INVESTIGATING INCLUSIVITY OF DIGITAL LEARNING AND TEACHING FOR OVERSEAS STUDENTS ENROLLED IN THE UK STEM PROGRAMMES

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Abstract: The growth in the number of overseas students has not only brought an increase to the local economy in the UK, but also led educators to consider how to improve students' engagement and learning experience. With the increasing number of overseas students choosing to enrol in British universities, there has been a considerable growth in research interest in their academic performance. In particular, this is an issue in STEM education as overseas students choose to study the STEM subjects more than other subjects in British universities making the STEM educational environment more multicultural and diverse compared to other programmes. Thus, increasing demand to improve students' engagement in these courses is required. Nevertheless, few recent studies have been conducted on the learning experience of overseas students in STEM education in the UK. In addition, the broader use of blended (face-to-face and online) education methods in universities due to the Covid-19 lockdown has transformed students' experience and expectations of teaching and learning. Overseas students are also no exception from the change of this behaviour; therefore, going forward, it is a strategic imperative to investigate the impact of the introduction of digital education and its uses on overseas students learning experiences in STEM education. This paper summarises the preliminary results of the latest research at the University of Sheffield investigating the learning behaviour of overseas students in STEM programmes.

Keywords: Chinese students, Overseas Students, Digital Applications, STEM Education, Cognitive Learning

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1. INTRODUCTION

1.1 Chinese learners in the UK during COVID-19

Chinese students are the largest group of overseas students in the UK (International student recruitment data, 2022) and their travel to study abroad has been heavily impacted by COVID-19 from 2019 to 2020. But in 2021, the number of study visas issued by the UK Home Office to Chinese students increased significantly to 135,457 (UK Home Office, 2021), even when the pandemic was not entirely over. Based on this data, we can see that Chinese students remain the largest group of overseas students for UK universities in the current global education market (Will Chinese students be back in Europe this year, 2021). The financial and social-cultural values created by recruiting Chinese students for the UK universities development has been recognised clearly and widely for years (International students are worth £28.8 billion to the UK - HEPI, 2022; Ryan, 2011). However, according to a recent report, the trend of Chinese students choosing to study abroad will reach a peak in the next five years and then stagnate or even start to drop (Chinese student flows tipped to peak within five years, 2022). This trend signals a change in education policy and social culture in China, where more students and their

families are finding that the advantages of studying abroad compared to staying at domestic institutions are no longer apparent, especially after the COVID-19 outbreak (Top Chinese graduates opt to stay at home for postgraduate study, 2022). But the report does not explain the underlying reasons for the decline, so further investigation of this area is needed. Are these changes simply due to the impact of the pandemic and other global challenges, such as climate change or recent war conflicts? Or are they due to the underwhelming quality of their studies and poor learning experience? The question of how to improve the learning experience of overseas students is always one of the strategic development issues facing most UK universities in order to remain competitive in the global education market. Thus, in the era of post-pandemic fresh investigations are needed to understand why overseas students choose to study at Western universities, the factors that influenced their choice of STEM subjects compared to other subjects, their experience of learning in a non-native language and factors influencing their academic performance.

Although there have been many similar studies in the past, there is little work have been carried out in recent years, especially after the COVID-19 pandemic. Past research has shown that the most immediate and significant reason for Chinese students choosing to study in the UK is the reputation of universities and the better career opportunities after graduation from elite universities (Rudd *et al.*, 2012; Iannelli and Huang, 2013; Cebolla-Boado *et al.*, 2016). However, the learning experience of Chinese students after they enrolled in UK universities varied due to cultural differences, individual experiences, emotional and identity transformation, and extra services provided by the institutions (Gu and Maley, 2008; Gu, 2015; Barnes, 2010; Crawford and Wang, 2014). COVID-19 outbreak had made a tremendous impact on how the education system works and led to the lockdown of educational institutions worldwide (COVID's Lessons for Global Higher Education, 2020). The mobility of overseas students worldwide was limited due to safety considerations and travel restrictions (Mok *et al.*, 2021; Yildirim *et al.*, 2021). Universities adopted temporary online teaching methods to maintain regular teaching and minimise learning losses during the pandemic; however, students' learning efficiency has been affected due to inadequate facilities and difficulties in adapting to online teaching style (Batubara, 2021; Lapitan *et al*., 2021). In addition, as non-native English speakers, Chinese students were more likely to be affected by language barriers when studying in Western universities (Cheng *et al.*, 2016; Hou and McDowell, 2013). Chinese students faced many challenges when studying in Western universities, and our preliminary observations in this study also revealed some similar issues with Chinese students' learning behaviour.

1.2 Digitalisation of higher education

The emergence of COVID-19 has taught a lesson to all educators and shareholders in higher education. Although we have the tools to teach online, their application, in reality, is not as satisfying as expected. As educators, we need to think further: should digital education be used only as an extra measure to support face-to-face teaching, or can it be developed independently into a unique educational system that can be used without any limitations? The world beyond the campus has entered the era of Industry 4.0 (Feise and Schaer, 2021), however, our higher education is still stuck in the fixed mode of teaching and learning in traditional classrooms. The digitalisation of higher education has gained widespread acceptance around the world, and the lockdown of COVID-19 has undoubtedly accelerated this process (Bhute *et al*., 2021). The digital applications and technologies such as modelling and simulation tools in engineering subjects are constantly being developed and integrated to solve practical problems (Kezunovic *et al.,* 2004).

The use of digital technology has made a significant impact on improving the learning effectiveness of students (Roman *et al.,* 2021). A previous study has shown that teaching with a digital gamified application can enhance educational outcomes, increase students' engagement and inclusiveness in learning, improve their understanding and awareness of course contents, and develop their problem-solving and critical thinking skills (Maxim, 2021). Digital technologies can meet the diverse learning needs of students with the access to learning contents anywhere and anytime, adapt contents depending on students' needs and provide timely feedback, furthermore, integrate students into the scientific community (Wijtmans *et al.,* 2014; Keengwe and Bhargava, 2013). Given the potential advantages of digital technologies, educators and researchers in higher education can design digital applications more contextualised, customised, and collaborative to bridge the language and cultural differences of learning for overseas students to improve their learning effectiveness in unfamiliar environments while at the same time meeting the teaching objectives at local level.

2. METHODOLOGY

This study examined the performance of MSc Environment & Energy Engineering students in the laboratory course of Applied Energy Engineering (CPE6311) in the department of Chemical and Biological Engineering at the University of Sheffield, which is a very popular postgraduate programme mainly taken by Chinese students. Direct class observation research methodology has been employed to study students learning behaviour during the practical sessions. The total number of observation groups was 12 and the total number of students participating in the lab course was 57. The distribution of student cohorts who participated in the course had been presented in Table 1. Four groups were all Chinese students, three groups had more than 80% Chinese students, and the other five groups were a mixed combination of Chinese students, home students and other overseas students.

Table 1. Cohorts Distribution in the Observed Groups.

	Number of Students	Percentage of Students (%)
Total	57	
Mainland China	33	58.00
Hong Kong, China	2	03.50
Other Overseas Countries	10	17.50
Home	12	21.00

The class observations were focused on the use of digital applications and languages, students' responses to instructor's questions, and the interaction between students and the instructors during the course. All the results presented in this paper are summaries of preliminary observation notes taken during the Autumn 2021. The notes were analysed using NVivo software to gather a particular theme and topics.

3. EARLY OBSERVATIONS

3.1 Digitalised education and current student learning

In the modern higher education system, digital, information and social network technologies are an integral part of the lives of new generation students. Looking throughout all types of education systems worldwide, incorporating new media and digital technologies has become a pressing reality rather than an imagination, just as most educators have realised that a digital transformation of higher education is taking place. Currently in most international universities, the use of information and communication technology (ICT), digital media software, cloud technologies, and access to massive open online courses (MOOCs) have already been integrated into traditional teaching approaches and treated as an indispensable part of students'

learning (Fu, 2013; Reyna *et al.*, 2018; Vakaliuk *et al.*, 2021; Marguerite 2012).
The transformation is not only changing the traditional teaching methods used by educators, but it also brings some new shifts into learners' learning behaviours. Growing up and immersing with modern technologies, these digital natives are fluent in the use of digital devices and applications (Prensky, 2001). Nowadays, learning is ubiquitous wherever the Internet is available (a digital network of education can be established, as shown in Figure 1). As these external resources and tools become more involved in education, learners' learning behaviours are also being influenced and changed more digitally.

Figure 1. The future of digitalised education.

This study observed a clear trend among both overseas and home students that most of them preferred to use mobile phones, tablets and laptops as the media for notetaking and data recording rather than traditional pen and paper notebooks. Current students would also feel more comfortable having these devices and technologies in the classroom or even in the laboratory. For example, when the students were asked to draw a P&ID (process and instrumentation diagram) of the experimental rig, the first reaction of most students was to take out their mobile phones and take pictures of the actual equipment. In addition, the students mostly used their electronic devices (e.g., smartphones and iPads) they brought to access the VLE and course content (i.e., BlackBoard and Google Drive) during the practical session.

3.2 Measuring how students learn

Have you ever wondered why you will learn or why you must learn? As a learner, we always start with a question to engage with learning. Our brains bring us questions. Several decades ago, educators haven't realised the importance of cognitive and brain neuroscience, likewise, neuroscience researchers rarely practice their findings in real classrooms (Bransford, 2000). Today's educational research is multidisciplinary and gradually moves from theoretical assumptions to more feasible pedagogical practices. As more learning theories emerge, new forms of curriculum, teaching, assessment, and feedback can be developed better to meet current learners' demands than the traditional ways we still use in universities and schools today (Bransford, 2000; Looney, 2011; Goldman and Pellegrino, 2015). Learning is a process by which the brain builds and strengthens neural links in the cortex when we see something new for the first time or repeat the relevant exercises (Owens and Tanner, 2017; Karpicke and Grimaldi, 2012). When we are learning, the working memory helps us deal with new and old information; after repeating and practising, they can be converted to form long-term memory. And the working memory capacity in learning is exactly one important topic of research concern in recent years. Working memory is a part of the human brain that facilitates the temporary storage and processing of information required for higher cognitive tasks like language comprehension, learning, and thinking (Baddeley and Hitch, 1994). It consisted of three subcomponents: the central executive, the visuospatial sketch pad, and the phonological

loop (Baddeley, 1992) (the summarisation of the memory system is shown in Figure 2). The functions of these three subcomponents have been explored to associate with human learning abilities. For example, working memory contributes to the acquisition of foreign languages (van den Noort *et al*., 2006), individual working memory deficits have an impact on mathematic competence (Passolunghi *et al*., 2007), and working memory reflects differentiation through expressive writing exercises (Yogo and Fujihara, 2008) and reading tests (Daneman and Carpenter, 1980). However, there are few studies that integrate working memory with engineering education and the application of digital tools in higher education.

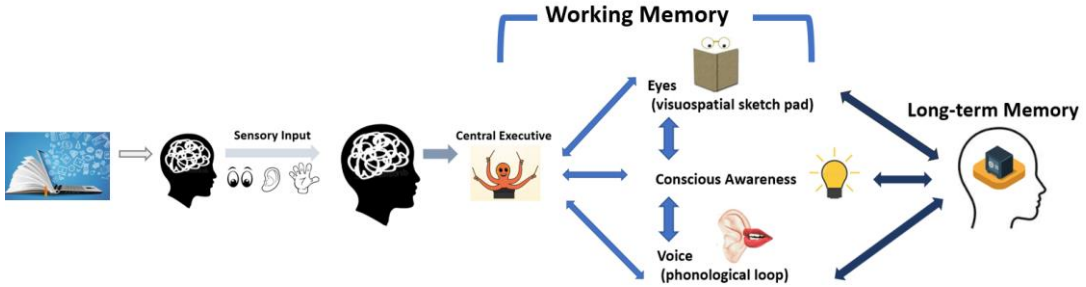

Figure 2. Learning with working memory (Modified based on Baddeley and Hitch 1994).

Through the in-class observation, we noticed that Chinese students were less likely to interact with the instructor. When the instructor asked a question, for instance, Chinese students did not respond in a direct and timely manner to the question (whether they knew the answer or not); instead, they remained silent. Even following a simple question, Chinese students still took a long time to think carefully of an appropriate answer or were hesitant to take a further action. In contrast, when other overseas students and home students were asked, most of them would try to give their own answer, which may not always be the right one, but they would attempt to respond rather than keep quiet. During the observations, we also found that when the teaching assistants tried to make connections or integrate with a student group, Chinese students would remain somewhat distant.

It was not very surprising to observe that in the course where most students are overseas (in this case, it was Chinese students in particular), the students communicated with their peers in their native language rather than the English language. It was emphasised that the use of the English language should be the most fundamental skill for overseas students studying at an international university, but in private Chinese students still communicated in their native language. Some Chinese students commented that if all my classmates are Chinese, why should I speak English? And some of them felt that there was no big difference between learning at the UK university and at the Chinese university.

4. FUTURE WORK

Further research to explore Chinese students learning style and the impact of language skills on their learning experience of STEM subjects will be conducted. Further, qualitative analysis will also be applied to investigate Chinese students' perceptions during their postgraduate studies in the UK. Data collected in this study will help to understand Chinese students' learning journey and experiences in UK universities. It will provide us with insights to understand the problems and demands of Chinese learners in STEM subjects at the master level, and help higher education institutions to improve their education for better intervention, moreover, to enhance overall student learning experience especially in very diverse and multicultural environments.

5. CONCLUSIONS

In summary, this paper presents the preliminary observations of a postgraduate taught laboratory course in a UK university. We have found that the engagement, inclusion and use of the language of Chinese students in a British classroom remain problematic and deserve further exploration. Although we have not yet discovered an effective solution to improve this situation, these observations provide a realistic basis for further purposeful research development. In the current phase of the research, we are focusing on examining the learning capacities of Chinese students studying engineering postgraduate taught courses in British educational environments. Once the underlying mechanisms for the emergence of learning problems among overseas students are clearly understood, we will further expand the research into developing digital applications for improving the learning effectiveness of overseas students in STEM courses.

The preliminary observations have revealed two central issues. First, the way in which university students learn and interact with others now seems to have changed in the digital era. Second, we found that English language proficiency is still one of the most critical factors affecting overseas students' inclusion in the class. The laboratory sessions allow students to have more freedom of movement and operation opportunities than lecture teaching, but the inclusion and engagement of students are still limited if the instructor cannot adapt the teaching to students' actual competence and needs. This is imperative for the current higher education system to be more tailored and personalised in teaching to meet the learning needs of students from different backgrounds.

In short, the growing trend of Chinese students enrolling in UK universities, especially for one-year postgraduate taught programmes, will continue in the coming years. Without further investigating of how Chinese students learn and adapt their strategies in a Western educational environment, the development of teaching and learning in British universities will not be improved in a more practical way. Not to mention that the Chinese government is already making internal changes to its policies for better domestic education development, and Western universities will have to face even more competition in the international education market soon. As human beings, our biological, and cognitive abilities to learn and the functions of our brains remain the same regardless of nationalities. It's just that today we live in a digital age and are more inclined to receive information and knowledge using digital devices and platforms. As modern educators, we should make good use of the benefits of digital and media technologies to make our teaching more efficient and inclusive for digital natives, no matter whether they are home or overseas students.

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