# The Influence of Online Teaching Interactive Behaviors on Sustained Learning Results of Learners

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Pin Zhang[1](✉), Xinshang Chang[2]
[1] Jiangxi University of Science and Technology, Nanchang, China
[2] Philippine Christian University, Manila, Philippines
zhangpin@jxut.edu.cn

**Abstract—**Along with the increasing maturity of mobile information technology, mobile-based online learning has become one of the main teaching methods that all kinds of schools should adapt themselves to during the COVID-19 pandemic. However, online education physically isolates teachers from their students, hence weakening their interactions. In the context of this spatial isolation, the frequency of interactive behaviors and quality of communication in online education should be strengthened to improve the sustained learning results of learners. After reviewing the previous literature, a questionnaire investigating the influence of online instructional interaction level on sustained learning results was designed. By considering self-efficacy as a mediating variable, the mediating effect of self-efficacy on sustained learning results at the interactive level of online teaching was analyzed and the difference in sustained learning results that can be attributed to years of familiarity with online learning was measured. Results show that teacher-student interaction has significant positive effects on sustained learning results, whereas student-student interaction has significant positive effects on sustained learning results. Self-efficacy completely mediates the role of teacher-student interaction and student-student interaction in effectively and significantly improving sustained learning results. The duration of online learning has a significant effect on sustained learning results. Conclusions provide an important reference for enriching the learning activity design principles of instructional interaction level.

**Keywords—**online teaching, interaction level, sustained learning, mediating effect, analysis of variance (ANOVA)

## 1 Introduction

The gradual improvements in mobile communication, artificial intelligence, and other technologies have fundamentally changed people's lives and provided learners with diverse tools for efficient learning. While contributing new professional content for education informatization, the rapid development of information technology also places huge pressure on traditional teaching and virtually affects other people's learning and life at all levels. Online education requires teachers to continue with their classroom teaching while simultaneously using powerful functions in an online learn-

ing environment by collecting large amounts of pictures, videos, and other resources. Meanwhile, students can learn diversified knowledge from multiple channels. This new teaching method has triggered a new "student-oriented" reform by organically combining high-quality online learning resources with zero-distance teaching and plays an important role in improving the skills and knowledge of learners in taking full advantage of both online and traditional learning and realizing their efficient integration and development. Supported by education information technology, online learning provides learners with situational, technical, interaction effect, resource, learning external evaluation, and other forms of support in their shift from intermittent learning to sustained learning and creates a vast space for them to achieve deeper knowledge system construction. In this way, online learning has become the best choice for teachers to realize a high-quality teaching reform. Education administrative departments at all levels have gradually moved from their initial construction of basic hardware and software facilities and their development of excellent teachers to improving the evaluation of online teaching effect, further enhancing the effectiveness of teaching and education, and improving sustained learning performance.

The interaction between teaching and learning has become a key factor that affects the learning enthusiasm of learners in the online learning process. Most online platforms focus on the use of information technology yet lack an effective design for facilitating teacher-student and student-student interactions. The interaction between teaching and learning essentially aims to shape man-machine interactions. Effective man-machine and interpersonal communication can be exercised in different ways to improve the learning participation of learners and promote their sustained thinking. The intermittent system learning that only focuses on mechanical repeated memory of knowledge cannot reflect well the fast and detailed changes in complex societies, whereas sustained learning focuses on understanding and using knowledge for students, advocates active social criticism and reflection, and emphasizes the interruption and construction of knowledge, which have become new goals in the information era. Vigorously cultivating the sustained learning ability of students is critical in this rapidly developing information era and in facilitating education and teaching reforms. Accordingly, colleges and universities in China have started to cultivate the sustained learning of students and improve their sustained learning to reform their educational talent training mode.

## 2 Theoretical background and hypothesis development

### 2.1 Interactive hierarchy theory

While online teaching has proliferated during the COVID-19 pandemic, this teaching method creates a time and space segmentation between the teaching behaviors of teachers and the learning behaviors of their students. Therefore, how to achieve efficient and timely instructional interaction has become a key problem in improving online teaching quality. Dewey [1] pointed out that instructional interaction is the core part of teaching activities. With the deepening of education theory and practice, the

type, content, and object of instructional interaction have undergone great changes, and the connotation of instructional interaction has expanded to include the interactions between learners and learning interfaces, between the learning content and learners, and between master teachers and assistants. Ally [2] demonstrated that in the instructional interaction process, a higher number of instructional interactions and a richer instructional interaction do not necessarily lead to a better teaching effect. Various types of instructional interaction cross and replace one another, and it was believed that there were equivalent interaction and interaction level. Li [3] proposed teaching interactive hierarchy theory, which has been widely recognized and applied in the field of education in China. The hierarchical model for instructional interaction (HMII), which covers operation interaction, information interaction, and concept interaction among others, systematically explores the most common types of interaction in online teaching to provide a detailed reference for interactive theory of online teaching.

### 2.2 Research hypotheses

Previous studies have concurred that an online teaching environment comprises teachers, students, machines, and other elements. In such an environment, the types and contents of instructional interaction are highly abundant. As for how instructional interaction affects learning performance, Patel [4] recognized the needs of individual learners during interactions. Results of practical teaching showed that the attendance rate of students in lectures and seminars remained high and that more interactions correspond to more obvious progress in the performance of students. Rostvall et al.[5] demonstrated that classroom interactions have a strong asymmetric power allocation that negatively affects the learning opportunities of students. Therefore, the interactions between teachers and students should take the interests of students into account. Llinares et al. [6] analyzed how primary school teachers use video clips to teach mathematics in an online learning environment and found that the different types of tasks and online discussion conditions in the learning environment affect the nature of interactions, thereby highlighting a relationship between collaborative interaction and higher-order thinking. Leaf et al. [7] analyzed the social stories and instructional interaction programs designed for 6 children and adolescents with autism spectrum disorder and found that between social stories and instructional interaction programs, these students mastered all 18 social skills that were delivered through the latter approach. Lovorn et al. [8] demonstrated that teachers use humor in class and promote open interactions with their students to significantly strengthen their learning interest. Johnson et al. [9] pointed out that the interactions between students and teachers play a critical role in the teaching process that is easily ignored by teachers. Therefore, teacher vocational trainings should focus on developing the interaction skills of teachers with their students. Goodyear et al. [10] explored teacher behavior in a student-centered learning environment and suggested that teachers should play an active role in classrooms and use a series of direct and indirect behaviors and dialogues to support and expand learning. Pianta et al. [11] argued that teachers are very important but often neglected resources in promoting student-teacher interactions. Therefore, teach-

ers should strengthen their relationships with their students to benefit the latter. Goldstein [12] pointed out that teachers can provide written comments on the rhetoric and content of the writings of their students as a way of interacting with them and proposed that such interaction can significantly improve the effectiveness of their comments and the modifications subsequently applied by their students in their writing. Margutti [13] believed that the positioning of the teaching objectives of an interactive organization can be reflected in the characteristics of conversations, and their findings provide a basis for criticizing the initiation-response evaluation model and characterizing the questions proposed in a teaching sequence. Gillies [14] found that those teachers who implement collaborative learning in the classroom participate in more intermediary learning interactions and make less comments on the discipline of their students compared with those teachers who only implement group activities. When these teachers adopt collaborative learning in the classroom, the words and behavior of their students are dominated by this learning mode, hence motivating them to observe discipline in the classroom. Stevenson et al. [15] showed that the reactions of students in a class are highly personalized and suggested that engaging in dialogue with dogs in schools can enhance the participation and interactions of students with their teachers. Wallace [16] proposed that the media should adopt the new modes of presentation and interaction being used in online teaching environments, in which the interactions between the social roles of teachers and students have important research value. Jon [17] investigated the effect of Korean Higher Education Institutions on promoting the interactions between domestic and international students and on cross-cultural ability. Results of their path analysis revealed that campus programs involving Korean and international students have positive and direct impacts on the interaction between these students and have positive and indirect impacts on their cross-culture competence. Arkoudis et al. [18] found that teachers can encourage more interactions between domestic and international students and effectively improve their cross-cultural communication skills.

The above studies show that in an online learning environment, the geographical locations of teachers and students are different and that their time may not be completely synchronized. Therefore, their interactions become unnatural. Teachers should therefore focus their energy on interacting with their students and promoting their teaching knowledge to realize a gradual transfer of knowledge from intermittent to sustained levels. Given that learning deep knowledge requires high levels of teacher-student and student-student interactions, schools of all types should focus on fostering such interactions in online learning environments for learners to study hard and rely on one another. Instructional interaction has many types and contents, among which teacher-student and student-student interactions are two core aspects that influence the other types of interactions. In teacher-student interactions, teachers serve as initiators of knowledge and skills who stimulate learners to complete their learning tasks, maintain their learning motivation, promote their knowledge learning through various measures, and guarantee their self-learning ability and efficiency. Online learning has two implementation forms, namely, synchronous and asynchronous interactions between teachers and students. Online learning also has highly diverse and personalized interaction forms among students. Students can choose topics they are interested in

and use whichever interaction forms they are proficient at (e.g., BBS forum, Weibo, group discussion, and group games) to demonstrate various interactive behaviors. Therefore, an efficient student-student interaction delivers highly realistic online learning experiences for learners.

The following hypotheses are proposed based on the results of the literature review:

- H1: Teacher-student interaction can effectively and significantly improve the results of sustained learning.
- H2: Student-student interaction can effectively and significantly improve the results of sustained learning.
- H3: Self-efficacy plays a mediating role in how teacher-student interaction effectively and positively improves sustained learning results.
- H4: Self-efficacy plays a mediating role in how student-student interaction effectively and positively improves sustained learning results.

# 3 Methodology

## 3.1 Questionnaire design

Many studies have explored how to realize teaching interaction and improve the learning effect for students in online learning environments. However, the types, levels of instructional learning, and results of sustained learning have not received much research attention. To explore online instructional interactions, this paper adopted the 15-item questionnaire of Kuo et al. [19], of which 8 questions explore teacher-student interactions and 7 questions explore student-student interactions. To investigate the results of sustained learning, which is a relatively broad concept, this paper adopted related items from the questionnaire of Campbell et al. [20] and formulated 5 additional questions. Given that online instructional interactions may affect sustained learning results through the own factors of learners, this paper adopted the 10-item self-efficacy questionnaire of Nicholas [21] and used self-efficacy as a mediating variable in the analysis. Four additional questions were formulated to collect the demographic information of the respondents, namely, their gender, grade, major, and years of online learning. The final questionnaire included 34 questions that were measured on a 7-point Likert-type scale where a higher score corresponds to a higher degree of recognition.

## 3.2 Objects of study

As an important education province in China, educational institutions in Jiangxi adopted a large number of online learning methods in response to the COVID-19 outbreak. Since 2019, Jiangxi comprehensively accelerated its integration and innovation of education information technologies, emphasized its vigorous implementation of “coverage action of network school space,” promoted the diffusion of high-quality

education resources, and further improved its construction of an information infrastructure that can be accessed by all its residents. With respect to online teaching, the province is planning to accelerate its transformation from construction to application, from equipment allocation to technology integration, from means to resources, and from forms to problem-solving. Taking these goals into account, this study selected the undergraduate students of a provincial college of science who engaged in online learning during the COVID-19 outbreak as the objects of this study. Random sampling was used in the participant recruitment. The Questionnaire Star Platform (www.wjx.cn) was forwarded to the selected students by the teachers or counselors working in the institute. A total of 267 questionnaires were sent out, of which 237 were returned and 206 were deemed valid, eventually leading to a 77.15% response rate.

**Table 1.** Descriptive Statistics of the Respondents

| Name | Item | Frequency | Percent (%) | Accumulative percent (%) |
|---|---|---|---|---|
| Sex | Male | 101 | 49.03 | 49.03 |
| | Female | 105 | 50.97 | 100 |
| Years of online learning | Less than half a year | 33 | 16.02 | 16.02 |
| | 6 months~1 year | 37 | 17.96 | 33.98 |
| | 1 year ~ 2 years | 34 | 16.5 | 50.49 |
| | 2 years ~ 3 years | 39 | 18.93 | 69.42 |
| | 3 years ~ 5 years | 29 | 14.08 | 83.5 |
| | More than 5 years | 34 | 16.5 | 100 |
| Major | Mathematics and applied mathematics | 22 | 10.68 | 10.68 |
| | Information and computing science | 44 | 21.36 | 32.04 |
| | Physics | 27 | 13.11 | 45.15 |
| | Applied physics | 11 | 5.34 | 50.49 |
| | Chemistry | 30 | 14.56 | 65.05 |
| | Applied chemistry | 21 | 10.19 | 75.24 |
| | Biological science | 45 | 21.84 | 97.09 |
| | Biotechnology | 6 | 2.91 | 100 |
| Grades | Freshman | 71 | 34.47 | 34.47 |
| | Sophomore | 70 | 33.98 | 68.45 |
| | Junior | 45 | 21.84 | 90.29 |
| | Senior | 20 | 9.71 | 100 |
| Total | | 206 | 100 | 100 |

# 4 Results analysis

## 4.1 Reliability and validity analyses

Table 2 shows that the questionnaire has a Cronbach's α of 0.891, which exceeds 0.8, thereby indicating that this instrument has high reliability.

**Table 2.** Cronbach's reliability analysis

| Name of variables | No. of question | Correction Item Total Correlation (CITC) | Item deleted α coefficient | Cronbach α coefficient | Cronbach α coefficient |
|---|---|---|---|---|---|
| Teacher-student Interaction | A1 | 0.705 | 0.867 | 0.886 | 0.891 |
| | A2 | 0.669 | 0.871 | | |
| | A3 | 0.617 | 0.876 | | |
| | A4 | 0.651 | 0.873 | | |
| | A5 | 0.626 | 0.875 | | |
| | A6 | 0.659 | 0.872 | | |
| | A7 | 0.655 | 0.872 | | |
| | A8 | 0.667 | 0.871 | | |
| Student-student Interaction | B1 | 0.571 | 0.799 | 0.823 | |
| | B2 | 0.545 | 0.804 | | |
| | B3 | 0.532 | 0.805 | | |
| | B4 | 0.596 | 0.795 | | |
| | B5 | 0.569 | 0.799 | | |
| | B6 | 0.583 | 0.797 | | |
| | B7 | 0.576 | 0.798 | | |
| Sustained learning results | Y1 | 0.681 | 0.875 | 0.888 | |
| | Y2 | 0.766 | 0.855 | | |
| | Y3 | 0.795 | 0.849 | | |
| | Y4 | 0.788 | 0.850 | | |
| | Y5 | 0.619 | 0.887 | | |
| Self-efficacy | M1 | 0.487 | 0.769 | 0.790 | |
| | M2 | 0.485 | 0.769 | | |
| | M3 | 0.534 | 0.763 | | |
| | M4 | 0.395 | 0.780 | | |
| | M5 | 0.391 | 0.780 | | |
| | M6 | 0.398 | 0.780 | | |
| | M7 | 0.513 | 0.766 | | |
| | M8 | 0.476 | 0.77 | | |
| | M9 | 0.468 | 0.771 | | |
| | M10 | 0.459 | 0.773 | | |

KMO and Bartlett's test were used to validate the questionnaire. Table 3 shows that the KMO value is 0.838 (above 0.8) with a corresponding *P*-value of 0.000 (below 0.01), thereby indicating that the questionnaire is very suitable for this study.

**Table 3.** KMO and Bartlett's test

| **KMO value** | | 0.838 |
|---|---|---|
| **Bartlett sphericity test** | Approximate Chi-square | 4941.723 |
| | Df | 435 |
| | p-value | 0 |

Table 4 shows that the AVE square root values of discriminant validity and the 4 variables are greater than the absolute value of the correlation coefficients between factors, thereby indicating the good discriminant validity of the questionnaire.

**Table 4.** Discriminant validity: Pearson's and AVE square root value

| | **Teacher-student interaction** | **Student-student interaction** | **Sustained learning result** | **Sense of self-efficacy** |
|---|---|---|---|---|
| Teacher-student interaction | 0.681 | - | - | - |
| Student-student interaction | 0.464 | 0.646 | - | - |
| Sustained learning result | 0.079 | 0.069 | 0.789 | - |
| Sense of self-efficacy | 0.461 | 0.401 | 0.277 | 0.548 |

Note: the digit of clinodiagonal is the AVE square root value

## 4.2 Correlation and regression results

Correlation analysis was performed to study the correlation of sustained learning results with both teacher-student and student-student interactions, and the Pearson correlation coefficient was used to indicate the strength of correlation. Table 5 shows that the correlation coefficient between sustained learning results and teacher-student interaction is 0.334, which is significant at the 0.01 level, whereas the correlation coefficient between sustained learning results and student-student interaction is 0.058, which is significant at the 0.05 level.

**Table 5.** Correlation coefficients

| | **Average value** | **Standard deviation** | **Teacher-student Interaction** | **Student-student Interaction** | **Sustained learning results** |
|---|---|---|---|---|---|
| Teacher-student interaction | 4.816 | 1.111 | 1 | | |
| Student-student interaction | 4.505 | 1.399 | 0.157* | 1 | |
| Sustained learning result | 4.932 | 1.385 | 0.334** | 0.058* | 1 |

*$p$<0.05, **$p$<0.01

Table 6 shows that the model passed the F-test ($F$=16.136, $p$=0.000<0.05). Another test was performed to check the multiple collinearity of the model, and results showed that all VIF values were below 5, thereby indicating the absence of any collinearity.

The D-W value is near 2, indicating the absence of auto-correlation in the model and correlation among the sample data.

**Table 6.** Linear regression results

| | **Standard coefficient** | ***T*** | ***p*** | $R^2$ | **Adjust $R^2$** | ***F*** |
|---|---|---|---|---|---|---|
| Constant | - | 8.893 | 0.000** | 0.137 | 0.129 | $F$ (2,203)=16.136, $p$=0.000 |
| Teacher-student interaction | 0.141 | 2.154 | 0.032* | | | |
| Student-student interaction | 0.335 | 5.122 | 0.000** | | | |
| D-W:1.691 | | | | | | |

* $p$<0.05, ** $p$<0.01

The regression coefficient of teacher-student interaction is 0.110 ($t$=2.154, $p$=0.032<0.05), thereby supporting H1, that is, teacher-student interaction has a significantly positive impact on sustained learning results. This result can be mainly attributed to the fact that in an online environment, teachers guarantee external conditions that can stimulate and improve the learning motivation of their students through positive case guidance, timely feedback, behavior guidance, reasonable encouragement, and other measures. An online teaching platform can extend the student-teacher interactions from traditional classrooms to the online teaching process and the time beyond online teaching activities, thereby greatly improving the time and frequency of student-teacher interactions. Teachers can also ask questions, discuss issues, leave messages, and adopt other ways to interact with their students in an online learning environment. Given its accessibility and massive storage, teachers and students can easily and quickly access the online teaching platform, extend their online real-time synchronous interactions to asynchronous interactions regardless of time and place, and demonstrate interactive behaviors when students familiarize themselves with knowledge or skills step by step. Online teaching also provides enough time for students to learn knowledge and realize synchronous or asynchronous interactions with their teachers. This platform organically combines teaching interaction behaviors inside and outside the classroom for such behaviors to last longer and for sustained learning to exert obvious effects.

The regression coefficient of student-student interaction is 0.265 ($t$=5.122, $p$=0.000<0.01), thereby supporting H2, that is, student-student interaction has a significantly positive impact on sustained learning results. This result can be mainly ascribed to the ability of students to choose an appropriate online expression form and expression content to achieve an efficient interaction with their classmates and to express their learning views. The online platform offers several functions, such as discussion areas and group cooperation that can help students realize a real-time interaction. The favorable interactive behaviors among students can help them maintain a high learning enthusiasm and offer them appropriate ways (e.g., forums, group questions, giving likes) to effectively communicate with one another. The instant or non-instant communication and collaboration behaviors of students on the online platform can fully stimulate their inner learning enthusiasm, relieve their loneliness

and helplessness, and improve their learning efficiency. Through this platform, students can discuss various knowledge points and create a course knowledge system via online mind mapping, which can promote good communication, facilitate their gradual shift from intermittent to sustained learning, encourage their continuous learning and communication, adjust their moods and motivations to a more sustainable state, and constantly improve their learning calendar and learning process to realize their construction of sustained learning knowledge and master complex technical skills.

### 4.3 Mediating role

Table 7 shows that both H3 and H4 are supported. Self-efficacy has a full mediating effect on teacher-student interaction that can effectively and positively improve sustained learning results. Meanwhile, self-efficacy has a full mediating effect on student-student interaction that can effectively and positively improve sustained learning results mainly because learning with a strong sense of self-efficacy can motivate students to actively participate in teacher-student and student-student interactions. Speakers and assistants should give full play to their leading role in curriculum setting, process management, and interaction in discussion areas, actively solve the questions of learners, ensure the smooth progress of their learning, focus on the real-time discussion among learners, guide their participation in in-depth interactions, ensure the quality of their interactions, and improve their interaction level. The interactive evaluation among students can also grant additional points to those learners who write high-quality course summaries and facilitate a scientific evaluation of the phased learning of learners. A higher sense of self-efficacy indicates that learners are more likely to gain a sense of achievement in online learning, improve their internal learning motivation and interest, focus on their learning process, maintain a high degree of concentration, and achieve a deep understanding of learning knowledge. Meanwhile, students with a relatively higher level of self-efficacy have a stronger yearning to gain knowledge through online education and can easily perceive the joy and charm of online learning. Therefore, teacher-student and student-student interactions provide an excellent basis for developing individual factors. Online education in colleges and universities can also encourage teachers to carry out a "one student, one teaching" personalized customized teaching plan.

**Table 7.** Mediating effect analysis

| | **Sustained learning result** | **Self-efficacy** | **Sustained learning result** |
|---|---|---|---|
| Constant | 4.366** (10.980) | 2.602** (9.552) | 3.334** (7.219) |
| Teacher-student interaction | 0.043 (0.512) | 0.202** (3.499) | -0.037 (-0.442) |
| Student-student interaction | 0.059 (0.766) | 0.272** (5.116) | -0.048 (-0.609) |
| Self-efficacy | - | - | 0.397** (4.014) |
| Sample size | 206 | 206 | 206 |
| $R^2$ | 0.008 | 0.257 | 0.081 |
| Adjust $R^2$ | -0.002 | 0.25 | 0.067 |
| *F* value | *F* (2,203)=0.774, *p*=0.463 | *F* (2,203)=35.090, *p*=0.000 | *F* (3,202)=5.924, *p*=0.001 |

* $p<0.05$, ** $p<0.01$ The value is "t value" in brackets

### 4.4 Influence of online learning duration

ANOVA was used to explore the differences in sustained learning results due to years of online learning. The participants had different years of online learning and showed significant differences in their sustained learning results ($p$<0.05, $F$=2.948, $p$=0.014). Significant differences were also observed between the group average scores. Specifically, the sustained learning results of learners with "one to two years" and "two to three years" of online learning were significantly better than those of other students. Learners cannot produce ideal sustained learning results if their online learning time is too short and if they lack online learning skills. Meanwhile, learners who have too long online learning years can easily perceive gaps in their online learning and use the familiar methods of hanging up and finding a substitute for learning to complete online learning on their own. As a result, they pay less attention to learning results and reduce their learning performance.

**Table 8.** Influence of online learning duration

| | **Years of online learning (average value ± standard deviation)** | | | | | | ***F*** | ***p*** |
|---|---|---|---|---|---|---|---|---|
| | ***1.0 (n=33)*** | ***2.0 (n=37)*** | ***3.0 (n=34)*** | ***4.0 (n=39)*** | ***5.0 (n=29)*** | ***6.0 (n=34)*** | | |
| Sustained learning result | 4.12± 1.41 | 4.59± 1.46 | 5.44± 1.24 | 5.00± 1.67 | 4.86± 1.48 | 4.76± 1.58 | 2.948 | 0.014* |

*$p$<0.05, **$p$<0.01

## 5 Conclusion

5G and mobile Internet technology have forced schools in China to carry out extensive online education during the COVID-19 pandemic that has driven a wide-range and in-depth expansion of online education. However, online learning aggravates the spatial physical isolation between the teaching of teachers and the learning of students, thereby emphasizing the importance of promoting instructional interaction and focusing on sustained learning results in the education field. This study designed a questionnaire to understand the influence of instructional interaction on sustained learning results, analyzed the mediating effect of self-efficacy on the sustained learning results of instructional interaction in the online learning context, and measured the difference in the sustained learning results of students with various years of online learning. The questionnaire had a Cronbach's α of 0.891, KMO of 0.838, and $P$-value of 0.000, thereby indicating its good reliability and validity. Both teacher-student and student-student interactions showed significantly positive effects on sustained learning results, whereas self-efficacy exerted a fully mediating effect on teacher-student interaction that can effectively and positively improve sustained learning results. Online learning years had a significant effect on sustained learning results at 0.05. Future research should further enrich the types and contents of online teaching inter-

action, analyze the influence of instructional interaction on different learning levels, and explore the influence of knowledge reciprocity on student-student interactions.

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## 7 References

[1] Dewey, J. (1903). Democracy in education. The Elementary School Teacher, 4(4), 193-204. https://doi.org/10.1086/453309

[2] Ally, M. (2004). Foundations of educational theory for online learning. Theory and Practice of Online Learning, 2, 15-44.

[3] Li, C. (2016). Principles and strategies for teaching and learning interactions in distance learning. China Distance Education, 9, 5-6.

[4] Patel, N. V. (2003). A holistic approach to learning and teaching interaction: factors in the development of critical learners. International Journal of Educational Management. 17(6), 272-284. https://doi.org/10.1108/09513540310487604

[5] Rostvall, A. L., & West, T. (2003). Analysis of interaction and learning in instrumental teaching. Music Education Research, 5(3), 213-226. https://doi.org/10.1080/1461380032000126319

[6] Llinares, S., Valls, J. (2009). The building of pre-service primary teachers' knowledge of mathematics teaching: interaction and online video case studies. Instructional Science, 37(3), 247-271. https://doi.org/10.1007/s11251-007-9043-4

[7] Leaf, J. B., Oppenheim-Leaf, M. L., Call, N. A., Sheldon, J. B., Sherman, J. A., Taubman, M., McEachin, J., Dayharsh, J., Leaf, R. (2012). Comparing the teaching interaction procedure to social stories for people with autism. Journal of Applied Behavior Analysis, 45(2), 281-298. https://doi.org/10.1901/jaba.2012.45-281

[8] Lovorn, M., Holaway, C. (2015). Teachers' perceptions of humour as a classroom teaching, interaction, and management tool. The European Journal of Humour Research, 3(4), 24-35. https://doi.org/10.7592/EJHR2015.3.4.lovorn

[9] Johnson, R. T., Johnson, D. W. (1985). Student-student interaction: Ignored but powerful. Journal of Teacher Education, 36(4), 22-26. https://doi.org/10.1177/002248718503600406

[10] Goodyear, V., Dudley, D. (2015). "I'm a facilitator of learning!" Understanding what teachers and students do within student-centered physical education models. Quest, 67(3), 274-289. https://doi.org/10.1080/00336297.2015.1051236

[11] Pianta, R. C., Stuhlman, M. W., Hamre, B. K. (2002). How schools can do better: Fostering stronger connections between teachers and students. New Directions for Youth Development, 2002(93), 91-107. https://doi.org/10.1002/yd.23320029307

[12] Goldstein, L. M. (2004). Questions and answers about teacher written commentary and student revision: Teachers and students working together. Journal of Second Language Writing, 13(1), 63-80. https://doi.org/10.1016/j.jslw.2004.04.006

[13] Margutti, P. (2010). On designedly incomplete utterances: What counts as learning for teachers and students in primary classroom interaction. Research on Language and Social Interaction, 43(4), 315-345. https://doi.org/10.1080/08351813.2010.497629

[14] Gillies, R. M. (2006). Teachers' and students' verbal behaviours during cooperative and small-group learning. British Journal of Educational Psychology, 76(2), 271-287. https://doi.org/10.1348/000709905X52337
[15] Stevenson, K., Jarred, S., Hinchcliffe, V., Roberts, K. (2015). Can a dog be used as a motivator to develop social interaction and engagement with teachers for students with autism?. Support for Learning, 30(4), 341-363. https://doi.org/10.1111/1467-9604.12105
[16] Wallace, R. M. (2003). Online learning in higher education: A review of research on interactions among teachers and students. Education, Communication & Information, 3(2), 241-280. https://doi.org/10.1080/14636310303143
[17] Jon, J. E. (2013). Realizing internationalization at home in Korean higher education: Promoting domestic students' interaction with international students and intercultural competence. Journal of Studies in International Education, 17(4), 455-470. https://doi.org/10.1177/1028315312468329
[18] Arkoudis, S., Watty, K., Baik, C., Yu, X., Borland, H., Chang, S., Lang, I., Lang, J., Pearce, A. (2013). Finding common ground: Enhancing interaction between domestic and international students in higher education. Teaching in Higher Education, 18(3), 222-235. https://doi.org/10.1080/13562517.2012.719156
[19] Kuo, Y. C., Walker, A. E., Belland, B. R., Schroder, K. E., Kuo, Y. T. (2014). A case study of integrating Interwise: Interaction, internet self-efficacy, and satisfaction in synchronous online learning environments. International Review of Research in Open and Distributed Learning, 15(1), 161-181. https://doi.org/10.19173/irrodl.v15i1.1664
[20] Campbell, C. M., Cabrera, A. F. (2014). Making the mark: Are grades and deep learning related?. Research in Higher Education, 55(5), 494-507. https://doi.org/10.1007/s11162-013-9323-6
[21] Nicholas, M. K. (2007). The pain self-efficacy questionnaire: taking pain into account. European Journal of Pain, 11(2), 153-163. https://doi.org/10.1016/j.ejpain.2005.12.008

## 8 Authors

**Pin Zhang,** Master, is an associate professor at the School of Art & Design, Jiangxi University of science and Technology. Her research interests focus on higher education and graphic design (email: zhangpin@jxut.edu.cn).

**Xinshang Chang,** Ph.D. Candidate, is currently studying at the Philippine Christian University. His research interests focus on Economic Management (email: cxs2008_jx@163.com).

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