Influences of Online Teaching Ability of University Teachers on Learning Engagement of Learners

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Abstract—Due to advances in education and informatics, online learning is now becoming a direction for teaching reform in universities. This in turn put learning engagement at the forefront of educational literature: online teaching activity has become a key component of teaching due to its strong influence on learning engagement and outcomes. This study analyzes the influences of teachers' online teaching ability (teaching design ability, resource development ability, teaching implementation ability, teaching evaluation ability, teaching reflection ability) on learning engagement across different majors and grade-levels. Research results showed abilities on teaching design, teaching implementation, teaching evaluation, and teaching reflection have significantly positive influences on learning engagement. These results provide important references in further exploring influencing mechanism of teaching activities on learning engagement, improve online teaching ability of teachers, and increase online learning engagement of students.

Keywords—university teachers, online teaching ability, learners, learning engagement, regression analysis, analysis of variance

1 Introduction

Online education has recently gained a lot of popularity in the realm of global education. It is quickly becoming a significant learning method to raise academic standards for students in China as a result of the advancement of information technology and significant advancements in university teaching reform. The set up overcomes the disadvantages of traditional classroom teaching, reflects the teacher-guiding and student-oriented educational philosophy, and provide students richer learning resources through a more efficient and communicative way. Online learning, with the help of national policies, has also been extensively applied in university teaching, thereby garnering recognition of teachers and students. Some universities launch professional courses for online learning which aim to improve educational teaching quality. Hence, online learning is crucial to China's higher education system and the implementation of teaching reform in China. As a result, a teacher's ability to teach online is essential for student development and performance, including learning process, learning emotions, learning engagement, etc.

It is important to learn the engagement of students to evaluate the entire learning process. Subsequent analysis shifts education keys from learning outcome to learning process, allowing teachers to better understand the process information of students during learning activities more intuitively, thus improving their learning effect and educational teaching quality. The effectiveness of teachers' online instruction has a significant impact on students' motivation to learn. The instructional activities of instructors will ultimately be used to implement any educational change. Teachers' online teaching ability is an important component of teaching activity and shows their professional quality. This allows for a more intuitive exploration on learning engagement and student learning outcome. In fact, a teachers' online teaching ability may implicitly impact on a student's progress in quality and thinking, in addition to having an explicit impact on a student's disciplinary knowledge and professional abilities. As a result, the current stream of literature is becoming increasingly interested in instructors' teaching activities. The majority of related research that are currently available, however, are based on typical classroom learning environments. With the notable progresses in education informatization and technology, institutions are moving towards online learning as a teaching method. A strategy in improving the caliber of teachers' online teaching ability could be further explorations on the enabling environment and conditions for teachers to improve their teaching abilities.

2 Theoretical bases and hypotheses development

2.1 Theoretical bases

STEM education theory argues that with the accelerated globalization and rapid economic development, education at the global level pays high attention to training of comprehensive talents. In 1986, the National Science Board issued the policy report of STEM education for the first time, which was the beginning of STEM education. Subsequently, Bybee, R. W. [1], Martín-Páez, T. et al. [2] and Kennedy, T. J et al. [3] studied the extensive and thorough use of STEM education, which is essentially interdisciplinary in nature. In practical scenario problems, students integrate and recombine the isolated disciplinary knowledge of different fields, solve problems through cooperation with others, and form new knowledge and ability. STEM education therefore aims to promote students to better know their relevant disciplines, strengthen their learning interests, cooperation consciousness and ability in problem solving and innovative creation, and aid them to cope with challenges in further education and employment.

2.2 Hypotheses development

Numerous research have been conducted on teachers' teaching practices. Generally, outstanding instructors should have the ability to develop other excellent teachers for the school and provide resources to enhance instruction. Studies on earners are engaged in their learning often concentrate on pertinent components and evaluation of affecting factors. Hence, learning engagement and teachers' teaching activities are tightly associated.

Sirum, K et al. [4] measured students' understanding to good experimental design standards through their open responses to hints based on daily life science problems. Results demonstrated that Experimental Design Ability Test is very sensitive to improvement of experimental design ability. Oxman, R [5] believed that Mind Map could improve thinking of an individual in a field and help teachers improve teaching design ability. Huang, S. Y et al. [6] introduced the digital escape room teaching method into teaching Natural Science for fourth graders where results show that the experiment group got higher scores in learning motivation and problem solving ability than the control group. McKenney, S et al. [7] pointed out that teachers should design new learning activities and create their own (technically enhanced) learning materials. A technical framework was proposed which could improve design knowledge and trans-project working ability of teachers. According to Chen, M. et al. [8], teachers can raise their professional standards through course design, which has a direct impact on students. McFadden, J. R et al. [9] demonstrated that teachers could improve their teaching design ability by formulating course development activities and strategies helping them develop from course design field to course implementation. For McKenney, S et al. [10] instructors' expertise in planning classroom instruction helped them become better at encouraging learning. Test results from before and after the study show that all of the students involved made considerable academic progress thanks to the teachers' high-quality teaching methods. Hence, Hypothesis 1 is proposed herein.

H1: Online teaching design ability of university teachers can improve learning engagement of learners obviously.

Teachers should give more attention to the development of teaching resources, according to Schlechty, P. C. et al. [11]. Summers, M et al. [12] posited that teachers' ability in using teaching resources had important influences on their sustainable development. Shohel, M. M. C et al. [13] corroborates this by arguing that resources for full use and development of teachers include course materials, classroom practice videos, classroom audios, classroom sources, and so on. Okemakinde, T et al. [14] suggested that increasing the effectiveness of teaching was facilitated by teachers' use of and development of instructional materials. Nwana, S. E et al. [15]'s survey found that most resources for computer educational teaching have not been used by teachers which explains the need to amplify teachers' resources for their teaching ability. Ong'amo, B. L et al. [16] found that teachers taught Swahilli poetry effectively by using and developing teaching resources to increase information size for learning and reserve of students. For Okori, O. A et al. [17], teaching materials included graphs, computers, TV, video and audio. These sufficient and relevant materials provided spaces for effective and high-efficiency teaching of science and Maths. Suggestively, teachers therefore deserve sponsorship of government, participate in various training programs developed by teaching resources, and thereby improve teaching quality. Hence, Hypothesis 2 is proposed herein.

H2: Online resource development ability of university teachers can improve learning engagement of learners obviously.

Gianoumis, S et al. [18] believed that natural language paradigm (NLP) is a naturalism teaching strategy for autistic children. In addition to helping teachers do their jobs more accurately, the thorough implementation of the challenging NLP program among kids helped learners' maladaptive behaviors decline. Carter, D. R et al. [19] believed that the multi-baseline design study was implemented in four classrooms for preschoolers between the ages of 33 and 63 months in order to determine whether positive active supports for teachers may effectively improve teaching quality. Results indicated a strong correlation between consultation and teachers' PBS implementation skills. Hirschstein, M. K et al. [20] also found that scientific and effective tutorship of teachers to students who participate in bully behaviors could decrease the observed attacks and damages in old students. Stormont, M. A et al. [21] encouraged the use of PBS in primary schools, and teachers can boost pre-corrective and praising of particular student behaviors by putting good PBS into practice, enabling additional earners' learning motivation. Flower, A et al. [22] believed that many teachers lacked preparations for behaviors that students might bring into classrooms, which brought challenges to teaching activities. Results showed that universities shall increase training of teachers in teaching implementation. Hence, Hypothesis 3 was put forward.

H3: Online teaching implementation ability of university teachers can improve learning engagement of learners obviously.

Iwanicki, E. F [23] demonstrated that effective teacher evaluations could encourage students to engage in independent study and raise their expectation. Teven, J. J et al. [24] discovered a connection between students' perceptions of teachers' concern and their assessments of those teachers, emotional learning, and cognitive learning. Meanwhile, Hallinger, P et al. [25] revealed how crucial it was for children' academic advancement for teachers to evaluate their academic achievement. Hazi, H. M et al. [26] pointed out that in the long run, corroborating the changes in teacher evaluation which may improve study of students needs to be further observed. Hill, H et al. [27] believed that teachers' evaluations may aid students in identifying their areas of weakness and potential for growth in their learning. Mulready-Shick, J et al. [28] showed how scientific teacher evaluation may aid nursing students in developing their nursing skills. Gálvez Suarez, E et al. [29] designed a teaching performance evaluation model based on academic preparation fields of students in the good performance framework of teachers. Results indicated that poor performance was associated with academic preparation and incomplete evaluation goals. Hence, Hypothesis 4 is forwarded herein.

H4: Online teaching evaluation ability of university teachers can improve learning engagement of learners obviously.

Kreber, C [30] deemed that teaching reflection included content reflection, process reflection and precondition reflection. Trees, K [31] pointed out that teaching reflection was a positive teaching strategy that could improve learning motivation of students. Marcos, J. M. et al. [32] agreed that teachers' reflection contributed to better professional growth, but instructors had little knowledge on how to practice reflection more effectively, which could impede teaching reflection. Romano, M et al. [33] introduced

three technological tools to stimulate and encourage reflective teaching of teachers. The findings demonstrated that teachers learned the benefits of each technology and that video instruction pushed them to reflect on their teaching techniques in the most profound ways. Luttenberg, J et al. [34] believed that good teaching reflection of teachers was beneficial to improve teaching ability and attract more learners to participate in independent learning. Hence, H5 was forwarded herein.

H5: Online teaching reflection ability of university teachers can improve learning engagement of learners obviously.

3 Methodology

3.1 Questionnaire design

According to the professional ability part of China's Basic Standards of Profession of University Teachers, a Survey Questionnaire of Online Teaching Ability of University Teachers in the Digital Age was compiled. Three sections made up the questionnaire: general information, STEM, and learner engagement. Part I measured general information and had five questions on gender, grade and major of students as well as education background and teaching age of teachers. Part II measured teaching ability of STEM. Here, the research questionnaire of Peterman, K et al. [35] and Griese, B et al. [36] was applied. Following respondent specialty, teaching ability of STEM was decomposed into five aspects with 25 questions. The five dimensions of teaching design ability, resource development ability, teaching implementation ability, teaching evaluation ability, and teaching reflection ability were measured by 4, 6, 5, 4, and 6 questions, respectively. Part III then measured learning engagement of learners using the partial questionnaire employed by Reeve, J et al. [37]. 7 questions were answered using a 7-point Likert scale.

3.2 Respondents

Because of COVID-19, many universities in China have carried out online teaching. In this study, a questionnaire survey was carried out in six universities in Henan Province, China, namely Zhenzhou University, Henan Agricultural University, Henan University of Technology, Zhengzhou University of Light Industry, Zhongyuan University Of Technology, and Henan College of Animal Husbandry and Economy. Since Henan is an agricultural province, students who major in food related degrees have much opportunities set out for them in the area. Teachers of these majors also underwent obvious education information reform. Hence, teachers and students of food majors were chosen in the questionnaire survey. The research team compiled the questionnaire through the Wenjuanxing Platform (https://www.wjx.cn/) and QR code was produced and sent to students. 354 questionnaires were collected and questionnaire data was screened through Excel. Ultimately, 287 valid questionnaires were gained, showing an effective rate of 81.07% for the final data set.

Table 1. Frequency analysis results of respondents

Name	Options	Frequency	Proportion
Gender of learners	Male	236	17.77%
	Female	51	82.23%
Grade of learners	Freshman	48	16.72%
	Sophomore	60	20.91%
	Junior	86	29.97%
	Senior	93	32.40%
Major of learners	Food Science and Engineering	56	19.51%
	Food Quality and Safety	70	24.39%
	Edible Fungi Science and Engineering	76	26.48%
	Bioengineering	42	14.63%
	Agricultural biotechnology	43	14.98%
Education background of teachers	Bachelor	16	5.57%
	Master	67	23.34%
	PhD	204	71.08%
Online teaching age of teachers	<3 years	129	44.95%
	3–10 years	62	21.60%
	10–20 years	35	12.20%
	20–30 years	20	6.97%
	>30 years	41	14.29%

Table 1 shows that females accounted for the higher proportion (82.23%) in food majors. Grade and major of learners distributions were also relatively balanced. Most teachers had PhD degrees (71.08%) and 44.95% teachers had online teaching activity for less than 3 years. Due to COVID-19 and increased PhD recruitment, more teachers with a high education level were forced to use online teaching methods.

4 Results analysis

4.1 Reliability and validity test

First, the questionnaire method must analyze the reliability of the questionnaire itself. Validity is the accuracy and effectiveness of measurement results. that is, whether measurement results have realized the expected goal.

Table 2. Reliability test results

Type of Variables	Name of Variables	No. of Variables	Number of Questions	Cronbach α	Overall Cronbach α
Independent variables	Teaching design ability	X1	4	0.942	0.889
	Resource development ability	X2	6	0.853	
	Teaching implementation ability	X3	5	0.820	
	Teaching evaluation ability	X4	4	0.784	
	Teaching reflection ability	X5	6	0.766	
Dependent variable	Learning engagement	Y	7	0.821	

Table 2 showed that the overall reliability of this study was 0.889 (>0.8), indicating the high reliability quality of research data. Therefore, research data can be used for further analysis. Moreover, Cronbach's α was higher than 0.7 for the five dimensions of teaching activities and learning engagement, indicating good reliability of the questionnaire.

Validity therefore also means whether questions can measure the desired contents accurately. Following extant literature, the scale was designed by perfecting existing scales continuously according to practical situations of experimental study under the guidance of relevant experts. This guaranteed an increased accuracy and validity of the questions.

Table 3. AVE and CR results of the model

No. of Variables	Average Variance Extract (AVE)	Combined Reliability (CR)
X1	0.804	0.942
X2	0.557	0.865
X3	0.599	0.862
X4	0.607	0.840
X5	0.500	0.809
Y	0.515	0.849

Table 4. Discrimination validity: Pearson's correlation and square root of AVE

	X1	X2	X3	X4	X5	Y
X1	0.896	–	–	–	–	–
X2	0.382	0.746	–	–	–	–
X3	0.325	0.487	0.774	–	–	–
X4	0.349	0.386	0.395	0.779	–	–
X5	0.365	0.238	0.284	0.294	0.707	–
Y	0.136	0.060	0.129	0.135	0.366	0.718

Tables 3 and 4 show that AVE was higher than 0.5 and CR was higher than 0.7, indicating the high convergent validity. Table 5 then showed that square root of AVE of all variables was higher than the maximum absolute of correlation coefficients among factors, indicating the questionnaire's good discrimination validity.

Table 5. KMO and Bartlett's test of sphericity

KMO Value		0.844
Bartlett's test of sphericity	Approximate chi-square	7632.7
	d*f*	496
	p-value	0.0

Table 5 showed that the approximate chi-square of the questionnaire was at 7632.7, *p*-value and KMO value were 0.01 and 0.844, proving the high internal consistency of the questionnaire. The questionnaire therefore had relatively high validity.

4.2 Regression analysis

Table 6. Linear regression results

Variables	Standardization Coefficient	T	P	VIF	Adjusted R^2	F
Constant	–	10.793	0.000**	–	0.669	F(5,281)= 116.814, p=0.000
X1	0.149	2.990	0.003**	2.142		
X2	0.005	0.138	0.891	2.106		
X3	0.660	18.671	0.000**	1.081		
X4	0.239	4.849	0.000**	1.008		
X5	0.091	2.649	0.009**	1.013		

Notes: D-W value: 1.630; **significance under the 1% significance level.

Table 6 then showed that the adjusted R^2 of the model was 0.669, indicating that independent variables could interpret 66.9% changes in the dependent variable. The model passed the F-test (F=116.814, p=0.000<0.05) and VIF values in the model were all lower than 5. This meant no collinear problem. The D-W value was close to number 2, indicating that there's no autocorrelation in the model. The regression results were good.

(1) H1 was true. Online teaching design ability of university teachers can improve learning engagement of learners obviously. Major reasons exposed are as follows: In today's knowledge economy, science and technology develop rapidly and knowledge becomes increasingly richer. The STEM education is developing continuously as a new education paradigm. In online teaching, teachers must carry out STEM courses smoothly and assure teaching effect. Teachers shall be lifelong learners since existing knowledge is not enough and shall therefore absorb and digest the latest knowledge and philosophy, expand field of view, improve their abilities, promote professional development, and increase self-values. Moreover, STEM courses may use various leading tools and technologies. For example, food technology and nutrition instructors shall learn how to make full use of leading learning contents such as synthetic biology, Internet of Things, artificial intelligence, additive manufacturing and nanotechnology, and master modern education technologies to improve teaching STEM. University teachers who have stronger online teaching design ability can guide students to solve real scenario problems better, break mind-sets, optimize knowledge structure continuously, and integrate multidisciplinary knowledge into a whole. When engaging in teaching activities, teachers must adopt a different persona, focus on the students' topic roles, and assist them as they learn and explore. Moreover, teachers shall be guider and observer to discover problems of students timely, give suggestions according to practical situations, and increase their learning engagement.

(2) H2 was false. Online resource development ability of university teachers is unable to significantly improve learning engagement of learners. It agrees with many research conclusions. This is because many university teachers have weak consciousness in online teaching development. Some teachers are accustomed to merely implementing courses developed by the government and colleges without making any adjustments to reflect students' real-world circumstances. Because of the gaps in deep thinking fail to establish a consciousness in teaching resource development. Besides, some university teachers lack of knowledge for resource development and lack of accurate understanding on relevant concepts of course resourcesThese personnel are unaware of the valuable materials and resources in life and cannot transform them into teaching resources creatively. Particularly, R&D of food enterprises progresses quickly, which requires university teachers to transform resources in daily life into study resources appropriate for students. Nevertheless, teachers have no time to design and develop online courses, thus making it difficult to train their STEM resource development ability. Hence, learning engagement of learners is not increased obviously.

(3) H3 was true. The ability of university lecturers to adopt online instruction can visibly enhance students' learning engagement. Major reasons for this include the following. Teachers can encourage students' initiative in an online classroom and use a teaching style that is more appropriate for college students. They are also good summarizing and synthesizing key points after class and have rich teaching experiences. Online teaching implementation ability of teachers requires transdisciplinary teaching ability and teachers shall be able to integrate scientific, technological, engineering and math knowledge, together with innovation consciousness and practice ability. University teachers with stronger online teaching implementation ability can realize localized innovation of professional knowledge according to China's practical situation more effectively. Teachers can fully comprehend training materials and improve their operational abilities. This plays a critical role in training of learners' skills and thereby increases learning engagement of learners.

(4) H4 was true. Online teaching evaluation ability of university teachers can improve learning engagement of learners obviously. The function of teaching assessment has evolved as China's "new engineering course" education has advanced, and more focus is now placed on student stimulation and feedback. Teachers must duly play their respective roles in evaluating, improve the teaching effect, and increase learning engagement of learners. Particularly, some courses similar with food majors require strong operational ability and strong course practice. In teaching, educators with stronger teaching evaluation ability are likelier to give specific and personalized evaluation and use technologies such as AI in teaching evaluation, aiming to encourage and guide students to academic activities and increase learning engagement.

(5) H5 was true. Online teaching reflection ability of university teachers can improve learning engagement of learners obviously. Reasons for this include the following. Teachers who can review, analyze, explore, and reflect on the teaching process have good teaching reflection skills. This aids educators in enhancing both the effectiveness and process of instruction. Particularly, more teachers with higher education levels have been employed by universities who focus more on successful

teaching aspects during teaching reflection and are apt to summarize their successful experiences. These educators combine education theory and further innovate their teaching method to perfect the teaching process continuously. Self-reflection based on teaching diary, reflection based on classroom video from the perspective of the third party and collective reflection through cooperation and communication can facilitate communication and cooperation of teachers are also beneficial for teachers to maintain good communications with students, pay attention to ever growing and changing learning demands, and increase their learning engagement.

5 Discussions

Table 7. Learners's variance test

Learning engagement	**Major of Learners (mean±SD)**					**F**	**P**
	1(n=56)	**2(n=70)**	**3(n=76)**	**4(n=42)**	**5(n=43)**		
	5.04±1.74	4.78±1.35	4.68±1.30	4.63±1.67	3.92±2.04	1.133	0.341
	Grade of Learners (mean±SD)					**F**	**P**
	1(n=48)		**2(n=60)**	**3(n=86)**	**4(n=93)**		
	3.75±0.35		5.04±1.24	4.61±1.41	4.76±1.51	1.169	0.322

Table 7 showed that there is no significant difference in learning engagement among learners of different majors and grades. This is due to food being a relatively practical major. Professional basic knowledge is taught during freshman and sophomore, when no obvious differences of online learning engagement are developed among learners. Moreover, due to COVID-19, online learning is offered to freshmen, sophomores, juniors and seniors, with no obvious difference of learning engagement being reflected. This is because all schools of these six universities proactively use online teaching which better coincides with the learning style of many learners.

Table 8. Teachers's variance test

Learning engagement	**Teaching Age of Teachers (mean±SD)**					**F**	**P**
	1(n=129)	**2(n=62)**	**3(n=35)**	**4(n=20)**	**5(n=41)**		
	5.19± 1.24	4.53± 1.31	5.20± 1.23	5.05± 1.15	5.00± 1.14	3.192	0.014*
	Education Background of Teachers (mean±SD)					**F**	**P**
	1(n=16)		**2(n=67)**		**3(n=204)**		
	4.64±1.36		4.78±1.46		4.69±1.47	0.191	0.826

Note: *Significance under the 5% significance level.

Table 8 showed that teaching age of teachers had significantly different influences on learning engagement of learners. The learning engagement of students is significantly increased by teachers who have been teaching for less than three years and between 10 and 20 years. This is because teachers with 10–20 years of teaching experience possess richer teaching experiences, master the online teaching method more flexibly,

and offer students more diversified learning resources throughout the teaching process according to course arrangement. This allows learners to acces their learning resources in different stages to deepen their understanding on knowledge and increase learning engagement. Most teachers with less than three years of classroom experience hold PhDs. These teachers are recruited for their talents and are more willing to participate in information-based teaching ability competitions organized by universities, such as state-of-the-art cartoon courseware making competitions, microlecture competitions, among others. Young teachers put such excellent works on the online learning platform, thus stimulating learning enthusiasm and power of students and increasing learning engagement of students.

6 Conclusions

This study investigated influences of online teaching ability of university teachers on learning engagement of learners. Three major conclusions were drawn herein: (1) teaching design ability, teaching implementation ability, teaching evaluation ability, and teaching reflection ability all have significantly positive influences on learning engagement of learners; (2) Resource development ability cannot promote learning engagement of learners; and (3) Teaching age of educators have obviously different influences on learning engagement of learners. Young teachers with PhD degrees and those with a teaching age of 10–20 years have strong online teaching ability and can significantly improve learning engagement of learners. It is suggested to increase measurement indexes of learning engagement of students and enlist learning efficacy as a mediating variable. Moreover, comparative test of teachers' online teaching activities may be executed by adjacent further studies.

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