in OMO setting, especially their behavior of reading course announcements which is the essential components of OMO learning.

3. Purposes and Objectives

The study was initiated to inquire the impact of learners' behavior of reading course announcements on their academic performance in OMO learning. This study was conducted at comprehensive university in central China during the post-COVID-19 era. The specific objectives of the present study include (1) Describing the students' behavior of reading CA in OMO learning; (2) Examining the impact of students' behavior of reading CA on their academic performance in OMO learning.

4. Methods

4.1. Samples and course schedules

There were totally 175 freshmen participating in this study and took the course named Basics of Computer Science. Among them, 80 students were from liberal arts and 95 from science and engineering. In terms of the gender, 64 are females and 111 are males. The distribution of students' major was show as table 1.

Table 1. The distribution of students' major

Major	Sample	Percent (%)
Visual Communication Design	13	17
Fine Arts	14	19
Environmental Art Design	19	25
Musicology	7	9
Dance	27	36
Industrial Engineering	10	13
Nuclear Engineering	10	13
Energy Engineering	12	16
Mechanical Engineering	63	84
	175	100

Due to the difference of knowledge base, 175 students were divided into two classes according to the discipline. Both the contents and length of the course were slightly different. The course for the liberal arts (CLA) lasted 12 weeks and included three compulsory modules: Microsoft Word, Microsoft Excel and Microsoft PowerPoint. The course for science and engineering (CSE) lasted 16 weeks and included four compulsory modules: Microsoft Word, Microsoft Excel, Microsoft PowerPoint and Microsoft Access. However, excluding Microsoft Access module, the requirements of the other three compulsory modules were the same to both the two classes. Table 2 recapped the course timeline and major activities of the two classes.

Table 2. Course timeline and major activities of the two classes

Time / Activities	W1-W3	W4	W5-W7	W8	W9-W11	W12	W13-W15	W16
Contents	Microsoft Word		Microsoft Excel		Microsoft PowerPoint		Microsoft Access	
CLA	CA	CT	CA	CT	CA	CT	—	—
CSE	CA	CT	CA	CT	CA	CT	CA	CT

Note: W is the abbreviation of week, CA is the abbreviation of completing the assignments; CT is the abbreviation of completing the test.

In each module, the students were required to submit some assignments to the teacher and complete the module test in the special software for exam. The score of the assignments (SH) was record as the daily performance. The score of the module test (SMT) was record as the exam performance. The students' final score of the course was the weighted sum of the two parts.

4.2. Instruments and implementation

The present study has applied the Rain Classroom (https://www.yuketang.cn/), which is an intelligent instructional tool developed by Tsinghua University, to transform the traditional classroom learning to OMO learning in the post-COVID-19 era. The application of the Rain Classroom is based on PowerPoint and WeChat. Teachers can easily carry out live broadcast teaching by using the Rain Classroom. Figure 1 shows the interface of the Rain Classroom on computer. Unlike the ordinary LMS, the Rain Classroom allows the students learning with their smartphones at any time and any place.

Figure 1. The interface of the Rain Classroom on computer

Before the class, the teacher prepared the courseware with the Rain Classroom. During the class, when the teacher starts the software embedded in the PowerPoint, the students who cannot come to the physical classroom can join in the online class through scanning the QR code of the course with their smart phones at any place. After the students joining in the online class, they can attend the class online and keep the same learning pace with their classmates. Outside of the class, teachers can provide the supplemental learning materials and giving some feedback to students' assignments by releasing the CA through the Rain Classroom. The main interface and special interface mentioned above of the Rain Classroom on smartphones were show as Figure 2. Most importantly, all of the students' learning behavior in the Rain Classroom will be tracked and feedback to the teacher.

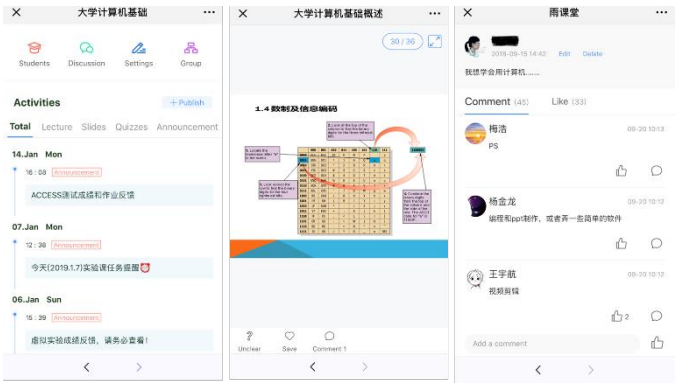

Figure 2. The main interface and special interface of the Rain Classroom on smartphones

4.3. Data collection and analysis

Students' behavior of reading CA was tracked and automatically collected by the Rain Classroom in the present study. As shown in Fig.3, the original data was downloaded and exported as the format of Excel through the Rain Classroom. Data were further compiled and analyzed using the Statistical Package for Social Sciences (SPSS19.0) and Microsoft Excel. Descriptive statistics were used to describe learners' behavior of reading CA. Correlation analysis was used to test the impact of learners' behavior of reading CA on their academic performance.

Figure 3. The interface for downloading and exporting data

5. Findings

5.1. Description of learners' behavior of reading CA

Ten announcements were released during the implementation of CLA through the Rain Classroom. In the same way, 22 announcements were released after the completion of CSE. The announcements were often released on the day before or after the class. As to the contents of the announcements, most of them were about the requirements of the assignments and the feedback to their assignments and module tests. Some of the announcements were about the supplementary learning resources of the course. A small percentage of the announcements were about the temporary arrangement of time and place of the course due to some emergency.

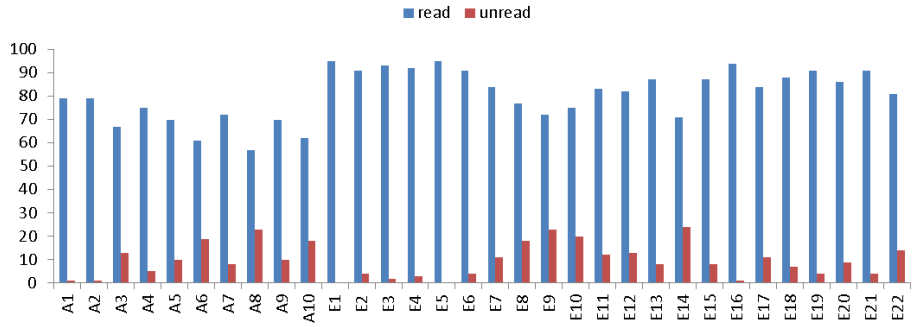

Figure 4. The distribution of the students' behavior of reading CA

As shown in Fig.4, the X axis represented the items of CA, while the Y axis represented the number of students. A1 represented the first announcement released during the implementation of CLA. E1 represented the first announcement released during the implementation of CSE. The blue bar in Fig.4 represented the number of students who read CA, while the red one represented the number of students who didn't read CA.

In Fig.4, it was obvious that most of the students read CA at the first few weeks of the course. In the later stages of the course, a small number of students began to ignore CA. Through individual interview with the students who read CA less than the others, it was found that they preferred obtaining the information of the class from their roommates who had viewed CA rather than viewing it on their WeChat. What's more, several students said they rarely used WeChat in their daily life.

5.2. Profile of learners' behavior of reading CA

The accurate time that every student read each CA was automatically collected and feedback to the teacher in the form of excel documents. The data was further processed with Microsoft Excel. The real time was transformed into the interval. The number of the readers of all the announcements was averaged.

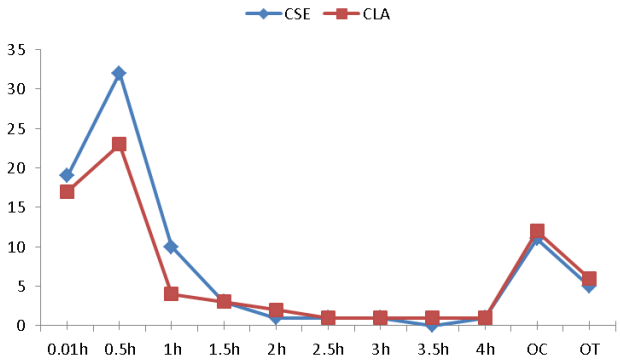

Figure 5. The time interval distribution of the learners' behavior of reading CA

In Fig.5, the X axis represented the time interval of the learners' behavior of reading CA, while the Y axis represented the average number of readers of all the announcements at different time interval. 0.01h represented 0.01 hours (less than one minute) after the announcement was released. 0.5h represented half an hour after the announcement was released. OC represented the time that students were on the class. OT represented the other time that except in the cases of above. The blue line represented the time interval distribution of the learners' behavior of reading CA in CSE, while the red line represented that in CLA.

As shown in Fig.5, it exhibited certain regularity that the time interval distribution of the students' behavior of reading CA. A small number of students read CA in less than one minute after it was released. Half an hour after CA was released, the number of students who read CA arrived at peak. In other words, more than half of the students read CA in half an hour after it was released. In addition, a number of students viewed CA on the class as well as a small number of them read CA on the other time.

5.3. The impact of learners' behavior of reading CA on their performance

Due to more than half of the students could read CA in half an hour after it was released, the time interval that half an hour was used as an important indicator of timeliness of students' reading CA. The more announcements the students read within half an hour after they were released, the stronger their timeliness of reading CA was. After processing the data of the timeliness of students' reading CA, the correlation analysis was carried out between the timeliness of students' reading CA（TCA）and their academic performance, including their score of the assignments (SA) and score of the module test (SMT).

Descriptive statistics of the variables was shown as Table 3. The Correlation analysis was shown as Table 4.

Table 3. Descriptive statistics of the variables

	N	M	SD	Min	Max
TCA	175	8.70	5.12	0.00	20.00
SA	175	90.51	10.70	15.00	100.00
SMT	175	89.26	10.32	27.00	100.00

According to data of Table 3, the number of CA that the students read within half an hour was 8.7 on average. Some students didn't read any announcement within half an hour after it was released. However, some students read 20 announcements within half an hour after they were released. The average of the score of the assignments (SH) and score of the module test (SMT) respectively was 90.51 and 89.26. Some students got full marks while some didn't pass the exam.

Table 4. The Correlation analysis between the TCA and other variables

TCA	SA	SMT

TCA	1	.227**	.150*
SA	-	1	.622**
SMT	-	-	1

**Correlation is significant at .01 level (2-tailed). *Correlation is significant at .05 level (2-tailed).

As shown in Table 4, there was significantly correlation between the timeliness of students' reading CA (TCA) and their score of the assignments (SH). The score of the assignments (SA) was also significantly correlated to the score of the module test (SMT) at .01 level. Besides, TCA showed significantly correlation with the score of the module test (SMT) at .05 level. It was suggested that the students, who had stronger timeliness of reading CA, got higher score of the assignments and the module tests.

6. Discussion

Although the students were able to read CA on their smartphones anytime and anywhere, their behavior of reading CA differed widely. Some students kept reading CA within half an hour after it was released during the whole course. Some students just kept reading at the first few weeks of the course. Moreover, some students ignored more than half of the CA due to seldom use WeChat in their daily life. According to the theory of social psychology, individual behavior manifests his inner attitudes and intentions. In this study, the students' behavior of reading CA just reflected their attitude toward the course.

It was exciting to find that the time interval distribution of the students' behavior of reading CA showed certain regularity. More than half of the students read CA in half an hour after it was released. Another small number of students preferred read CA on the class. This finding was quietly coincident with the investigation of Time in 2012 that a quarter of the nearly 5000 respondents would pay attention to their smart phones every 30 minutes and a fifth of them even pay attention to their smart phones every 10 minutes (Gibbs, 2012). As to those who preferred read CA on the class, they seemed behaved passively toward the course.

There was an extremely significantly correlation between the timeliness of students' reading CA (TCA) and their score of the assignments (SA). In this study, the more announcements the students read within half an hour after they were released, the stronger their timeliness of reading CA was. So, the timeliness in the present study was also able to reflect the regularity of their reading behavior. According to Jo's study, the regularity of learning is a strong indicator for explaining learners' consistent endeavors and awareness of learning (Jo, Kim, & Yoon, 2014). This was appropriately manifested in this study that the greater timeliness of students' reading CA, the more time they would like to spent on modifying their assignments until it was perfect.

There was a significantly correlation between the timeliness of students' reading CA (TCA) and their score of the module test (SMT). This finding was easy to understand based on the previous analysis. The more time the students spend on completing the assignments, the better they grasped the basic knowledge and skills and the better they would perform in the module exams. It was also confirmed in Dvorak's study that students with high grades in the course work on assignments early and more regularly (Dvorak & Jia, 2016).

7. Conclusion and recommendation

The study focused on the students' behavior of reading CA in the OMO learning setting supported by the Rain Classroom. However, not all students paid attention to CA and their behavior of reading CA differed widely. It was exciting to find that the time interval distribution of the students' behavior of reading CA showed certain regularity. In this study, more than half of the students read CA in half an hour after it was released. Besides, it was found by correlation analysis that the timeliness of students' reading CA (TCA) was extremely significant correlated with their score of the

assignments (SA). Meanwhile, There was a significantly correlation between the timeliness of students' reading CA (TCA) and their score of the module test (SMT).

Based on above findings, some implications were provided for teachers to implement OMO learning in the post-COVID-19 era. Firstly, the timeliness of students' reading CA was recommended as an important indicator to judge the students' attitude toward the course and predict their academic performance in OMO learning. Secondly, teachers need pay more attention to those who often ignored the CA or read CA at a long time interval, which can effectively prevent the student at risk to left behind. Finally, teachers should choose the right time to release CA to ensure the majority of students can read it at the first time.

In addition, the findings of this study should be considered with respect to several limitations. First, given the specific context of this study that carried out in one university in China, caution should be exerted in drawing general conclusions considering the cultural differences. Besides, the study just focused on the students' behavior of reading CA and explored its impact on their academic performance in OMO learning with simple statistical method. In future study, more factors and more technologies and methods needed to be considered to analyze the students' behavior and its impact on their academic performance in OMO learning.

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Integrating gamification into future educational leadership education:

A case of cognitive apprenticeship for inexperienced learners

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Abstract: *Adopting a "cognitive apprenticeship" (CA) approach to instruction (Lave & Wenger 1991; Collins & Kapur, 2014), a strategy game 'SimSchool' is developed to create situated learning for both undergraduates and postgraduates to act like school leaders to select colleagues and apply strategies in decision-making and problem-solving. The CA approach addresses the challenge of providing a simulated, situated school environment for many students lacking or have little teaching and school working experience. Players/learners have to apply knowledge in the courses in playing the game, while the simulation "coaches" them through feedback, hints, and scaffolding during gameplay. The new simulation game is designed to integrate motivational gamification elements to enhance players' user and learning experiences. The system requirements and gamification algorithm in a cognitive apprenticeship framework are discussed to highlight the unique functions of the three main components of the game.*

Keywords: educational leadership education, gamification, situated learning, system requirement, algorithm

1. Introduction

This paper provides descriptions of the ongoing development and implementation of an online module involving a web-based game to promote understanding in school governance and school organisation. Students have to integrate and apply knowledge learned in the courses offered by an educational leadership department at a university in Hong Kong. The learning process with gamification elements is designed to motivate students to explore different combinations of strategies to tackle problems and challenges in schools. These combinations of strategies are grounded on research findings found in previous research in educational leadership (Walker & Ko, 2012; Bryant, Ko & Walker, 2018). Learners are thus immersed in several situational contexts resembling what they may encounter in authentic school situations.

The developers of a pioneer simulation on teaching organisational change in higher education Making Change HappenTM (Showanasai, Lu & Hallinger, 2013) reported that management courses integrating simulation-based learning significantly higher student ratings on overall perceived instructional effectiveness, action-directed learning, student engagement, quality of assessment and feedback, and instructor effectiveness in Thailand (Lu, Hallinger & Showanasai, 2014). However, this simulation lacks gamification. Therefore, the current game is designed to enhance pedagogical innovativeness, maximise broad applicability in courses at different levels, and ensure sustainability that keeps learners' long-term interests. Upon completing the online module with this game, students are expected to address problem-solving tasks in situational contexts in schools.

2. Application of cognitive apprenticeship in educational leadership education

The ecology of educational leadership education in Hong Kong has changed significantly in the last two decades that poses a challenge for traditional educational leadership education. There is a new demand for providing preservice

teachers knowledge of school governance at the undergraduate level as teacher participation in school leadership and management is much emphasised in the government's school-based management policy (Ko, Cheng & Lee, 2016). Moreover, most postgraduate intakes have shifted from experienced teachers two decades ago to fresh graduates and inexperienced teachers with little and no school administration experience. Traditional educational leadership programmes and pedagogies are often developed assuming the learners are experienced teachers who can understand theories and concepts by reflecting on their experiences and knowledge of school contexts.

Accordingly, a cognitive apprenticeship approach (Collins & Kapur, 2014) provides a theoretical framework to design a game to engage these inexperienced learners with an apprenticeship of learning to handle complex school management tasks that cannot be simulated in a typical university classroom setting. "Cognitive apprenticeship emphasises that knowledge must be used in solving real-world problems" (Collins & Kapur, 2014, p.110). "A serious game is a digital game created to entertain and achieve at least one additional learning goal" (Dörner, Göbel & Effelsberg & Wiemeyer, 2016, p.3). While traditional apprenticeship of school management requires years of experience or practicum to develop the target skills in a real school, a cognitive apprenticeship through a serious game can simulate a situated learning environment (Lave & Wegner, 1991) of school management that bring the cognitive processes required in decision making into the open, where students can observe and practice them, and the instructor can check student practices and accumulate data for learner analytics.

3. Gamification in a serious game simulating school situations

"Gamification refers to a process of enhancing a service with affordances for gameful experiences to support user's overall value creation" (Huotari & Hamari, 2017, p.25). Applying gamification to support learning depends on situational contexts and motivational affordances of a game. A motivational affordance is effective if it can increase the learner/player's enjoyment and engagement. Examples of motivational affordances include points, leaderboards, badges, levels, and feedback (Fischer, Heinz, Schlenker & Follert, 2016). When developing a serious game for a broad range of courses, the developers have to consider what gamification elements, or motivational affordances, can and should be included for a wide range of learners as players, from undergraduates to doctoral students. SimSchool is designed to serve as a "virtual school" that augments teacher-leader preparation by supporting the development of leadership skills before working in real schools or other educational contexts. This serious game immerses the learners in challenges that bother resilient teachers and schools (e.g., classroom management; curriculum innovation) (Day & Gu, 2013; Gu & Day, 2007; 2013) and result in new crises that add complexities to teachers' work (e.g., cyberbullying; COVID).

4. Design Plan of Online Module

The online module was required to adopt a student-centred design. The teacher education university's faculty office developed a proposal template to facilitate course instructors to use a Backward Design model to work out the lesson design (Childre, Sands, & Pope, 2009). The Backward Design model involves three stages: Stage 1 is to identify the desired outcomes. Stage 2 is to determine acceptable levels of evidence (i.e., assessment). The final stage is to design learning activities that will make the desired outcomes happen. The Faculty eLearning team assisted the instructors in refining their initial thoughts into a final plan.

The plan required instructors to enhance the student learning experience, scope out and structure the learning tasks and activities to support students in performing well in the lesson and ultimately achieve the intended learning outcomes. There were two guiding questions:

1) What are the elements of the simulation game that will build up learners' fundamental knowledge/skills?
2) Will the simulation game guide students to develop higher-order skills such as application, analysis,

evaluation, or creation outlined in the course module?

5. Design and Implementation of the Gamification Algorithm

The gamification algorithm was first conceptualised with an architecture, followed by a series of system requirements identifying all the game stakeholders and captures all the user stories. Once the system requirements were written up and captured, the gamification algorithm design was drawn.

5.1. System Requirements

A series of system requirements was written up based on discussions of four developers of a grant on an online module of educational leadership education courses: the first author as an instructor of various educational leadership courses at a leading teacher education university in the Asia Pacific region, the second author as a programmer, a graphic designer specialised in game interface design, and a programmer coordinator experienced in online course development. The proposed game is expected to involve two major stakeholders, an instructor, who would set up the game parameters, and the player who is the student interacting with the game. The instructor asked himself a series of questions regarding the game application:

a) Why and how would the instructor interact with the game application?
b) How and when would the player interact with the game application?

The instructor wrote up the system requirements based on inputs from other developers on these questions. The requirements provided a high-level description of what the application should be doing and why the functionality is needed. Acceptance criteria were included to ensure the application has achieved the defined user requirements. There are three components in the game: The Instructor, the Player, and the System. The Instructor component is a unique component of SimSchool to ensure its applicability and sustainability by allowing an instructor to set and reset the gamification for current and future course content. The Instructor can create and add Strategy, Task, Colleague, and Random Crisis for the Players and view their learning progress as shown in the selected system requirements. The Player component will select a Task or Crisis set for different simulated schools; they can choose their Strategy and Colleague to tackle the Task or the Crisis. To motivate the Players to compete, they can compare their results and ranks with other Players. Lastly, the System component of SimSchool will randomise a Task or a Crisis, generate Strategy specifications and Colleague characteristics, and update Players' scores and records during and after the gameplay.

5.2. Gamification Algorithm and Cognitive Apprenticeship

The proposed gamification algorithm is unique in several areas compared to other algorithms. First, in addition to the scenarios and tasks specified in the existing database or a system process, a GameMaster(or leader) can set up new ones. Such an addition allows the GameMaster to tailor the game to students' abilities by creating different situations and tasks for them to respond to, thus providing a unique experience for each player. Second, the gamification algorithm ensures the GamesMaster can set the difficulty for each 'level' for the game. Third, the algorithm ensures that gameplay would also be challenging for the player and ensure they have sufficient skills. Finally, the randomisation of the gamification elements ensures the player would have to respond adaptively. Therefore, the Players cannot rely on memory or exploit specific game mechanics to complete the level.

A player develops his/her skill in the game like a school management apprentice advances skills in school management. Once the player has completed all the TASKs set by the GameMaster, the gamification algorithm would calculate the overall 'Effect' points. If the player has accumulated sufficient 'Effect' points, they would be allowed to proceed to the next level and play the game with or complex scenarios set by the GameMaster. However, if the player

has not accumulated enough points, the algorithm will not allow the user to proceed to the next level. Instead, they would be present with the different failed tasks or crises in a 'Progress' report, which allows them to look at areas to improve on before going to the level.

To ensure the apprenticeship reflects in the gameplay, we designed the algorithm such that the GamesMaster can set up the game with the different tasks and situations for the student to interact. In this setup, the gamification algorithm would generate a series of tasks and crises for the student. In a typical game, the student will need to earn 'Effect' points based on their interactions with the game environment. Thus, a Player is an apprentice in both the gameplay and conceptual knowledge of school management strategies. Still, the more s/he applies what they learn in the classroom about school management, they learn how to select strategies and staff to tackle different tasks at different school levels. Successful completion of a task will reinforce the Player in choosing the specific effective strategy and develops a rich web of memorable associations between them and the simulated problem-solving contexts.

6. Conclusion

We have introduced the rationale and design of a new serious game to support educational leader preparation. We adopted a cognitive apprenticeship framework to address how we need to coach students who lack the understanding of school contexts as their predecessors through situated learning outside the classroom. The simulation allows the learners to apply concepts, knowledge, and theories learned in the lectures to select strategies and colleagues to tackle simulated tasks and crises. The gamification is also expected to provide fun and cognitive appeals to the new generations with digital games. Researchers and teacher educators can benefit from the derived data and learner analytics to improve the game and course content.

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Review of Emotion Recognition Based on Brain-Computer Interface in Educational Research

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Abstract: *This review analyzed the educational researches on emotion recognition based on Brain Computer Interface. The researches conducted experiments with four types of purpose: theorical purpose, strategic purpose, purpose and relational purposes; Emotion recognition involves emotion synthesis, emotion detection, emotion classification and emotion feedback; Most of the papers have discussed the findings, the limitations and the future studies. BCI devices have a great potential for educational purposes, collecting neurophysiological data, recognizing learners' emotions, and finally improving learning performance.*
Keywords: BCI, Learner's emotion, Emotion recognition, Educational research

1. Introduction

Over the years, strong empirical evidence has emerged, showing that emotion has a significant effect on students' learning performance. (Vezzani, C., Vettori, G., & Pinto, G., 2018) provided participants a preliminary validation of Learning Conception Questionnaire (Liverta, & Marchetti, 2001) which aimed to measure conceptions of learning a holistic way by including belief, academic emotion, and causal attributions. The results show that the conception of learning as negative emotions and anxiety was positively correlated with the conception of learning as external attribution of failure. However, it is not easy to understand accurately human emotions. The study (Vezzani, C., Vettori, G., & Pinto, G., 2018) using a self-report questionnaire assumes a certain level of students' awareness of their emotional experience in learning, but it's uncertain whether students' statements corresponded to coherent actions in learning.

With recent advancements in technology, brain-computer interfaces (BCIs) that can capture human emotions in real time have been developed greatly and can have a potential use in learning and teaching. Brain computer interfaces (BCIs) make use of control signals from neural activities to help human interact with their surroundings, instead of depending on the peripheral nerves and muscles. It measures brain signals, then extracts specific features from these signals, and translate these features into output signals, providing direct communications between the brain and external devices. Mampusti and et al. (2011) have created a model of human emotions, which include boredom, confusion, engagement and frustration, using electroencephalography (EEG) signals. BCI mathematics educational game can help students effectively reduce math anxiety (Verkijika, S. F. and De Wet, L., 2015). There is a novel way in which BCI device can be used for educational purposes.

Although there are literature reviews and analyses on BCI, such as classification algorithms for EEG-based brain-computer interfaces, extracting neurophysiological signals reflecting users' emotional and affective responses to BCI use (Liberati, G., Federici, S., & Pasqualotto, E., 2015), classifying emotion recognition based on EEG BCI system research

(Al-Nafjan, A., Hosny, M., Al-Ohali, Y., & Al-Wabil, A., 2017), and reviewing on PEEGT in educational research (Xu, J., & Zhong, B., 2018), there is no comprehensive review or analysis on emotion recognition based on BCI in educational researches. Thus, the purpose of this article is to conduct a comprehensive review of emotion recognition via BCI in education.

2. Background

2.1. Brain-Computer Interfaces (BCIs) in Education

A Brain-Computer Interface (BCI) is a communication system where people send messages or commands to the external world in real time, without relying on the brain's normal output pathways of peripheral nerves and muscles which like extraocular muscles or facial muscles. It enables users to communicate and interact with their surroundings by supporting goal-directed thinking and cognitive function (Liberati, Federici, & Pasqualotto, 2015). Brain-Computer Interfaces (BCIs) have gained interested because of the real-time interaction between the human brain and the machine, within Computer Science, Medical Science, Behavioral Science, Robotics, Gaming and so on. And also, BCI devices have a great potential for educational purposes, deciphering learners' cognitive states, helping them communicate with others, control machines by brain activity and improve their learning performances and acquisitions.

Advances in the development and use of BCI technologies offer different options to users. One of them is eye tracking technique, by which, the process of learner's visual observation of learning contents can be understood (Molina, Navarro, Ortega, & Lacruz, 2018). And electromyography (EMG) is used to help learners control direct their own muscles and promote the training of their motor skills (Carter, & Russell, 1985). Besides, magnetoencephalography (MEG), positron emission tomography (PET), functional magnetic resonance imaging (fMRI), optical imaging and more invasive electrophysiological methods are examples to support education by integrating learners' brain activity. However, such technology like MEG, PET, fMRI and so on are usually technically demanding, inconvenient to carry and expensive. Fortunately, electroencephalography (EEG) and related methods recently attract more educators and relevant researchers, which require the low-cost, simple operation and portable equipment. At present, the use of portable EEG in educational researches focus mainly on reading context, e-learning, presentation patterns of learning materials, interactive behavior, edutainment, motor skill acquisition and promoting learning performance (Xu, & Zhong, 2018).

In the existing relevant researches, the application of BCI into education mostly concerns about the following three aspects: learning material and context, learning behavior and activity, learning performance and acquisition. First, learners' cognitive load levels, attention degrees as well as emotional states can be assessed by means of BCI devices when they are reading, studying online or in the exams (Ray, & Chakrabarti, 2016; Liu, Huang, Liu, Chien, Lai, & Huang, 2015). Second, various activities are carried out in the such interaction like teacher-student interaction and learner-machine interaction (Huang, Liu, Lai, & Liu, 2017; Verkijika, & De Wet, 2015). But few studies focus on the interactive behaviors and activities during peer learning. Third, in terms of the relationship between BCI and learning performance, Alemdag and Cagiltay (2018) who reviewed 58 studies related eye tracking research on multimedia learning explain that learner's visual search efficiency and attention to relevant pictures is positively or mostly positively associated with learning performance.

2.2. Researches on Learner's Emotion

To date, there seems to be a consensus that emotion or affect plays a vital role in the cognitive processes of human. Jung, Wranke and et al. (2014) proved that emotions result in the reduction of one's logical reasoning performance. Naismith and Lajoie (2018) considered emotion as one of the factors which make learners' attention to computer-based

feedback. And Tyng, Amin, Saad and Malik (2017) summarized the current studies on the impact of emotion on learning and memory. Furthermore, although the interest in the relationships between learners' emotion and learning is growing, emotional impacts on learning remain controversial. Previous empirical studies have found that positive emotions (like enjoyment) can enhance learning and cognitive process, while negative emotions (like anxiety) have an adverse effect on learning (e. g. Sabourin, & Lester, 2013). However, Chung, Cheon and Lee (2015) suggest that arousing positive emotion and negative emotion are both beneficial to learning. Thus, the questions of learners' emotion in education are complex.

Emotion can consist of two dimensions, valence (positive or negative) and arousal level (calm or arousing) (Chung, Cheon, & Lee,2015; Obergrisser, & Stoeger, 2016). Based on that, various models of affect or emotion were built. For example, in Russell's circumplex model of affect, the x-axis measures emotional valence and the y-axis measures the arousal level. The model focuses on subjective experiences in different valences and at different arousal levels. And by means of Self-Assessment Manikin Model (SAM model), people's affective reaction (like attention and active thinking) to stimuli can be measured directly. According to these theoretical basises, Shen, Callaghan, et al. (2008) followed Russell's circumplex model of affect and Kort's learning spiral model and developed an affective e-learning model, in order to explore learners' emotional evolution. Li, Zhao, Liu and et al. (2010) collected EEG signals and used the SAM model to classify learners' emotional state and analyze their attention. Nevertheless, learners' emotion is so complex that two dimensions cannot measure and recognize emotion accurately. This review will explore in relevant educational what emotions are concerned researches and what prototypes are used.

By emotion recognition, researchers and educators can utilize various tools or technologies to detect and classify learners' emotional states, and then get feedback to optimize learning behavior and cognitive process. Moreover, computers or machines also have a chance of imitating emotional expressions by recognition to communicate with learners. Since the study of Terfloth and Rackensperger (1975) proving the efficacy of training emotional behavior in groups, three approaches have been used to recognize emotions (Tyng, Amin, Saad, & Malik, 2017) in educational contexts: (1) subjective approaches, (2) behavioral investigations of facial, vocal and gestural expressions, and (3) objective approaches through neurophysiological signals (e.g. brain wave, heart rate, skin temperature, blood volume pulses, eye movements, et al.) (e.g. Oh, Kim, & Park, 2019; Choi-Koh, & Ryoo, 2019 ; Azevedo, & Gašević, 2019). The accuracy and comprehensiveness of emotion remain questionable regardless of the increase focuses and technological advancement on emotion recognition. One of the solutions is experimenting with the fusion of multimodal techniques, and so do many researchers have done (e. g. Ray, & Chakrabarti, 2016; Choi-Koh, & Ryoo, 2019). All in all, this review mainly pays attention to emotion recognition based on the third approach above in educational researches.

2.3. Researches on Leaners' Emotion Recognition Based on BCI

Learning emotions are intricately intertwined with brain functions. When people are learning, their emotional responses involve some changes or activities in the autonomic system regulated partly by cerebral system (Patrão, Pedro, & Menezes, 2016). For instance, if a student is anxious during an examination, he or she will sweat, accompanied by the increase in heart rate, cutaneous blood flow and changes in the specific areas of the cerebral cortex. To date, such changes have been visualized directly or indirectly by brain-computer interfaces. These techniques have the following characteristics in recognizing learner emotions.

First, since emotions are regarded as continuous states, the continuous observation by BCIs is a substantial step to recognize learner's emotion (Liu, & et al., 2015). Second, learner's physiological data can be recorded in real time by some efficient algorithm. On one hand, the real-time measurement of physiological data is useful in recognizing learner's emotion (Verkijika, & et al., 2015). On the other hand, some invisible brain states like emotions during learning process can be made visible in real time utilizing the neurofeedback of BCI (Antle, Chesick, & Mclaren, 2018). Third, to our best

knowledge, emotion recognition of BCIs is more accurate and more objective than other approaches. The physiological responses from BCIs are straightly related to the expression of learners' bodily changes, primitively and reactively (Vieira, & da Silva, 2017). Thus, emotion recognition based on BCIs helps to identify the learner's intention instead of ambiguous interpretation by verbal utterance (Prendinger, & Ishizuka, 2005).

3. Research purpose

The great potential of BCI in education and technological advancements provide possibility to recognize learner's emotion in many educational contexts. Accordingly, the purpose of this review was to explore the applications of BCI into educational emotion recognition based on the comprehensive analysis of existing empirical studies. Specifically, this review will address the following research questions.

1. What are the purposes of emotion recognition by BCI in educational researches?
2. How are BCI used to recognize learners' emotions in relevant educational researches?

4. Methods

4.1. Eligibility Criterias

To be included in this review, the following eligibility criteria had to be considered:

1. Articles must be published in peer-reviewed journals in English.
2. The focuses of the articles must be emotion recognition by BCIs in educational contexts.
3. Articles must be empirical research articles

In this review, we have excluded meeting abstracts, book chapters, conference proceedings, workshop descriptions, masters and doctoral dissertations. And those did not focus on learners' emotion or carried out empirical studies without BCI use were also excluded.

4.2. Literature Search Procedure

Two search efforts were engaged in for the purpose of this article. Initially, the information was retrieved Web of Science (WOS) database using the follow search string: (Brain computer interface OR brain machine interface OR EEG OR EOG OR DMG OR ECG OR Skin conductance OR physiological data) AND (emotion OR frustration OR anxiety OR excitement OR affective OR affection OR passion OR sentiment) AND (instruction OR education OR educational OR learning OR learn OR learner OR teaching OR teach OR student) NOT (machine learning OR deep learning OR transfer learning). Then, to increase results consistent with the topic of this review, we searched the reference lists of included researches for referrals to other's primary research (Figure 1).

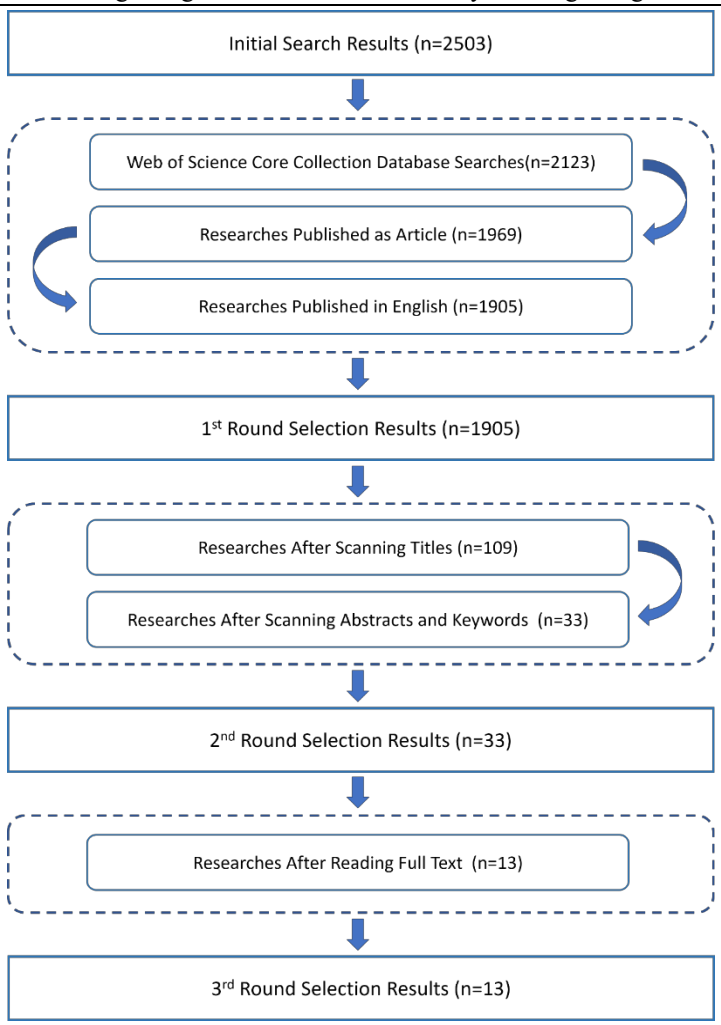

Figure 1. Search Process. n refers to number of papers.

4.3. Study Feature Coding

In order to conduct this review, we developed a study feature coding scheme including a set of categories. During the process of scheme constructing, Liberati, Federici and Pasqualotto (2015) provided substantial insights for our coding. Information was extracted from each study on the following aspects:

1. Basic Information
    a. Title
    b. Publication
    c. Year
2. Research Purposes
    a. Questions
    b. Objectives
3. Emotion Elicitation
    a. Focus(es)
    b. Educational Context
    c. Emotional Prototype
    d. Methods
    e. Orientation (Synthesis/Detection/Classification/Feedback)
4. Subjects
    a. Number
    b. Gender Ratio
    c. Learning Stage(s)
    d. Relationship between Subjects (Group/Individual)
5. Data Collection
    a. BCI Devices
    b. Portability
6. Findings
    a. Data Processing Methods
    b. Results

c. BCI Data Acquisition Technique
d. Single/Multimodality
e. Frequency & Duration
f. Other Peripheral Data

7. Reflection
   a. Research Limitations
   b. Future Studies

5. Results

5.1. Q1 What are the purposes of emotion recognition by BCI in educational researches?

The research purposes of the 13 papers we filtered can be categorized into four types: 1 paper with theorical purpose, 5 papers with strategic purposes, 4 papers with technological purposes and 3 papers with relational purposes (Figure 2).

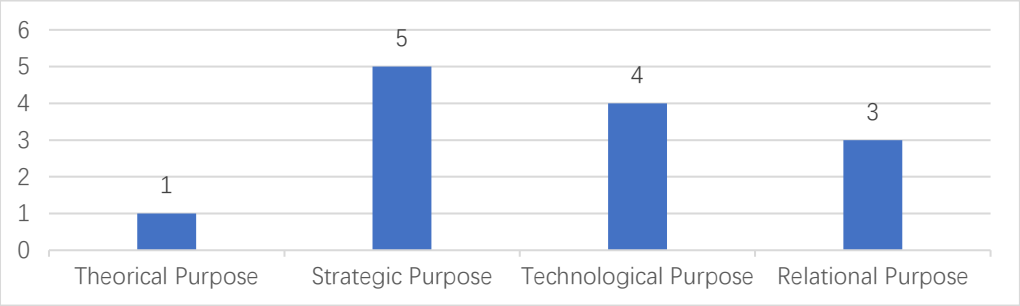

Figure 2. Research Purposes of Papers.

5.1.1. Research with Theorical Purpose

In the papers we have analyzed, there was only one paper focusing on the structure of learner emotion detection for Affective E-Learning System. Ray and Chakrabarti (2016) proposed an affective e-learning model inputting the fusion of learners' facial images and biophysical signals. Their research suggests that e-learning environments can take advantage of bio-physical and expression with efficient classification to explore the learners' emotion evolution.

5.1.2. Research with Strategic Purpose

5 of 13 papers explored the effectiveness of specific instructional strategy during learning process by emotion recognition based on BCI. Some of them focused on the implication of learning activities, while others used positive stimulus to improve learning. Verkijika and et al. (2015) aimed to determine whether BCI mathematics educational game is beneficial to reduce students' math anxiety. And the results showed that math anxiety negatively affected on mathematics performance. Haataja, Malmberg and Järvelä (2018) detected learners' affective states which included emotional states in collaborative learning. But the monitoring of affect occurred the least in this study. In addition, Stiller, Kattner, Gunzenhauser, Schmitz (2018), Lai, Liu, Liu, Huang (2016) and liu, et al. (2015) revealed that students engaged in positive stimulus, such as applause feedback, funny images and reappraisal, can experience more positive emotions and thus achieved better outcomes.

5.1.3. Research with Technological Purpose

In the 4 papers focusing on technological purposes, Prendinger, et al. (2015) evaluated the impact of the Empathic Companion agent which detected learners' emotions by recording Skin Conductance (SC) as well as Electromyography (EMG), and addressed their affective states. The experiment proved that empathic feedback has a positive effect on stress level. The other three papers with technological purposes improved the learning performance by developing learning systems or platforms to recognize and respond to emotional changes (Anolli, & et al., 2005; Santos, Uria-Rivas, Rodriguez-Sanchez, & Boticario, 2016).

5.1.4. Research with Relational Purpose

The relational purpose refers to the focuses on the influence of emotion in learning or the relationships between emotion and neurophysiological states in learning. In the 3 researches with relational purposes, Li and et al. (2012) explored learner's affect based on EEG and combined emotional valence and arousal to classify and analyze learners' affect. Gregersen, Macintyre, & Meza (2014) collected physiological data and other peripheral data to describe and account the patterns of heart rate and self-ratings of anxiety in Spanish language tests. Besides, in terms of skill training, Kinnear, Kelly, Stradling and Thomson (2013) examined the evidence that it's helpful to understand the learning process of drivers appraise on-the-road hazards from the cognitive domain and drivers' emotions and feelings played a critical role in risk appraisal.

5.2. Q2 How are BCI used to recognize learners' emotions in relevant educational researches?

As extracted according to our coding scheme, the information about utilization of BCI to recognize emotion in education can be analyzed from three aspects.

5.2.1. Emotion Recognition

Emotion recognition we mentioned concentrates on some inner states from physiological signals as learners could control their facial, vocal and behavioral expressions (Liu, & et al., 2010). It involves emotion synthesis, emotion detection, emotion classification and emotion feedback. Emotion synthesis can be seen as artificial imitation of emotional expressions physically. But there was no one research taking emotion synthesis as orientation in the 13 specific papers. The learners' emotions are mainly detected to confirm the effectiveness of researches. Few studies focused on emotion classification (Li, & et al., 2012) and emotion feedback (Rodriguez-Sanchez, & et al., 2016; Prendinger, & et al., 2015; Li, & et al., 2012; Ray, & et al., 2016).

5.2.2. Data Capturing

Among the 13 papers, the data captured included Heart Rate (HR), Skin Conductance (SC), Blood Volume Pressure (BVP), Electrodermal Activity (EDA), EEG, EMG, Respiration Rate (RR) and other neurophysiological techniques, and some researches applied more than one technique.

5.2.3. Subjects

The subjects of these studies participated the experiments in different contexts, such as e-learning, the laboratory conditions, testing and so on. The number of subjects ranged from 1 to 129, and only one of the 13 papers monitored emotional states of learners into groups (Haataja, & et al., 2018).

6. Conclusion

This review explored the focus, empirical details and the future work on emotion recognition based on BCI. There is a great potential to apply BCIs in recognizing educational emotions. But higher accuracy of recognition is needed to detect and classify complicated emotions. The prototype of learner's emotion needs to be built. And the emotional states of learners in groups need to be explored.

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Bibliometric and Visualized Analysis of Publications on Video-based Teacher Professional Development Programmes Based on Scopus and VOSviewer

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Abstract: *Video-based professional development (PD) programme is a promising approach that alters pre-service and in-service teachers' practices and enhances students' learning by providing evidence-based training for teachers. However, the trends in the researched video-based PD programmes over time have not been summarized in the existing literature. To fill this gap, this research visualizes the trend of research from the Scopus database through bibliometric analysis using the VOSviewer. A total of 350 articles were used for the analysis and six clusters of keywords were identified. The keywords from publications before 2011, between 2011 and 2015, and between 2016 and 2020 are analysed and visualized through the bibliometric networks (science maps). Three major changes over time are identified, which are the changes in disciplines, the increasing use of classroom discourse analysis, and the emerging focus on teacher noticing. With the bibliometric and visualized analysis, this study maps the landscape of existing research on video-based PD programme and suggests directions for further research.*

Keywords: Video-based professional development programme, bibliometric analysis, visualization, science mapping, teacher education

1. Introduction

The constant reform and development in education call for the need of improving instructional quality, which can be highly influenced by professional development (PD) programmes as teachers are the centre of the transformation (Tekkumru-Kisa & Stein, 2017b). One of the most popular PD programmes for both pre-service and in-service teachers is the observation of classroom practices. The key challenge in observing and analysing a classroom practice lies in the real-time classroom context and its multifaceted components. To address the complexity in the classroom, multiple kinds of artefacts have been used to elicit teachers' thinking, reflection and discussions. Artefacts such as students work, assessment products, lesson plans and lesson videos enable teachers to slow down the pace of teaching by revisiting a lesson multiple times through different lenses (Roth et al., 2011). One of the informative and promising artefacts that can be used for PD programmes is classroom videos.

Authentic classroom videos provide rich evidence of learning and teaching and can be analysed from various perspectives. For example, videos can capture the classroom behaviours that may not be easily noticeable (Vogler et al., 2018), or record the dialogues between teachers and students for productive classroom discourse analysis (Chen et al., 2020; Vogler & Prediger, 2017). However, teachers can hardly learn how to improve their teaching simply by watching classroom videos, while skilful integration in PD programmes can contribute more effectively in this regard (Tekkumru-Kisa & Stein, 2017a; Vogler & Prediger, 2017). In addition, although the design of current PD programmes follows certain rules and rationales, they do sometimes yield disappointing results that suggest a need for effective PD design rationales (Roth et al., 2019). And thus, it is necessary to summarize the existing research on video-based PD programmes and identify the promising keywords.

Bibliometrics allows quantitative evaluation of trends in research over time, which measures the influence of publications in the academic community. First, bibliometrics allows the identification of highly cited papers. A paper with a high citation usually means a significant impact in the field, which is much reviewed by peers and scholars (Xie et al., 2020). Second, co-occurrences of keywords can help identify the relevance of keywords that are similar and based on the same topic through cluster analysis and the network of co-occurring keywords can be visualized by constructing a science map. A science map helps to identify the hot topics as well as the scholar dynamics of the field (Yu et al., 2020). In terms of the tools for visualizing the bibliometric networks or science mapping, VOSviewer is a powerful software using co-citation and coupling of literature to show the connection of research topics and trends in a particular knowledge field (van Eck & Waltman, 2014).

To conclude, video-based PD demonstrates its virtue in altering teachers' practices with a mindful design, but the trends and hotspots in this field need to be further explored. This article aims to present an overall trend of the scientific outputs and published articles on video-based PD through bibliometric lenses. As such, this research is guided by the following research question: What topical issues are researchers concerned with across time, deriving from the keywords of all peer-reviewed articles on video-based PD?

2. Research Methods

This research visualizes the trend of existing research from the Scopus database through bibliometric analysis using VOSviewer. The bibliometric analysis provides data and quantitative guidance for evaluators' decision making on tactical, strategic and policy levels, through using statistical indicators to characterize a large number of scientific articles (Narin et al., 1994). Output and impact are seen as the primary concepts in bibliometrics through publications and citations, which boost our understanding in, but not limited to，keywords interaction and scientific mapping (Hassan et al., 2020). The bibliometric analysis uses descriptive, quantitative correlational methods, semantic techniques and visualization of the results.

2.1. Data source

For the initial search, "video-based professional development" was used as the query to retrieve data from the Scopus database. As suggested by de-Miguel-Molinaa et al. (2015), the search queries need to be reviewed with the preliminary results for refinement. With careful examination of the results returned by the initial search, the following string was searched in the topic (including title, abstract and keywords): (video-based OR videotaped) AND ("professional development" OR "teacher education"). A total of 460 articles were returned under the period of "all years" using the Scopus database. All indexed literature of the year 2020 was also included as the search took place during the fourth quarter of 2020. To further refine the results, the following exclusion criteria were adopted: a) published in languages other than English; b) not a peer-reviewed article; c) studies beyond the teacher PD context. The abstract screening was conducted by two researchers independently and 110 articles were excluded at the screening phase while 350 articles were finally used for bibliometric analysis after the application of the exclusion criteria and manual exclusion. The articles were extracted to a CSV file for posterior visual representation using VOSviewer software.

2.2. Analysis and tools

This study firstly examined the bibliometric data of the selected articles through keyword frequency analysis and co-occurrence analysis. Developed by Van Eck and Waltman (2010), VOSviewer is a popular source for bibliometrics study (e.g., Fernáández Batanero et al., 2019; Hassan et al., 2020; Marín-Marín et al., 2019) which can be downloaded from http://www.vosviewer.com/. The software created the co-occurrence of the keywords that were selected by respective

authors through the bibliographic data. The clustering of co-occurrence keywords helps with exploring the sub-domains labelled by the most frequent keywords (Tseng, 2011). In addition, the most cited articles were listed in the later part.

3. Findings

To present the network of co-occurring keywords, keywords (in the title, abstract and authors' keywords) of all the 350 selected articles were automatically extracted and visualized by VOSviewer 1.6.15 (see Figure 1). Among the total 668 keywords, 53 of them occurred at least 3 times. After removing the duplicated and synonymous words from the 53 most frequently occurring keywords, 25 were finally used for cluster analysis. The cluster analysis provided by VOSviewer grouped words according to their strongest co-occurrence. The weight of each descriptor can be observed with reference to the size of its node, as well as its links with other nodes that show their relationships (Fernáández Batanero et al., 2019). Each cluster was shown in its respective colour and grouped in proximity with each other. The thickness of the link measures the proximity between words, with higher link strength indicating closer proximity of the words (van Eck & Waltman, 2010). The homogeneity analysis and the thematic clusters helped to generate 6 clusters, which are analysed as follows:

Cluster 1: related to the methods of video-based PD programme research. This cluster grouped 6 items, with the most important ones being: conversation analysis (weight 6), case study (weight 5), and collaboration (weight 5).

Cluster 2: related to the context of video-based PD programmes. This cluster grouped 5 items, with the most important ones being: professional development (weight 22), higher education (weight 2) and teacher training (weight 2).

Cluster 3: related to the features of using videos for PD in the mathematics subject. This cluster grouped 4 items, including: teacher knowledge (weight 13), mathematics teacher education (weight 6), pedagogical content knowledge (weight 5) and noticing (weight 4).

Cluster 4: related to the design of video-based PD programme research. This cluster grouped 4 items with the most important ones being: assessment (weight 5), middle school (weight 5), and experimental design (weight 4).

Cluster 5: related to the subject where video-based PD was adopted. This cluster grouped 3 items, including: teacher learning (weight 18), video analysis (weight 6) and mathematics education (weight 5).

Cluster 6: related to the aims of video-based PD programmes. This cluster grouped 3 items, including: teacher education (weight 21), professional vision (weight 5), and lesson analysis (weight 5).

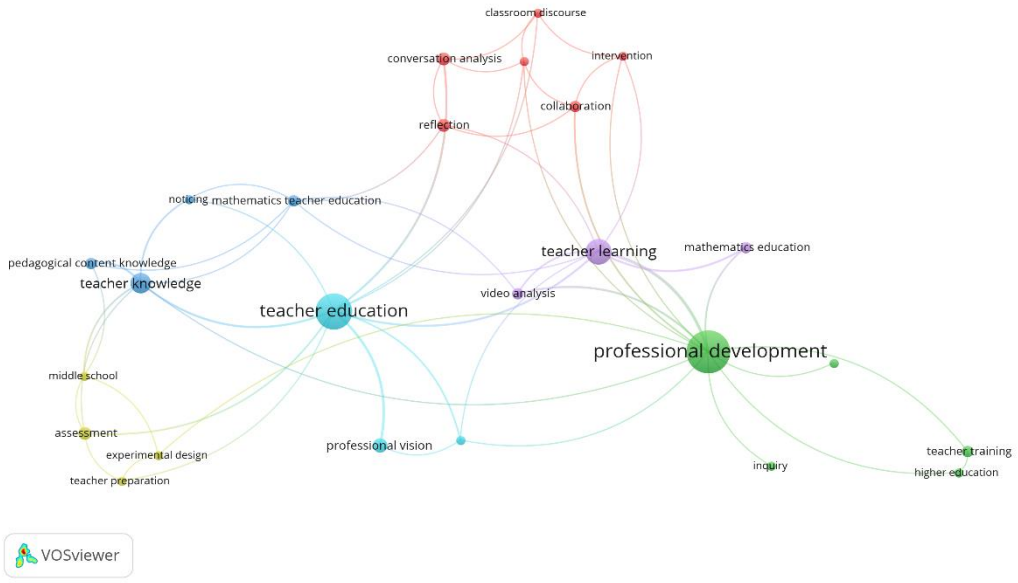
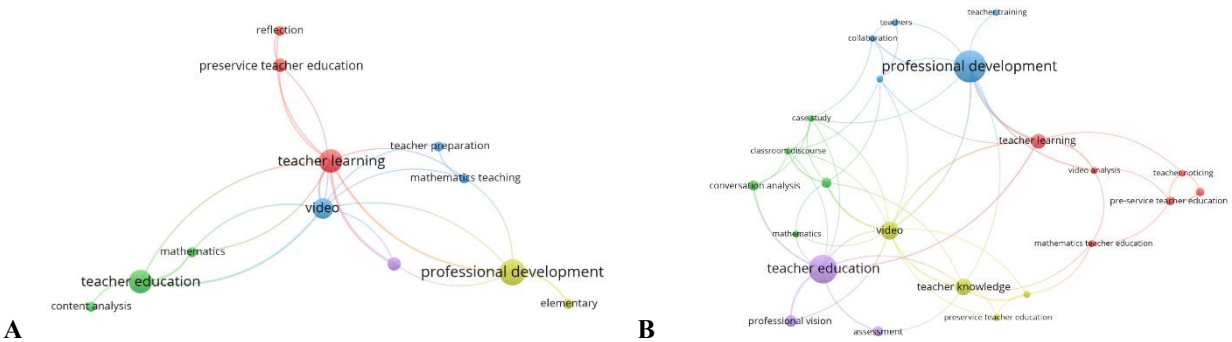


Figure 1. Tagged bibliometric map of 25 keywords (the size of the nodes indicates the weight of the keywords)

In addition, the trend of research on video-based PD is revealed in Figure 2. Three maps of the keyword co-occurrence are used to show the difference between three time periods, namely, before 2010 (83 articles), between 2011-2015 (105 articles) and between 2016-2020 (162 articles). Other than a gradual increase in articles published throughout the years, the maps also reveal the shift of the four clusters as mentioned above. Three core changes can be found. First, as can be seen from the map, the dominant subject employing video-based PD before 2015 was “mathematics”, while “science” and “biology” have been added to the discussion since 2016 and become the new hot spots. Second, regarding the research methodology, classroom discourse and conversation analysis have become heated since 2011 and lasted till 2020. Third, “teacher noticing” has become an emerging research topic in this field since around 2011.



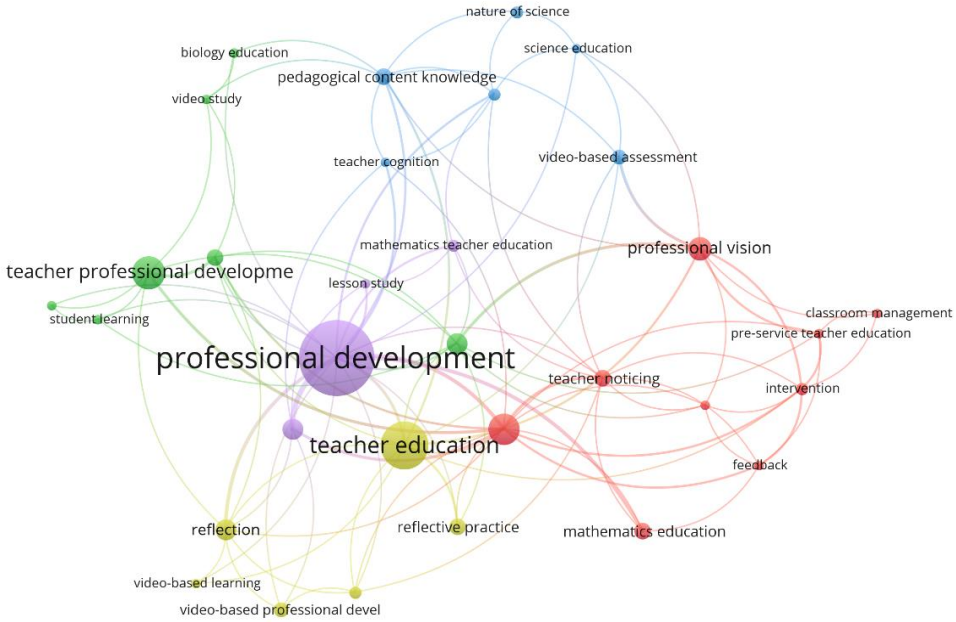


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Figure 2. Overview of research trend revealed by author keywords. Bibliometric map of publications (**A**) before 2010; (**B**) between 2011-2015; (**C**) between 2016-2020.

The number of citations reflects the impact of an article, and the most cited articles from the 350 articles were listed in Table 1, which were also used as the starting point of the literature review. The most cited article among all is by van Es & Sherin (2008) and has been cited 491 times, while the 13th most cited article by Barnhart & van Es (2015) has been cited 108 times. A higher number of citations indicates a stronger influence of the article (Martínez-López et al., 2018). Using the thirteen articles as the starting point of further exploration into the key debate of the field echoes with the two core changes across time mentioned above——the addition of biology and science into the disciplines and the diversification of methodology.

Table 1. List of most cited (more than 100 times) research article with total citations (TC)

Rank	*Reference*	*TC*	*Rank*	*Reference*	*TC*
1st	(van Es & Sherin, 2008)	419	**8th**	(Nilsson, 2008)	149
2nd	(Sherin & van Es, 2009)	364	**9th**	(van Es & Sherin, 2010)	135
3rd	(Star & Strickland, 2008)	296	**10th**	(Voss et al., 2011)	133
4th	(Santagata et al., 2007)	182	**11th**	(Seidel & Stürmer, 2014)	111
5th	(Seidel et al., 2011)	175	**12th**	(Santagata & Angelici, 2010)	110
6th	(Rosaen et al., 2008)	167	**13th**	(Barnhart & van Es, 2015)	108
7th	(Roth et al., 2011)	155			

4. Discussion

The bibliometric analysis revealed that there is a growing trend of studies promoting effective video-based PD, which indicates an increasing level of research, collaboration and funding in this area. This study helps direct researchers to emerging topics for studying and identifying key literature as cornerstones in this field. It gives a bird's-eye view of the research area to save time and bring inspiration for PD programme designers. Three key themes have seen the development over three time periods (before 2011, between 2011 to 2015 and between 2016 to 2020), which are the changes in disciplines, the use of classroom discourse analysis, and the focus on teacher noticing.

First, this study is not an exhaustive review of the existing literature, so that it is worth mentioning that Mathematics and Science dominate the discussion of video-based PD (see Table 2). Video-based teacher PD programme is not popularly used in humanities subjects such as English and Art. The heavy focus on Science and Mathematics subjects also determines the focus of these studies, including subject matter knowledge (e.g., Roth et al., 2011), content knowledge (CK, e.g., Nilsson, 2008), pedagogical content knowledge (PCK, e.g., Santagata et al., 2007), professional vision (e.g., Seidel et al., 2011), and classroom discourse (e.g., Chen et al., 2020). Although using Science and Mathematics seems to be a trend in the field, it should be highlighted that more research in humanities subjects is needed in the area to examine the effectiveness of the video-based PD programmes for teachers in other disciplines.

Table 2. Disciplines of the video-based PD programmes

Disciplines	***Author***
Science	(Barnhart & van Es, 2015; Nilsson, 2008; Rosaen et al., 2008; Roth et al., 2011; Roth et al., 2019; Seidel et al., 2011)
Mathematics	(Borko et al., 2011; Chen et al., 2020; Rowland et al., 2005; Santagata et al., 2007; Santagata & Angelici, 2010; Star & Strickland, 2008; van Es et al., 2014; van Es & Sherin, 2008; Vogler & Prediger, 2017; Voss et al., 2011)
Out of school time programmes	(Akiva et al., 2017)
Not mentioned	(Barnhart & van Es, 2015; Gröschner et al., 2014)

Another substantial hotspot for analysis is the interaction between teachers and students, which is reflected by classroom discourse. Mediated by language use, a major source of input in a classroom is teacher talk and teacher-student dialogues, which highlights the processes and transactions to make meanings of the subject content (Chin, 2006). The widespread interaction pattern between teachers and students is called Initiation-Response-Follow-up (IRF), which is seen as not effective as teachers are too controlling while students are not expanding their ideas (Chen et al., 2020). Video-based PD programmes can improve teachers' instructional language use by giving more precise and effective instructions (Chen et al., 2020; Vogler & Prediger, 2017). To enhance the economy of language, teachers shall adopt productive classroom dialogue elements in lesson plans (Gröschner et al., 2014), which can be further reviewed through videos. The quality of classroom discourse affects students' learning outcomes.

Lastly, through the use of videos, the PD programme has shifted from memory-based to evidence-based. To see the unseen in the classroom, teacher's vision can be enhanced especially through a video-based PD programme. Classroom interactions are usually complex, and videos allow teachers to review the pedagogy from multiple perspectives, and a group of teachers may have different interpretations even for the same video (Steeg, 2016). Teacher noticing is one of the major topics in video-based PD programme research, which is the ability to identify key incidents in a classroom (Star & Strickland, 2008; van Es & Sherin, 2002). In addition, what an individual has noticed may vary, and the reasoning behind is equally important as what they have noticed (van Es & Sherin, 2008). Teacher noticing and knowledge-based reasoning utilize the concrete evidence provided by videos and examine the classroom interaction in further detail.

Although the data used was relatively comprehensive and objective, there are indeed limitations. One limitation is that Scopus may not fully cover all the relevant literature in the field but only those indexed. Moreover, the five-year blocks used to divide the time periods when analysing the trend of research may be too broad. A narrower divide may generate more detailed findings of the analysis. Also, although the most cited literature provides insights on the fundamental rationale for developing a video-based PD programme, the most recent literature was not the emphasis in the analysis. A combination of the latest publication and most cited articles may help to understand the current development of the video-based PD, which can help to update the findings in the future.

5. Conclusion

Through bibliometric analyses, this study first presents the topical issues derived from the keywords of peer-reviewed articles on video-based PD, and then discusses the three emerging topics in video-based PD programme research. Future research may expand the scope from science disciplines to humanities disciplines. Videos have the potential to shift the PD programmes from memory-based to evidence-based and even data-driven through statistical analysis of classroom discourse. The videos shed light on the aspects that are usually unseen by the teachers, for example, revealing students' thinking through analysing teacher-student dialogues or through effective teacher noticing. It is worth considering how the videos can be further converted to quantitative data for learning analytics and educational data mining, which can yield further insights for the development of PD programmes.

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The Transformation of Performing Arts Education in Hong Kong during COVID-19

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Abstract: *Lectures, tutorials, and other face-to-face training sessions are the main components, and online learning is used only as a supplementary pedagogy for the traditional performing arts education in the past. Due to the Covid-19 pandemic, performing arts educators have to change most of their teaching methodologies from face-to-face to online. Synchronous online learning lectures (facilitated by technologies such as Zoom, Cisco Webex, Google Class, Panopto etc.), regular webinars, innovative performance projects, and e-learning are implemented at the Hong Kong Academy for Performing Arts (HKAPA), for student self-regulated learning to engage students in the active learning environment.*
To help educators to locate the key issues and improve the teaching and learning experience in the performance arts education, a questionnaire survey about how COVID-19 pandemic affected the performing arts education, and what are the core issues for the online teaching & learning was taken in July 2020. The survey results from both the teachers (76) and students (163) are analysed in this study. In the survey, teachers and students share lessons, insights, and recommendations on the online teaching and learning. The result of the teaching and learning survey contribute to the scholarship in this understudied field. It also provides guidance for improving the online teaching and learning in performing arts education.

Keywords: performing arts education, COVID-19 pandemic, hybrid learning, synchronous online learning, questionnaire survey

1. Introduction

This document provides descriptions of the fonts, spacing, and related information for the GCCCE2021 paper and Previously, traditional approach in teaching and learning is ritually exercised at The Hong Kong Academy for Performing Arts (HKAPA). HKAPA is a leading tertiary institution in performing arts, ranked no.10 in the world and no.1 in Asia under Performing Arts category, by the QS Ranking in 2021 (*QS World University Rankings* 2021). The Academy offers academic programmes from diploma/foundation to master's degree level in six faculties: School of Chinese Opera (CO); School of Dance (DA); School of Drama (DR); School of Film and Television (FTV); School of Music (MU); School of Theatre and Entertainment Arts (TEA).

In the first half of 2020, the daily lives and performing arts teaching and learning have undergone unexpected changes as the COVID-19 pandemic sweeps across the continents. This situation demands the traditional face-to-face learning pedagogy change to entirely online learning.

The pandemic provides an opportunity for applying the technology in the education, with the pressure and the need for technologies to support learning. Teachers are urged to think of learning first and the technology second.

Understanding how students are motivated to learn, by applying tested frameworks that structure creative and learning processes and employing the best variety of pedagogical practices. Such approach should guide educator to lead 'live' and online teaching equally and efficiently. Another view, the disruption caused by Covid-19 is an opportunity for teachers to transform educators' practice in ways borne out by research, and for institutions to review their curricula in terms of what is taught, when, and through what medium – "doing the things online that make sense online."

To know how online mode helped teachers' teaching and students' learning, and how to further improve the teaching/ learning experience in the Covid-19 pandemic period, a questionnaire survey was conducted with APA faculty and students in July 2020 (the end of the semester). A total 162 students and 76 faculty staff from different schools and departments involved in the survey.

2. Literature Review

In the past decade, the assistant of technology has enhanced academic performance. Ha & Kim (2014) reports the deep learning methodology can improve the satisfactory of involved students. The benefits and challenges in education, integrating Internet of things (IoT) into the curriculum and educational environments are reported by Kassab et al. (2019). Zhou & Li (2019) implement a mobile learning pedagogy in theatre art, with simultaneous and exploratory environment, which provide the flexibility and efficiency environment to experience learning in terms of time and location. However, a lack of well-organised learning management system integrating mobile technology hampering the learning outcome, is reported in Zhou & Li (2019) Though technology conducive to engagement and the playing field in education, access and expertise are intimately linked to socioeconomic status Anderson (2012).

Similar problems are also suggested when implementing technology in creative arts. For instance, a lack of flexibility in relation to navigation and interface, time in developing resources, competency level of tutors (confidence in developing online resources balanced against other flexible open resources) and factors affecting the engagement of 'digital residents' Power & Kannara (2016).

Some performing arts subjects mainly depend on one-on-one teaching basis and real-time interaction. The conduciveness or necessary for blended learning may be limited because of additional burden on time for preparation and work. Ruokonen & Ruismäki (2016), in contrast, indicate that blended learning provides students studying music more opportunities for independent and constructive learning. Pike (2017) explores the potential for using a synchronous online piano teaching internship for music graduate pedagogy interns. Their methodology demonstrates that it is practical to enhance the interaction between students and instructors online by applying innovative pedagogical methods, and the feedback from students become more important in this new method, because the teaching focus from teacher-oriented to student-oriented. Students gain deeper understanding about the teaching content during the process. In short, the use of technology benefits and enhances teaching and learning.

Joseph & Lennox (2021) reports the challenges and opportunities of the online music teaching and practice in Australia. They find the online teaching encourages passive students to engage more personal experiences, foster a sense of connectedness between family and even the extent of the wider community, by reviewing the pre-recorded videos and the Zoom recordings. Meanwhile, they report some disadvantage of this method, e.g., unauthentic learning experience because students do not have the musical instruments at home, the practice cannot be replaced by other media (e.g. watching YouTube videos to mimic the sounds), and lack of action-driven activities reduce students' learning motivation. Gibson (2021) presents a hybrid ethnography: online collaborative musicmaking, teaching and learning pedagogy to overcome the problems caused by COVID-19 pandemic. It provides a content driven discussion instead of performance driven discussion for mentees to make them more active in the discussion sessions. Uninspired by low volume of viewers

in live stream channels, events are not running as smooth as usual due to some technical issues, and tension between real-time sessions and pre-recorded sessions are also mentioned in their work.

Referring to the previous studies, it is highly demanded to locate the core issues to improve the teaching and learning experience in the performance arts education for surmounting the challenges of the COVID-19 pandemic in performing arts education.

3. Research Questions

In this study we investigate how the COVID-19 pandemic has affected the performing arts education, and how we the educators could do better in post-pandemic world? What aspects of the work translate well to online platforms? and which require significant changes, which simply can't be taught online?

We narrowed the focus by formulating the following two research questions:

1. How has being online affected your teaching/ learning?
2. What are the core issues in the online teaching & learning period from the views of teachers and students.

4. Method

In order to explore the answers to the above research questions, we conducted a survey study among the teachers and students in HKAPA.

4.1 Data Collection

4.1.1. Sample and procedure

In July 2020, a survey was conducted with APA faculty and students to examine a) how being online during the temporary closure of the Academy has affected learning and teaching, and b) how the Academy can better support online learning. The goal is to inform how to better prepare for quality and flexible learning in the post-pandemic world. A total 163 students and 76 teaching staff from different schools and departments participated in the survey. (Figure 1) Below are key findings and recommendations.

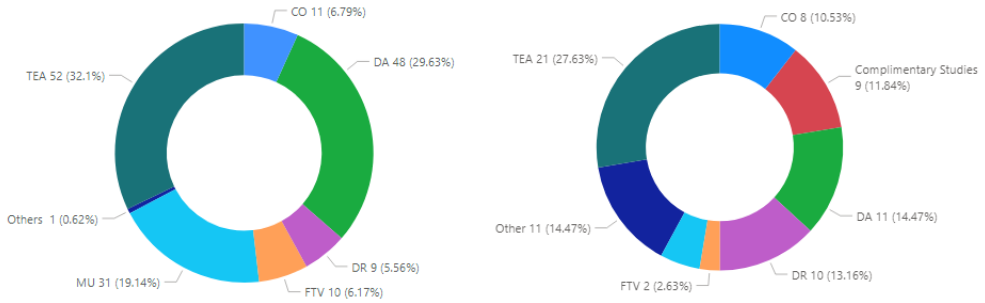

Figure 1. The survey respondents

5. Results and Discussion

For the research question 1, "How has being online affected your teaching/ learning?", following four key themes are emerged from the responses of teachers/ students: 1) Physicality of performing arts education and embodied knowledge are not suitable for online learning; 2) Materiality and studio learning are inappropriate in the online environment; 3) Blended online learning may work or can enhance the learning experience; 4) It takes more time for preparing the online materials and class.

For the research question 2, "What are the core issues in the online teaching & learning period from the views of teachers and students.", Technology, Learning Environment, e-learning Pedagogy are the core issues during the online teaching & learning period, highlighted by both teachers and students from the survey result.

5.1 Technology

The use of various digital devices plays critical roles in the online teaching & learning, with the rapid advancement of information and communication technologies (ICT). ICT (such as Zoom, Cisco Webex, Google Class, Panopto etc.) supports the synchronous online learning for teachers and students. Music teachers are surprised to find their students learning better via online education, regarding the quality of sound, as well reduced recourse to instruments and musicians, necessitated the practice of silent conducting. this way. For example, in order to successfully conduct music in silence, students need to mentally retain detailed knowledge of the score. *"It's a pity that we did not have the chance to put them in front of an orchestra and conduct what they learnt,"* a music teacher says, *"because I felt that they learnt their scores far better than last semester when we were interacting with each other face-to-face."*

Moreover, digital devices, internet access, asynchronous learning platforms are the most concerned factors in the technology area among participants.

Digital devices: 59% of teachers believed that students' lack of computer and mobile access negatively affected their learning, and 52% of students agreed or agreed strongly that they needed better access to devices (Figure 2)

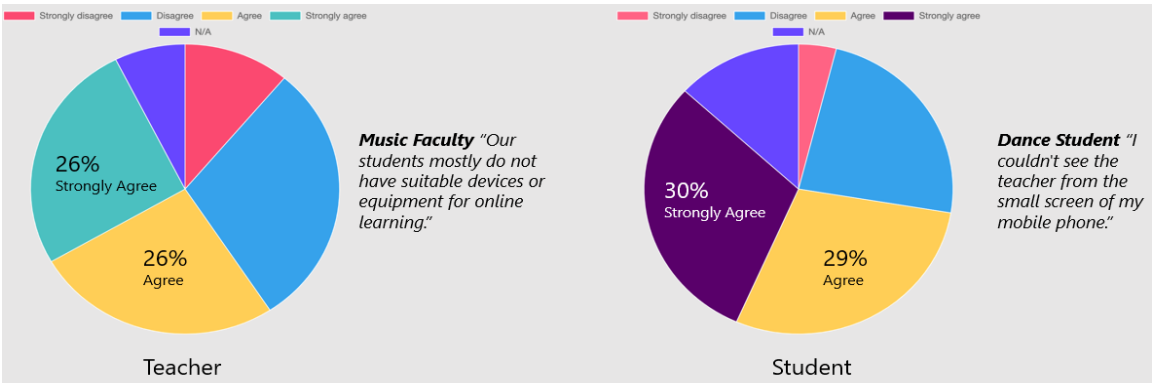

Figure 2. The responses on digital devices

WIFI access: 74% of the teachers believed that students' lack of WIFI access affected learning. Meanwhile, 51% of students believed that their WIFI was too slow for online learning (Figure 3).

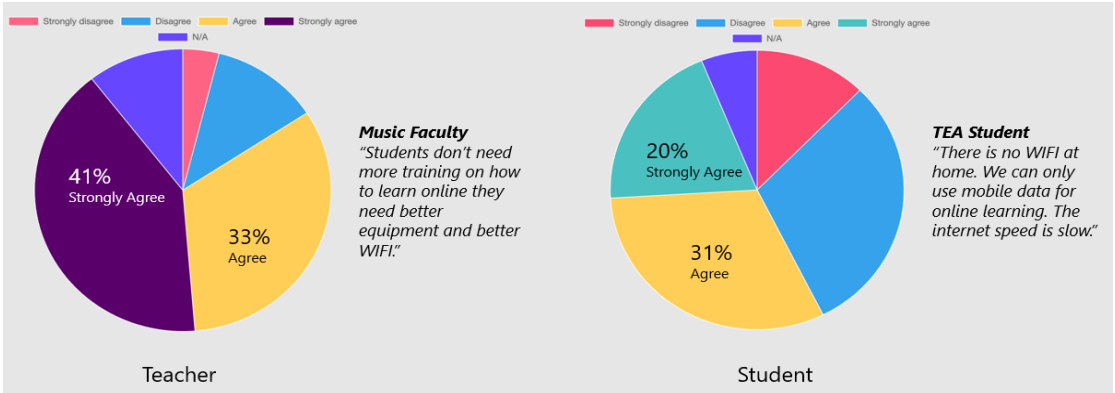

Figure 3. The responses on WIFI access

Asynchronous learning management platform (LMS - Canvas): 51% of students used Canvas or similar 'asynchronous' platforms to access resources. 71% of these users agreed or strongly agreed that resources on Canvas or similar platforms helped them to learn. 46% of faculty used Canvas or a similar 'asynchronous' learning platform for sharing resources. 97% of these users agreed or strongly agreed that the platform helped them to teach (Figure 4).

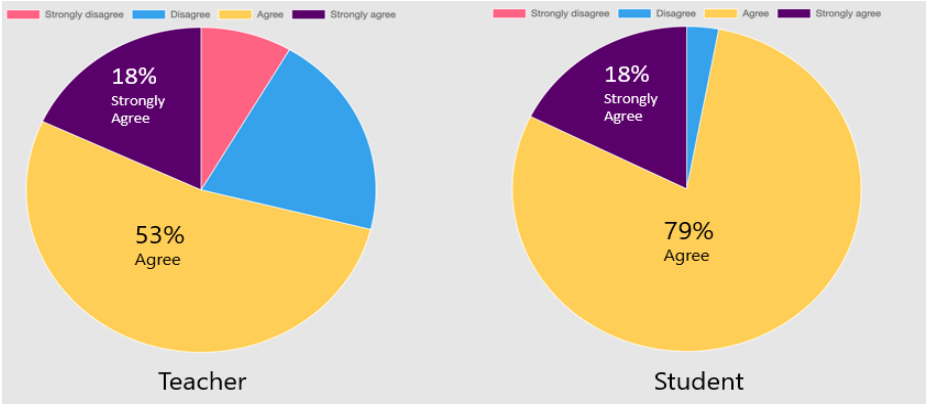

Figure 4. The responses on asynchronous learning management platform

Synchronous learning (Zoom): About 90% of the participants (teacher) have used Zoom or similar tools for teaching. Of them, 86% believed that the tools helped them to teach. Close to 90% of students have used Zoom or similar tools for learning. 57% felt that live lessons helped them to learn (Figure 5).

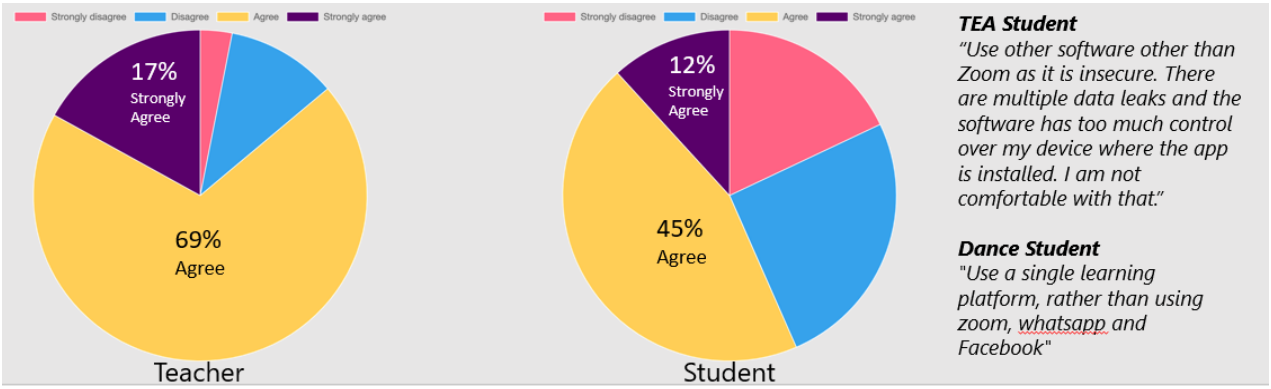

Figure 5. The responses on synchronous learning

5.2 Learning Environment

More than half of the students reported that their home environment was not conducive to make learning effective. One Dance student says: *"It's hard to achieve the quality/feel of the dance. The floor at home is not right. It is difficult to dance. For the foundational training, it's hard to do small jumps or turns."* Or having family in the learning environment, one Drama student says: "*Doing exercise at home made me embarrassed in front of my family members because sometimes they didn't understand what we are doing."*

The loss of access to studios and facilities created similar barriers. One TEA faculty reports: *"Students have no opportunities to put things into practice, so they don't know how to operate practical objects or machines."*

Staff and students recognised several issues transferring practical classes online. For example: Chinese folk-dance pedagogy had to do with teaching through words and physical demonstration. Two things complemented each other. "Physical demonstration" means showing, physical experience, mental and bodily feelings. This part was lost in online learning context; thus, it had a negative effect on teaching.

On the other hand, the performance arts education is different from other traditional subjects. It is not only about theoretical knowledge, but students need to learn via practice. It is evident that online learning approach cannot cover all the related skills and techniques, and therefore, cannot cover the entire curriculum.

5.3 e-Learning Pedagogy

Interaction, class length / schedule, and online resources are the key factors in the e-learning pedagogy from the survey result.

The development of quality interactions in the online class with students is essential. Teachers and students found it is difficult in the online class. Students' reluctance to turn on their cameras is one obstacle and the class size is another barrier. Students would value smaller groupings in online classes. One CO faculty staff reports: "*It is more difficult to observe students' learning attitudes online as some students feel embarrassed to turn on their camera*.", and "*Hard to engage all students when class size is bigger than 10."*

Class length / *schedule* is another key point agreed from both teachers and students. Some comments from the teacher and students are drawn in Figure 6.

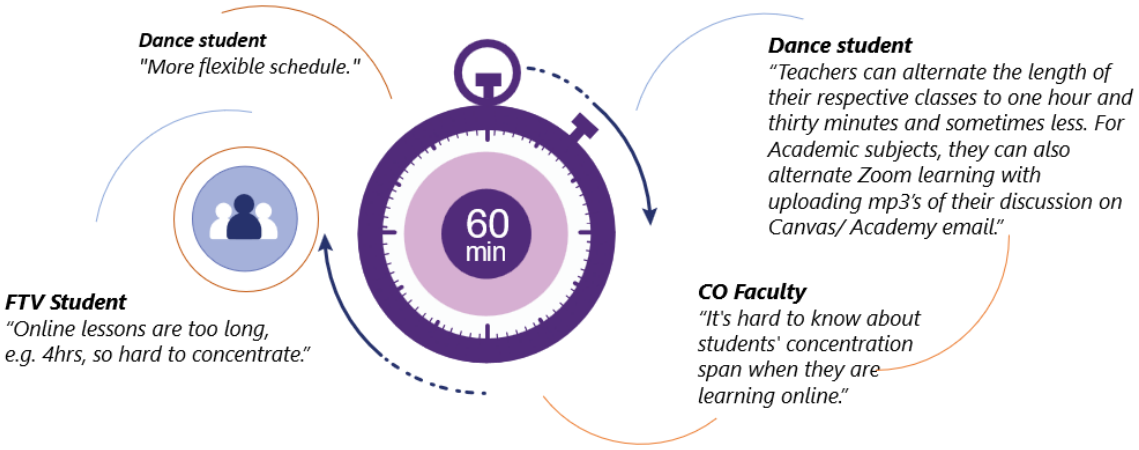

Figure 6. The views on class length

It's worth noting that students are aware of the pre-created online learning resources are useful for their preview the lesson content, and practise after class. However, teachers find making the resources/materials needing extra effort, time, and skills, which they do not have. That includes video/audio editing, to list a few.

5.4 Recommendations

To improve the teaching & learning experience for both students and teachers, following recommendations are summarized for the online teaching and learning.

For student:

1. A loan scheme for computers and technical equipment for students is necessary.
2. Financial support is considered for students, e.g., internet costs, hardware upgrade, etc.
3. Both synchronous learning tool-Zoom and Team are suggested for the online teaching and learning.
4. Curriculum adjustment (careful review on which content is suitable for online education) are highly suggested for students, considering students' home environment of teaching and learning.
5. Smaller groups/teams, and flexible class schedule are suggested in the synchronous online class.

For teacher:

1. Professional training - course (re)design, online pedagogy, appropriate use of asynchronous vs synchronous, blended learning, digital resources, video production.

2. Flexible curriculum delivery – review and adjustment of content is recommended by teachers t a) what can be best taught online vs face-to-face; and b) what can be taught synchronously (live) vs asynchronously (students work on their own time).

3. Faculty brainstorm - meetings/workshops for teachers to share their blended/online learning practice at the School/Academy levels. in particular, for teachers to share what they have learned, what worked, and what did not work.

6. Conclusion

The social distancing measures of Covid-19 demands a revolution of the education model, from the traditional face-to-face teaching pedagogy to a new synchronous online learning approach. With the new approaches applied, performing arts educators are anxious to know how the online affected teaching/ learning during the pandemic period, and What are the core issues in the online teaching & learning period from the views of teachers and students.

Our research demonstrates the questions for the performing arts educators, and locates Technology, Learning Environment, e-learning Pedagogy are the core issues for the online teaching & learning. These challenges are highlighted by both teachers and students. The pandemic enters into different stages around the world and the challenges of online teaching and learning will persist for a while in the foreseeable future. This study aims to provoke thought than to provide answers and it challenges educators to rethink performing arts education and other practice-based subjects.

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