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Investigating the Experiences and Performance Of Chinese Master Students Studying UK Engineering Courses

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ABSTRACT

Given the rising proportion of Chinese students attending UK universities in recent years (11.2% of overseas students in the UK, 2022) of Chinese students enrolled at UK universities and the notable socio-economic contributions resulting from their presence, it becomes imperative for educational researchers and policymakers further to investigate this student cohort's learning experiences and academic outcomes. The necessity is emphasised by the fact that 60% of the postgraduate taught (PGT) students in the University of Sheffield's MSc programme in Environmental and Energy Engineering are of Chinese origin. Therefore, this study aims to supplement and update existing research insights by examining these overseas students' learning and teamwork performance at British universities. The study was undertaken in two phases: an online survey and a project-based design workshop. The survey (54 responses received) explores the factors of Chinese students deciding how to team up with others; through the workshop integrated with the Belbin team role theory (61 participants attended), the Chinese students' teamwork performance in engineering practical activities is discussed. The findings show that (1) Engineering students decide to work with others in groups mainly because they know each other in advance; (2) According to the results of the Belbin test obtained from PGT students, the Chinese engineering students' team roles were more likely to be social-oriented, while other students (both home and other overseas students) tended to prefer action-oriented roles; (3) Working in Belbin-engineered groups promoted students' leadership, initiative, and effort in teamwork than working in self-selected groups.

INTRODUCTION

In the past decade, with the trend of internationalisation of education, an increasing number of Chinese students have chosen to go to higher education institutions in the United Kingdom for further studies. Especially in the two years following the end of the COVID-19 pandemic, it is clear that the number of Chinese students studying in the UK has resumed its year-on-year growth wave (Lem, 2022). The increase in international students is not only due to the lifting of international travel restrictions on COVID-19 but is also influenced by China's economic and social development and the increasing competition for domestic educational resources (Pan and Xiao, 2008; Department of Development Planning, 2023). Although more families in China are considering and willing to send their children to Western countries for education, the differences between Chinese and Western education considering the philosophical and theoretical foundations and education styles (Watkins and Biggs, 1996; Brown and Gao, 2015; Li, 2004; Tan, 2015; Ritter et al., 2020) can make it difficult for Chinese students to adapt to the Western education system and affect their academic performance. In addition to traditional classroom-based education, developing students' teamwork skills is also one of the critical components of Western university learning (Riebe, Girardi and Whitsed, 2016).

Within contemporary higher education, the emphasis on group learning and collaboration extends beyond being merely a means of exchanging ideas, it is also recognised as a crucial method for fostering students' critical thinking, communication, and interpersonal skills. However, teamwork in a cross-cultural context can be challenging. Chinese students are more likely to face additional challenges due to cultural differences in communication habits, decision-making styles, and perceptions of authority (Foster and Stapleton, 2012; Lau and Jin, 2019). Not only do they have to overcome the language barrier, but they also have to be able to adjust their learning methods and thinking patterns to ensure that their studies go smoothly. Further regarding engineering courses, which are the most common major for Chinese students to study in Western universities (Tang, Collier and Witt, 2018), teamwork is an indispensable part of their current studies and future work. Therefore, to facilitate Chinese engineering students' learning and teamwork skills in the British education environment, this study will explore the performance and differences of postgraduate taught (PGT) students working in a group within a Chemical Engineering module and provide practical strategies and suggestions for designing and organising further practical curriculum.

LITERATURE REVIEW

Chinese Students at UK Universities

Chinese students studying at UK universities have become a topic of great concern in recent years. With the development of China's economy and the deepening of globalisation, more and more Chinese students are choosing to further their studies at Western universities. More than 100,000 Chinese students in UK universities are enrolled in various majors in 2022

(Gov.uk, 2023). For most Chinese students coming to the British educational environment for the first time, how to achieve the desired academic achievements, improve their adaptability and cope with cultural differences are the problems they urgently need to face and solve. The academic achievement of Chinese students in Western universities has been one of the main focuses of global educational researchers. A recent paper has stated that Chinese students are highly self-disciplined and goal-oriented during their college studies through comparative research (Ye et al., 2023). However, other investigations have also shown that Chinese students are relatively deficient in critical thinking and innovative capacity, relying too much on rote memorisation and passive learning styles (Turner, 2005; Clark and Gieve, 2006; Huang, 2008; Tian and Low, 2011; Sit, 2013).

Despite the excellent educational resources available in most British universities, Chinese students still encounter a range of challenges, such as language barriers, cultural shocks and limited social networking in their overseas study (Hodkinson and Poropat, 2014; Cebolla-Boado, Hu and Soysal, 2018; Tang, Collier and Witt, 2018). Further research has also found that it is common for Chinese students to find it difficult to adapt to Western teaching models and learning styles in the first few months (Wu, 2015). But then, most of them will adjust and adapt gradually to the local academic and social environment. Another topic often discussed about Chinese students studying abroad is the impact of cultural differences on their academic lives. There are noticeable cultural differences between Eastern and Western countries regarding values, behaviours, communication, and learning styles (Wang, 2007; Hu et al., 2014). These cultural differences can confuse and frustrate Chinese students socially and academically. Therefore, developing cross-cultural communication, cooperation, problem-solving, and conflict-resolution skills are crucial for Chinese students' academic success in UK universities.

Teamwork in Higher Education

Higher Education is a nexus of individual learning, growth, and transformation. As students prepare to face the diverse and complex challenges of global society, it is necessary to emphasise the necessity of teamwork in their learning phase. In today's higher education, students, educators, and academic institutions constantly seek ways to develop and optimise teaching and training for teamwork, collaboration and communication across disciplines in a professional environment. In addition to academic ability, teamwork is also one of the essential transferable skills necessary for all students. Past studies have indicated that the higher education system plays a vital role in cultivating college students' teamwork skills (Dunne and Rawlins, 2000; Tarricone and Luca, 2002). In higher education, the way to cultivate students' teamwork skills is mainly through group learning and team-based collaboration to complete the course project (Rasiah, 2014; Vlachopoulos, Jan and Buckton, 2020). Organising team-building activities, such as outdoor development training and teamwork games, allows students to stimulate their teamwork awareness and cooperation skills (Dunne and Rawlins, 2000; Drake, Goldsmith and Strachan, 2006; Cooley, Burns and Cumming, 2015). Successful group work can be achieved by scheduling group learning, where students are divided into

small groups, assigned responsibility for different tasks and have shared goals (Tarricone and Luca, 2002).

The factors influencing teamwork have also attracted researchers' attention by further observing and investigating the students' teamwork behaviour. For example, individual personality traits, such as attitudes and values, can impact the development of teamwork skills (Juhász, 2010; Forrester and Tashchian, 2010). As well as the different cultural backgrounds of team members may make them have various working styles and patterns and affect the development of teamwork in a multicultural environment (Doukanari et al., 2021). Moreover, the quality and process of teamwork are also affected by the external environment, such as the event organisers and social support (Castka, Bamber and Sharp, 2003).

Belbin Team Roles

Dr Meredith Belbin's research into team dynamics at the Henley Management College in the 1970s culminated in the development of the Belbin Team Role theory. This theory suggests that individuals in a team tend to assume one (or two) of nine specific roles that complement and sometimes conflict with others. Still, together, they can contribute to the overall success of the team (Belbin, 2010a; Belbin, 2010b). These roles range from implementers (IMP), shapers (SH), completer finishers (CF), monitor evaluators (ME), specialists (SP), plants (PL), coordinators (CO), resource investigators (RI), teamworkers (TW).

Undoubtedly, implementing the Belbin Team Role Test in higher education can provide a multitude of benefits, such as self-awareness and personal development, enhanced communication and transferable skills (Aritzeta, Swailes and Senior, 2007; Aranzabal, Epelde and Artetxe, 2022). There has long been a perceived need for developing teamwork in higher education curricula (Springer, Stanne and Donovan, 1999). From a student's point of view, the ability to work in a team is integral to their studies and professional work. For employers of prospective graduates, teamwork has also become one of the factors considered in their recruitment. There is an increasing worldwide trend to formulate graduate attributes and essential skills to clearly outline the goal of education to achieve in preparing students for entry into the industry (Barrie, 2007; Routledge, 2023). A study notes that working in groups can serve as a valuable method to amplify the intricacy of the learning process, thereby improving students' capabilities for navigating complex problems after graduation (Livingstone and Lynch, 2002). However, some researchers have also found that group work at the undergraduate level can be problematic and may reduce individual motivation due to the presence of parasite and opportunist behaviours (Houldsworth and Matthews, 2000; Marin-Garcia and Lloret, 2008).

Furthermore, with the continuous development of society and education, there is now a consensus among us that the attributes required of global graduates should include the ability

to work flexibly in teams, communicate effectively, collaborate proficiently, listen attentively to others, and compete in future employment environments (Kuh, 2008; Routledge, 2023). Regardless of the professional field, teamwork skills are becoming increasingly necessary to prepare students for future career challenges. Therefore, integrating the Belbin team role theory into the higher education curriculum is more than applying an academic tool; it also reflects the evolving requirements of education itself. As we move towards a future where transferable skills, teamwork, and adaptability to new environments are as critical as specialised knowledge, utilising and optimising tools like the Belbin team roles will provide students and educators with invaluable guidance.

RESEARCH QUESTION(S)

Addressing the need to investigate overseas students' teamwork behaviour in a UK master's programme, this paper presents a workshop study to examine overseas students' learning experience, team role orientations and performance in group work. Thus, the study is guided by the following research questions:

(1) What factors contribute to PGT students deciding their self-selected groups?

(2) Are there differences in the team role orientation between Chinese and other students?

(3) How do PGT students behave in teamwork in self-selected vs. engineered groups?

METHODOLOGICAL APPROACH

To answer these research questions above, we have designed and implemented a project-based design workshop for postgraduate taught (PGT) students in a Chemical Engineering teaching module (CPE6311 Applied Energy Engineering). The research project has been ethically approved by the Department of Chemical and Biological Engineering ethics committee at the University of Sheffield, ensuring the ethical compliance of the research. The Belbin Team Role Self Perception Inventory (BTRSPI) employed in the course module was secured through the procurement of the test by the module leader. In order to evaluate the students' performance in groups, the Belbin team role test is integrated into the workshop's teaching and learning activities. The workshop is delivered in the autumn semester of the academic year 22/23 and lasts 4 hours. The total number of participants in the course was 61, of which 52 completed the Belbin Team Role test prior to the workshop. During this workshop, the students work in two different groups. The first type is that students are free to decide and choose their own groups according to their own perceptions, which is called the self-selected group. For the second type, the instructors form the group according to the

students' BTRSPI results, considering each student's 1st and 2nd role choices and the most balanced possible group composition with Belbin's role and team formation theory (Aritzeta, Swailes and Senior, 2007; Van de Water, Ahaus and Rozier, 2008), which is called the engineered group. An example of a Belbin team role-balanced group circle is presented in Figure 1. It is important to note that in this study only the team role test was used to provide students with more options for working in groups, and that all students had the same learning time, objectives, resources and support throughout the workshop. Therefore, the student's learning process and contents were not affected by the various group setting.

The workshop teaching is divided into two parts:

1) Recognising teamwork and team roles: Instructors introduce students to how to perform effectively as a team and conduct a practical session called "Lost at Sea" that engages students to experience working with others. In this section, the students work in a self-selected group.
2) Designing a Chemical Engineering project: The students are asked to design a desalination plant and calculate the associated capacity and parameters. In this section, the students work in the Belbin-engineered group.

At the end of each section, the students need to complete a self-assessment form (SAF). The scale in the individual assessment form allows students to rate themselves in five areas: leadership, cooperation, initiative, attitude and effort from 0 to 10 (individual performance score). In addition to rating individual performance, the students are also required to evaluate the different groups in which they are involved on a scale of 0 to 10 (group performance score). The methodology to design this Belbin role-integrated project-based design workshop is presented in Figure 2.

Figure 1. A Belbin team role-balanced group circle was applied in the workshop

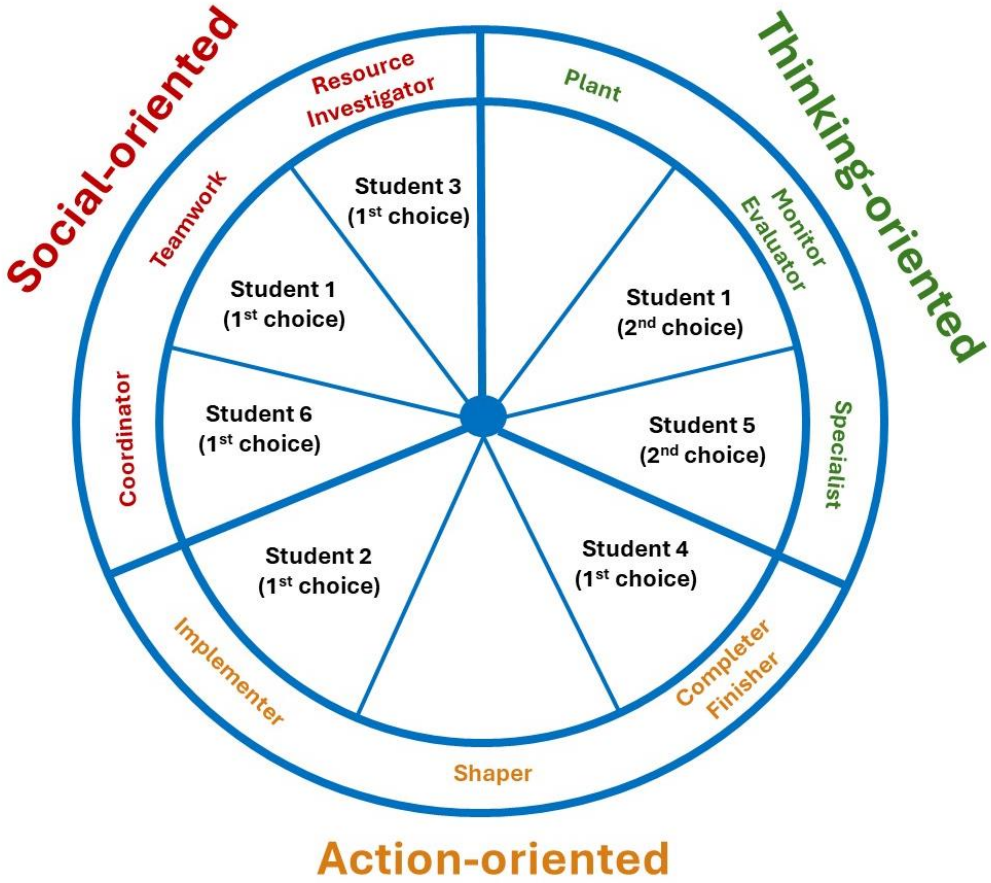
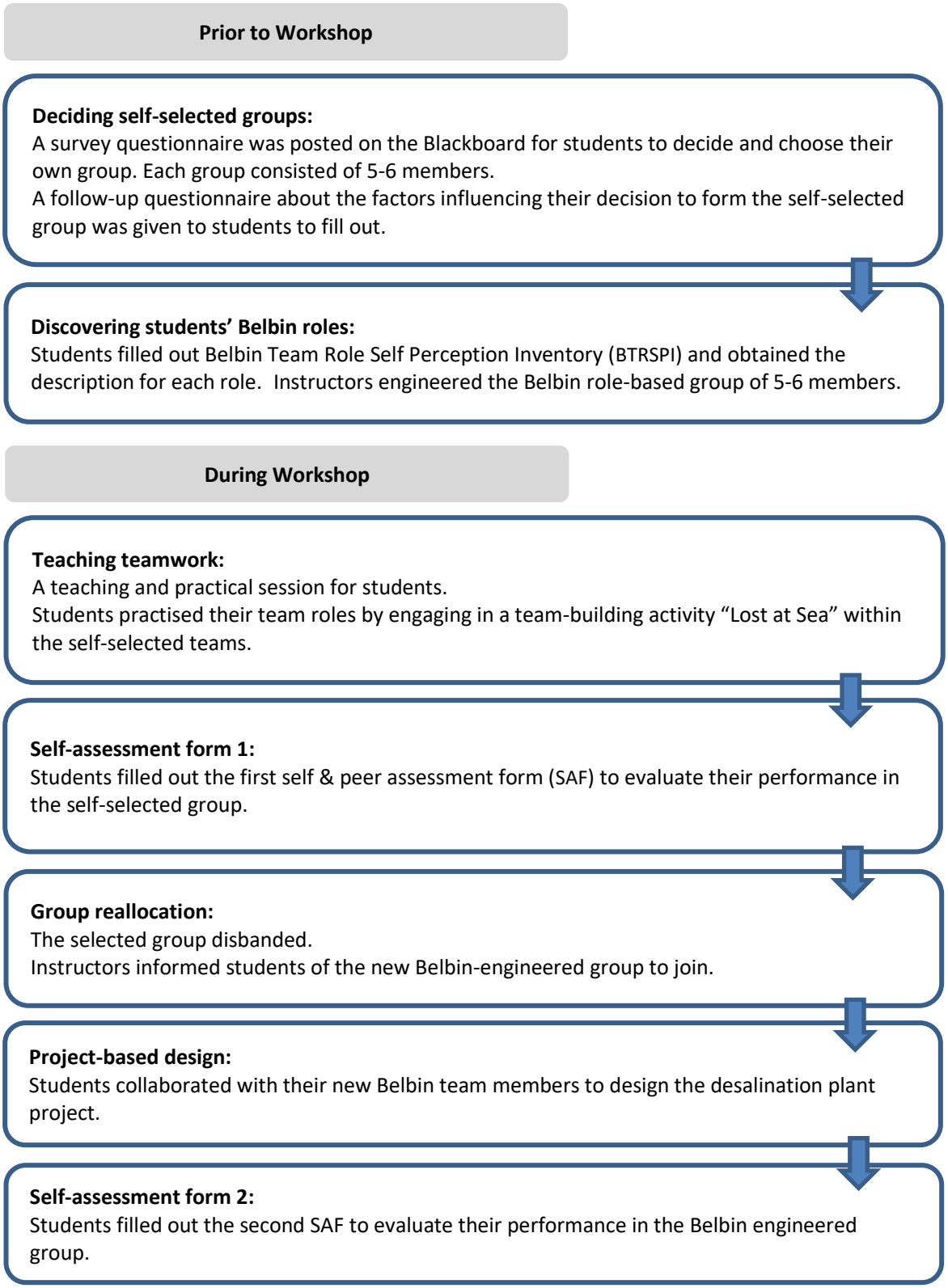


Figure 2. Schematic procedure for the Belbin team role-integrated workshop



KEY FINDINGS

Reasons for Engineering PGT Students to Form Their Self-selected Groups

In general university practical courses, students can choose their study groups freely. These self-selected groups are formed based on students' preferences for their working partners. However, there is no relevant data published to state and define the influencing factors when students form groups freely. Therefore, in this study, we surveyed to investigate the factors influencing students' decisions when they chose their own group. The survey results, as shown in Table 1, reveal that among the students who participated in the workshop, 58% of them perceive that knowing someone in a group is the main influencing factor for them to join a self-selected group (35% have friends within a group; 13% join a group after receiving an invitation from someone they know; and an additional 10% team up with acquaintances). In addition to the majority of students choosing to team up with acquaintances, 40% of students are willing to work with people they don't know well. The final 2% of the students decided to join a group for other reasons, but no specific reason was given.

Table 1. Factors influencing PGT students to form self-selected groups

Factors	Response percentages
My group members are all my friends.	35%
Someone in the group invited me.	13%
We are familiar with each other but not friends.	10%
We decide randomly.	40%
Other reasons.	2%

Different Belbin Team Roles Frequency Showed among Engineering PGT Students

Another critical aspect to investigate in this study is the Belbin team role orientation among engineering PGT students. In the workshop, PGT students studying the MSc Environmental and Energy Engineering course completed the BTRSPI, and the frequency percentage of their team role orientations is shown in Table 2. Since 67% of the students attending this workshop are Chinese PGT students, we presented and compared the team role orientations of Chinese students and students from other countries to gain an explicit understanding of the differences in Belbin team formation among various students. According to the data, it can be seen that the majority of Chinese students (49%) tend to be social-oriented roles, while in contrast, other students (including British home students and overseas students from other countries) are more inclined to be action-oriented roles (with 37% of them). It can also be observed that the number of students who prefer thinking-oriented roles does not exceed 20% in both student cohorts, and it is the minor proportion among the three major Belbin team role categories.

Table 2. Differences between the team role orientation of Chinese students and students from other countries

Belbin team role orientation	Frequency percentages	
	Chinese (N=31)	Others* (N= 21)
Thinking-oriented roles	19%	13%
Action-oriented roles	24%	37%
Social-oriented roles	49%	27%

* The range of students of "Others" nationalities mentioned in this table includes Home students, European students, Middle Eastern students, and Other Asian students (except Mainland China).

Students' Performance Change in Different Groups

After students have identified their own Belbin team roles and participated in the workshop activities, their performance is measured using self-assessed scores in the SAF form. These scores include (1) individual self-assessment scores in leadership, cooperation, initiative, attitude, and effort and (2) group evaluation grades for all members' participation in two different groups. Table 3 presents the mean and standard deviation of individual performance scores for students engaged in two workshop activities (teaching teamwork and project-based design) in both the self-selected and the Belbin-engineered groups. In the four self-assessment indicators (leadership, initiative, attitude, and effort), the means for the Belbin-engineered group are higher than the self-selected team. These results indicate that working in the Belbin-engineered groups can enhance the level of individual engagement among other members and motivate them to actively participate in group activities, thereby improving individual performance. However, regarding the cooperation score, the mean of the self-selected group is higher than that of the Belbin-engineered group. Additionally, the overall group grade of the self-selected group is also higher than that of the Belbin-engineered team. This score decline suggests that students working in the Belbin-engineered group may be unfamiliar with the new team members and unsure of the way they work with each other, thus leading to a lack of cooperation within the group and a drop in students' overall group performance ratings. In addition, there was only a 0.43 difference in the mean grades of the overall performance between the two groups rated by students. An independent t-test was conducted to determine whether there is a significant difference in the performance mean between the means of the assessment scores for two types of groups, which showed that the difference in means between the two groups is not statistically significant ($p > 0.05$).

Table 3. Performance difference between groups

	Self-selected group (N=35)				Belbin-engineered group (N=35)			
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.
Leadership	6.23	1.50	3	10	6.54	1.38	3	9
Cooperation	7.57	1.40	5	10	7.23	1.72	2	10
Initiative	6.74	1.69	5	10	7.23	1.61	2	9
Attitude	7.51	1.27	5	10	7.54	1.40	4	10
Effort	7.09	1.36	5	10	7.40	1.35	4	10
Group Grade	8.69	1.43	5	10	8.26	1.38	5	10

DISCUSSION

Recapping the findings, it is evident that when students are given the freedom to choose their group, they tend to prefer working with acquaintances. The factors confirmed by the students for forming self-selected groups suggest they are more willing to collaborate with individuals they know to ensure better group performance. However, this self-selected form of grouping can also lead to parasite and opportunist behaviour patterns, where some students rely on others in the group without contributing themselves (Marin-Garcia and Lloret, 2008). It is widely accepted that teamwork is one of the essential transferable skills, but teaching it to diverse student cohorts is challenging and time-consuming. Teamwork is an indispensable practical part of higher education and an important aspect that students will inevitably experience in the workplace after graduation. Although educators in higher education have made efforts to provide students with opportunities for learning and practising teamwork, it takes work to control the quality and process of team performance (Meslec and Curseu, 2015).

In our research, the primary attempt is to integrate Belbin team roles into teaching practice, as this team role theory has been widely used in many university education scenarios (Marin-Garcia and Lloret, 2008; Meslec and Curseu, 2015; Aranzabal, Epelde and Artetxe, 2022). Hence, we expect to enhance students' understanding and application of team cooperation and teamwork skills in the designed Chemical Engineering workshop by introducing and applying the Belbin team theory. The results enable us to determine that integrating Belbin team roles in teaching can facilitate students' performance in group collaboration (Zarzu,

Scarlat, and Falcioglu, 2013). It seems evident that the Belbin team system successfully promotes students' behaviour in the group to a certain extent. However, due to the limitations in the workshop's design and arrangement, the Belbin theory's introduction did not achieve the desired effect. After completing the project-based design by each group, we did not provide clear criteria to assess the students' work. Without a final evaluation of overall performance, it may have led to students' lack of motivation and goals in collaborating on the project and prevented the level of engagement and interaction among group members. We have also discovered that it can be challenging for PGT students to fully understand and practise the rules of the Belbin team roles, especially for students enrolled in one-year PGT programmes at UK universities, as most are overseas students and the curriculum duration is limited. They do not have sufficient class hours to gradually understand teamwork's content, significance, and necessity of teamwork and practise different team roles' duties in real situations.

From an educator's perspective, we expect to provide students with useful learning materials and allow them to understand and practice teamwork skills. From the students' point of view, they also hope to acquire more skills that will benefit their future career development within the limited classroom learning time. But, it is evident that applying the Belbin test in a one-year PGT programme may not fully meet the practical learning needs of such students. However, this does not mean that we abandon using team role theories such as Belbin, but rather that we will optimise and design team formation and collaboration methods that are more suitable for practical application in students' learning in one-year PGT programmes in the UK.

CONCLUSIONS & RECOMMENDATIONS

This study provides insights into the teamwork and collaboration with PGT students in UK university teaching. Firstly, we report the findings of a workshop study on the preference factors of PGT students when forming a self-select group. We found that the self-selected groups are often based on whether team members know each other. Most students probably do not realise the impact of balanced team function and composition on overall team performance. Compared to forming a self-selected group, if students form a group based on the Belbin role theory, it can improve the group's overall performance but require further learning with relevant theories and extra hours to practise. However, for overseas students with limited study duration in the UK master's courses, it will be more challenging for them to grasp and practice teamwork skills. On the other hand, due to the limitations of the implementation of this study, there was insufficient systematic explanation when introducing Belbin team roles to students before the workshop, nor was there further evaluation to examine whether the group members assigned their respective role responsibilities in each

group activity. In addition, the self-assessment form used as the team collaboration measurement was simplistic to provide comprehensive feedback on the team's overall performance. Therefore, our future research will explore and design a new team role inventory questionnaire and assessment method more suitable for assessing PGT students' practical experience and teamwork performance. We will also include more diverse evaluation measures, such as students' individual cognitive and learning abilities and language proficiency in learning.

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