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USING MODERN COMMUNICATION MEDIA AS A LECTURE BASE FOR ENGINEERING STUDENTS: AN INTERNATIONAL COOPERATIVE COURSE IN INTRALOGISTICS PLANNING

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ABSTRACT

In order to improve the intralogistics planning and intercultural competence of engineering students an international cooperative course in intralogistics planning has been initiated and realized between the Technical University of Munich (TUM) in Germany and the Tongji University in China. The course was launched in the summer of 2016 and has been offered three times so far. During the course, students work in global virtual teams (GVTs) and solve a case study in the field of intralogistics planning supported by modern communication media. As of the winter semester 2017/2018, this paper describes the course's concept in detail and provides recommendations based on experiences from conducting the course as well as the students' feedback. The main finding suggests that the usage of modern communication media as a lecture tool is supportive of teaching methods and approaches of intralogistics planning.

KEYWORDS

Global Virtual Teams, Modern Communication Media, Virtual Exchange, International Cooperative Course, Intralogistics Planning, Engineering Education, Intercultural Competence

1. INTRODUCTION

To succeed in today's working environment engineers need to have excellent "hard" technical skills and knowledge, but also to develop their soft skills (Berglund and Heintz 2014; Robles 2012; SitePoint 2016). Therefore, candidates who possess both technical and non-technical skills and experience are preferred by employers (Tong 2003). Moreover, globalization makes cross-border cooperation more and more common in every working field. Thus, specific knowledge and intercultural competence are key success factors for engineers (Borri, Guberti and Melsa 2007; Hazelton, Malone and Gardner 2009).

According to a survey of the German Chambers of Industry and Commerce (DIHK) in 2013, every second German industry project was planning to invest in foreign countries, from which China and the USA were the most favourite ones (von Borstel 2013). Against this background, besides their technical knowledge, international engineers need to be able to develop their soft skills and communicate in foreign languages. Both will help them for working collaboratively and efficiently in international project teams. 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 2018). In the mentioned survey, one third of the companies with investment intentions were planning to expand their production capacities to foreign countries (von Borstel 2013). These companies usually face various challenges like where to build their production sites abroad, how to design their plants or how to optimize their material flows.

The goal of the course "Planning of intralogistics systems in an international context" is to teach engineering students from different nations the most important methods for the planning of material flow and logistics processes in intralogistics practically based on a real project. Besides, it aims at strengthening the international und cross-cultural competence of the participants who elaborate a case study in multinational teams located in different countries. This paper points out the benefits of using modern communication media as a lecture base.

In this paper, the findings from conducting this course which was held for the third time in the winter semester 2017/2018 are presented. Thereby, recommendations for carrying out an international cooperative course with the usage of modern communication media can be given.

The paper is structured as follows: Section 2 outlines generally related work and activities as regards international exchanges using modern communication media in engineering education. The specific design and the execution of the initiated course are introduced in section 3. In section 4, the results from the latest student feedback are shown. Recommendations are derived from previous experiences and reactions and described in section 5. The paper ends with a conclusion and future perspectives in section 6.

2. RELATED WORK AND ACTIVITIES REGARDING THE USE OF MODERN COMMUNICATION MEDIA IN ENGINEERING EDUCATION

Understanding that it is important to address and develop the competence of engineering students before sending them off to the working world, universities increasingly offer and promote different programs and courses in an international context. International travel-based experiences such as study abroad or international internships are popular programs in this context (Parkinson 2007).

These programs offer the benefit that students learn first-hand about different cultures during their study visit or working stay in foreign countries. Studies reveal that students who participate in longer study abroad programs, show a positive change in their soft skills, language proficiency and also in intellectual and cognitive development (Custer 2016). Nevertheless, not all students, especially the undergraduate students, can afford such a travel-based program due to high costs or time issues (Ball 2011; Maldonado et al 2014). According to a report of the German Academic Exchange Service (DAAD) in 2015, only about one half of the enrolled students in Germany has studied abroad or were planning to study abroad. In the engineering field, this share is even lower (Woisch and Willige 2015).

In addition to cost and time challenges a lack in preparation can make studying in foreign countries less effective or even lead to failure. Studies found out that students become more confident and learn more productively if they have the awareness of cultural differences before going abroad (Del Vitto 2008). Under these conditions, universities are beginning to search for additional and effective possibilities to offer their students low cost and easy ways to enhance their skills.

With the rapid development of computer- and Internet-based technology, so-called global virtual teams (GVTs) have become a business requirement in multinational organizations and projects. A GVT is a "temporary, culturally diverse, geographically dispersed, electronically communicating work group" (Jarvenpaa and Leidner 1999). People of such a group 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 by using modern communication media to provide an international virtual exchange for their students. Compared to study abroad programs, lectures based on these technologies do not involve high costs and effort. Moreover, they are scalable and flexible regarding time and can therefore be adopted as an alternative or supplement to study abroad programs (Custer 2016; Taras et al 2013).

Virtual exchanges using communication media are often used in language or international communication courses (Custer 2016; Lamy and Goodfellow 1999; Munkvold, Zigurs and Khazanchi 2011). In management education or business courses, where teamwork is needed, GVT-based virtual exchanges are becoming increasingly common (Taras et al 2013).

In the working field of software development, GVT is even more deployed, especially in large IT companies who have several software development groups located in different countries around the world. Therefore, some GVT-based courses are found in software engineering education to improve the students' understanding of a distributed cooperative software development process (Edwards and Sridhar 2003; Richardson et al 2006).

However, only a small number of courses based on virtual exchanges and modern communication media exist in other engineering fields. To name one example, the course "Engineering the future: A global Endeavour" was a joint transnational project 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 worked in international 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, Wold and Moore 2015).

To initiate further courses based on modern communication media is also interesting in the area of intralogistics, a very international field of work with a lot of potentials. The course "Planning of intralogistics systems in an international context" offers an innovative and exemplary possibility in engineering education. As there is an increasing number of projects in China operated by German investors (von Bostel 2013), a collaboration between Germany and China has been chosen for this lecture. The course is held in English and the teams also communicate primarily in English which is a foreign language for almost all participants. Thereby, it is opened and interesting not only for German and Chinese students but to all international engineering students enrolled at both universities.

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

3.1 Course Content

The international cooperative course between the Technical University of Munich and the Tongji University was entitled "Planning of intralogistics systems in an international context". In this lecture, students get to know relevant planning methods and procedures of material flow and intralogistics planning and learn how to apply them by solving a given case study.

Therein, students play the roles of employees of a planning office. The planning office is hired by a German company located in Shanghai to plan a new factory site due to increasing demands for their products. For this reason, the currently existing intralogistics systems and processes need to be investigated and analysed in detail. Based on this analysis, the new site's material flow as well as its intralogistics have to be planned.

Although the case study's story background is fictional, the majority of the used data has been provided by the German company. That guarantees the students to get an interesting and enriching insight into real-world industrial processes and planning activities in a logistical context.

Figure 1 shows the typical phases of intralogistics planning. They are used as a basis for the course contents. 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 and activities need to be handled. The case study is split into three parts, each one contains different tasks and activities.

Part 1 deals with the tasks and activities 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 and material flow numbers. Furthermore, a site selection for the new factory has to be done by investigating three different possible Chinese sites with respect to different location factors which have to be evaluated in a benefit analysis. An appropriate layout has to be developed for the selected new factory site.

A more detailed planning is then carried out in part 2. With the help of provided information, students are asked to design two possible system alternatives for the central warehouse of the new factory site:

1. A high-bay racking warehouse with manually operated narrow-aisle stackers and
2. a high-bay racking warehouse with automated stacker cranes.

In part 3, both of the two prepared planning alternatives need to be compared and evaluated by means of a non-monetary benefit analysis as well as different methods of static and dynamic capital budgeting. A decision on the best investment has to be elaborated after evaluating the system alternatives monetarily and non-monetarily. The subsequent phase of implementation is not considered in the case study.

By solving the case study, students get to know the typical tasks which arise in the different phases of intralogistics planning and learn how to solve the tasks by using the methods presented in the respective lectures.

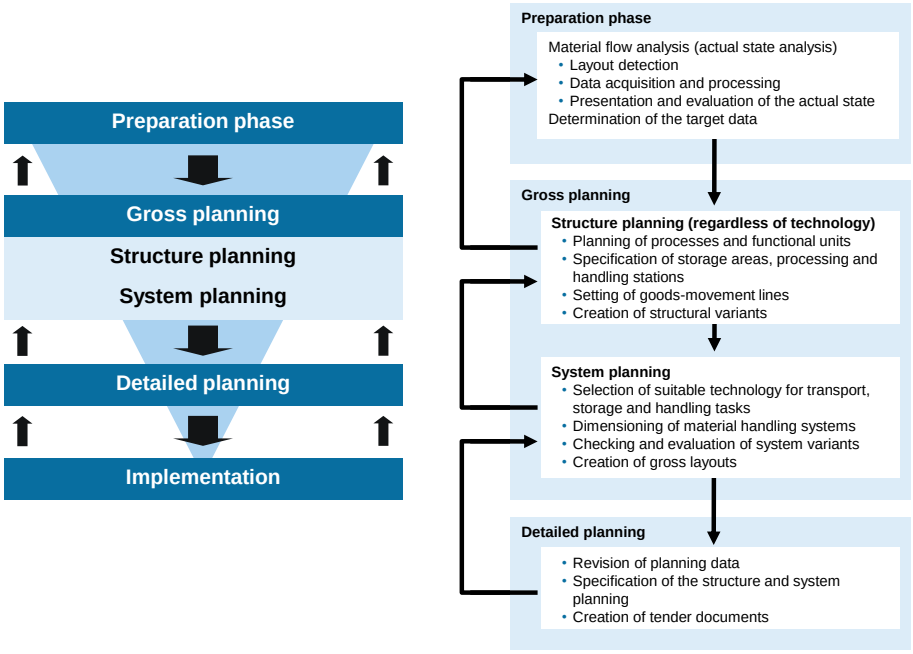


Figure 1. Phases, tasks and activities of intralogistics planning (course content)

3.2 Course Organization

The different curricular structures and study schedules of the participants present a major challenge to joint transnational courses (May, Wold and Moore 2015). 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. Hence, the course has to be arranged with respect to the different academic calendars.

Besides, the different time zones (difference of seven hours in winter) need to be considered while planning the course and its four obligatory lectures (Figure 2):

- Kick-off and lecture part 1 (factory planning),
- Test part 1, student presentation part 1, lecture part 2 (storage system planning),
- Test part 2, student presentation part 2, lecture part 3 (capital budgeting) and
- Test part 3, student presentation part 3, summary and feedback.

Each of the lectures takes about two hours, resulting in time slots in the morning in Germany (08:30 a.m. till 10:30 a.m. MET) and in the afternoon for students in China.

In the beginning of the lectures, the theoretical content taught in the previous lecture is examined by means of a short written test. After the test, one third of the teams has to present their results for the week's part of the case study and answer the supervisors' questions related to their elaborations. Afterwards, in each obligatory lecture, theories as well as methods to solve the tasks of the respective following part are explained to all of the students via live broadcasting between TUM and Tongji and questions related to the contents are answered. The official lecture ends here and the students get the opportunity to organize their teamwork with their team members to solve the tasks of the case study.

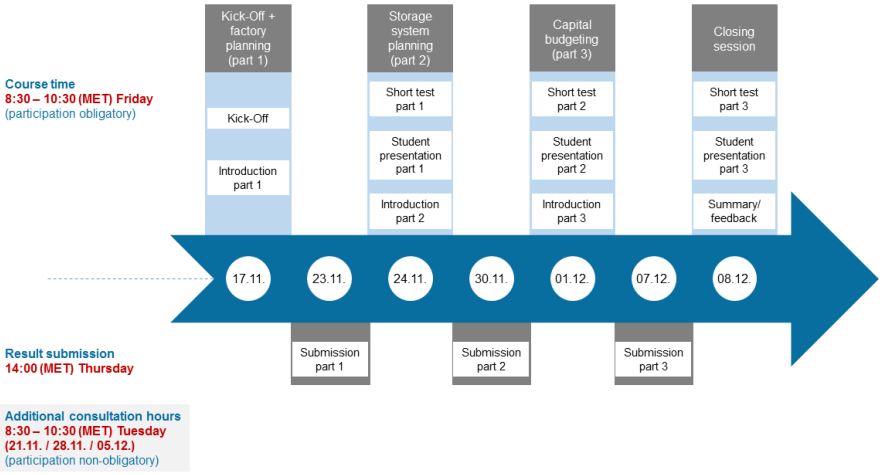


Figure 2. Course schedule and organization (winter semester 2017/2018)

Previous to the first lecture, the students are assigned to different teams. Each team consists of five to six students – the design of the case study implies this number of team members. Furthermore, the students are equally distributed to TUM and Tongji in order to lay the foundation of GVTs, which requires team members to work together while being sited at different locations.

Due to the time difference between Germany and China and the individual study schedules the students are free to organize the teamwork by themselves according to their individual needs. Therefore, the use of modern communication media, like OneDrive or Skype, is a necessity. However, additional consultation hours are provided once a week for each part of the case study. The consultation hours are non-obligatory. Hence, the students have the possibility to consult the supervisors when they have questions or difficulties to solve the tasks. Additional questions can be asked independently from the consulting hours at any time via Email to the supervisors.

Each week, the solution of the teamwork has to be submitted in a written document to the supervisors via email the day before the next lecture. The students have to use a provided template for the submission. Besides, each student team (shown in Figure 2) has to present their partial result in front of the class in one of the lectures. The teams have the opportunity to choose one or more team members as representatives. The presentation has to last 12 to 15 minutes and is broadcasted in real time. The final grade is then calculated by the individual result of the short written tests, the submitted solution documents and the group presentation.

3.3 Communication Tools

As introduced, the four obligatory lectures are conducted via live broadcasting. The web conferencing tool from the German National Research and Education Network, DFN, a non-profit association for promoting communication networks for science and research in Germany, is a convenient tool and used for the lecture. The tool supports audio and video conferences and also whiteboard and document sharing applicable for presentations and chat discussion (https://www.vc.dfn.de/en.html). Moreover, there are no privacy issues when using DFN. The lectures are presented in PowerPoint and broadcasted via this tool for each obligatory lecture including a bidirectional audio-visual webcast. Student presentations are equally broadcasted in real time (shown in Figure 3).

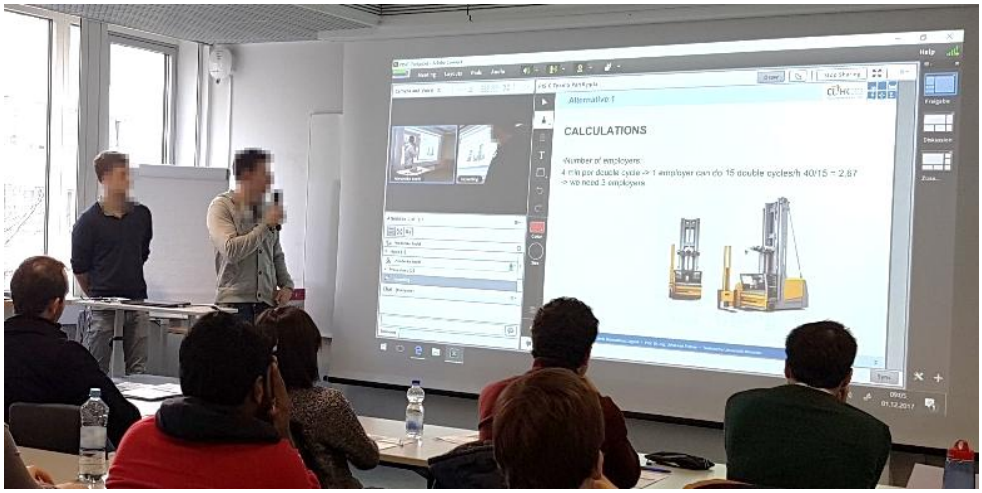


Figure 3. Student presentation via DFN-tool

Table 1. Features of possible teamwork and communication media

Functions \ Tools	Email	OneDrive	Skype	DFN	WhatsApp	WeChat
Chat			x	x	x	x
Group chat			x	x	x	x
Calls			x	x	x	x
Video calls			x	x	x	x
Group calls			x	x		x
Voice messages					x	x
Share documents	x	x	x	x	x	x
Show docs online		x		x		
Working together live and online		x				

Students are asked to organize their teamwork by themselves, as described previously. Besides DFN, several other tools like Skype, WhatsApp or WeChat can be used for live communication. The features of these are introduced to the students in the kick-off meeting (shown in Table 1). The students are free to decide which media they prefer to use.

3.4 Teaching and Learning Methods

A combination of different teaching and learning methods is applied in this course in order to improve the students' learning outcome regarding methods and applications for the planning of intralogistics systems.

First of all, the supervisors explain necessary theories and methods to all of the students by using comprehensible examples. This takes place via live broadcasting between TUM and Tongji in each obligatory lecture. Consequently, every student has the possibility to ask questions regarding the content to clarify all open issues. This interaction gives the students as well as the supervisors an idea of the participants' different knowledge in intralogistics planning. Weekly short tests at the beginning of the lectures help the students to deepen their general theoretical intralogistics knowledge and methods for planning tasks.

The entire case study is set up as a role play in which students play the roles of being employees of a planning office. They receive different and new information about the factory every week. The students are free to plan their team work. Anyway a task division with subsequent discussion is suggested by the supervisors for solving the case study. As an example, in part 2, students are asked to design two planning alternatives for the central warehouse. This task offers the possibility to split the team into two groups, with each subgroup elaborating on one alternative. After that, the results can be compared and a discussion can subsequently be conducted. Students have to submit their solutions in the form of a text document (without limit in pages) which they have to write together in a comprehensible and consistent way. Additionally, each team is asked to submit presentation slides for one of the three parts of the case study. They are assigned to one lecture where they have to present their results to the other students.

Thus, student's presentations form another learning method of the course. Each team has to present their solutions via broadcasting to supervisors and students from TUM and Tongji. Afterwards, questions regarding the different approaches are asked followed by open discussions. The situation of presenting and asking questions during live broadcasting helps the students to become more confident in speaking in front of a larger audience, especially with a microphone and video camera directed towards them.

4. LATEST STUDENT FEEDBACK

Surveys help to reveal the course quality and the students' opinion about the international and GVT-based class. The explicit results of an online survey conducted with students attending the course in the winter semester 2017/2018 are used to outline the feedback and show possible improvements that can be derived as lessons learned.

In total, 42 students from both universities attended the course in the mentioned semester: 23 from the TUM and 19 from the Tongji University. Half of the students were international students studying abroad in Munich or Shanghai and coming from different countries, such as Spain or Sweden. Figure 4 shows the distribution of students to the universities and additionally the amount of international students.

For the closing lecture, the attending 42 students were asked to complete an anonymous online survey in order to receive their feedback regarding the organization, execution and effectiveness of the course. This feedback is the main basis for the further improvement and development of the course. The feedback received in the first and second execution in summer 2016 and winter 2016/2017 is considered alike (Wang et al 2017).

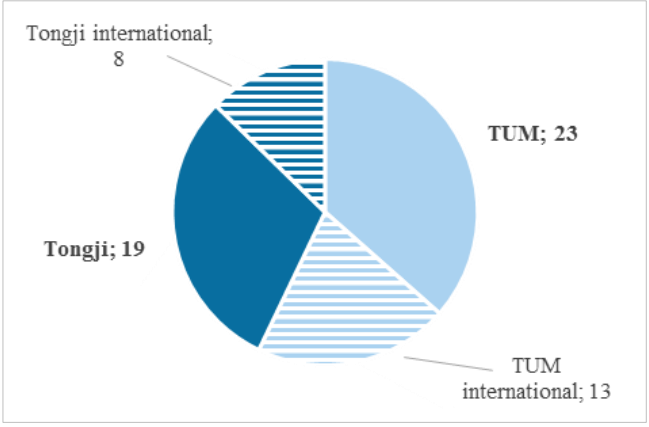


Figure 4. Participating (international) students at TUM and Tongji

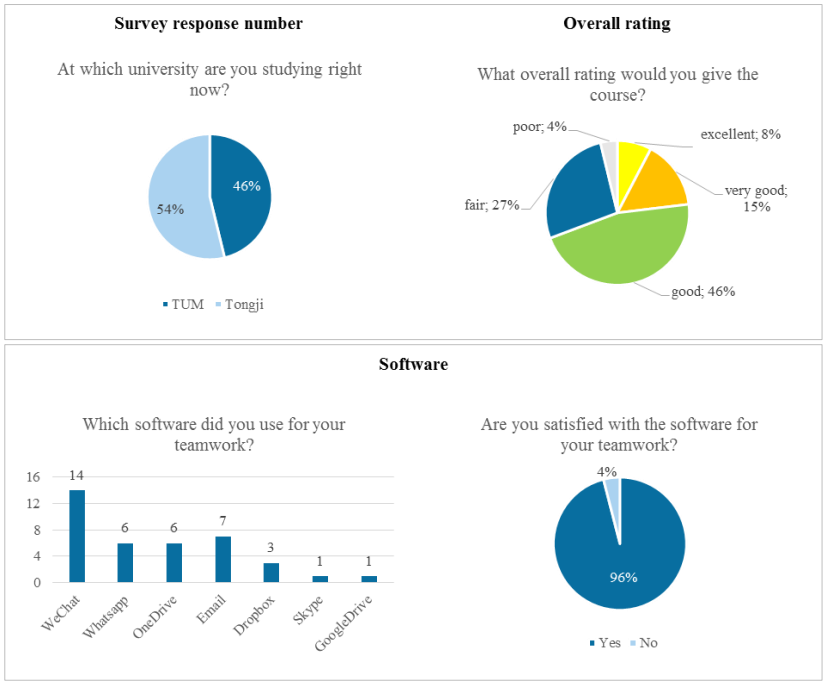
28 of 42 students participated in the online survey. Therein, the proportion of German and Chinese participants was almost balanced. Figure 5 shows the key results of the student feedback.

Most of the students are satisfied with the course. More than two-thirds of the survey participants rated the course as at least "good". The students used different communication media to solve the case study, including WeChat, Email, WhatsApp, OneDrive, Dropbox,

Skype and GoogleDrive. Among them WeChat, Email, WhatsApp and OneDrive were the most popular tools. The students were mainly satisfied with the chosen communication media.

The given case study and the prepared course materials were also evaluated as “good” or better (approx. 77 %). The difficulty of the case study was assessed mainly as balanced. While the majority of students had no problems within their teamwork, some students still had difficulties working together. According to the feedback, the main reasons were a lack of prior knowledge in intralogistics planning and the limited language skills. Different motivational aspects, time difference and agreement finding can also be named as team work issues.

At the end of the survey, the students had the possibility to leave additional comments. There, two main aspects have been named which can be considered when conducting the course in the following semesters. Firstly, due to different knowledge levels of students in intralogistics planning, more time needs to be spent to introduce and explain the needed basics and methods for solving the tasks. Secondly, technical and Internet connection problems, especially regarding sound quality during the lectures require an improvement of the equipment.



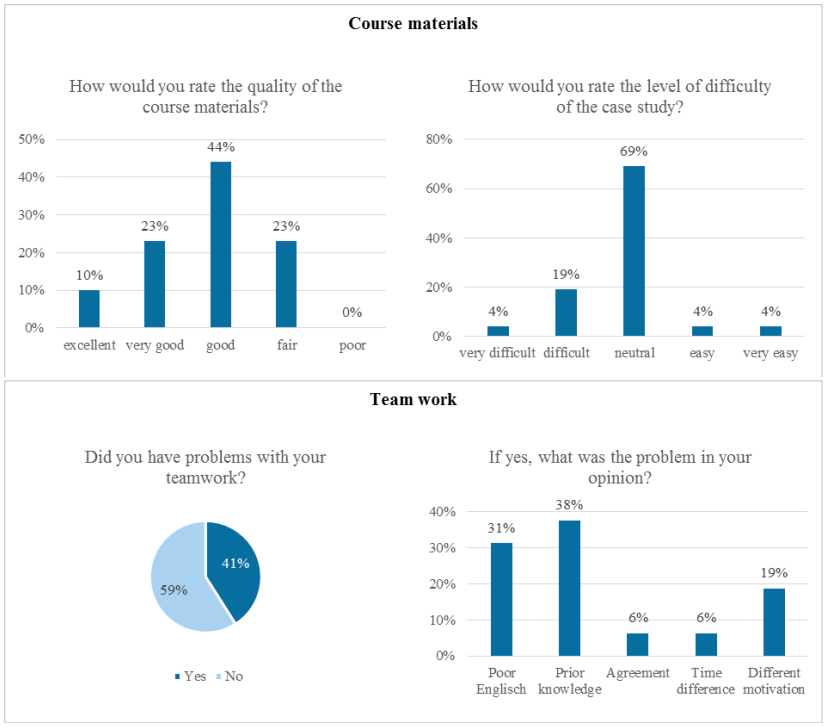


Figure 5. Student feedback

Nevertheless, the majority of students stated that the course has helped them to enhance their intralogistics planning competence as well as their soft and language skills. In general, they would recommend the course to other students. The results of the survey prove that a GVT-based course using modern communication media as a lecture base is an effective way to improve the competences of engineering students.

5. RECOMMENDATIONS BASED ON PREVIOUS EXPERIENCES AND REACTIONS

To ensure a high quality of such a lecture, the following recommendations can be given. Those are derived from the students' feedback as well as the supervisors' impressions and experiences with the course since its implementation. The recommendations can be categorized into organization, technologies and teamwork and learning.

5.1 Organization

A course for students who belong to different universities and are situated in different places needs to be planned very well and carefully. To avoid preventable problems or redundant work, a good coordination between the supervisors of both universities is enviable. They have

to swap information and clarify teaching tasks and to-dos for every lecture is inevitable. The introduction presentation, the task description as well as the short tests of each part have to be exchanged between the supervisors at least two days before each lecture in order to be able to print the needed materials and information for the students.

A second major task is to give clear and precise organizational information for the students. Therefore, a document should be prepared and provided several days before the first course. It contains all of the mentioned information such as submission deadlines, scope and time of the written tests and grading. Thus, it helps the students with the course's guidelines and structure.

5.2 Used Technologies

For a GVT-based course, broadcasting and communication media play a very important role. The use of technologies can hereby be clustered into the technologies which were necessary and used to hold the lecture and the technologies which were used by the students to work collaboratively.

Poor IT-settings or an unstable Internet connection highly influence the course quality, especially of an international course. Therefore, it is important to set up and test the wiring and equipment for sound and video transmission via Internet various times prior to the first lecture and in advance of every lecture. Figure 6 gives an overview of the used technology and its interaction at TUM in winter 2017/2018.

DFN, the selected tool, has proved to be a very effective tool for the course. However, it is recommended to test its functionality in cooperation with the partner university every time shortly before conducting the course and to adjust video and audio settings in the most appropriate way to guarantee a live broadcasting at a good quality.

As mentioned earlier, the students were free to choose the media for their teamwork themselves. In the winter semester 2016/2017, OneDrive has been proven to be a very useful tool for the teamwork, especially when team members prefer to work together on a specific document in real time. However, some students in China have complained that the Chinese connection for OneDrive is very unstable, which has influenced their working progress a lot. This was confirmed by the latest survey conducted in winter 2017/2018. As a result, students tend to use WeChat or Email to communicate with each other as well as to combine presentations and written assignments to one document afterwards.

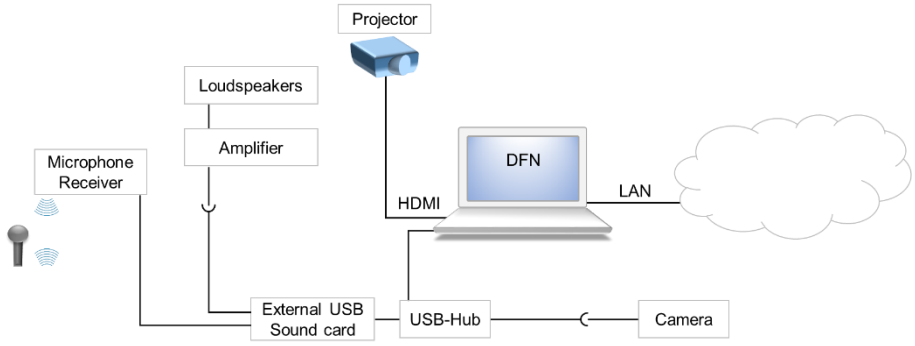


Figure 6. Technology used for broadcasting the lecture

5.3 Teamwork and Learning of Participating Students

Apart from the management of organization and technology, one big challenge faces the teams themselves. It is commonly known that team work, aside from all its given advantages, can in general lead to diverse problems which need to be solved (Humphrey 2017). The meeting of different characters with different opinions can often lead to discussions and prevent the fast success of a team. Even more challenges arise when a team is formed out of persons with different cultural backgrounds located in various countries. Each of the members grows up in a specific culture and thus, has an individual imprint with different values which influences their behaviours.

To name an example, it is usually reported that Asian students are reticent and passive learners (Braddock et al 1995; Jones 1999). Many researchers think that this behaviour results from certain cultural attributes of Asian societies (Turner and Hiraga 1996; Griffiths et al 2014). However, some researchers have argued that these allegations of reticence and passivity set up against Asian learners are over-generalized (Liu and Littlewood 1997; Cheng 2000). This behaviour may therefore be true for some Asian students but those stereotypes cannot be universalized. The causes of problems in international teams are situation and person specific and are equally related to both a lack of language proficiency and varying levels in theoretical knowledge.

To support the teams in the best way possible some helpful measures have been identified. They have grown with each iteration of the course. The following strategies have been implemented to strengthen the motivation and learning readiness of the students:

- To get into contact with the other team members located in Shanghai the supervisors ask all team member to introduce themselves via broadcasting during the kick-off lecture (shown in Figure 7).
- With respect to the time difference, students are free to organize their teamwork by themselves. In this way, they can find a proper time frame and place and thus, have the best solution for all of them to conduct their discussion and come to a joint solution.
- The teaching methods in the course have been extended after gaining useful experiences within the first two courses, like task division and offering additional consultation hours.
- Take the time accordingly to explain needed methods and knowledge (e.g. the functions of stacker cranes) to make sure that all students are on the same level of knowledge.

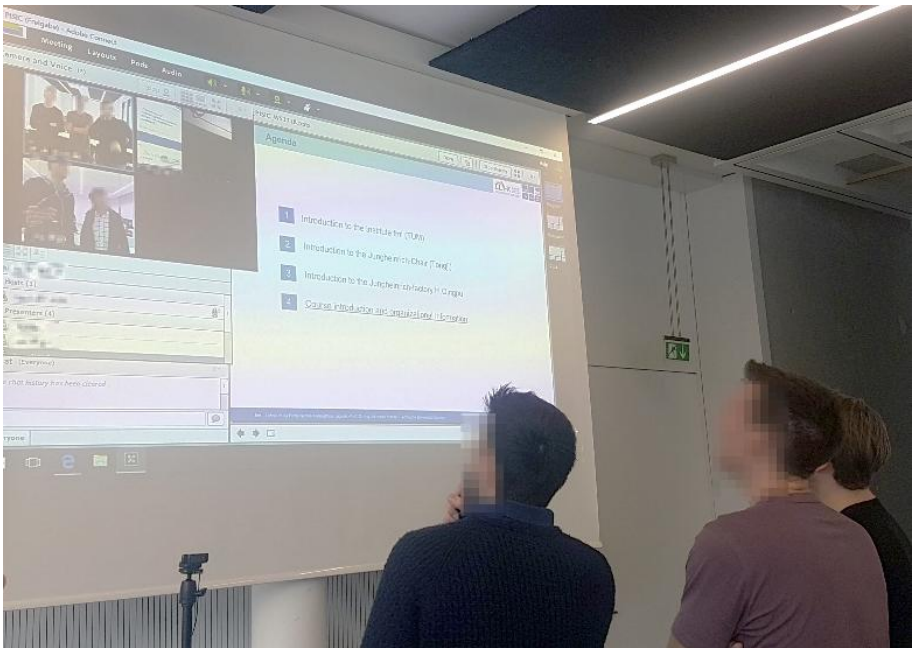


Figure 7. TUM students introducing themselves to their Tongji team members via DFN

By deploying the above mentioned strategies and methods, most of the students were motivated to actively participate in the course. It shows up that potential problems resulting from different levels of prior knowledge in intralogistics planning and limited language skills can be reduced by appropriate and thoughtful teaching methods and support.

Anyways, it is hardly possible to eliminate all problems since the members have to face different challenges (e.g. intralogistics as a new and unknown topic, putting effort into solving the case studies, learning for the tests, communicating in a foreign language, working with other students they do not know), using DFN as an example for a modern communication media is a very effective and motivating way to teach engineering students.

6. CONCLUCSION AND FUTURE PERSPECTIVES

The course that has been developed and improved provides an innovative and exemplary possibility to teach engineering students by using modern communication media. A course in this form has been a first attempt not only at the TUM but also at the Tongji University in the summer of 2016. By building up GVTs using modern communication media, students located in geographically distant places are given the opportunity to learn new methods and approaches, communicate with each other, carry out teamwork on specific engineering tasks and jointly work out solutions.

In this paper, the course has been described in detail including the course content, the course organization, the teaching and learning methods as well as the deployed communication tools. Furthermore, student feedback and recommendations were described.

By sharing the experiences, inspiring ideas can be provided to other institutions or supervisors in engineering education interested in implementing GVT-based lectures. According to the student feedback, a course offered in this extraordinary way is proven to be supportive in teaching methods and approaches of intralogistics planning. It also improves the intercultural competence and teamwork abilities of engineering students.

GVT-based virtual exchanges like this can also be used as an alternative way for the preparation of study abroad programs or internships abroad. Additionally, it indeed supports the international exchange of students from different countries and universities. The students get to know partner chairs and universities by participating in the course as well as insights in the different cultures.

As mentioned, a majority of the data which are used in the case study has been collected from a German company in China. In the future, a higher focus will lie on the cooperation between academic institutions and industry. Thus, more practical elements or real-world cases can be integrated into the course and make it more relevant for students attending it. In this way, students can also gain practical experiences while improving their technical knowledge.

Finally, based on the survey, various improvement suggestions that were identified as well as the supervisors' experiences are pursued in order to make the course even more effective regarding the intralogistics planning knowledge of engineering students.

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