Investigation of Face-to-Face Class Attendance, Virtual Learning Engagement and Academic Performance in a Blended Learning Environment

Na Li, Jie Wang, Xiaojun Zhang, and Roland Sherwood

***Abstract*—The purpose of this research is to investigate the correlation within three key variables in relation to students' learning outcomes: face-to-face class attendance, virtual learning engagement, and academic performance. A sample course with 3783 students' data were analysed by applying a quantitative research methodology. The research data included one semester's attendance records, students' virtual learning engagement on the university centralized virtual learning environment and the average academic performance Both Spearman's correlation coefficient and Pearson's correlation coefficient were used for the hypothesis's tests according to the variables' data characteristics. This research has verified the positive correlations between face-to-face class attendance and academic performance, virtual learning engagement and academic performance in a blended learning environment at a Chinese transnational university, which are consistent with existing research. The finding about the positive correlation between the face-to-face class attendance and virtual learning engagement suggests that students can benefit from both traditional and contemporary teaching formats by integrating the virtual learning elements into the face-to-face class delivery.**

***Index Terms*—Virtual learning environment, attendance, academic performance, blended learning.**

I. Introduction

Since the Internet was first introduced into education in the early 1990s, learning was diversified as online learning became possible [1]. The traditional face-to-face teacher centred lecture delivery has been challenged by the online learning's many benefits, e.g. the learning can happen any time at anywhere. After over 30 years' development, online learning did not replace the traditional face-to-face teaching format. The flexibility of delivery could be the blended learning opportunities by mixing the face-to-face class and online virtual learning. New learning behaviours emerged with the impact of the virtual learning environments (VLEs). Grab predicted that the greater flexibility in delivery afforded by VLEs will change the way students approach studying [2] in 2008, which I believe has actually happened in the past 12 years. The integration of VLEs into teaching and learning, compared with other countries such as the UK and the US, is a recent phenomenon in China. There has been a surge in the use of Internet-based technology in education over the last decade, especially since the Chinese government issued the Ten-year Development Plan for Education Information (2010–2011) in 2012, which aims to promote the integration of technology into teaching and learning in both K-12 and higher education institutions [3].

Xi'an Jiaotong-Liverpool University (XJTLU), as a British - Chinese joint transnational university, has integrated both Chinese and Western learning and teaching pedagogy into its practices. A Moodle based virtual learning environment named ICE (interactive communication environment) has been setup and used as the centralized teaching and learning platform since 2006. This VLE (ICE) provides a web-based communication platform for teachers and students to access learning resources and interactive online activities, e.g. online forum, online quiz, paperless assignment and etc., in order to enhance teaching and learning [4]. From a recent ICE user feedback interview, some of the teachers have concerns that the face-to-face class attendance rate will drop if the students can easily access to all learning materials from ICE without going to class. Teachers from other universities have raised similar concerns that an unintended consequence of placing lecture resources online may be the increased absenteeism [5], [6]. Teachers' anxiety of using new technology to teach might cause by these concerns [7]. More research is needed to explore whether class attendance has positive or negative correlation with students' online engagement.

Furthermore, the group of teachers who pay attention to the attendance rate might be doing so because they still believe that attendance is the key assessment of student's engagement in the traditional face-to-face teaching. However, the situation has changed because students' class engagement can be measured by many other ways, including the in class interactive polling, warm up online quiz and real time online brainstorming activity. The VLEs are designed to provide dynamic and interactive virtual engagement which allow new ideas to realize functions (e.g. in class real time online polling, online shared notepad for in class brainstorming and etc.) of the constructivist approach in the learning environments [8]. Many studies evaluated whether the VLEs can meet those needs by examine the virtual learning effects in students' academic performance [2], [5], [6]. The online assessments on VLEs are commonly used to assess students' learning engagement, learning progress, and academic performance. Consequently, this research aims to investigate the correlation of the students' virtual learning engagement, face-to-face class attendance, and academic performance, which could provide practical implications in developing

Manuscript received February 18, 2020; revised November 9, 2020.

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doi: 10.18178/ijiet.2021.11.3.1498

online assessment strategies for better teaching and learning in the blended learning environments.

II. Literature Review and Hypotheses

Blended learning is considered as the most effective and most popular mode of instruction adopted by educational institutions due to its perceived effectiveness in providing flexible, timely and continuous learning by mixing the traditional face-to-face class and online learning [9]. Virtual learning environments (VLEs) are becoming more flexible in facilitating blended learning, e.g. automating some of the tedious aspects of teaching and assessment by marking student's online tests or examinations, thus freeing up capacity for better quality communication and interaction [10]. The scholarly debate on the relationship between face-to-face class attendance and virtual learning engagement has existed for many years. Weatherley and his team argued that the access to information online has caused the low-class attendance and impacted students' academic performance negatively in a research conducted in 2003[5]. Two years later, Grabe and Christopherson revealed that students who attended face-to-face class most consistently made greater use of online resources and have higher academic performance [6]. In 2017, Nemetz conducted a comparative research about online learning and face-to-face learning with two group of students. The research results showed that online students performed equally and archived good academic performance as well as face-to-face students [11]. This reminds us that the situation might be different if we shift our focus from the disadvantages of competition between traditional face-to-face class delivery and online virtual learning to the advantages of their coexistence.

Moreover, teaching and learning are complex and hard to measure by only checking the delivery formats [12]. One of the most commonly used evaluations for teaching and learning is to assess how the actual learning outcomes match the intended learning outcomes [13] based on students' academic performance. The intended learning outcomes are pursued and integrated throughout timely and sufficient formative and summative assessments [14]. Online activities on the VLEs can extend the efficiency and sufficiency of both formative and summative assessments. For example, the online quizzes can be easily reused by different group of students once set up. Quiz questions can be randomly chosen from a large question bank, so that students can perform self-assessment exercises as many times as they need out of the class. Teachers can use the online quizzes to do in class real time learning progress checks or formal examination with the benefits of highly efficient auto marking. Therefore, the use of online assessments is encouraged so that virtual learning engagement can facilitate the assessment process, collect digital feedback and increase the student's ability to regulate their academic performance, and enhance the efficiency, sufficiency, and effectiveness of the assessment [15].

To measure the virtual learning engagement, most of the studies have gathered data via survey questionnaires to collect self-reported learning behaviours [7], [9]. An important data source, VLEs' log file, has been overlooked. All the user actual teaching and learning behaviours are recorded in the VLEs' log file. These log data are more objective and more accurate than the self-reported data. The difficulty is that these actual use data are massive and are stored in the system database, which is very complicated for researchers without a database technical background to retrieve [16]. Recently, the possibility of integrating an external analytics tool into the VLEs creates learning analytics for providing complementary data to the log [17], which also increases the opportunities for educators and researchers to measure the virtual learning engagement and academic performance from a systematic view by analysing the users' actual use data of the VLEs.

In connection with the above research gaps, we hypothesize:

H1. Students' attendance in face-to-face class will have a positive correlation with their academic performance.

H2. Students' attendance in face-to-face class will have a positive correlation with virtual learning engagement.

H3. Students' virtual learning engagement will have a positive correlation with their academic performance.

III. Methodology

A. Data Collection and Sample Characteristics

The VLE platform named ICE (https://ice.xjtlu.edu.cn/) has been used as the university's centralized virtual learning platform for over 13 years in a blended learning environment. The selected course, which included 3792 students and 220 online activities, was one of the largest courses within the university and the data was collected from a whole semester from September 1st, 2019 to January 18th, 2020. Students enrolled were year one undergraduates from various programmes. The face-to-face attendance was recorded via the online attendance activity on ICE. Hundreds of online activities were used for both summative assessments and formative assessments through the semester, which provided sufficient data in relation to face-to-face attendance, virtual learning engagement, and academic performance.

To the best of knowledge, the large size of log data is hard to collect and calculate, which is the main reason that not much research in this area has been conducted in a university setting. With the integration of the learning analytics platform (Zoola) to the VLE system (ICE), the massive raw log data was computed automatically with the defined report logic and algorithm. As a result of data incompletion filtering, 9 out of 3792 students were excluded and 3783 students were included as the final sample.

B. Measures

1) Face-to-face class attendance

At the beginning of every lecture, the students were required to record attendance according to university policy. They needed to log on the VLE system (ICE) with their personal account and connect to the university WIFI on their mobile devices to complete this activity. The WIFI connection was to make sure the students were physically in the classroom by IP restriction. The teacher would then give students the QR code to scan and the password to fill in to

successfully take the attendance record. Teachers and managers can access students' online attendance records conveniently on the VLE system (ICE). This was how we retrieved the face-to-face class attendance data.

2) Virtual learning engagement

The teachers of the selected course have spent a significant amount of time on designing the curriculum by integrating the traditional lecture delivery and virtual learning activities and resources. Resources of corresponding teaching topics such as slides, related external website URLs, preview materials, etc. were posted on the ICE before class so the students would have time to digest the fundamental but necessary terminologies through self-study. Then the teachers and students could focus on brainstorming and reflection during the lecture or seminar. In-class quizzes were taken in every lecture to test the students' learning results of the preview materials given before class and the content delivered by the lecturers in class.

A very innovative learning activity worth mentioning here was the online massive video assignment after class through which students could express their own opinions around topics related to the module. Students could form groups on the VLE platform (ICE) with friends who shared the same interests and start to shoot the micro video in their spare time. The video submission process happened also online and the teachers could view and grade the videos after the submission. Scientific grading method, Rubric, was adopted during the assessment. Students could receive feedback from teachers first time, which gave them time for modification and improvement. The whole process of group choice, video submission, grading and feedback reception, which was different from the traditional way, saved time and energy and also stimulated students' great enthusiasm into the micro video program and this part had also become one of the most popular academic activities among Year 1 students. This micro video program acted as a supplement and extension of the lecture content.

In summary, the blended teaching and learning strategy provided more learning opportunities for students both in and out of class, which showed a good combination of virtual learning and in-class learning. The time spent recorded the hours each student has spent on ICE for virtual engagement. A pop-up window would display every 15 minutes to allow students to confirm if they were still active for learning. The learning analytics tool Zoola were integrated in ICE and provided time spent reports for teachers and managers to easily download.

3) Academic performance

The assessments of this course were made up of 4 components with different weighting proportions: paper based final examination (30%), online interaction (20%), in-class quiz (20%) and micro video coursework (30%). The online interaction, in-class quiz and micro video coursework were considered as online assessments and have taken up 70% of the total academic performance.

IV. Data Analysis and Results

The hypotheses of this research were tested with the use of the Spearman's correlation coefficient and Pearson's correlation coefficient. The Spearman's correlation shows the strength of the monotone associations while the Pearson's correlation coefficient presents the linear relationship between two variables that are normally distributed [18]. The variables' characteristics were analysed first to identify the suited correlation model. Then the three hypothesized correlation were tested with the appropriate correlation coefficient. All the tests were computed in the IBM SPSS statistics version 21.

There are a number of rules of thumb surrounding the strength of different levels of association, we employ the following benchmark from Chen and Krauss's book:

- Coefficient between −0.3 and +0.3 = weak correlation
- Coefficient between −0.3 and −0.7 or between +0.3 and +0.7 = moderate correlation
- Coefficient less than −0.7 or greater than +0.7 = strong correlation

A. Variable Characteristics Analysis

As one of the most common measures of correlation between two continuous variables, the Pearson's correlation coefficient relies on some critical considerations [18] which tend to be affected by the characteristics of the variables in the data analysis. Firstly, it is better if the two variables in the hypothesis are continuous (e.g. the data type is interval or ratio). Table I shows the variable codebook of this research. The key variables are attendance, engagement and grade. They are all interval data, which are considered as continuous and appropriate for computing Pearson's correlation coefficient. Secondly, the two variables in the hypothesis are approximately normally distributed [19]. As the Fig. 1- 2 depicted, both the engagement and grade variables' histograms approach the shape of a normal distribution approximately. But the Fig. 3 shows that the attendance data are clumped with a large frequency of 100, not normally distributed. According to the instructions, we used the Spearman correlation to test Hypotheses related to the attendance variable [20].

B. Spearman Correlation Test

The Spearman rank order correlation measures the degree of association of ordinal-level data by examining the ratio of the sum of the squared differences in the ranks of the paired data values to the number of variable pairs [21]. Technically, the Spearman rank correlation coefficient (rs) is defined by the following formula (1):

$$r_{s=}1 - \frac{6\sum d^2}{N(N^2 - 1)} \tag{1}$$

The significance test of Spearman correlation relates to the sample size Z. Equation (2) shows, the relationship between the two variables is more likely random if the value of Z is bigger and the hypothesis should confidently be accepted [21]. The sample size (3783) in this research was good for the Spearman correlation test.

$$Z_{rs} = r_s\sqrt{n-1} \tag{2}$$

TABLE I: VARIABLE CODEBOOK

Variable Name	Variable Label	Type	Width	Decimals	Measurement level
ID	Encoded student ID	Numeric	4	0	Nominal
attendance	Student's overall average face-to-face class attendance percentage within the first semester	Numeric	5	2	Interval
engagement	Student's overall average time spent (hours) on the VLE course page within the first semester	Numeric	5	2	Interval
grade	Student's overall average online assessments grade as the academic performance within the first semester	Numeric	5	0	Interval

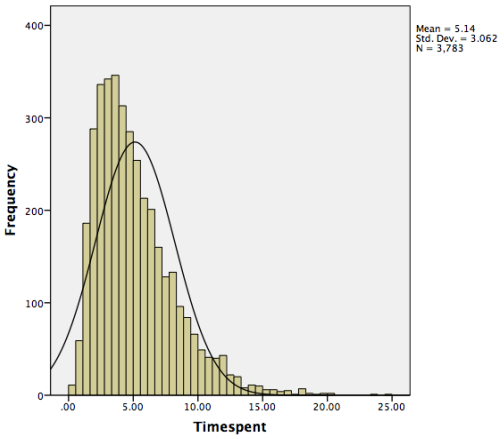

Fig. 1. Histogram of the engagement (time spent in hours) data.

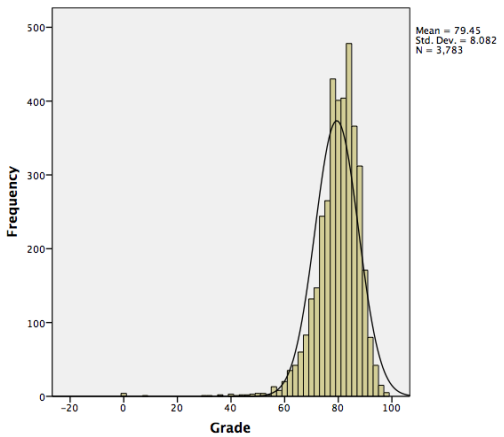

Fig. 2. Histogram of the grade data.

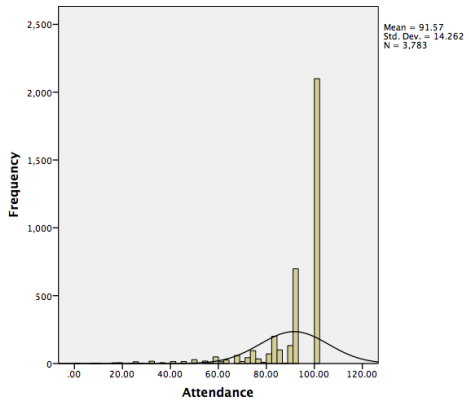

Fig. 3. Histogram of the attendance data.

We tested the hypothesis H1 and H2 with the Spearman's correlation coefficient and the results are as follows:

H1. Students' attendance in face-to-face class will have a positive correlation with their academic performance.

As Table II shows, there is a correlation of 0.50 between the two variables; this is statistically significantly different from zero (p-value < 0.05). According to the association level benchmark, this suggests that the face-to-face class attendance has a moderate positive correlation with grade (academic performance). The model test result indicated that the hypothesis H1 is accepted. This is also consistent with previous research [5], [6].

H2. Students' attendance in face-to-face class will have a positive correlation with virtual learning engagement on VLE.

Table III reports a correlation of 0.34, which indicates that the face-to-face class attendance and virtual learning engagement on VLE are positive correlated at a moderate level. As a result, the hypothesis H2 is also confirmed.

C. Pearson Correlation Test

The Pearson's correlation coefficient measures the linear association between two continuous variables. This means that when values for one of the variables are high, the values of the other variable also tend to be high (positive correlation) or low (negative correlation). Equation (3) shows how to compute Pearson's correlation coefficient between two variables named X and Y [18]:

$$\rho = \frac{\sum_{i=1}^{N}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{N}(X_i - \bar{X})^2}\sqrt{\sum_{i=1}^{N}(Y_i - \bar{Y})^2}} \quad (3)$$

The numerator of (3) determines whether the correlation is positive, negative or zero. The denominator of (3) scales the entire calculation so that the highest possible positive correlation is +1 and the lowest possible negative correlation is −1.

We used the dataset including 3783 paired values for each of the two variables to test the H3 hypothesis:

H3. Students' virtual learning engagement will have a positive correlation with their academic performance.

Table IV reports a correlation of 0.35, which is statistically significantly different from zero (p-value < 0.05). This indicates a moderate positive linear relationship between students' virtual learning engagement and their academic performance.

TABLE II: SPEARMAN CORRELATION COEFFICIENT OF THE STUDENT'S FACE-TO-FACE CLASS ATTENDANCE AND THEIR ACADEMIC PERFORMANCE

			Attendance	Grade
Spearman's rho	Attendance	Correlation Coefficient	1.000	.499**
		Sig. (2-tailed)	.	.000
		N	3783	3783
	Grade	Correlation Coefficient	.499**	1.000
		Sig. (2-tailed)	.000	.
		N	3783	3783

**. Correlation is significant at the 0.01 level (2-tailed).

TABLE III: SPEARMAN CORRELATION COEFFICIENT OF THE STUDENT'S FACE-TO-FACE CLASS ATTENDANCE AND THEIR VIRTUAL LEARNING ENGAGEMENT ON VLE

			Attendance	Time spent
Spearman's rho	Attendance	Correlation Coefficient	1.000	.344**
		Sig. (2-tailed)	.	.000
		N	3783	3783
	Time spent	Correlation Coefficient	.344**	1.000
		Sig. (2-tailed)	.000	.
		N	3783	3783

**. Correlation is significant at the 0.01 level (2-tailed).

TABLE IV: PEARSON CORRELATION COEFFICIENT OF THE STUDENT'S VIRTUAL LEARNING ENGAGEMENT AND ONLINE ASSESSMENTS GRADE

		Time spent	Grade
Time spent	Pearson Correlation	1	.354**
	Sig. (2-tailed)		.000
	N	3783	3783
Grade	Pearson Correlation	.354**	1
	Sig. (2-tailed)	.000	
	N	3783	3783

**. Correlation is significant at the 0.01 level (2-tailed).

V. DISCUSSION AND CONCLUSION

In this paper, we set out to broaden our understanding of the influence of virtual learning in blended learning environments by testing three hypotheses in relation to the correlations within the face-to-face class attendance, virtual learning engagement and academic performance. According to different variables' characteristics, the Spearman's correlation coefficient test was conducted to test the hypotheses between the face-to-face class attendance and academic performance, face-to-face class attendance and virtual learning engagement. The Pearson's correlation coefficient was applied to test the correlation between the virtual learning engagement and academic performance. Fig. 4 summarizes the results with a triangular model. First, the face-to-face class attendance has positive correlation with both academic performance and virtual learning engagement. In other words, students with higher face-to-face class attendance will have better academic performance. Second, the virtual learning engagement has positive correlation with academic performance as well. These two findings are consistent with other studies' conclusions [22]-[24].

In response to teachers' concerns about the negative influence the virtual learning might bring to the face-to-face class attendance, the third research result shows that face-to-face class attendance has positive correlation with virtual learning engagement, which indicates that face-to-face class attendance and virtual learning engagement are not competitors. There are two reasons: firstly, the online assessments were designed to assess different learning outcomes according to the teaching and learning schedule. This kept a synchronized increase of engagement for both virtual learning and face-to-face learning. Secondly, teachers have designed in-class instead of off-class online quizzes for students to take. Students can take the online quizzes only if they are physically in the classroom, connect their cell phone with the university WIFI and login to the VLE system with their personal system account. The more classes the students attended, the more virtual learning engagement opportunities the students have via the online quizzes.

As Fig. 4 shows, the face-to-face class attendance and virtual learning engagement both have positive correlation with academic performance, which suggests that the coexistence of the two teaching and learning delivery formats might bring doubled advantages to students' academic performance if both formats are well designed to enhance teaching and learning. On the other hand, if the teachers provide the online resources on VLEs but just simply repeat the same content in the face-to-face lecture (e.g. read the PPT slides), the relationship between virtual learning engagement and face-to-face class attendance can be negative. Consequently, the practical implication for teachers and curriculum designers is to integrate appropriate virtual learning activities into the face-to-face class delivery for better student engagement and higher academic performance in a blended learning environment.

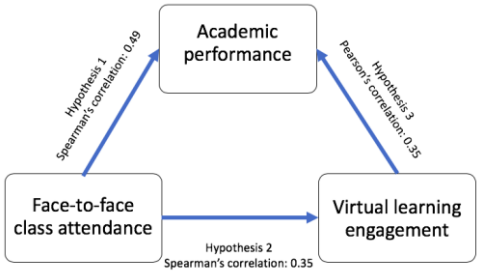

Fig. 4. Correlations within the face-to-face class attendance, virtual learning engagement and academic performance.

VI. Limitations and Future Research

There are a number of limitations attached to this research. The first limitation relates to the sample. We've selected one large course from one university, which might have learning culture bias. It is better for future research to conduct research on multiple courses at different universities. The second limitation is the research method. This study has applied a quantitative research approach to test three hypotheses by using the actual use data from the VLE system. When conducting research, multiple data sources are encouraged. Further studies by using different data source (e.g. self-reported questionnaires, interviews, and/or focus groups) are recommended. This research has only measured the online academic performance, which is the third limitation. Future study will include the paper based final examination results. The last limitation is about the use of learning analytics. In this research, we only used learning analytics as a tool to generate and calculate reports. However, the power of learning analytics is far more than this. Many scholars [25] – [27] indicated that learning analytics provide valuable insights into learning and teaching that takes place at the whole institution and will allow all of the stakeholders to focus on enhancing and improving the quality of learning and teaching. The future research shall take in depth look at learning analytics' impact on teaching and learning practices.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Na Li conducted the research, analysed the data and wrote the majority of the article. Jie Wang wrote the measures section. Prof. Xiaojun Zhang supervised Na Li and edited the article. Roland Sherwood proofread and edited the article.

Acknowledgement

Na Li would like to thank Dr. Trevor Mahy for the proofread and peer review to this manuscript.

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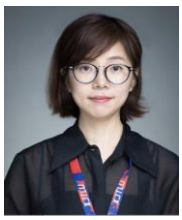

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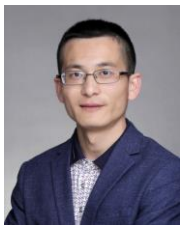
Jie worked as intern in Xi'an Jiaotong-Liverpool University (XJTLU in short) during the summer, 2015 and after her graduation, she joined XJTLU at Suzhou City, Jiangsu Province, China. Since then she has been worked as the Module Leader of Self-management course at Chinese Culture Teaching Center for almost 5 years. She has written and published several articles: < Heidegger's Concept of Time> (Chongqing, China; Chongqing University of science and technology, 2013); < Micro Course—New Educational Mode in HE under the Background of Chinese-foreign cooperatively-run Universities> (Suzhou, China: Research on humanities education, 2019); < Xi'an Jiaotong-Liverpool University--Example: General Course of Critical Thinking Training at Chinese-foreign cooperatively-run Universities> (Guangzhou, China: Report on the Development of Critical Thinking in China, 2019). Her current research interest is about teaching pedagogy in Higher Education.

Ms. Wang works for the Student-teacher Liaison Committee and Teaching Center Committee at Xi'an Jiao-tong Liverpool University. She's also member of Academic Quality and Standards Sub-Committee.



Xiaojun Zhang was born in China, in 1984. Prof. Xiaojun Zhang got his PhD degree at Xi'an Jiaotong University in year 2013. He joined Xi'an Jiaotong-Liverpool University and acted as the Deputy Director of Institute of Leadership and Education Advanced Development (ILEAD), which was created by him under the support of university leaders. Now Xiaojun is the Head of Department for ILEAD at Xi'an Jiaotong-Liverpool University in China. ILEAD is a unique and leading centre for education innovation, development, and education of educators (degree programmes) in education globally. The main business of ILEAD includes pedagogical programmes (Postgraduate Taught and PhD degree programmes), support for XJTLU student learning, educational and professional development for XJTLU staff, global community for education innovation, training and development initiatives for external educators and professionals in education sector, and research on future university (internationalization, learning and teaching, educational leadership, educational management).

Prof. Zhang's research area is institutional change and the role of leadership in institutional change in higher education context. He is also interested in learning and teaching topics in universities. He has been published more than 70 academic papers and 3 books in these areas. His research focus on problems in practice and pay attention to practical implications. Most of his research has been adopted in his training programmes for higher education practitioners.

Roland Sherwood was born in UK, 1977. Roland Sherwood received his master's degree in educational technology from Manchester University in 2008. He currently works as manager for educational technologies at Xi'an Jiaotong-Liverpool University, located in Suzhou, China, where he coordinates educational technology-related initiatives and projects across the University. Additionally, he leads on the delivery of educational technology-related components of the University's Postgraduate Certificate in Professional Studies (PGCPS) programme, and other related programmes. He has also spoken across China and Asia with regard to institutional approaches to educational technology provision and related topics. Prior to joining XJTLU, Roland's career variously saw him take-up educational technology and education-related roles across Europe, Asia and Africa in support of the work of public, private and non-governmental organisations.

Mr. Sherwood is a member of the Association for Learning Technology (ALT).