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Virtual reality for developing intercultural communication competence in Mandarin as a Foreign language

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Abstract

Intercultural communicative competence (ICC) is the ability to interact and communicate appropriately with people from different cultures. The lack of ICC among non-native speakers has resulted in misunderstandings during interactions. Although Malaysia is a multicultural country, there has not been much emphasis in developing ICC in the curriculum. Students in higher education institutions have low levels of ICC. This is also true among students taking Mandarin as a Foreign Language (MFL) in Malaysian polytechnics. Virtual reality (VR) can engage students in the cognitive and affective domains. There is a potential for using VR to improve students' ICC, particularly when students are engaged in producing their own immersive VR environments. Hence, a quasi-experimental research was designed to determine whether utilizing and developing VR environments related to Chinese culture could improve the level of ICC among students. The participants were 31 students enrolled in a MFL course at a polytechnic. The findings indicated a significant increase in the measures of ICC after the implementation and was verified from student feedback through surveys and interviews. VR has the potential for improving ICC levels as it could be used to develop positive attitudes towards another culture. Further studies could be done to investigate whether VR could be used to develop ICC and engage other Malaysian students. ICC is important and needed for cross-cultural collaborations and interactions to promote respect and compassion for other cultures in a community.

Keywords Virtual reality · Intercultural communicative competence · Cultural competence · Instructional design · Affective domain

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Introduction

While globalization has contributed to economic growth, it has also produced diversity of thoughts and values as a result of interactions among people from different cultures, could provide different world views which encourage innovation and transformation (Gill, 2016; Kaur et al., 2017). Experts claim that globalization would produce culturally-free trends (Richey et al., 2007), but in Asian countries such as Malaysia, culture and heritage are still valued and deeply ingrained into society. China, one of Malaysia's largest trading partners, has a culturally-rich economy (Syed Jaafar, 2019). For example, differences exist between appropriate Asian and Western protocols for addressing senior management or an older person, conducting business meetings and dinning etiquette. Such protocols are even employed to design office layouts. Hence, cultural competence during communications with the Chinese is an advantage as misunderstandings may arise due to the different beliefs and ideologies which could otherwise be avoided (Gill, 2016). Intercultural communicative competence (ICC), comprising of cognitive, affective and behavioural skills in a target language, is required for effective cross-cultural interactions (Bennett, 2008; Deardorff, 2006b; Krishnasamya et al., 2014; Lustig & Koester, 2006; Perry & Southwell, 2011; Wang, 2011; Zhao, 2016). A person with ICC considers the cultural perspectives of the people of the target language and is sensitive to the differences of the intercultural elements between the cultures.

In Malaysia, Mandarin is used for both international and local trade. As a result, Mandarin as a Foreign Language (MFL) is a popular course among students in higher education institutions as graduates who are proficient in Mandarin are highly sought after by employers. Malaysia has a pluralistic society with 69.1% Malays and 23.2% citizens of Chinese ancestry (Department of Statistics Malaysia, 2018). Ideally Malaysian students should have high ICC with their Chinese peers, but research shows students enrolled in multi-ethnic, multicultural and multilingual public universities have less ethnic-diverse experiences (Tamam & Abdullah, 2012). Even Malay students who had high interest in learning MFL had low levels of ICC, which was likely due to the lack of emphasis and resources on ICC (Chan et al., 2018a, 2018b).

Research on developing intercultural attitudes and ICC with technology in language learning has been limited (Russell et al., 2013; Wang & Ku, 2010). Although digital games (Hoffman & Nadelson, 2010; Wu et al., 2014), virtual worlds (Lan et al., 2018; Wang et al., 2012) and virtual reality (VR) (Wong & Notari, 2018) have been used to engage students in learning a language, there has been little research focused on designing instruction for the affective domain.

Virtual reality (VR) can provide a highly-immersive and interactive environment for users (Makransky & Lilleholt, 2018; Yang et al., 2010). Although the results of the impact of VR on the cognitive learning domain are mixed, results are fairly consistent for the affective domain as students are highly motivated learning with VR (Snelson & Hsu, 2019). As VR has been linked to developing positive attitudes (Avgousti, 2018; Liu et al., 2018; Makransky & Lilleholt, 2018; Munezane, 2019), there is a potential that VR can be used in developing ICC (Tussyadiah et al., 2018). Furthermore, allowing students the opportunity to develop their own VR environments in different cultural contexts could motivate and empower their learning of culture and language (Bricken, 1992; Laurillard, 2012). There is a need for more research on using VR for teaching in the affective domain (Makransky & Lilleholt, 2018; Yeh & Lan, 2018). Therefore, this study seeks to investigate whether MFL learners involved in producing and identifying cultural elements in

their own VR environments, would improve in the cognitive and affective domains of ICC in a MFL course at a polytechnic in Malaysia. To provide context for the research, we will briefly explore the importance of ICC, the use of digital media for teaching ICC and research on VR.

The importance of intercultural communicative competence (ICC) in cultural-linguistic interactions

ICC is the ability to interact effectively and communicate appropriately with people from other cultures (Arasaratnam, 2009; Deardorff, 2006a, 2006b; Krishnasamya et al., 2014; Perry & Southwell, 2011). ICC enables one to interpret cultural differences and behave in a culturally-acceptable manner (Lustig & Koester, 2006; Wang, 2011; Zhao, 2016). A Chinese person usually addresses an unrelated middle-aged lady on the street as "aunty", and yet relationships in Chinese families conforms to a strict hierarchy. Proper etiquette during dining is also important to ensure the longevity of business relationships.

Most foreign language education emphasize intercultural competence (American Council on the Teaching of Foreign Language, 2017; Council of Europe, 2017; The Office of Chinese Language Council International, 2010). This emphasis is for learners to make connections to culture and compare sensitive intercultural elements in the target culture with their own (Chan et al., 2018a). As a result, ICC in language learning focuses on not only developing knowledge but also skills, attitudes and awareness of culture in the language (Deardorff, 2006a, 2006b; Lussier et al., 2007; Vos, 2018). Attitudes and empathy have been identified as the most important components of ICC (Deardorff, 2006b).

In ICC, the cognitive domain is knowledge of cultural products and practices in different socio-cultural contexts (Byram, 1997; Lussier et al., 2007). In Mandarin, knowledge on the forms of introduction, conversation starters, and identification of cultural items (culinary utensils and Chinese cuisine) seem to be required before confidence in using the language is developed (Chan & DeWitt, 2019; Shadiev et al., 2018).

A positive attitude towards the language also includes the readiness to view other cultures with an open mind and showing tolerance and respect towards the cultural practices (Byram et al., 2002; Deardorff, 2006b). Being willing to participate in intercultural exchanges, and acknowledging the customs and beliefs of others is the first step towards peaceful coexistence (Chan & DeWitt, 2019; Byram, 1997; Lussier et al., 2007).

Intercultural skills are language strategies employed in different contexts to interpret behaviors and avoid ethnocentric perspectives which may cause misunderstandings (Deardorff, 2006b; Lussier et al., 2007). In business situations, Chinese people offer a handshake in greeting while Malay culture prohibits contact between different sexes (except for family members). Hence, identifying and interpreting non-verbal behaviours, and negotiating a shared understanding is a skill that requires understanding of cultural rules (Bennett, 2008; Lussier et al., 2007). The skill of discovery and interaction, to identify the significance, connotations, similarities and differences during verbal and non-verbal interactions is needed as it is impossible for the learner to learn all the rules and elements of the culture (Deardorff, 2006b). Therefore, being alert and open in discovering the numerous auspicious signs and taboos in Chinese life and culture during interactions is an important ICC skill (Byram, 1997).

Critical cultural awareness occurs as the learner evaluates another culture during interactions and makes judgement with a degree of rational acceptance (Byram, 1997). Some

Chinese cultural and religious practice may diverge from Muslim Malay beliefs, and providing a safe environment for students to explore and develop cultural awareness and sensitivity, has the potential to provide cross-cultural interactions and help promote general respect and compassion for others in the community.

The domains of ICC are inter-twined and not distinct (Byram, 1997). However, having the context where relationships and situations are made explicit during communication may develop the students' personal characteristics such as tolerance and empathy, and hence, increase ICC level (Hiller & Wozniak, 2009; Perry & Southwell, 2011). The wealth of research indicates the importance of understanding culture when engaging individuals who are from other cultures and speak different languages. Based on this rationale, there is also the need to consider the role of digital media for fostering ICC.

The use of digital media for developing ICC

Studies in designing instruction for ICC are limited. Research on culture has focused on the learners' culture, and less on developing cultural awareness or designing for the affective domain of learning (Munezane, 2019; Russell et al., 2013; Wang & Ku, 2010). When teaching culture, cultural experiences have been provided through readings, simulations and videos (Kohlberg, 1984; Shadiev et al., 2018). Interactions, either in real life or video games (Jenkins et al., 2009; Shadiev et al., 2018; Young, 2009), and stories of real-life incidents (Wang & Ku, 2010) can stimulate interest and develop ICC within developmental niches (Stotz, 2017). Children develop knowledge and skills of their culture within a complex system of interactions among individuals, family members and their community in developmental niches (Wang et al., 2020). Digital media such as VR could provide the developmental niches for these complex interactions within the culture.

Computer interventions (Aslan et al., 2018) and video games (Hoffman & Nadelson, 2010) can instil a positive affect for cultural awareness. Virtual worlds have also been used for improving listening and speaking skills in English as a Foreign Language (EFL) (Lan et al., 2018; Wang et al., 2012) and MFL (Pasfield-Neofitou et al., 2015), and VR have been used for role-playing scenarios for MFL (Wong & Notari, 2018). However, there does not seem to be studies on the development of ICC using digital media.

Positive attitudes can be developed when learners have autonomy in learning and develop their own meaningful content for it to be shared among their peers (Shadiev et al., 2018). Learners developing content in virtual worlds collaboratively while solving problems in EFL, have shown more autonomy and interest in learning (Yeh & Lan, 2018). Hence, a constructionist approach where learners produce their own materials, can engage and empower learners (Laurillard, 2012). The literature indicates that digital media has a variety of positive ICC pedagogical utility but the immersive medium of VR is still an area of only recent growth.

The pedagogical affordances of virtual reality

VR is a computer-generated simulation of an environment with interactivity (Makransky & Lilleholt, 2018; Yang et al., 2010). Real-time reactions and user-motions, detected by devices, head-mounted displays (HMD), body trackers, gloves or touch controllers, results in a perceptual and emotional response to create the illusion of immersion in a virtual environment

(Cummings & Bailenson, 2015; Innocenti, 2017; Tussyadiah et al., 2018). Immersive VR systems can be specialized displays in a cubical CAVE (Cave Automatic Virtual Environment) or HMDs with high fidelity, while less immersive VR is desktop VR (Innocenti, 2017; Makransky & Lilleholt, 2018). While interactions within a CAVE is normally processed with a personal computer and uses tethered devices (HMD and external sensors) to track users' movements, stand-alone untethered devices (a HMD with its own system, or a mobile device in a VR viewer) can offer realistic experiences due to the high fidelity systems which excludes the physical reality (Makransky & Lilleholt, 2018; Tussyadiah et al., 2018).

VR has been used for education where games and simulations have been used to improve learning outcomes (Potkonjak et al., 2016; Shin, 2017). VR has been effective for the cognitive domain and can improve geometric problem solving (Hwang & Hu, 2013; Passig et al., 2016). In contrast, other studies show that using VR did not influence (Merickel, 1992) or had reduced learning outcomes due to the higher cognitive load (Makransky et al., 2017). Hence, research on the effectiveness of VR has been inconclusive.

Despite the inconclusive evidence on learning impact, students definitely enjoy learning with VR (Snelson & Hsu, 2019). VR has helped students develop positive attitudes for learning biology (Shim et al., 2003), especially when students were involved in constructing and viewing their own VR environments (Bricken, 1992). In environmental education, VR has been used for the development of positive attitudes among college students (Liu et al., 2018) and influenced behavioral intentions due to the higher sense of presence, motivation, and immediacy of control (Makransky & Lilleholt, 2018). For intercultural learning, a study where 21 students from China and Uzbekistan were required to undertake an intercultural learning activity supported by VR technology, showed that VR provided the students a sense of presence, immersion and an authentic cultural experience (Shadiev et al., 2020). Another study involving 96 students in Hong Kong, China who engaged with three different cultural VR scenarios, showed that VR enhanced student's intercultural sensitivity (Li et al., 2020). Hence, VR technology has the potential to facilitate the development of ICC.

In VR, semiotic scaffolding is provided by overlaying information on cultural elements in virtual environments and providing developmental niches for interactions with the environment (DeWitt & Sukhoverkhov, 2020, November 29; Hoffmeyer, 2015). VR technology can heighten the sense of presence in a digital environment, and contributes to learning in the affective domain. This is because VR users are engaged with the intercultural experience and motivated to use the technology.

VR provides a much higher level of immersion and immediacy of control than other media, thus enabling greater sense of control and autonomy in learning (Makransky & Lilleholt, 2018; Moreno & Mayer, 2002). The concept of immersion arising from the tracking level, stereoscopy, and field of view enables students to believe in their presence in the environment they are interacting and constructing their knowledge (Cummings & Bailenson, 2015). The students construct knowledge through their interactions in VR using the same knowledge construction processes in the physical world (Winn, 1993). Thus, this study attempts to investigate whether students who design their own immersive VR environments of Chinese culture for viewing could improve their ICC level in MFL.

Methods

This research is a quasi-experimental research with an intact group of students for a period of 3 weeks (Hulbert, 2008; Ross & Morrison, 2004; Shadish et al., 2002). The group was intact as these students were all in an existing MFL class. The students' level of ICC before and after the design activities were recorded and feedback on their learning experience was obtained through a survey and interview of selected volunteers.

Research setting and participants

The higher education institution in this study was a polytechnic offering MFL courses. The volunteers, 22 females and 9 males aged 21–25 years, were mostly Malay with one Indian student, and were enrolled in the fifth semester of diploma programmes for Quantity Surveying and Civil Engineering. Participants were enrolled in the elementary level MFL course but none of them had any linguistic background in Mandarin. However, the participants had some interactions with the local Chinese community, conversing namely in Malay or English.

Instruments

The domains of ICC, measured using the Survey of Students' Intercultural Competence (SSIC) employs a five-point Likert scale (Chan & DeWitt, 2019) (see Appendix 1). The instrument had previously been piloted with a homogenous sample and had high internal consistency with Cronbach Alpha values more than 0.80 (see Table 1).

The students' feedback on their learning experience was obtained using the Survey on Learning Chinese Culture through VR (SLCCVR), comprising of 13 items with a five-point Likert-scale and seven open-ended questions (see Appendix 2). Further, interviews were conducted to obtain rich data on the students' experience.

The production task

The students were provided five 360-degree images related to Chinese culture according to the themes in the MFL curriculum (Chinese home life, dining, traditional medicine, calligraphy, temple scenario, and tea ceremony). Students had to download these images on their personal mobile phone and identify cultural artifacts in the images as they viewed them in VR-mode using VR viewers. Then, working in pairs, the students selected a theme

Table 1 Survey of students' intercultural competence

ICC domains	Number of items	Cronbach alpha
Knowledge	29	0.93
Skills	13	0.84
Attitudes	9	0.90
Awareness	8	0.93

and worked on designing an interactive VR environment using the *Google Tour* application with at least two images. The cultural artifacts in the images had to be tagged and labelled in both *pinyin* and Chinese characters (e.g., Chinese lantern: "*dēnglóng*/灯笼"), with a short description on its use in Chinese culture. The students could research on the artifacts to gather more information.

The students were familiar in using technology as they were from a science background and had no difficulty following the instructions on developing their VR learning environments. Students were provided a VR environment as a benchmark and were tasked with exploring and identifying significant cultural elements to be accurately tagged in *pinyin* and Chinese characters, and described in English. The production task was done in a computer lab. The MFL instructor facilitated and scaffolded the process and conducted weekly progress meetings for continuous improvement. Finally, the interactive VR environment was published and shared among the course participants who downloaded their environments onto their mobile phones and viewed them in the VR mode.

Procedure

Ethics approval and participants' informed consent was obtained before the SSIC was distributed among the students. On completion of the production task, the different VR environments on the Chinese cultural themes were shared and viewed. Then, the SSIC and SLCCVR were conducted. Next, seven females and three male students were selected to ensure equal representation of their age, gender, language background and education, and invited to be interviewed on their experiences.

A comparison of the level of ICC before and after the intervention was done and analysed using t-tests to determine if there were any significant difference while the feedback from the SLCCVR was analysed using percentages. The responses to the open-ended questions and the transcripts of the audio-recorded interviews were open-coded according to the ICC domains (knowledge, skills, attitudes and awareness), the affordances and challenges of the VR technologies, and suggestions for improvement. Next, axial-coding was done and the data was synthesized into emergent themes.

Findings

Data from the survey showed that the VR-based task was the first experience using VR for almost all participants (97%). Most of the participants (54.8%) agreed that VR provided an authentic experience of the real world. Data emerging from the interviews showed that the students were amazed by the experience of using VR: "I was fascinated to learn the details on Chinese culture using this VR technology (S1); VR is great as I am able to see all around me! (S3)."

In investigating levels of ICC in MFL, analysis of data from the SSIC before and after the task indicated an increase in all domains (see Table 2). Firstly, the assumptions of normality were tested using Shapiro–Wilk's test for each ICC domain. The Shapiro–Wilk's test before and after the task were significant ($p > .05$), indicating the scores were normally distributed (Before task: knowledge ($p = .60$), skills ($p = .50$), attitudes ($p = .70$) and awareness ($p = .65$), and after task: knowledge ($p = .57$), skills ($p = .50$), attitudes ($p = .70$) and awareness ($p = .65$).

Table 2 Level of ICC among students based on mean scores before and after the production task

ICC domains	Before task			After task		
	Mean	SD	ICC level	Mean	SD	ICC level
Knowledge	2.07	.46	Low	4.00	.51	High
Skills	2.61	.61	Low	4.34	.38	Very high
Attitudes	3.33	.69	High	4.36	.42	Very high
Awareness	3.21	.77	High	4.36	.44	Very high

SD standard deviation

Knowledge

In the knowledge domain, the increase in scores before ($M = 2.07$, $SD = .46$) and after the task ($M = 4.0$, $SD = .51$) (see Table 2) was significant, $t(31) = -14.5$, $p < .001$ (see Table 3). All the students interviewed noted that they gained knowledge on Chinese culture: "I experienced the customs and culture of the Chinese (S13); felt the situation in a Chinese home (S26)." Students experienced a first-hand view of customs such as tea-drinking and use of traditional medication.

The students admitted gaining knowledge from the immersive experiences using VR: "I gained a lot of knowledge; it was very effective for the users (S23); It gave me a realistic perspective, felt like being in a Chinese house, temple and restaurant, I got to see all the tools and objects in a Chinese house, which I never knew about (S11)." VR allowed them to gain knowledge on different aspects in rich authentic environments by providing cognitive scaffolding and developmental niches to interact in which were related to prayer customs, architecture and significance of paintings in the home: "I got to know about the importance of the koi (fish) painting as the koi signifies prosperity and fame, and I got to see the significance of each fish in the painting (S27)." The use of VR resources for learning was a new experience and enabled the students to learn experientially in a new way. VR allowed the students to personally interact within the culture and when the information was tagged, it highlighted the beliefs and attitudes of the people in the culture.

Table 3 Paired samples t-tests of students' mean scores in the ICC domains before and after the production task

ICC domains	Paired differences					t	df	Sig. (2-tailed)
	Mean	SD	Std. error mean	95% confidence interval of the difference				
				Lower	Upper			
Knowledge	− 1.93	.740	.13	− 2.20	− 1.66	− 14.52	30	.00
Skills	− 1.73	.71	.13	− 1.99	− 1.47	− 13.51	30	.00
Attitudes	− 1.04	.88	.16	− 1.36	− .71	− 6.58	30	.00
Awareness	− 1.13	.98	.17	− 1.49	− .77	− 6.46	30	.00

SD standard deviation

Skills

In the skills domain, the increase in scores before ($M=2.61$, $SD=.61$) and after the task ($M=4.34$, $SD=.38$) (see Table 2) was significant, $t(31)=-13.5$, $p<.001$ (see Table 3). Students used discovery and both verbal and non-verbal interaction skills as they researched information, asked questions among peers and the tutor to identify information which could be tagged in the VR environments they developed. After production, interactions would be within the developmental niches of the VR environment. Students would interact with people in relevant contexts and cognitive scaffolds were provided when users clicked on the interactive tags to discover new information. This process of discovery would have developed their interest. In addition, students were persistent and interested in their research: This engagement with VR was followed by research in the culture: "I did a lot of research online to find the names and information about tools used in Chinese calligraphy (S13)."

The survey indicated all students were interested and none had indicated any negative aspects: "I am more interested in learning Chinese culture (S21)." This participant's comment was attributed to the use of VR and the production activity they did: "VR technologies, followed by the online searches for information on culture, made me more interested to learn Chinese culture (S18)." Hence, the students were developing their ICC skill by discovering new cultural information through their virtual interactions.

In the production activity, the *Google Tours* were successfully tagged with cultural objects in Mandarin (see Fig. 1). These environments were then shared among peers in the class who had the opportunity to experience and discover new cultural environments in VR. This shared learning process was evidenced during the interviews: "I can learn Chinese culture in the VR environments. The *Google Tour Creator* enabled us to share our work and provided us with a lot more information. I explored the Chinese temple, now I know what it's like inside a temple (S8)."

In addition, the students had the ICC skill of interpreting behaviors as they observed Chinese culture and related to their own. One participant elaborated on his experience: "I am
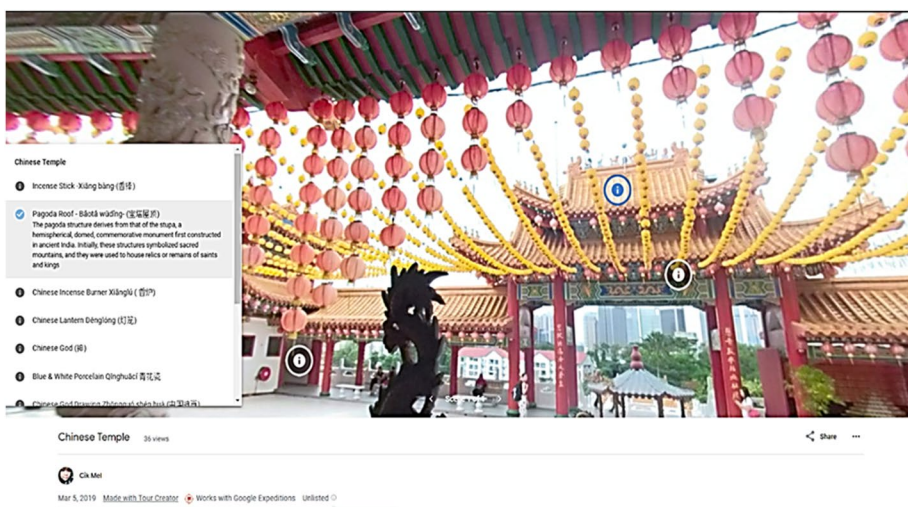

Fig. 1 *Google Tour* of a Chinese temple with tagged objects

more matured in my thinking, I begin to understand their culture, and have less of a negative attitude towards them as I am more aware of their culture (S30)." This participant's comment indicates a better and more tolerant understanding of the culture. The skill of interpreting and relating enables them to have a less ethnocentric perspective, and less bias (Deardorff, 2006b).

Attitudes

In the attitude domain, the increase in scores before ($M=3.33$, $SD=.69$) and after the task ($M=4.36$, $SD=.42$) (see Table 2) was significant, $t(31)=-6.6$, p<.001 (see Table 3). There was a willingness and readiness to learn Chinese culture among students. Students wanted to use VR to learn more on cultural topics related to ceremonial customs (71%), Chinese traditional costumes (48.4%), food and drinks (42%), festivals (35.5%) as well as music and dance (22.6%) from the survey.

The curiosity in exploring different cultures and perspectives with openness is an ICC attitude (Byram, 1997; Byram et al., 2002): "I want to know about the customs related to weddings, taboos, and the upbringing of children which enables them to succeed in life (S6)." A sense of respect and openness to learn from the other culture developed as students were open and appreciative of the customs and understood their cultural values (Byram et al., 2002).

Awareness

In the awareness domain, the increase in scores before ($M=3.23$, $SD=.76$) and after the task ($M=4.36$, $SD=.44$) (see Table 2) was significant, $t(31)=-6.5$, $p<.001$ (see Table 3). Students became more aware of their cultural differences: "I learned the differences between my own (Malay) culture and the Chinese culture (S1)." "From my research on Chinese calligraphy, each character has a meaning and a shape, the way of writing differs from the Islamic Arabic script (S13)." Students' VR experiences brought a cultural awareness which in turn promoted respect and compassion during cross-cultural collaborations and interactions (Byram, 1997).

The students began to evaluate the new culture rationally with a degree of acceptance (Byram, 1997) and began to develop new realizations: "The Chinese race has been around for a long time, and the Chinese seem to value their culture and customs (S20)." These kinds of realizations enabled an understanding of the relation between their culture and the Chinese culture. There was a sense of awe apparent in some of the students' responses: "Each element has its own meaning. There are hidden values in their culture and maintaining harmony is important. I am amazed at the details (S7)." The students also came to new realisations of the implications of the culture on people's lives: "The Chinese seem to stress on the environment and life: The peaceful culture and love of nature (S6)."

VR production task for learning culture

Immersive technologies seemed to be effective for developing ICC even though many students had never used the technology. Immersive experience involving VR allowed and encouraged experiential learning: "VR technologies was a new experience which made me feel like I was at that place (S22); I felt like I was at the actual place, and felt the real world

(S23)." VR enabled the students to improve their cultural understanding: "I am able to understand the culture better using VR (S10)."

Students learnt about culture that they may not have explored otherwise without VR. "I benefited from using VR to explore the Chinese restaurant, house, tea house and herbal shop. I had new experiences which I never knew about through VR (S9)." The realization that there were things they had never known about Chinese culture was obvious in many of the responses: "I improved my knowledge of Chinese culture, getting to know more about a Chinese house, herbal shop and restaurant: all of which I never knew about (S15)." The participants may have responded in this way because of their lack of interaction related to culture with the Chinese community (Fig. 2).

The production task proved to be meaningful for the students. This understanding emerged during the interviews: "The group production work in *Google Tour Creator* helped me improve my understanding of culture and my Mandarin language skills (S5)." The combination of immersive VR and production-based activities improved their ICC.

The high cognitive load in the rich VR environments did not seem to be a problem for the students: "VR is effective for learning. I got to learn more in-depth details about culture, and it captured my interest. It was a new experience using VR (S20)." Instead, the details related to culture in the environment was appreciated.

VR for language learning

Although this study did not focus on VR for mastery of language skills, many respondents mentioned improvement in Mandarin language skills. "Exploring the culture in detail helps me acquire skills in Mandarin to avoid misunderstandings during communication (S12); I learned more vocabulary in Mandarin during my search for information while creating the *Google Tour* (S28)." Students felt that VR should be used more often for learning: "The use of VR needs to be continued: it's very good and positively impacts Mandarin learning

Fig. 2 A VR view inside a Chinese restaurant

(S16)." Some even suggested VR for other subjects: "I totally agree that VR tours should be used in other subjects. It is very open-ended. Other than culture, there are many other things that can be explored using VR tours (S3)." These comments indicate a high level of satisfaction and intention to use VR in future.

Challenges in using VR

VR experiences are highly motivating. Students were actively producing their VR environments. "It was very interesting and I am very excited and enjoy (learning) Chinese culture (S28)." Some students noted a time-saving feature related to travelling when using VR: "VR technologies makes learning more interesting and saves time (S14)."

There were some technological challenges faced by some students in developing the virtual environments. High-speed internet connectivity was required and some students had difficulties outside campus: "When the internet speed is slow, the VR is also slow (S4)." Slow internet caused problems when developing the VR environments and students had to work on their environments while they were on campus where connectivity was better.

The slow internet speed affected the use of the development app. "*Google Tour Creator* takes very long to load and it is sometimes difficult to log-in (S7)." Some of them faced problems while tagging and editing in the application: "There were problems when I 'edit' the description on *Google Tour Creator* (S6)." However, others did not have difficulties: "I did not face any technical problem with the *Google Tour Creator*. It only requires high speed internet access for the VR task. There was clear guidelines and instructions on how to use *Google Tour Creator* for those who were new to it (S31)."

The fidelity of VR environments on mobile devices might have affected participants' experiences (Innocenti, 2017). One participant stated "The view was not clear (S22); The items could not be seen clearly. It was difficult to identify and name items which were far off (S13)." This visibility issue might have been the reason for complaints such as eye-strain and dizziness among some students. Further investigation was warranted to determine possibilities in improving the fidelity for a better experience.

Discussion

In this study, MFL learners in a polytechnic were involved in producing and identifying cultural elements in their own VR environments. Their levels of ICC in the cognitive and affective domains were measured to determine whether there was improvement. The discussion focuses on the VR production task as well as the cognitive and affective domains.

The VR production task

The students were highly motivated in producing and viewing the VR environments. Motivation seems to be a key feature when VR is used in education (Makransky & Lilleholt, 2018; Shim et al., 2003; Snelson & Hsu, 2019). A heightened sense of immersion when students interact within the VR environment is attributed to motivation (Innocenti, 2017; Makransky & Lilleholt, 2018; Tussyadiah et al., 2018). In this study, students used their personal mobile devices with VR viewers, which was sufficient for an immersive

interactive experience in the VR environments (Innocenti, 2017; Tussyadiah et al., 2018). Students who had mobile devices with higher specifications had higher fidelity and experienced a heightened sense of immersion and overall better experience.

The cognitive domain

The production task related to Chinese culture was effective for developing students' ICC as significant increases were recorded for the ICC domains. Cognitively, intercultural knowledge improved as students experienced Chinese customs directly, and had better recall of knowledge. Culture, at most times, is not explicitly stated but experienced in the nuances within the environment. To provide additional cultural context for creating their own VR environments, the students were exposed to Chinese cultural practices via 360-degree videos which they experienced using their VR headsets. These Chinese cultural practices included a tea ceremony, various restaurant and dining experiences, traditional writing or calligraphy, a Buddhist temple, an ancestor worship experience and a traditional medicine shop. These VR experiences gave cultural meaning and context to the environments and created developmental niches to scaffold the students' interactions (DeWitt & Sukhoverkhov, 2020, 29 November; Stotz, 2017). Students would then subsequently use their experiences and interactions to research on cultural artifacts and create their own interactive 360-degree experience. For example, the koi fish is prominently featured in paintings in a Chinese house or temple as it symbolizes good fortune. The 360-degree videos and photos of the house and temple were developmental niches (DeWitt & Sukhoverkhov 2020, 29 November) and provided semiotic scaffolding (Hoffmeyer, 2015) for the learner to enquire more about the fish and discover cultural attributes. Examples of cultural attributes might be the number and colours of the fish which corresponded with wealth and prosperity. Students learn about these cultural attributes, which would prompt the discussion around cultural customs and taboos for gift-giving and inauspicious numbers. The learner with ICC could then sequence the right strategies for communication (Chan & DeWitt, 2019; Lussier et al., 2007).

Skills

Intercultural skills improved significantly as the task provided unique opportunities to discover and interact individually in the VR environment. As students searched for information to interpret cultural elements they were interested in, they related to and tagged these elements in their environments. Hence, designing these environments allowed the students to gain a deeper insight into the culture as they interpreted the cultural rules, such as favourable topics and habits, during communication (Lussier et al., 2007). Hence, as students discovered new things about Chinese culture, they compared and contrasted their cultural observations to their own culture. For example, the differences between Chinese and Islamic calligraphy, or traditional Chinese and Malay herbal medicine were new and surprising to many of the participants. The Chinese Taoist religious practice was very different from the Muslim Malay culture and the use of VR provided an insight so students could relate with their own culture (Byram, 1997; Byram et al., 2002). These cultural encounters might reduce bias towards others' personal culture, which could be a consideration for further investigation.

Attitudes

In terms of attitudes, students became more open towards the culture after exploring and discovering the new customs (Byram et al., 2002; Deardorff, 2006b). Students were interested in ceremonial customs (weddings and funerals), festivals, foods and drinks. This interest was perhaps due to the students' lack of exposure in these areas. However, a positive attitude seemed to be reflected as students wanted to see how the Chinese brought up their children to be hardworking and successful. Students were more respectful, tolerant and willing to participate in intercultural exchanges although there were differences and taboos between their customs (Byram, 1997; Lussier et al., 2007). Students became critically aware that there were differences between Chinese and their own culture (ways of eating, using utensils, perception of auspicious symbols and taboos). Students reflected on their own cultural practices and developed a rational acceptance of other cultures. This cultural awareness could contribute to better communication and enhance future collaboration in business and other areas (Byram, 1997).

Hence, the levels of ICC could be improved when VR was used. As noted by researchers, these domains might not be easily distinguished (Heyward, 2002; Perry & Southwell, 2011). For example, viewing the VR environments on Chinese calligraphy led to students discovering and identifying differences between Chinese and Muslim calligraphy, which contributed to a positive attitude and increased awareness. Further, skills of discovery may enable students to find differences in culture, which could influence their evaluation and awareness of the culture. However, Byram's (1997) framework could still provide viable evidence for ICC among the students (Vos, 2018).

This study on ICC has contributed to the need for more studies in cultural awareness and designing instruction for the affective domain (Russell et al., 2013; Wang & Ku, 2010). The VR videos of the environment provided a diverse cultural experience for developing ICC, similar to traditional video (Kohlberg, 1984; Shadiev et al., 2018). However, the VR videos provided a sense of presence and immersion and an interest in discovering cultural details. Although there were fewer interactions with real people in VR, people were videoed going about their normal tasks in cultural contexts, similar to how videos and video-games were used for learning culture (Jenkins et al., 2009; Shadiev et al., 2018). Interactions were through the interactive tags, which when clicked provided new information to discover, which could contribute to students' learning (Lan et al., 2018; Pasfield-Neofitou et al., 2015). In addition, interaction with the tagged information provided the vocabulary in Chinese script and *pinyin*, and more information about the cultural elements, which was not normally available in other media (Pasfield-Neofitou et al., 2015). Further, these authentic cultural contexts in Chinese culture were made meaningful as the student could relate it to the experience in the VR environment (Wang & Ku, 2010). Hence, VR was a useful resource for capturing authentic stories for evoking students' interest and positive emotions.

The production task provided more context-relevant immersion and visualization to encourage communication and might have provided for the positive emotions (Wu et al., 2014). Processes such as task-orientation and socialization can develop positive emotions (Hoffman & Nadelson, 2010). Students had autonomy as they could decide the cultural elements to explore. Production-based strategies made it meaningful as students developed VR environments for their peers to use (Shadiev et al., 2018). As students gathered information on cultural elements in English, and then translated to Mandarin, they were supported with online translations and could call on their facilitators for assistance (Yeh & Lan, 2018). During this process, the students could improve their vocabulary and reading (Wang et al., 2012). A production-based strategy could be used for developing VR and is highly motivating. This strategy engages and empowers students making them self-regulators of their learning (Laurillard, 2012).

Conclusion

This empirical study investigated whether MFL learners had improved their cognitive and affective domains of ICC through producing and identifying cultural elements in their own VR environments in a MFL course at a polytechnic in Malaysia. Our findings indicate that there was a significant improvement in ICC in the cognitive and affective domains of learning MFL as students' skills and attitudes had improved after producing VR environments about Chinese culture. Hence, students' production-based activities in VR could be used for developing positive attitudes and emotions when learning subjects such as foreign languages.

Although there were challenges in implementation such as lack of internet connectivity in the rural areas, the lack of fidelity of the devices, and the high cognitive loads in the VR environments, most students were able to overcome such issues (Makransky et al., 2017). Instead, most students appreciated the details in the VR environment which might be attributed to the visually rich learning environments. In this environment, students had the opportunity to create their own digital media with highly interactive elements in VR which increased students' motivation and engagement with the cultural content. Future studies could investigate the effects of the fidelity of the devices and interactivity in different content areas. Further empirical studies could also investigate whether there is a relationship between ICC levels and language achievement. Hence, more studies could be done in different cultural contexts to determine whether immersive VR (IVR) could be used to develop ICC for different languages.

There are several limitations in the study. The increase in ICC levels and other emotions could be due to the novelty of using VR for the first time. The students were also volunteers and hence, could have been more motivated to succeed. Further, in a highly multi-cultural country like Malaysia, the students would already have some knowledge of Chinese cultural beliefs which could be stereotypes of Chinese culture which may have influenced their perceptions. In addition, the 360-degree videos and photos used avoided depicting any culturally unacceptable or disturbing images, which might have contributed to positive reactions. Thus, rigorous investigations using VR for the affective domain should be extended to participants in different cultural settings and contexts, with different pedagogical strategies to determine the effectiveness of using IVR. Students could be presented with different cultural scenarios to challenge their fundamental beliefs and investigate their reactions. Positive emotions are important for avoiding conflicts during intercultural communications in a pluralistic society when people of different cultures live together. Hence, providing for immersive experiences in a safe environment where students can explore and develop an awareness of other cultures could improve cultural understanding and promote more harmonious relationships between people of different cultures.

Appendix 1

Survey of students' intercultural competence (SSIC)

Background

1   Gender

☐ Male   ☐ Female

2.   Age

☐ below 21   ☐ 21-25   ☐ above 25

3   Nationality

☐ Malaysian   ☐ Others _____

4   Race

☐ Malay   ☐ Chinese   ☐ Indian   ☐ Others:_____

5   Your present study programme is

☐ Diploma in _____

☐ Degree in _____

☐ Others _____

6   Your first language is

☐ Malay   ☐ English   ☐ Tamil   ☐ Others _____

7   Your second language is

☐ Malay   ☐ English   ☐ Tamil   ☐ Others _____

8   How long have you been studied Mandarin?

☐ Never   ☐ < 1 year   ☐ 1- 6 years   ☐ > 6 years

ICC knowledge

Please select the response that most accurately describes you for each statement and circle the appropriate number on the scale.

	Statement					
A1	I know the layout of a typical Chinese house in Malaysia	1	2	3	4	5
A2	I know the general furnishing choices among Chinese for their living hall, such as furniture and worship setting	1	2	3	4	5
A3	I know the general furnishing choices among Chinese for their dining hall such as furniture and tableware	1	2	3	4	5
A4	I can name some common Chinese traditional collections in Chinese homes	1	2	3	4	5
A5	I can describe the Chinese life styles from the setting of their house	1	2	3	4	5
A6	I know the setting of the dinner table at a Chinese restaurant	1	2	3	4	5
A7	I can name Chinese cutlery (tableware) used in a Chinese restaurant	1	2	3	4	5
A8	I know the common interior decorations in Chinese restaurants	1	2	3	4	5
A9	I know basic Chinese table manners	1	2	3	4	5
A10	I can name a few common Chinese cuisine which is served in a Chinese restaurant	1	2	3	4	5
A11	I am familiar with the display at a Chinese herbal medicine shop	1	2	3	4	5
A12	I can name some common Chinese herbs which are available in a Chinese traditional herbal medicine shop	1	2	3	4	5
A13	I can name some famous herbal soup which are available in pre-packaged form in a Chinese herbal medicine shop	1	2	3	4	5
A14	I know the function of some Chinese herbs	1	2	3	4	5
A15	I know the different types of herbal processors which are used in a Chinese herbal shop	1	2	3	4	5
A16	I know how some herbs for medicines are cut and packed for sale	1	2	3	4	5
A17	I can experience the effort in doing Chinese calligraphy	1	2	3	4	5
A18	I can name four primary tools used in Chinese calligraphy	1	2	3	4	5
A19	I can name different scripts/styles of Chinese calligraphy	1	2	3	4	5
A20	I know the correct way of grasping the Chinese brush in Chinese calligraphy	1	2	3	4	5
A21	I know the different format of calligraphy which is usually displayed on the wall	1	2	3	4	5
A22	I can tell the value of the art in Chinese calligraphy	1	2	3	4	5
A23	I can describe the common layout of a prayer hall in Chinese temples	1	2	3	4	5
A24	I can describe the common external features of Chinese temples	1	2	3	4	5
A25	I know the basic ritual of worship in a Chinese temple	1	2	3	4	5
A26	I can name six types of Chinese tea	1	2	3	4	5
A27	I know the equipment used in a Chinese tea ceremony	1	2	3	4	5
A28	I can tell the process of drinking Chinese tea/Chinese tea ceremony	1	2	3	4	5
A29	I can tell the significance of serving Chinese tea in Chinese culture	1	2	3	4	5

1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

ICC skills

Please select the response that most accurately describes you for each statement and circle the appropriate number on the scale.

	Statement					
B30	I can identify the differences between the Chinese house and my own house in terms of furnishing	1	2	3	4	5
B31	I am able to contrast the practices of table manners in Chinese culture and my own culture	1	2	3	4	5
B32	I am able to identify the position of the cutlery used during a Chinese meal	1	2	3	4	5
B33	I can tell the difference between the art of Chinese calligraphy and the art of writing in my own culture	1	2	3	4	5
B34	I am able to differentiate the style of writing Chinese calligraphy with that in my own culture	1	2	3	4	5
B35	I am able to contrast the layout of the Chinese temple and the mosque/church in my culture in terms of architecture	1	2	3	4	5
B36	I am able to compare the prayer section of the Chinese temple with that in my own culture	1	2	3	4	5
B37	I know where to get the ingredients to make a soup with Chinese herbs	1	2	3	4	5
B38	I am able to compare the Chinese traditional medicine with the traditional medicine in my culture	1	2	3	4	5
B39	I am able to participate in a Chinese tea drinking ceremony	1	2	3	4	5
B40	I can experience the process of drinking Chinese tea	1	2	3	4	5
B41	I can employ appropriate strategies (such as internet websites, YouTube, books, VR photos or videos) to elicit the information of Chinese culture from various sources	1	2	3	4	5
B42	I can use my knowledge of Chinese culture to overcome the misunderstanding/stereotypes towards the Chinese culture by the people of my own race	1	2	3	4	5

1 = Strongly disagree; 2 = Disagree; 3 = Neural; 4 = Agree; 5 = Strongly agree

ICC attitudes

Please select the response that most accurately describes you for each statement and circle the appropriate number on the scale.

	Statement					
C43	I am interested in discovering information on Chinese culture such as Chinese calligraphy, Chinese herbs, tea ceremony, restaurants, temples, and others	1	2	3	4	5
C44	I can appreciate the cultural elements at a Chinese temple	1	2	3	4	5
C45	I am confident in exploring the cultural differences between Chinese culture and my own culture	1	2	3	4	5
C46	I am curious in experiencing the true Chinese culture in my daily life	1	2	3	4	5

	Statement					
C47	I am interested in discovering other people's perspectives of Chinese cultural practices	1	2	3	4	5
C48	I respect the practices of Chinese traditional culture by the Chinese in my neighbourhood	1	2	3	4	5
C49	I accept that there are cultural differences between Chinese culture and my own culture	1	2	3	4	5
C50	I am ready to cope with the differences between Chinese culture and my own culture	1	2	3	4	5
C51	I am willing to clarify to others who misunderstood some of the Chinese cultural practices	1	2	3	4	5

1 = Strongly disagree; 2 = Disagree; 3 = Neural; 4 = Agree; 5 = Strongly agree

ICC awareness

Please select the response that most accurately describes you for each statement and circle the appropriate number on the scale.

	Statement					
D52	I recognize the uniqueness of different cultures	1	2	3	4	5
D53	I am sensitive towards the cultural features shown in different cultures	1	2	3	4	5
D54	I am aware of the values in Chinese culture from the cultural practices/ activities such as Chinese table manners, tea ceremony and calligraphy	1	2	3	4	5
D55	I am aware of the significance of the practice of traditional Chinese culture among Chinese people	1	2	3	4	5
D56	I am aware of the cultural distinction between Chinese culture and my own culture	1	2	3	4	5
D57	I perceive the potential conflicts that may arise from the different perspectives on certain cultural aspects	1	2	3	4	5
D58	I am conscious of the aspects of Chinese culture which are prohibited in my own culture	1	2	3	4	5
D59	I am able to reach an understanding of the stereotypes towards Chinese culture that may arise from my own culture	1	2	3	4	5

1 = Strongly disagree; 2 = Disagree; 3 = Neural; 4 = Agree; 5 = Strongly agree

Appendix 2

Survey on learning Chinese culture through VR technologies

(A) Please select the response that most accurately describes you for each statement and circle the appropriate number on the scale.

1	The VR images were very attractive	1 2 3 4 5
2	I am interested in using VR technologies in exploring Chinese culture	1 2 3 4 5
3	The VR images are practical for the learning of Chinese culture	1 2 3 4 5

4	The VR technologies are effective for the learning of Chinese culture	1 2 3 4 5
5	The use of VR in the process of teaching and learning helps in better understanding of Chinese culture	1 2 3 4 5
6	The VR images provided sufficient Chinese cultural information	1 2 3 4 5
7	The used of VR helped to improve my exposure on Chinese culture	1 2 3 4 5
8	The used of VR in cultural learning increased my awareness of intercultural understanding	1 2 3 4 5
9	The discovery of Chinese culture through VR technologies stimulated my intercultural awareness	1 2 3 4 5
10	I became more aware of the conventional/traditional cultural practices and cultural features in Chinese culture	1 2 3 4 5
11	Through the VR activities, I am able to search for the information on Chinese culture	1 2 3 4 5
12	I became more curious towards Chinese culture and my own culture	1 2 3 4 5
13	I have met the course learning outcomes	1 2 3 4 5

1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

(B) Please elaborate in detail and provide your feedback on following aspects.

1. Is this the first time you are using a VR viewer for VR images and videos? What are the new experiences you have gained from the VR technologies in learning Chinese culture?
2. How are the VR technologies beneficial to you in learning Chinese culture? (Please reflect on your experience in exploring the Chinese restaurant, Chinese house, Chinese tea ceremony, Chinese herbal shop, Chinese temple and Chinese calligraphy center using VR technologies, in terms of knowledge, skills, attitudes and intercultural awareness).
3. Describe the significance of some of the cultural elements which you tagged in your VR tour, to the Chinese? Reflect on these cultural elements? Did you obtain any new insights? (Examples of cultural elements: the koi fish, the lantern, porcelain, tea ceremony).
4. What other Chinese cultural content would you like to learn and explore with VR?
5. What problems did you encounter when using the VR technologies for learning Chinese culture?
6. Would you recommend the use of VR technologies as being an effective method for learning of culture in Mandarin as a foreign language? Why?
7. Is there any additional feedback/anything else you would like to share.

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