ENHANCING INTERCULTURAL COMPETENCE OF ENGINEERING STUDENTS VIA GVT (GLOBAL VIRTUAL TEAMS)-BASED VIRTUAL EXCHANGES: AN INTERNATIONAL COLLABORATIVE COURSE IN INTRALOGISTICS EDUCATION

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ABSTRACT

In order to enhance the intercultural competence of engineering students, an international collaborative course in intralogistics education was initiated and realized between the Technical University of Munich in Germany and the Tongji University in China. In this course, students worked in global virtual teams (GVTs) and solved a concrete case study in the field of intralogistics in a virtual setting via modern communication tools. This paper introduced the course in detail and reported lessons learned from conducting the course and student feedback. The findings of this study suggested that teaching using GVT-based virtual exchange is effective in improving intercultural competence of engineering students.

1. INTRODUCTION

In order to succeed in today's working environment, engineers need not only to have excellent "hard" technical skills, but also to develop their "soft skills" which is also known as interpersonal skills, people skills or personal attributes that one possesses (Berglund and Heintz, 2014; Robles, 2012). A lack of soft skills will cost time and money (SitePoint, 2016). Therefore, in almost every job listing, soft skills are required, and candidates who posses both technical and non-technical skills are preferred by employers (Tong, 2003).

With the increasing globalization, the cross-border collaboration is more and more common in the industry. Intercultural competence has been becoming one of the most important soft skills which engineers need to develop today. According to a survey of the German Chambers of Industry and Commerce (DIHK) in 2013, every second German corporation was planning to invest in foreign countries and the most favourite ones are China and the USA (von Borstel, 2013). Alone in China, the number of the affiliates operated by German investors achieved 5200 in 2015 (Germen Chamber of Commerce in China, 2015). Against this background, global engineers need not only to be able to communicate in foreign languages, but also, just as importantly, to develop their cross-cultural competence which will assist them in working collaboratively in their expatriate assignments.

In the working area of logistics in a globalized context, this competence has become indispensable. While people usually emphasize this competence in the area of supply chain management, corporations also need more and more employees with intercultural abilities in the working field of intralogistics. The term „intralogistics" is defined by the German Mechanical Engineering Industry Association (VDMA) as the organization, control, execution and optimization of the internal material flow, information streams and

goods handling in industrial, commercial and public facilities (Friedrich, 2012). In the survey of DIHK, one third of the companies with investment intentions were planning to expand their production capacities in foreign countries (von Borstel, 2013). These companies usually face the challenges where to build their factories, how to design their factories and how to optimize their material flows of their production in the foreign countries.

In order to prepare students for their jobs in a global market, the Institute for Materials Handling, Material Flow and Logistics (fml) at the Technical University of Munich (TUM) has initiated und designed an international course in cooperation with the endowed chair of the Jungheinrich Foundation at the Tongji University in Shanghai. The goal of the course "Planning intralogistics systems in an international context" is on the one hand to teach students the most important methods for the planning of material flow and logistics processes in the intralogistics, on the other hand it aims to strengthen their international und cross-cultural competence.

In this paper we present the findings from conducting the course. Section 2 presents the related work and activities regarding international exchanges especially virtual exchanges in engineering education. After that, we introduce the design and the execution of the course in section 3. In section 4, student feedback and lessons learned are discussed. Our paper closes with a conclusion and future perspectives in section 5.

2. RELATED WORK AND ACTIVITIES

Realizing that it is important to address and develop the intercultural competence of engineering students before they are sent off to the working world, universities increasingly offer and promote different kinds of programs to provide students opportunities to train this skill. International travel-based experiences such as study abroad or international internships are the most popular programs in the recent years (Parkinson, 2007). These programs have the benefit that students learn first hand about a different culture during their study visit or working stay in the foreign countries. Studies show that students who participate in longer study abroad programs demonstrate a positive change on intercultural competence, language proficiency and also on intellectual and cognitive development (Custer, 2016). However, because of the high cost und time issues, not all of the students, especially the undergraduate students, are able to afford such a travel-based program (Ball, 2012; Maldonado et al., 2014). According to a report of the German Academic Exchange Service (DAAD) in 2015, only about half of the enrolled students in Germany have studied abroad or are planning a study abroad period. In the engineering field, this proportion is even lower (Woisch and Willige, 2015). In addition to the cost and time challenges, an unprepared study in foreign countries could also be less effective or even fail. Studies found out that students become more confident and learn more productively if they have the awareness of cultural differences before they go abroad (Del Vitto, 2008). Under these circumstances, universities are beginning to search for additional ways to enhance the intercultural competence of their students.

With the rapid development of computer and Internet technology, global virtual teams (GVTs) have become a business necessity in multinational organizations. A GVT is a "temporary, culturally diverse, geographically dispersed, electronically communicating work group"(Jarvenpaa and Leidner, 1999). People of the groups are distributed in different countries and "rarely meet in person, conducting almost all of their interaction and decision making using communications technology"(Chudoba and Maznevski, 2000). As GVTs are increasingly common and important in the working world, some universities have also launched GVT-based courses or trainings to provide an international virtual exchange for the students. Compared to study abroad programs, virtual exchanges are not associated with high cost and investment. Moreover, they are scalable and timely more flexible and can therefore be adopted as an alternative or supplement to study abroad programs (Custer, 2016; Taras et al., 2013).

Virtual exchanges are often used in language or intercultural communication courses (Custer, 2016; Lamy and Goodfellow, 1999; Munkvold et al., 2011). In management education or MBA courses, where teamwork is needed, GVT-based virtual exchanges are becoming increasingly popular (Taras et al., 2013). In the working field of software development, GVT is increasingly used, especially in large IT companies who have numerous software development groups residing in different countries around the world. Therefore, some GVT-based courses are found in software engineering education which are mainly aimed at helping students better understand the distributed collaborative software development process (Edwards and Sridhar, 2003;

Richardson et al., 2006). However, in other engineering fields, there exist only few courses based on virtual exchanges. "Engineering the future: A global Endeavour" was a joint transnational course between the Technical University of Dortmund in Germany and the University of Virginia in the USA. This course contained a section with a role-playing simulation which focused on nuclear energy. Students had to work in multinational teams and played the roles of different stakeholders such as government representatives, nuclear company representatives, environmental activists, journalists and so on. In the end, a nuclear energy policy based on the group discussion had to be developed by each team. The course was a pilot project for improving intercultural competence of engineering students using online role-playing simulation and it mainly focused on social-technical systems and cross-cultural contact (May et al., 2015).

The course we have developed provides an innovative and inspiring possibility in engineering education. In this course, students have to work in GVTs and solve together a concrete case study in the field of intralogistics.

3. DESIGN AND EXECUTION OF AN INTERNATIONAL COLLABORATIVE COURSE FOR INTRALOGISTICS PLANNING

3.1 Course Content

The international collaborative course between the Technical University of Munich und the Tongji University was entitled "Planning of intralogistics systems in an international context" and it was primarily designed for graduate students with a background in intralogistics. In this course, students learn the relevant planning methods and procedures in the working field of intralogistics by solving a case study. In the case study, students play the roles being employees of a planning office, who is commissioned by a renowned German company in Shanghai to plan a new factory due to an ongoing increase in demand. For this reason, current intralogistics systems and processes need to be investigated and analysed. Based on the analysis, the new factory as well as its logistics systems are to be planned. Although the story which is told in the case study is fictional, a big part of the data which are used in the case study was collected from the company, so that the insight into the real-world industrial processes could be guaranteed. Figure 1 shows the typical planning phases for the intralogistics planning. The planning process principally consists of four phases: the preparation phase, the gross planning, the detailed planning and the final implementation. In each phase, different sub tasks need to be handled. The case study is split into three parts and each part contains different tasks. Part 1 deals with the tasks in the preparation phase and the gross planning phase. Students are asked to carry out a comprehensive material flow analysis of the current factory based on the given information. Furthermore, a site selection using benefit analysis for the new factory is to be performed and a layout for the new factory is to be developed. In part 2, a more detailed planning is carried out. Based on given information, students are asked to design two possible system alternatives for the central warehouse of the new factory: 1) a multi-bay racking warehouse with narrow-aisle stacker and 2) a high racking warehouse with stacker cranes. In part 3, both of the two prepared variants need to be compared by means of a benefit analysis as well as different methods of capital budgeting. By solving the case study, students get to know the typical tasks which occur in different phases of intralogistics planning and learn the methods to solve the tasks.
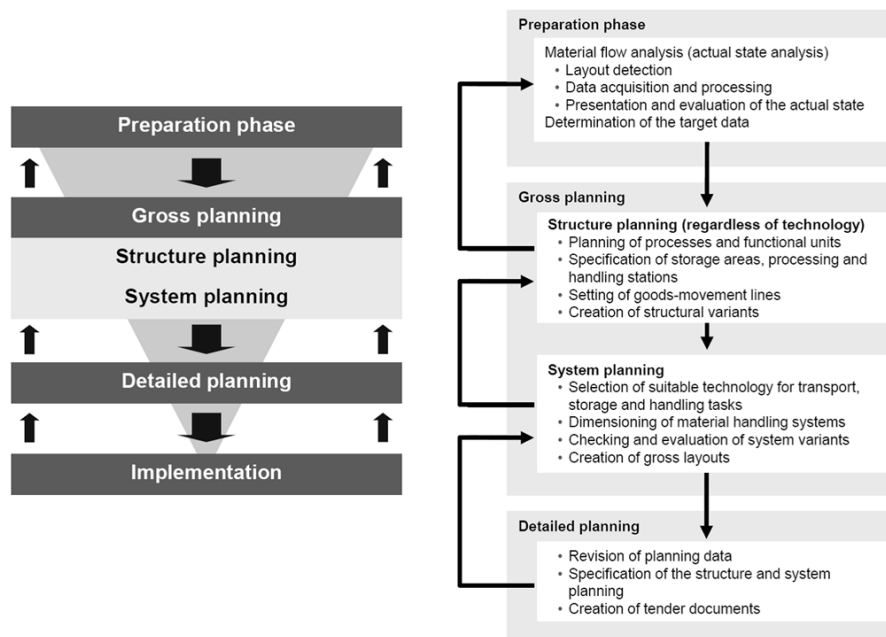
Figure 1. Phases and the related tasks of the intralogistics planning (course content)

3.2 Course Organization

The different curricular structures and study schedules present major challenges for joint transnational courses (May et al., 2015). For example, a lot of the graduate students from Tongji University are doing internships or are participating in study abroad programs during the summer semester. Therefore, the course had to be arranged in the winter semesters. Furthermore, the German lecture period in winter semester usually starts in the middle of October and ends in the middle of February, whereas the Chinese lecture period lasts from the beginning of September to the end of December. Therefore, we had to arrange the course with respect to the different academic calendars. Furthermore, the big difference of the time zones (seven hours in winter) also needed to be considered while planning the course. The course had totally 4 obligatory dates (Figure 2): Kick-off and part 1, part 2, part 3 and the closing session. Each date took about 2 hours. In each obligatory date, theories as well as methods to solve the tasks of the respective part of the case study were presented to all of the students via live broadcasting between TUM and Tongji. After that, the students needed to organize their teamwork with their team members to solve the tasks of the case study together. They had to submit their solution in a written document to the supervisors via email the day before the next course date. Besides, selected student teams had to present their results in front of the class in the next course date. In the winter semester 2016/2017, we had totally 40 students from both universities in the course: 22 from the TUM and 18 from the Tongji University. We built 9 teams, each team consisting of 4-5 students (2-3 from the TUM and 2 from the Tongji university). For each part of the case study, we selected 3 teams to present their results. The teams were asked to choose one or more team members as representatives to do the presentation. However, most of the students decided to present the results as a team, splitting the speaking time equally among all of the team members.

Because of the time difference between Germany and China and the different study schedules, we gave the students the freedom to organize their teamwork by themselves according to their individual needs. However, we provided consultation hours twice a week, for each part of the case study. The consultation hours were non-obligatory. Yet students had the possibility to consult the supervisors when they had questions or difficulties to solve the tasks. During consultation hours, computers with Internet connection were provided so that the students also had the possibility to carry out their teamwork under supervision.

There was also a short written test for each part of the case study. The short written tests, the written documents as well as the presentation made up the final overall grade of the students.
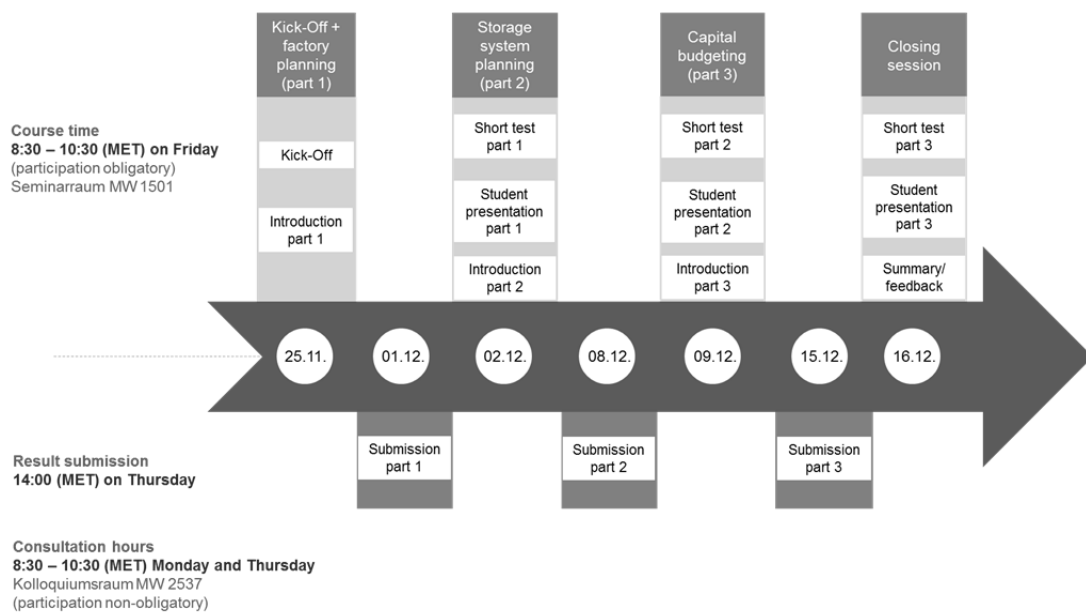
Figure 2. Course schedule and organization (Winter semester 2016/17)

3.3 Communication Tools

As already introduced, the four obligatory course dates were conducted via live broadcasting. We used the web conferencing tool from the German National Research and Education Network, DFN, a non-profit association for promoting communications networks for science and research in Germany. The tool supports multipoint audio and video conferences, whiteboard and document sharing, archive for PowerPoint presentations, role management e.g. moderator or participant, chat discussion and much more (https://www.vc.dfn.de/en.html). For each obligatory course date, the lectures were presented in PowerPoint and broadcasted via this tool, including a bidirectional audio-visual webcast. Student presentations were also live broadcasted in the same way (Figure 3).

As introduced previously, students were asked to organize their teamwork by themselves. We conducted a research regarding possible teamwork and communication software and listed the features of these software in the kick-off meeting. Besides DFN, Skype, WhatsApp and WeChat (the most popular chatting App in China) can also be used for live communication. However, there are still some differences in the features. OneDrive is a file hosting service of Microsoft. The biggest advantage of OneDrive is that it supports online collaboration. People have the possibility to edit Word or PowerPoint documents at the same time online and any change of the documents can be seen by all in real time. The above mentioned software were introduced by the lecturers. However, students had the freedom to decide which software they use according to their own needs.
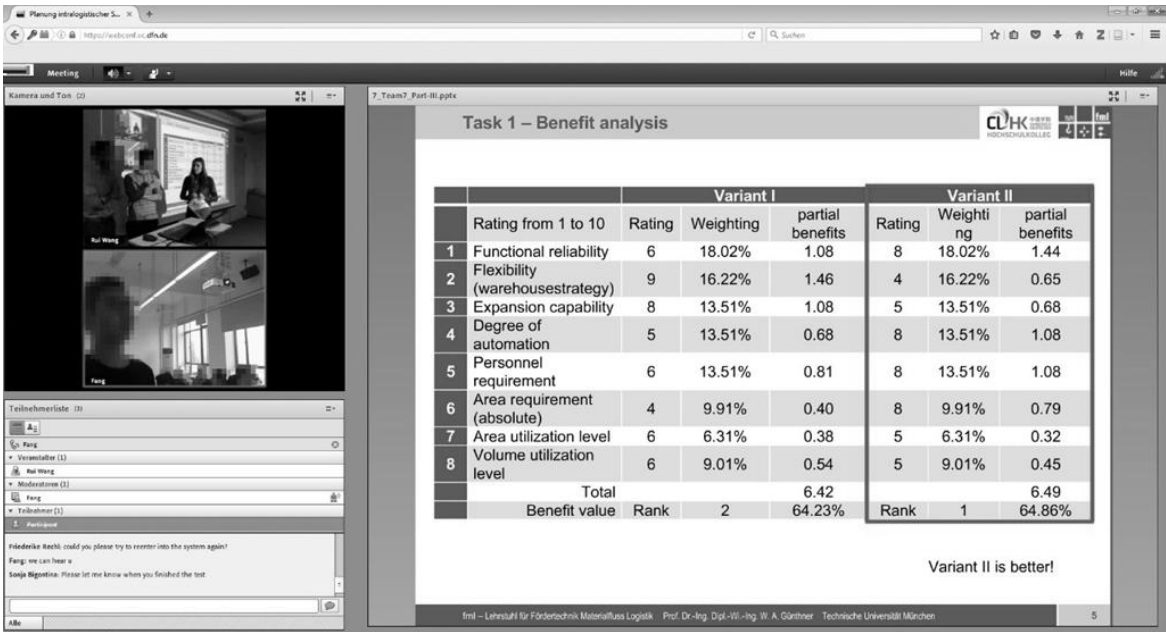
Figure 3. Live Broadcasting via DFN-tool

3.4 Teaching Methods

We applied different teaching methods in this course. The first part of the case study (factory planning) was set up as a role play. Students in a team played different roles of the planning office and got different information about the factory. To get the complete information for solving the case study, they had to work closely together and exchange information with each other. For the second and third part of the case study, we suggested task division with subsequent discussion. In part 2, students were asked to design two system alternatives for the central warehouse. They were suggested to divide the tasks inside their teams. For example, in some teams, students at TUM designed one alternative and students at Tongji designed another alternative. After that, they compared their results and conducted a subsequent discussion. In part 3, the benefit analysis as well as different methods of capital budgeting could be carried out in the same way.

4. FEEDBACKS AND LESSONS LEARNED

At the conclusion of the course, students were asked to complete an anonymous online survey designed to get their feedbacks regarding the design, execution and effectiveness of the course. We had totally 40 students and got 26 responses from the online survey.

The key results of the student feedback are shown in Figure 4. Most of the students are very satisfied with the course. More than half of the survey participants rated the course as "excellent" or "very good". Regarding teaching methods, most students preferred task division with a subsequent discussion. However, there are also some participants who preferred roleplay or both. Students used different software to conduct their teamwork, including OneDrive, Skype, WhatsApp and WeChat. Among them, OneDrive and WhatsApp were mostly used and students are principally satisfied with the software. While most students had no problems with their teamwork, some students still had difficulties in working with their teammates. According to the opinions of the surveyed students, the main reasons were the cultural difference and limited language skills. Time difference, lack of team spirit and also different prior knowledge also played a role. Almost all of the students stated that the course has helped them to improve their intercultural competence and that they would recommend the course to other students.

The results of the survey proved that a GVT-based course is effective to improve the intercultural competence of engineering students. Not only from the student feedback but also from the conduction of the course and the consultation hours, there are the following important lessons we have learned.
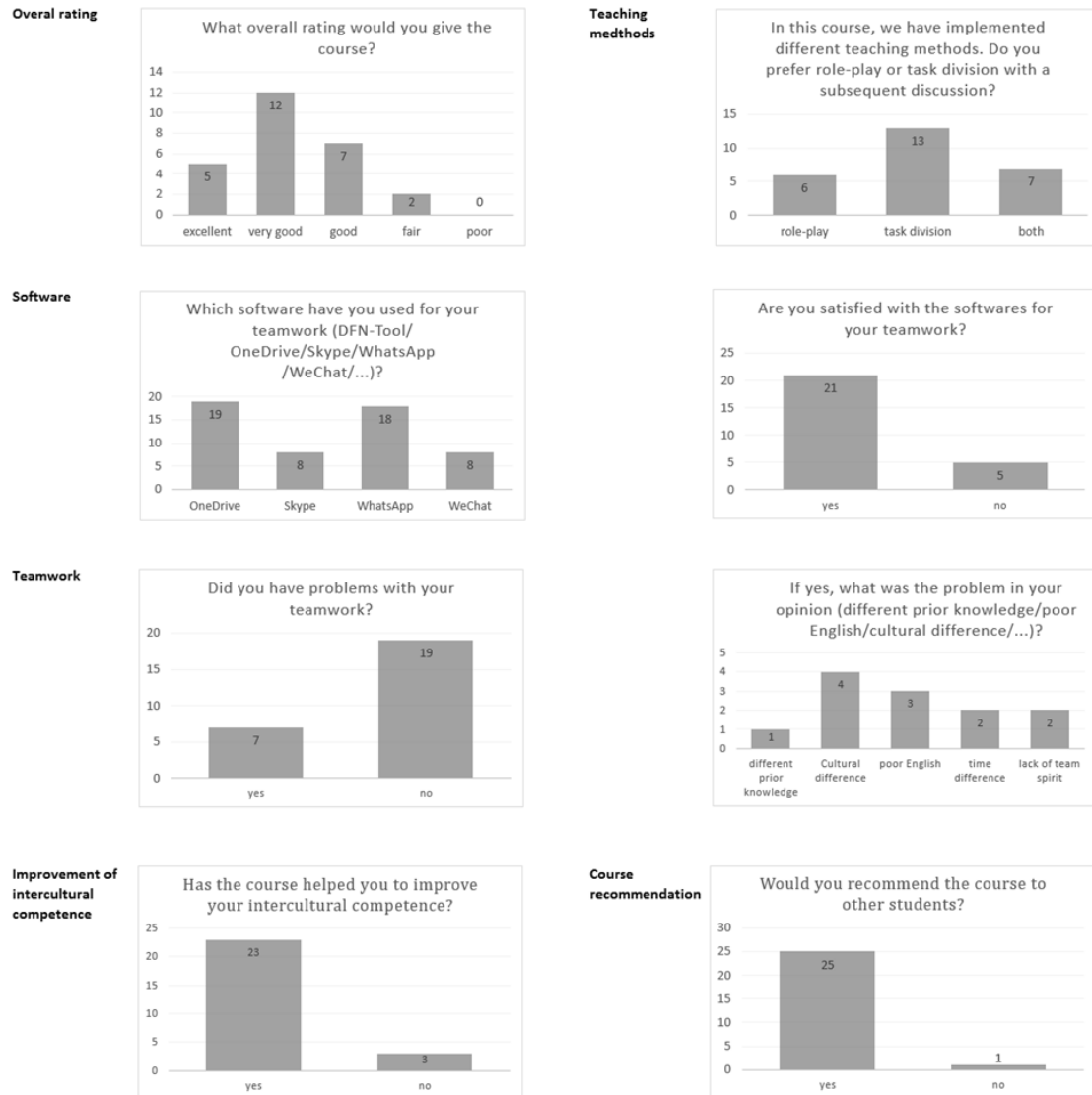

Figure 5. Student feedback

4.1 Organization

A course for students who are situated in different places needs to be very well and carefully organized. It is recommended to structure the entire course thoroughly and think ahead about possible problems which may arise and their solutions before the course starts. Organizational information needs to be clear and precise. In our course, we have prepared a document with all of the organizational information such as submission deadlines, scope and time of the written tests, etc. and have sent it to all of the students at the beginning of the course so that the students have always had a clear instruction to follow throughout the course. In order to avoid unnecessary problems or work, it also requires a good coordination between the instructors at both universities to exchange information and clarify teaching tasks and to-dos for every course date.

4.2 Technologies

For a GVT-based course, broadcasting and communication software plays a very important role. Especially for an international cross-country course, improper IT-settings or unstable Internet connections dramatically influence the course quality. Therefore, it is important to set up and test the IT and Internet environments before the course starts and also before every course date. The tool we have chosen (DFN) has proved to be a very effective tool for the course. However, we still have tested it every time before the course started and adjusted the video and audio settings in the most appropriate way so that a live broadcasting with a fine quality could be guaranteed.

As mentioned in the last part, we have given the students the freedom to choose the software for their teamwork themselves. OneDrive has proved to be a very useful tool for the teamwork, especially when team members would like to work on a specific document in real time together. However, some students in China have complained that the OneDrive connection in China is very unstable, which has influenced their working progress a lot. Alternatives to OneDrive need to be found in the future. Since there are a lot of possible software tools for audio and video conferences, students had no problems with this kind of communication.

4.3 Teamwork

It is usually reported that Asian students are reticent and passive learners in classrooms (Braddock et al., 1995; Jones, 1999). Many researchers think that this behaviour results from certain cultural attributes of Asian societies (Griffiths et al., 2014; Turner and Hiraga, 1996). However, some researchers have argued that this allegations of reticence and passivity set up against Asian learners are over-generalizations (Cheng, 2000; Liu and Littlewood, 1997). Although this behaviour may be true for some Asian students, the causes are situation specific which are more likely related with the teaching methodologies and the lack of language proficiency.

In the designing phase of the course, we have considered this factor which could potentially influence the teamwork. Therefore, we have implemented various strategies to promote the motivation and willingness of the students to better participate in the teamwork. Firstly, we introduced diverse teaching methods to this course, including role play and task division. Secondly, considering the time difference, we allowed the students to organize their teamwork outside the course by themselves. In this way, they could find a suitable time frame and place and might feel more at ease to conduct their discussion. Thirdly, we introduced a presentation part to the course. Students might be more motivated for the teamwork when they know that they are going to present the results in front of the class. Fourthly, we kindly asked the students to give a short summary about the collaboration within their team including the following key questions: 1) How often did your team (all members) meet virtually? 2) Did you split the tasks within the team? If so, please state in this document who worked out which task. In this way, students felt more obliged to better participate in the teamwork. Finally, through the entire course, we encouraged the students to inform us if they had problems with their teamwork so that we could help them to solve the problems or conflicts right away.

By deploying the above mentioned strategies and methodologies, most of the students were motivated and participated actively in their teamwork and most of them were also satisfied with their teammates. It has been proven that potential problems resulting from cultural differences and the difference in time can be compensated or even avoided through appropriate and thoughtful teaching methodologies.

5. CONCLUSION AND FUTURE PERSPECTIVES

The course we have developed provides an innovative possibility to improve the intercultural competence of engineering students. A course in this form is a first attempt not only at the TU Munich but also at the Tongji University. By building up GVTs using modern communication technologies and platforms, students distributed in geographically distant locations have the opportunity to communicate with each other, carry out teamwork on concrete engineering issues, jointly work out solutions and make decisions. In this paper, we have introduced the course in detail including the course content, the course organization, the teaching methodologies as well as the deployed communication tools. Furthermore, student feedback and lessons learned were discussed extensively. We hope to provide inspiring ideas to other institutions or educators in

engineering education by sharing our experiences. According to the student feedback, a course in this way is proved to be effective in improving the intercultural competence of engineering students. We think GVT-based virtual exchanges could be used as an alternative way or as a supplement as well as a preparation for study abroad programs or internships abroad. Furthermore, it also indeed promotes the international exchange of students from different countries and universities. The students got to know our partner institute and university better by taking part in the course. Some have asked about possible study abroad or internship possibilities at the partner university and one student has even already applied for it directly after the course.

As mentioned, a big part of the data which are used in the case study was collected from a German company in China. In the future, we will further expand the collaboration between academic institutions and industry and hope to be able to put more practical elements or real-world cases into the course. Moreover, by interacting with the industrial partners, we also hope to be able to arrange industrial internship positions for students in the context of the course. In this way, students could also gain more practical experiences while improving their technical knowledge and intercultural competence, which is particularly important in today's engineering education.

ACKNOWLEDGEMENT

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