Investigating the Relationship among Students' Interest, Flow and Their Learning Outcomes in a Blended Learning Asynchronous Forum

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Abstract: Blended learning environment provide an important platform for university student learning. The use of text data, generated from the asynchronous forum to explore students' intrinsic aspects of user posts in such communities, is critical for adjusting teaching strategies. Therefore, information about their interest and flow indicators has become important for educators to host online discussions. Flow experience is a sense of immersive and feeling enjoyable and can reflect a person's inner feelings. In order to explore the influence of learning interest and flow on the learning outcome, our study uses temporal emotion-aspect model (TEAM) to mine student interest hidden in forum text data, and simultaneously uses a flow scale to measure the flow state of students during their learning process. The results show that: 1) Interest topics unrelated to teaching content are negatively related to learning outcomes. 2) Interest topics related to teaching content will provoke students' ability to balance their skills and challenges, but have a negative effect on autotelic experience in the flow experience. Interest topics related to entertainment have a negative effect on students' skills to meet the challenge, concentration and autotelic experience in discussion-based learning. Students may tend to lose self-consciousness in the entertainment-centric discussion. 3) There influence factors between flow and learning outcomes are loss of self-consciousness and concentration.

1 INTRODUCTION

Blended learning environment as a special campus model, realize the organic integration of online course resources and traditional classroom teaching on campus, which help teachers optimize the teaching methods and improve teaching quality. Blended learning environments are courses targeted at relatively fixed learning groups, so it can better combine the online data, clicks, online duration, order of lecture chapters, and offline research tools, such as questionnaires, interviews, scales, etc. So, scientists can conduct more accurate researches on students' behaviors, emotions and other aspects.

Learning interest reflects a psychological preference of learners in the process of learner resource interaction. In general, learners' interest can be represented by their online behaviors in online learning environments. The text data generated from learning platforms provide researchers potential opportunities to explore students' interest, helping teachers better control their courses procession, which can facilitate timely intervention on students with special needs.

Flow is an important indicator of describing students' subjective feelings in learning processes. Having a flow experience means that when a student takes part in an activity, he/she is devoted to the current work and so calm that he/she forgets the time passes, and feel a sense of space. Current researches on flow focus on the following aspects: 1) Explore the necessary conditions for arousing students' flow experience in digital game learning; 2) The way to improve the scale to measure flow more accurately. In this way, educators can integrate digital games into teaching more harmoniously and enhance students' learning pleasure and performance.

In blended learning environments, asynchronous discussion forums, as a communication tool, are used

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extensively to support students' interaction and engagement in online courses (Dringus & Ellis, 2010). Students have flexible time to control their learning process in asynchronous forums. The defect in asynchronous discussions is that communication is not in time. Researchers have done a lot of work to explore the influential factors of discussions, or design tools to help students achieve collaborative learning in asynchronous forums (Murphy, 2004; Kear, 2004; Dennen, 2005). However, students' interest, flow and their relationship with learning outcomes are rarely studied. In view of the lack of existing researches, this paper aims to explore students' interest through the temporal emotion-aspect model (TEAM) (Liu et al., 2019), revealing the relationship among students' interest, flow and learning outcomes. It can provide a reference for teachers to understand students' interest and indicators of their flow levels in blended learning forums.

This paper is organized as follows. In the second section, we review the methods of interest mining and educational researches on flow. The third section is the methodology and introduction of the experiment. The fourth section summarizes the findings and limitations of our study.

2 RELATED WORKS

2.1 Interest Mining

In online learning environments, students generate large amounts of numerical and textual data. In a virtual environment, Gu, Zhu, Zhao, & Zhang (2008) used learners' gazes, manipulations, gestures, dialogues and other behaviors to mine users' potential interest via stages of web mining. Similarly, in E-learning and blended learning environments, the content of posting in the course forum has also become a research hotspot for many educational researchers. The interaction between learners and forums is mainly to browse, post and reply posts. In terms of the interaction mode in forum postings, researchers analyzed the social network and forum texts by calculating the number of posts, time of posts and dialogue and other basic learning records (Salter & Conneely, 2015; Liu et al., 2018; Liu et al., 2019).

Based on the forum texts, this paper uses TEAM to deduce students' implicit interest. TEAM stems from the unsupervised emotional topic model named Latent Dirichlet Allocation (LDA), which automatically calculates the emotion-oriented aspect probabilistic distributions over words for the overall discussion. In fact, many researchers have proposed relevant optimization based on LDA to quantify factors of learning interest and preferences within unstructured texts. For example, Jo & Oh (2011) proposed SLDA (sentence-LDA), and then extended SLDA to the Aspect and Sentiment Unification Model (ASUM). Its outputs pairs of {aspect, sentiment} called senti-aspects, automatically discovering what aspects are evaluated in reviews and how sentiments for different aspects are expressed. Pengfei Wu, Shengquan Yu, & Dan Wang (2018) used a learner-topic model, which combining learners generated content and their dynamic interactions with learning resources. They mined learners' knowledge interest and collection interest, then combined them to generate keywords.

2.2 Flow Experience

Flow experience refers to a positive experience produced by an individual when he/she is dedicated to tasks. This experience makes people forget the passing of time, lose the sense of space and immerse themselves in the enjoyment (Csikszentmihalyi, 1990). In education, the flow experience is often studied in gamification-based learning contexts, and flow is regarded as a measure of design levels of digital games (e.g. Kaur, Dhir, & Rajala, 2016; Perttula, Kiili, Lindstedt, & Tuomi, 2017; Buil, Catalán, & Martínez, 2018).

Csikszentmihalyi (2006) divides the state of flow into nine dimensions: 1) Flow seems to occur when individuals are well balanced the challenge of tasks and their skills; 2) Individuals experience a spontaneous and automatic sense when doing an activity; 3) An activity has specific goals; 4) Unambiguous feedbacks as to how well one is performing; 5) A sense of control is needed; 6) A state of focused concentration on things on hand; 7) Loss of self-consciousness; 8) There is a distortion of the transformation of time; 9) Individuals enter a state of autotelic experience, showing activities are thought as intrinsically rewarding. The first five dimensions can be reduced to flow antecedents The remaining four dimensions represent indicators of flow. The nine dimensions have been the basis for different researchers to measure flow levels and its indicators (e.g., Jackson & Marsh, 1996; Jackson & Eklund, 2002; Kiili, 2005; Fu, Su, & Yu, 2009; Hamari & Koivisto, 2014;).

Exiting researches have shown the relationship between these dimensions (Buil, Catalán, & Martínez, 2019). Moreover, students with higher flow levels tend to obtain higher learning outcomes in

game-based learning, using eye-tracking technology (Tsai, Huang, Hou, Hsu, & Chiou, 2016).

Prior researches have shown that gaming experience, age, and gender have been verified to be nothing to do with flow levels (Kiili, 2006). Hence, an understanding of what elements provide flow experience and what learners' real interest in blended learning environments asynchronous forum, can be considered as critical factors for adjusting teaching strategies to ensure learners' active participation and outcomes. Interestingly, existing researches concerning flow experience have focused mainly on games. To address this research gap, this study used TEAM to mine students' interest and used a flow scale to test students' flow levels, in an attempt to explore the relationship between learners' interest, flow and learning outcomes. Our study aims to answer the following research questions:

(1) Does the mined interest topics reflect the real interest of learners? What is the relationship between learner interest and learning outcomes in the blended learning environment?
(2) Is there any relationship between learners' interest and flow experience in the asynchronous forum?
(3) Which indicators of flow are significantly related to learning outcomes?

3 METHODS

3.1 Participants

The data set of this paper is retrieved from the course "Freshmen Seminar" on a university blended learning platform, ranging from September 2018 to January 2019. This course is aimed at freshmen students majoring in English. The purpose of offering this course is to discuss the cultivation of professional skills and to communicate some issues about career planning. A total of 66 students enrolled in this course. Our collected data included 4880 posts with a standard deviation of 46.39 and an average of 73.94.

The data also included 66 valid questionnaires to measure their levels of flow in the course. The average final grade of the students is 89.04 (on a scale of 0-100), and the standard deviation is 4.73.

3.2 Materials and Instruments

3.2.1 Temporal Emotion-aspect Model

This paper uses TEAM to calculate learners' interest topics in the sense of probabilistic distribution. TEAM assumes that the words in a single sentence are drawn from one aspect and one emotion. The same pair of {emotion, aspect} called emot-aspect. TEAM belongs to an unsupervised model. So, it doesn't need manual aggregations on emot-aspect associations of the posts at the same time zone. And no post-processing is required to calculate the emotion orientations of different semantic units to aspects under different emotion labels. It can output emotion-specific aspect probabilistic distributions. TEAM utilizes Gibbs sampling to estimate the hidden parameters.

3.2.2 Flow Scale

This study translated and modified the Flow Scale for Games (FSG) to measure students' state of flow in the blended learning environments forum. The scale consists of 25 questions, 23 single-choice questions, and 2 open-ended questions. The table uses a five-point Likert scale, and scores of different questions are combined to represent students' preferences towards different dimensions of flow. Our analysis of the learners' questionnaire shows the internal consistency to be 0.80 (Cronbach's alpha is 0.80), indicating that our scale has good reliability.

3.2.3 Learning Outcomes

This study uses learners' final grade as an operational definition of learning outcomes because there is no intervention in their performance. So, our hypothesis is that, in the state of nature and non-intervention, the final grade in the course reflects their consistent learning habits and attitudes. And there will be a certain correlation with their learning outcomes. So course' final grade can represent learning outcomes.

4 RESULTS

4.1 Mined Interest Topics

Interest can be represented as a topical word that co-occurs with positive emotions. This study uses the positive emotion dictionary as a seed lexicon to capture the words related to a positive learning experience, by calculating the probability of each topic appearing in a forum post. Finally, we obtain 50 interest topics, and make them as $T = \{T_1, T_2, T_3 ... T_{50}\}$.

To examine the reliability and validity of the obtained interest, we use a post-test questionnaire to inquire about what topics they really were interested in. Comparing the deduced interest with the self-

reported interest collected by the questionnaire, we can obtain that the average accuracy rate of the interest mining reaches 0.799. From this matching result, we can find that the modeled interest topics can indeed reflect the interest of students to an extent.

Table 1 shows some of the partial results of mined interest topics. For example, topic 7 represents reading, and the keywords are "impression", "book", "reading" and so on. Among them, underlined words represent positive emotional words, such as "profound", "like".

4.2 Interest Topics That Are Not Related to Teaching Content Are Negatively Related to Learning Outcomes

The descriptive results of learnings' interest and learning outcomes are shown in Table 2. To explore their relationship, multiple regression analysis is performed by using interest as the independent variable and learning outcomes as the dependent variable. Since there are too many interest topics, it is not easy to explore all the mined interest. So typical interest topics, T6, T7, T8, T13, T44, T45 and T50, are selected as the dependent variables. T13 and T50 talk about the English level, and other topics don't have much to do with learning itself. T7 and T44 talk about literature such as novels or movies. T6, T8, T45 talk about professionalism, life values, mentality. In our study, it proves that the model uses these topics to explain the learning outcome has 68.5% explanatory power, and the adjusted R^2 indicates still has 64.7% explanatory power.

It can be observed that T6, T7, T8, T44 and T50 are negatively correlated with learning effectiveness, and T13 is positively correlated with learning outcomes. Comparing and analyzing the above topics with teachers' postings, it is found that the topics are positively related to learning outcomes and are significantly relevant to the teaching content of the teacher, such as T13 ($\beta = 34.8$, $p = 0.001$). The

Table 1: Interest topics vocabularies.

Interest topic	Top 10 words with the highest probabilities
Reading books T7	印象/impression (0.034), 深刻/profound (0.029) 书/book (0.028) , 读/read (0.014), 文学/literature (0.015), 作品/works (0.011), 故事/story (0.011), 喜欢/like (0.010), 王子/prince (0.009), 小说/novel(0.009)
English learning T13	learning (0.035), study (0.022), know (0.017), English (0.017), agree (0.013), good (0.013), important (0.012), strategies (0.008), plan (0.007), improve (0.007)
Mentality T45	literature (0.059), reading (0.059), great (0.055), 问题/question (0.014), 心态/mentality (0.012), 锻炼/exercise (0.010), 强化/strengthen (0.010), 实践/practice (0.010), 冷静/calm (0.008), 解决/solve (0.006)

Table 2: Regression coefficients of interest topics on learning performance.

	Unnormalization coefficient		Normalization coefficient	
	B	S_e	Beta	t
(const)	91.726***	0.978		93.742
T50 English level	-80.092***	20.596	-0.327***	-3.889
T13 English learning	34.800**	9.664	0.303**	3.601
T44 Literature	-587.084***	155.492	-0.294***	-3.776
T8 Life values	-42.516	22.754	-0.168	-1.868
T7 Novel	-109.380**	30.995	-0.278**	-3.529
T45 Mentality	-174.233**	58.212	-0.237**	-2.993
T6 Professionalism	-38.604*	16.508	-0.209*	-2.338

Note: ***p < 0.001, **p < 0.01, *p < 0.05

content of this topic is all written in English, sharing their own English learning experience, content and career planning. Topics that are negatively related to learning outcomes and not related to the teaching content of the teacher, e.g., T44 (β = -587.084, p = 0.000), mainly involve the real-life interest, such as watching movies or reading novels. T45 (β = -174.233, p = 0.004) talks about mentality, and so on. However, some topics related to teaching content are not strongly explanatory to the negative correlation between teaching content and their grades. This issue needs to be further studied in combination with offline students' learning situation.

4.3 Descriptive Result of Flow Levels

As can be seen from Table 3, students' flow tests showed that the average flow score is 3.55, higher than the median 3.00 (median of a 5-point Likert scale), indicating that most of the students have a positive flow state in this course. And the Cronbach's alpha estimate of the reliability of flow antecedents and experience are found reasonable (α = 0.79, α = 0.64). Only the reliability of loss of self-consciousness is relatively poor.

Compared with the score of flow experience, the score of antecedents is relatively lower. We can tell that tasks assigned by teachers in the blended learning environment are specific, and students are satisfied with the teaching platform. The score of loss of self-consciousness is lower than others (Mean = 2.32). The explanation given by the students in the questionnaire are summarized as follow: 1) The discussion topic given by the teacher are too boring. 2) Some students are not interested in some discussions. 3) Some students are disturbed by external things such as mobile phones and urgent matters. 4) Some students lose concentration and inquiry into the problem.

4.4 The Relationship between Interest and Flow

In order to explore the relationship between student interest and flow, this study performs a Pearson correlation analysis between flow components and key interest topics.

As shown in Table 4, T6 representing professional skills is positively correlated with Q1 representing learning challenges, with a correlation coefficient of

Table 3: Description of low dimensions included in the FSG (N = 66).

Element	Item number	Flow dimension	Min	Max	Mean	Std Dev.	α
Flow antecedents	1, 10	Challenge	2.00	5.00	3.69	0.62	0.54
	3, 12	Goal	2.00	5.00	4.06	0.59	0.47
	4, 13	Feedback	2.00	5.00	3.71	0.75	0.65
	6, 15	Control	3.00	5.00	4.10	0.51	0.55
	2, 11	Playability	2.00	5.00	4.19	0.66	0.83
Indicators of flow experience	5, 14, 19, 21	Concentration	1.25	4.25	3.12	0.64	0.57
	8, 17	Time distortion	1.50	5.00	3.41	0.77	0.57
	9, 18, 20, 22	Autotelic experience	1.75	4.75	3.40	0.84	0.90
	7, 16	Loss of self-consciousness	1.00	4.50	2.32	0.75	0.42

Note: α = Cronbach's alpha

Table 4: Pearson coefficients between interest and flow.

Interest content	Interest topic	Flow state	r
Competence	Professionalism T6	Challenge Q1	0.245*
	English level T50	Autotelic experience Q18	-0.249*
Entertainment	Novel T7	Challenge Q10	-0.252*
	Movie T44	Loss of self-consciousness Q7	0.445**
		Concentration Q19	-0.278*
		Autotelic experience Q22	-0.254*

Note: **p <0 .001, *p < 0.05

0.245 ($p < 0.05$). And T50 representing the English level is negatively correlated with Q18 representing autotelic experience, with a correlation coefficient of -0.249 ($p < 0.05$). The correlation coefficient between T7 for novel and Q10 for challenge is -0.252 ($p < 0.05$), the correlation coefficient between T44 for entertainment and Q7 for Loss of self-consciousness is 0.445 ($p < 0.001$), the correlation coefficient between Q19 for concentration is -0.278 ($p < 0.05$), and Q22 for autotelic experience reaches -0.254 ($p < 0.05$).

Based on the interest explored from this forum, it is found that most types of interest topics do not affect the level of flow, but the interest related to professional skills' development and entertainment will significantly affect the level of flow. Discussions involving relevant professional knowledge need to apply a large amount of knowledge, and the discussed problems are difficult, which requires students to achieve a balance between challenges and skills. In the process, students need to stop and think, which will affect their sense of intrinsically rewarding to a great extent. In the same way, when a learner focuses on irrelevant content, he/she will ignore the teaching content, not pay attention to the challenge of the task. Because be interrupted by distraction, it results in incoherent behaviors.

4.5 The Relationship between Flow and Learning Outcomes

Similarly, we try to use correlation analysis to detect the relationship between flow and learning outcomes. The result shows that Q7, represents the loss of self-consciousness, is negatively correlated with learning outcome ($r = -0.242$, $p < 0.05$). Q19, that represents concentration, is positively correlated with the learning outcome. ($r = 0.278$, $p < 0.05$). The result shows that most of the flow indicators may not influence learning outcomes. But, the remarkable factors about flow and learning outcomes are self-conscious and concentration. When focusing on what they are doing, students may not be interrupted by the outside. In the learning process, they need to be clearly aware of their actions, and correct any deviations from their goals.

5 DISCUSSIONS

In a long-time, leaning performance can only be represented through final grades. So, learning processes seem to be a black box that no one knows what happened in it. Through exploring which factors may dominate learning outcomes, teachers can comprehend their students' learning processes and adjust their teaching methods.

There is a phenomenon that when we are fully engaged in current activities, we will forget the passage of time. Even in a noisy environment, we can still feel peace of mind and realize where we are and marvel at the passage of time when the task is completed. For this strange phenomenon, Csikszentmihalyi named it to flow experience for the first time. Therefore, as a perspective to evaluate students' intrinsic motivation, flow levels may help researchers to explain students' external performance, such as performance and behavior.

This present study innovatively introduced the concept of flow into the forum discussions, attempting to examine the relationship between learners' interest, flow and learning outcomes in a blended learning platform. To the best of our knowledge, our study addressed the prior literature gap of examining students' flow experience. To test students' flow levels, we use Flow Scale for Games (eg., Hou, 2015; Hsieh et al., 2016). The scale contains two aspects: flow antecedents and indicators of flow experience.

Results show that combined with the post-mortem test, TEAM (Liu et al., 2019) can be effectively used to mine students' interest. In terms of interest and learning outcomes, we find interest topics related to teaching content is positively correlated with the learning outcome, and vice versa. With regard to the relationship between interest and flow, flow's indicator of loss of self-consciousness is negatively correlated with their learning outcomes, and concentration is positively correlated with their learning outcomes. The thing maybe that students need to choose appropriate skills to deal with challenges related to the cultivation of professional skills. Otherwise, they will lose the sense of challenge if they are interested in entertainment information, which distracts their attention from studies, interrupting the continuity of learning. According to our results, the relationship between flow and learning outcomes is influenced by facts, loss of self-consciousness and concentration.

To improve students' learning outcomes, here are some pedagogical practices for teachers. Teachers should pay attention to discussion processes in asynchronous forums, and irregularly interact with their students keeping discussion topics related to teaching content. Teachers can enhance students' learning outcomes by adjusting the flow's level. When feeling a sense of loss of self- conscious, the major of students

may not immerse themselves in their studies but entertainments. To avoid be attract, there may often mind themselves to concentrate on their work. So, in long-time discussions, teachers can provide some useful information to attract them, or ask challenging questions to inspire their curiosity.

Although a limited number of samples are involved in the experiment, combined with the postings of each student to describe their personal flow experience, the results obtained in this study after data analysis are explanatory and consistent with the real feelings of students participating in the course discussion. But it should be noted that this study has some limitations. In the courses, posts account for only 15% of the final grade. When trying to use the mined interest topics in the forum as independent variables to interpret students' learning outcomes, small parts of interest topics are not very explanatory, such as T50. Therefore, more factors need to be added to explain overall learning outcomes.

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