

Effects of Asynchronous Interaction on Positive Emotional Experiences of Learners during Online Learning

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Abstract—Online education is appreciated by an increasing number of people, and how to guarantee positive emotional experiences of learners during online learning becomes a core problem that has become the concern of education researchers. Online asynchronous interaction is an important communication method among learners during online learning. Owing to shortages and defects in time and space, interaction channel, and interaction content, online learning easily produces many “emotional blanks.” This research reviewed studies on online asynchronous interaction and emotional experiences at home and overseas. A total of 356 students majoring in Nursing from 5 universities in Henan Province were invited for the questionnaire survey. Influences of online asynchronous interaction, including people-to-system (P2S), people-to-people (P2P), and people-to-content (P2C), on the positive emotional experiences of learners were analyzed. Differences in positive emotional experiences under different weekly online asynchronous learning hours were estimated. Research results showed that Cronbach’s α of the questionnaire is 0.920, KMO value is 0.840, and the sphericity test significance is 0.000, indicating that the proposed questionnaire has very good reliability and validity. Evidently, P2S, P2P, and P2C can promote the positive emotional experiences of learners. Influences of weekly online asynchronous learning hours on frequency ($F = 3.648, p = 0.006$), intensity ($F = 2.560, p = 0.038$), and duration ($F = 2.523, p = 0.041$) of positive emotional experiences have statistical significance. Research results have important references in promoting online asynchronous interaction strategies, implementing specific interventions to online asynchronous interaction behaviors, and better providing convenient asynchronous online teaching services to students.

Keywords—online asynchronous interaction, learners, positive emotional experiences, analysis of variance, linear regression, questionnaire technology

1 Introduction

Current society is undergoing a new era of rapid development of culture and technology. China’s higher education development is undergoing reform, from expansion and extension to development connotations. Higher education system reform, major

setting, and course construction, as well as updating of teaching methods, have important theoretical and practical significance. Focus is also directed to personality and spiritual development of people. Student-oriented education philosophy centers on the needs and development of students. It stimulates learning enthusiasm and promotes the comprehensive development of students in terms of knowledge, abilities, and quality. Students are subjects of classrooms. That is, they can learn knowledge and improve their abilities and can also participate in classroom activities positively, acquire relaxed and interesting feelings, and gain good emotional experiences. Teachers, as classroom guides, shall considerably focus on the emotions, abilities, and quality training of students, as well as respect their differences. Information technology centered at network and multimedia technologies is emerging rapidly and presenting flourishing development. It has brought profound reforms to the production mode, work mode, and lifestyle of the people, as well as new opportunities and challenges to online education. Modern information technology significantly expands the space–time boundaries of education, and improves learning interest, efficiency, and initiatives of people in an unprecedented manner. In particular, it reforms the modes, channels, and means of interpersonal communication. Online learning environments can provide learners with digitalized learning environments and abundant learning resources, and can realize timely extensive communication and exchanges between students and teachers and among students. Universities and colleges at different levels in China, influenced by the COVID-19 pandemic, adopt online teaching, and numerous face-to-face teaching courses in traditional universities have set online assistance to improve the teaching effect. Consequently, online teaching practices achieved rapid development in China. Online teaching includes synchronous and asynchronous teaching. Asynchronous online teaching enables students to relatively control their learning time and progress and encourages and gives them opportunities to reflect. Given that teachers and students are most excited with asynchronous online teaching, asynchronous online interactive teaching is provided except for online learning resources for reading. Teacher–student and student–student interactions are changing from the original letters and telephones to online asynchronous interactions. Most universities and colleges in China have set up electronic bulletin board system for teacher–student and student–student online asynchronous interactions. In particular, teachers and students implement online asynchronous communication in terms of learning problems and learning experiences, which have achieved preliminary performances. Positive emotional experiences are important manifestation modes of people’s life and survival. These experiences are characterized by the coexistence of abundance and hierarchy, coexistence of stability and fluctuation, and coexistence of explicitness and implicitness. With the era of rapid development, competition becomes increasingly fierce. The environment faced by university students differs significantly from those in middle schools. In this case, positive emotional experiences of university students may attract extensive social attention. People have realized that focusing exclusively on student learning is insufficient. Considerable focus should be given to the positive emotional experiences of students and their physical and psychological health.

2 Theoretical bases and hypotheses development

2.1 Theoretical bases

Moore, J. C [1], an American online education scholar, proposed three basic interaction theories between online teaching and learning: (1) interaction between students and teaching content of education resource course learning material subject, (2) interaction between students and teachers, and (3) interaction between students and students. This theory believes that course design, which has high structuralization, and rare teacher–student dialogue may increase interaction distance, and adapting to the varying needs and conditions of different students is extremely difficult. By contrast, courses with flexible structure and high teacher–student dialogue degree may shorten interaction distance and can adapt to the different needs and conditions of teachers and students. “Learning self-control” is used to describe the phenomenon that some learners choose teaching objectives independently, and dominate and control most learning processes. Different learners have different abilities in making decisions on learning. The success of online education depends on the basis of schools and teachers considering the self-control ability of learners, providing them with learning materials with appropriate structuralization, and giving the appropriate number of dialogues with the appropriate quality.

Social learning theory of Bandura, A et al. [2], a renowned American psychologist, is mainly composed of three core components: interaction determinism theory, observation learning, and self-efficacy learning theory. Interaction determinism theory emphasizes that individuals, environment, and behaviors act as determinant factors that are mutually interlaced. The two-way mutual influencing and observational learning of these determinant factors is also called substitutive learning. Bandura divided social learning into direct and observational learning. Direct learning is the learning process, in which individuals respond to stimuli and, thereby strengthening the process. Observational learning means that individuals form the concept of how to engage into some new behaviors by observing others’ behaviors, and guide actions by using such a coding information in future. Self-efficacy concerns markedly on the effects of individual features during the learning process. Social learning theory elaborates how people learn in a social environment to form and develop their personalized theories. Virtual learning community based on network is different from the real social environment. Moreover, technical means is required to complete interactive learning among people, and complete social learning between teachers and students and among students through interaction.

2.2 Hypotheses development

Continuous innovation of network technology provides flexible and diversified forms for online education, which enriches the education content and ways for its unique advantages and tremendous potentials. Online asynchronous interaction remains an important way for social interaction between teachers and students in the community.

It has incomparable advantages, such as free of time limit for interaction, full thinking on problems, easy triggering of different thoughts and opinions, and comprehensive profound understanding. How online asynchronous interaction behaviors influence the positive emotional experiences has been studied by many scholars. Williams, C [3] believed that the use of new technologies should be considered to transfer courses into electronic learning environment, suggested to encourage students to participate in such activities, and recommended that teachers help to create an effective and exciting electronic learning environment. Wilhelm, S et al. [4] analyzed the validity of online discussions, and results demonstrated that additional studies are needed to explore students' opinions on usefulness of online learning discussions. Karray, F et al. [5] believed that human-computer interaction (HCI) can clearly promote the learning motivations of learners. Carroll, J. M [6] believed that HCI is an essential link in the learning process of learners. Jaimes, A et al. [7] analyzed the main methods of HCI and focused on the body, gestures, gazing, and emotional interaction. Lopatovska, I et al. [8] introduced emotional theory, emotion research methods, and their roles in the information behaviors of humans. Jeon, M [9] introduced emotions and emotional components in human factor (HF) and HCI. He indicated out that emotional experiences in HCI include emotional design, happy learning, Kansei engineering, and emotional calculation. Hudlicka, E [10] reported that the unprecedented growth of HCI technology and method is conducive in re-determining effective and advisable HCI requirements. In particular, emotional HCI is an emerging research field. Siegert, I et al. [11] realized natural HCI and recognition of emotions and intentions has experienced more concerns. Webster, J et al. [12] demonstrated that HCI can produce positive consequences related with work, and that gameplay in HCI is a potential important topic in studies on information system. Esposito, A et al. [13] found that HCI system with good behaviors has important promotion to access to profitable online and short-distance social services in the future. Hence, the first hypothesis was proposed in this study:

H1: People-to-system (P2S) significantly promotes positive emotional experiences.

In online learning, emotional communication between people is significant. Davidson-Shivers, G. V et al. [14] indicated that discussions of students include nine types of substantial and non-substantial comments. In the two types of discussions, groups dominated by women often publish more comments than groups dominated by men. Parasuraman, R et al. [15] demonstrated that online interaction among people is the major experience source of online learning. Çebi, A et al. [16] showed that students who make longer interactive activities with classmates achieve higher performances, and team learning strategies are different in self-control and learning environment. Pawan, F et al. [17] analyzed an online education program for teachers and found that strengthening collaboration and interaction among teachers can enhance their "sense of teaching presence." Moreover, three intervention strategies that may be helpful were proposed to increase collaborative interaction of teachers during online discussions. Zhang, J. H et al. [18] believed that in hybrid learning environments, students of the experimental group, which uses interactive teaching behaviors, significantly improved their academic performances, learning motivation, learning attitude, and self-efficacy. York, C. S et al. [19] believed that in online learning, there are many factors influencing interpersonal interaction between students and teachers. Results showed that influencing

factors of interpersonal interaction in online courses include group work, course environment, mode use, community, and types of discussion problems. Liu, I. F et al. [20] analyzed whether or not interaction among people may produce collaborative learning effects in online learning communities, and found that interaction among people has significant influence on improving the future development of online English learning communities. Almusharraf, A et al. [21] indicated that strengthening interaction through online platforms can promote transition from offerings of teachers to student-centered online learning. Slagter van Tryon, P. J et al. [22] believed that in online learning environments, high-efficiency communication among people can promote online learners to perceive online learning environmental changes and improve learning motivations. Hence, the second hypothesis was proposed:

H2: People-to-people (P2P) significantly promotes positive emotional experiences.

People-to-content interaction (P2C) is one of the major aspects of online asynchronous interaction. With respect to how P2C influences emotional experiences of online learning, Vesa, J et al. [23] demonstrated that richness and ability to provide multiple communication relational modes of media stimulate the use of multi-access technology. Ye, D et al. [24] proved that knowledge construction occurs in the process when students read and make comments of others' posts. High-quality courses provide practical strategies, encourage students to broaden their vision, and contact with other students positively. Liu, M et al. [25] carried out systematic key reviews in studies using analysis in higher education since 2016, and believed that a good teaching method plays an important role in supporting the teaching activities of higher education. Therefore, the third hypothesis was proposed:

H3: P2C significantly promotes positive emotional experiences.

3 Methodology

3.1 Questionnaire design

This questionnaire was composed of three parts. Part I mainly investigates the general information of the respondents, including gender, grade, school and weekly online asynchronous learning hours. Part II measures asynchronous interaction, mainly including P2S, P2P, and P2C. Jo, I., Park, Y et al. [26] was mainly used, and four, five, and five measurement questions were provided to P2S, P2P, and P2C, respectively. Part III measures positive emotional experiences. Research results of Klonsky, E. D et al. [27] were mainly applied, including the frequency, intensity, and duration of positive emotional experiences. They were measured using five questions each. All questionnaires were measured using a Likert-5 scale.

3.2 Respondents

Henan is a major province in Central China. Owing to the COVID-19 pandemic, university students attending online teaching are increasing. In this study, a QR code was generated through the Wenjuanxing platform (www.wjx.cn) and sent to students

majoring in Nursing in Zhengzhou University, Institutes of Technology of Henan, Henan University of Science and Technology, Henan University, and Huanghuai University. Questionnaires were filled in by students voluntarily. A total of 436 questionnaires were sent, 356 of which were valid and were collected after deleting questionnaires that were not completed or filled poorly. The effective recovery rate was 81.65%. To control measure errors and assure objectivity and scientificity, the test was sent anonymously and collected on site. Basic descriptive statistical analysis, reliability and validity analyses, regression analysis, and analysis of variance were performed to the collected data using SPSS 26.0. The descriptive statistical results of the respondents' basic information are listed in Table 1.

Table 1. General information of the respondents

Name	Options	Frequency	Percentage (%)	Cumulative Percentage (%)
Gender	Female	285	80.06	80.06
	Male	71	19.94	100
Grade	Freshman	43	12.08	12.08
	Sophomore	83	23.31	35.39
	Junior	172	48.31	83.71
	Senior	58	16.29	100
Schools	Zhengzhou University	51	14.33	14.33
	Henan University	76	21.35	35.67
	Xuchang University	96	26.97	62.64
	Huanghuai University	91	25.56	88.2
	Nanyang Institute of Technology	42	11.8	100
Weekly online asynchronous learning hours	<1 h	4	1.12	1.12
	1–3 h	25	7.02	8.15
	3–5 h	87	24.44	32.58
	5–8 h	111	31.18	63.76
	>8 h	129	36.24	100
Total		356	100	100

Table 1 shows that most Nursing majors are females, accounting for 80.06%. The respondent numbers of the five universities were relatively balanced, thereby assuring representativeness of the respondents.

4 Result analysis

4.1 Reliability and validity test

Reliability refers to stability and repeatability of research methods, conditions, and results. In this study, reliability of content analysis was mainly tested by reliability in coder and reliability among coders. This research performed statistical analysis of the survey data mainly using SPSS 26.0. Consistency check of the questionnaire data was carried out, and results are shown in Table 2.

Table 2. Reliability test results

Variable Types	Names of Variables	Number of Questions	Cronbach's α	Cronbach's α
Independent variables	P2S	4	0.779	0.920
	P2P	5	0.890	
	P2C	5	0.882	
Dependent variables	Frequency of positive emotional experiences	5	0.938	
	Intensity of positive emotional experiences	5	0.928	
	Duration of positive emotional experiences	5	0.926	

Table 2 shows that Cronbach's α of the general scale is 0.920, indicating that the validity of the research questionnaire can be accepted. This result demonstrates that the validity of the questionnaire can meet the research needs.

Table 3. KMO and Bartlett test

KMO value		0.840
Bartlett sphericity test	Approximate Chi-square	12463.983
	df	406
	P-value	0.000

Table 3 shows that KMO analysis and Bartlett sphericity test were performed to the official questionnaire data. The KMO value is 0.840 (>0.80) and Bartlett sphericity test significance is 0.000, thereby reaching the significance level. This result indicates that the questionnaire has good validity and can be used for further analysis.

4.2 Regression analysis

Table 4. Linear regression results

Regression Path	Standardization Coefficient	T	P	VIF	F	D-W Value
P2S → Frequency of positive emotional experiences	0.189	3.897	0.000***	1.045	F (3,352) = 30.414, P = 0.000	1.405
P2S → Intensity of positive emotional experiences	0.056	3.753	0.000***	1.04		
P2S → Duration of positive emotional experiences	0.385	8.058	0.000***	1.009		
P2P → Frequency of positive emotional experiences	0.031	2.683	0.008***	1.045	F (3,352) = 2414.432, P = 0.000	2.072
P2P → Intensity of positive emotional experiences	0.969	82.779	0.000***	1.04		
P2P → Duration of positive emotional experiences	0.021	1.812	0.071*	1.009		
P2C → Frequency of positive emotional experiences	0.963	78.021	0.000***	1.045	F (3,352) = 2169.247, P = 0.000	1.667
P2C → Intensity of positive emotional experiences	0.039	3.208	0.001***	1.04		
P2C → Duration of positive emotional experiences	0.028	2.294	0.022**	1.009		

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% significance levels, respectively.

As shown in Table 4:

- (1) H1 is true. P2S can significantly promote positive emotional experiences. The main reason is that the Internet environment is an open learning environment, which is equipped with abundant learning resources and tremendous information. However, tremendous information results in many learners failing to find the desired learning materials from the vast learning resources. Many students have spent considerable time in searching for relevant learning data. If teachers can provide the corresponding learning resources for learners and shorten their time for searching, then it may significantly improve the interaction effect. Moreover, there are many other lures in the network environment and many learners often cannot engage in regulated learning at regulated time. This situation requires learners to be highly conscious in learning to assure asynchronous learning time. Compared with traditional teaching, online teaching have extensive resources and considerable information, but it still has some disadvantages. For beginners, abundant information easily makes learners misunderstand information. Given that many resources in the network have not been classified well, learners cannot acquire the needed knowledge systematically. A good online teaching information system can distinguish knowledge points effectively. This condition can make learners acquire abundant relevant teaching knowledge and also make them strengthen their knowledge learning. The Internet

is a new medium, and many university students easily learn various operation skills related to online systems. Learners and systems can make high-efficiency interaction timely, thereby improving the positive emotional experiences of learners. A good P2S interaction is a progressing process and shall run through the entire online asynchronous interaction. In this process, the teaching, cognitive, and emotional interactions between teachers and students are not fixed but present a dynamic development process. This situation requires teachers to design appropriate learning experiences at appropriate times in different stages, and provide learning guidance to learners, thereby facilitating high-efficiency network learning.

- (2) H2 is true. P2P can significantly promote positive emotional experiences. The main reason is that in the network asynchronous interaction forum, learners make frequent interaction behaviors, and asynchronous interaction is beneficial for cognitive interaction among learners. In a network, the learning atmosphere can only be created through text interaction between teachers and learners. Such a learning atmosphere requires high consciousness among learners. In the organization of the learning process, teaching process organization of traditional learners relies on the organization of teachers. Teaching in a network environment depends on the organization of learners. Interpersonal relations in a network environment is relatively loose, and learners are frequently viewed as an ID. The sense of spatial distance between teachers and learners is an important reason that influences asynchronous interaction in a network environment. In the traditional classroom environment, shortening spatial distance leads to the increasing frequency of mutual interaction and contact between teachers and students. They easily obtain familiarity with each other, and interpersonal relationship is relatively better. They easily gain the trust of the other party and can make free communication in interaction activities. Teacher–student or student–student interaction is implemented on a network and is mainly based on asynchronous interaction, which is discussed in this study. Online asynchronous interaction allows teachers and students or students and students to log in a specific discussion forum on the Internet at different times to establish discussion topics or analyze and discuss topics established by others. Any party participating in the discussion has sufficient time to think and express their own opinions. Meanwhile, collision and communication of different opinions and standpoints are beneficial for learners to obtain a comprehensive and profound understanding of things. Thus, their resolution and cognition of complicated ideas are improved.
- (3) H3 is true. P2C can significantly promote positive emotional experiences. Given that interaction in a traditional classroom lack a network to provide learning resources, conflicts that occur during the interaction of learners cannot be solved immediately, thereby resulting in failure to obtain deep cognitive levels. However, asynchronous interaction in network environments helps learners to make deeper cognitive interaction, strengthens cooperative learning among them, and keeps the equal status between learners and teachers and among learners to attract positive engagement of learners. Time delay in asynchronous interaction effectively enhances the practices of learners' thinking. Resources provided by good online learning networks enable learners to obtain sufficient learning resources. These aspects help learners improve their cognitive level. Context-based interpersonal

interaction in network environments takes the mainstream. Good interaction between people and contents can make a statistics on frequency of occurrence of such a major learning information. Online asynchronous interaction can help learners significantly express their own thinking and opinions in text, improving logical thinking ability, and character control ability of learners. This situation offsets the many defects of traditional face-to-face discussions. For example, some students are too shy to speak in the classroom, or make simple and superficial speeches that have insufficient thinking but many sensibilities.

4.3 Discussions

Table 5. Analysis of variance results of the effects of weekly online asynchronous learning hours on positive emotional experiences

Analysis Items	Options	Sample Size	Mean	F	p
Frequency of positive emotional experiences	<1 h	4	4.7	3.648	0.006**
	1–3 h	25	4.54		
	3–5 h	87	4.14		
	5–8 h	111	3.95		
	>8 h	129	4.32		
	Total	356	4.18		
Intensity of positive emotional experiences	<1 h	4	4.4	2.56	0.038*
	1–3 h	25	4.46		
	3–5 h	87	4.03		
	5–8 h	111	3.83		
	>8 h	129	4.07		
	Total	356	4.02		
Duration of positive emotional experiences	<1 h	4	4.05	2.523	0.041*
	1–3 h	25	4.53		
	3–5 h	87	4.02		
	5–8 h	111	4.01		
	>8 h	129	4.24		
	Total	356	4.13		

Table 5 shows that influences of weekly online asynchronous learning hours on frequency of positive emotional experiences are significant at the 0.01 level ($F = 3.648$, $p = 0.006$); its influences on intensity of positive emotional experiences are significant at the 0.05 level ($F = 2.560$, $p = 0.038$); and its influences on the duration of positive emotional experiences are significant at the 0.05 level ($F = 2.523$, $p = 0.041$). This result fully interprets the evident differences of weekly online asynchronous learning hours in the analysis of variance of positive emotional experiences. The main reason is that longer weekly online asynchronous learning hours make it easier for online

asynchronous interaction between teachers and students and among students. Effective online asynchronous interaction enables teachers and students to log in specific discussion forums at different time to establish topics and publish opinions, or respond to topics of others. Students participating in discussions have a long time to reflect and express opinions and make full reflection on discussing problems. Through collision and communication with different opinions and standpoints, students can reach a relatively comprehensive and profound understanding of complicated ideas. Therefore, longer online asynchronous interaction learning hours can help students to connect different concepts and establish continuous knowledge structure. This situation improves the logical thinking ability of students and ability of expressing their ideas in text significantly and offset many defects of face-to-face discussions. For example, students are too shy to speak in classroom or make simple and superficial emotional speeches, or have difficulty in engaging in rational thinking.

5 Conclusions

Education technology represented by the Internet is changing the education and learning modes of people, and urges people to change their conceptions of education and learning. Establishing a life-long learning system and stepping into a study-based society are the requirements of time proposed by the knowledge economy and information society. A good online asynchronous interaction intervention has an important role in online learning effect and experiences of learners. If teachers adopt strategies and modes of online asynchronous interaction behaviors, then learners will easily achieve the expected effects of course designers and managers. In this study, 356 students majoring in Nursing from Zhengzhou University, Institutes of Technology of Henan, Henan University of Science and Technology, Henan University, and Huanghuai University were invited to participate in a questionnaire survey. Influences of online asynchronous interaction (i.e., P2S, P2P, and P2C) on positive emotional experiences of learners are analyzed. Some major conclusions are drawn. (1) Cronbach's α is 0.920, KMO is 0.840, and Bartlett sphericity test significance is 0.000. This result demonstrates that the proposed questionnaire has very good reliability and validity. (2) P2S, P2P, and P2C can significantly promote the positive emotional experiences of learners. (3) Influences of weekly online asynchronous learning hours on frequency ($F = 3.648$, $p = 0.006$), intensity ($F = 2.560$, $p = 0.038$), and duration ($F = 2.523$, $p = 0.041$) of positive emotional experiences have statistical significances. This study suggests the proposal of effective intervention strategies and measures according to observation and analysis of social interaction behaviors of learners in the future, and improve deep studies on online asynchronous interaction behaviors.

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