



Research on Model of Student Engagement in Online Learning

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ABSTRACT

In this study, online learning refers students under the guidance of teachers through the online learning platform for organized learning. Based on the analysis of related research results, considering the existing problems, the main contents of this paper include the following aspects: (1) analyze and study the current student engagement model, In view of the characteristics of online learning activities and online student characteristics, this paper introduced the student engagement model from the student behavior engagement, knowledge engagement and emotional engagement three dimensions; (2) analysis student 's behavioral engagement. The degree of student engagement is mainly calculated by the student's learning behavior data. Then used related methods to calculate learning behavior of student engagement degree. To develop the evaluation indicators of these learning behaviors, to study the method of calculating student engagement through these behaviors. (3) Analysis of Students' Cognitive Engagement. Through study the relevant literature of students' cognitive engagement and analyze the contents of the student's course of study, To develop the corresponding evaluation index and evaluate the students' cognitive engagement degree. (4) Analysis of students' emotional experience degree. Used the self-evaluation method to obtain students e experience information during online learning, to quantify students emotional experience degree and analysis.

Keywords: student engagement, behavioural engagement, cognitive engagement, emotional engagement

INTRODUCTION

Online learning was arise with the development of network technology, computer technology and other technology development, it emphasized the openness of learning source and students communication during learning process. The online learning has become the mainstream learning style, a large number of learners participate in online learning. However, due to the connection between teachers and students 'communication is not enough, students participate in online learning is not ideal, student participate persistent and efficiency is not good enough. Student engagement is a necessary condition for learning, and student engagement has an important impact on online learning. Therefore, it is necessary to analyze

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State of the literature

- In addition to trying to clarify student participation, the researchers also looked at the impact of student engagement.
- There are more factors involved in online learning, and there are more factors influencing student engagement.
- Student engagement can have an impact on factors such as student learning, learning satisfaction, learning performance, etc.

Contribution of this paper to the literature

- From research model perspective, engagement and theoretical support are defined. In the parameters and the measurement of students, the students of the explicit behavior and students to participate in the corresponding dimension, build the students to participate in all dimensions model can be measured.
- From research dimension perspective, the study was conducted from the different dimensions of student engagement in the study, and the combination of the students' emotion and the relevant psychological external reflection.
- This study formed a comprehensive evaluation method system based on content, correlation student's cognition, emotion and skill, and measured the engagement.

and study the engagement of students in online learning, to help teachers understand the engagement of students in order to facilitate timely intervention, to help students reflect their own learning and promote their engagement in the learning process. Student engagement is a quantitative question of student engagement, including the quantification of student's behavior, the quantification of cognitive engagement, and the quantification of emotions. At present, research has focused on study of the student engagement in the construction of theoretical models, explicit behavior statistics, influencing factors and effect analysis, lack of precise measurement of student engagement. Therefore, the paper introduced a credible and measurable model of student engagement, and analyzes the students' behavior engagement mode, cognitive engagement behavior and emotional engagement behavior. Specific research work is mainly reflected in the following aspects:

Firstly, Construct Students' Engagement Model in Online Learning. Taking into account the existing model of excessive attention to student performance behavior, the lack of cognitive and emotional considerations and other issues, according to the student-centered constructivist learning theory, the elements of online learning and the influencing factors, the factors that affect students' engagement, introduce S-TEC student engagement model. Combined with the characteristics of student engagement in online learning, and then proposed the "three dimensional four degree" analysis framework of students' engagement model.

Secondly, use comprehensive weight method to analysis student behavior participatory. Based on the students' engagement in the learning activities, this paper introduced the student's behavior engagement attribute classification combined with S-TEC

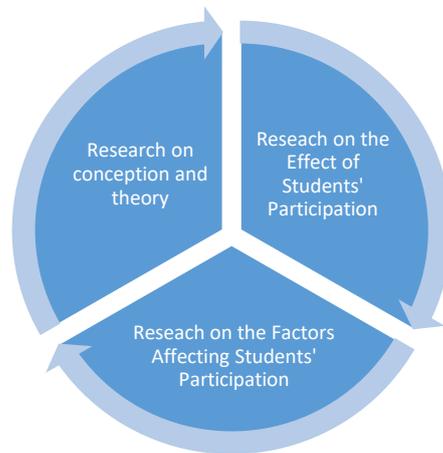


Figure 1. Research status

student engagement degree model and analysis frame; Considering the problem of setting the weight of students' engagement behavior, the paper introduce the combination method of weighting based on subjective and objective;

Thirdly, use gray partial correlation method to analysis of students' Cognitive Engagement degree. This paper based on the knowledge of Bloom's cognitive process, and then expands the students' cognitive engagement in order to form the cognitive engagement dimension; considering the characteristics of mutual influence between low level dimension and high level dimension, we propose the use of partial correlation analysis to calculate the weight of each dimension.

Fourth, use cloud model method to analysis students' emotional engagement degree. This paper use EKMAN six basic emotion as research foundation, combined with students' learning mood during online learning, then conclude the students' emotion experience division.

LITERATURES REVIEWING

Considering the characteristics of time and space separation during online learning between teachers and students, therefore, many scholars have explored the engagement of students in online learning, and have obtained rich theoretical and practical results. At present, the study of student engagement in online learning is mainly focused on three aspects, as **Figure 1** shows.

(1) Research on conception and theory. Researchers have basically introduced the importance of students' engagement in learning, which recognizes that students' engagement can be divided into behavioral engagement, cognitive engagement and emotional engagement. Researchers have also proposed broader concepts such as the fact that student engagement is defined as a complex process of online and offline, although the factors

considered are more comprehensive, but increase the difficulty of student engagement in the measurement and evaluation.

(2) Research on the effect of students' engagement. There are many factors, such as the use of audio mail, Facebook, etc., also exists students' of their own factors, such as gender, ability, etc., and teachers effect elements, such as teacher intervention.

(3) Research on the factors affecting students' engagement. Researchers studied the relationship between student performance and engagement in two online environments (simultaneous forums such as chat rooms, asynchronous forums such as discussion forums), the purpose is to better understand the relationship between the two online environments, in order to develop in the online education environment to promote student learning decision. Students' performance is measured by final exam results and comprehensive program performance, the number of student engagement is measured by the number of students who have commented and asked questions. The results show that the quality of students' engagement is positively correlated with the results of the final exam. The number of students participating in the study is positively related to the comprehensive curriculum performance. The engagement of the forum is more important than the asynchronous forum.

RESEARCH DESIGN

Student engagement is an important element of active learning and participatory learning and an important factor in student learning success, therefore, it is necessary to combine the elements of online learning, and the establishment of online learning student engagement model, then uses this model to analysis student engagement. Although the S-TEC student engagement model takes into account all the elements in general, but analyzes the student engagement in the actual learning process is not enough rely on this model. Therefore, based on the participatory model of S-TEC students and the engagement characteristics of online learning process, this paper puts forward the "three-dimensional four-degree" analysis framework of student engagement model, as [Figure 2](#) shows.

(1) Behavioral engagement analysis. Behavioral engagement is a concrete behavior of a student in the learning process. Although the behavior of students in the online learning environment has a certain degree of inaccuracy and deceptive, but the frequency, breadth and depth of behavior engagement can still reflect student engagement. This paper takes the frequency, breadth and depth of behavior engagement as the basis for the analysis of students' behavior engagement.

(2) Research on the effect of students' engagement. There are many factors, such as the use of audio mail, Facebook, etc., also exists students' of their own factors, such as gender, ability, etc., and teachers effect elements, such as teacher intervention. In this paper, the analysis of students' engagement is mainly based on the analysis of students' online discussion. Since the number of students' posts, replies and comments has been considered in the engagement of behavior, therefore, in the analysis of cognitive engagement, this paper consider the content of the depth and breadth of the two aspects.

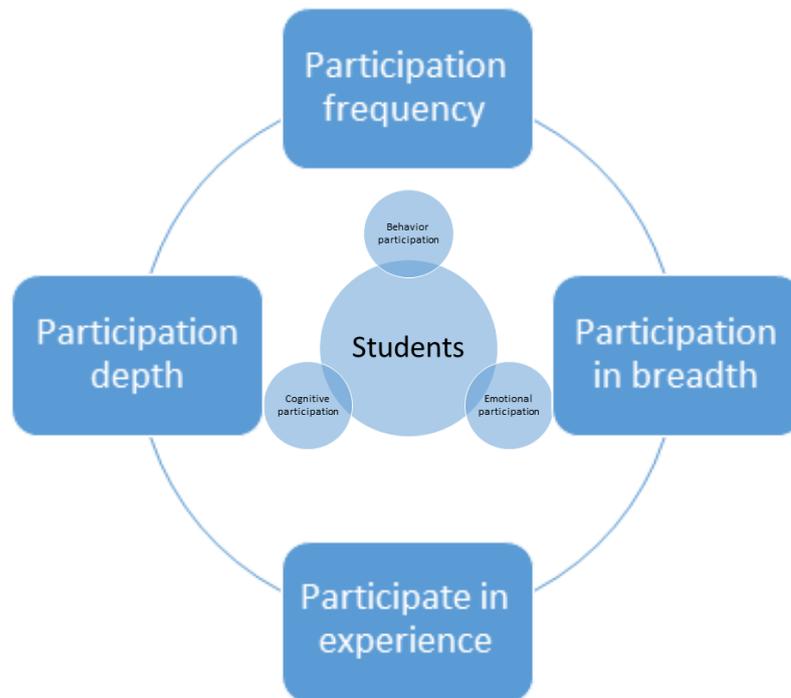


Figure 2. Three-dimensional four-degree" analysis framework

(3) Emotional engagement analysis. Emotional engagement refers to the emotional response of students in the learning process; students will show a different emotional experience during participate in the completion of specific tasks. This article will be from the perspective of student emotional experience to carry out research.

EVALUATED MEASUREMENTS

(1) Research on engagement degree of student behavior based on comprehensive weight method. In the process of online learning, there are many attributes of students' engagement behavior, which need to be combined with multiple students to participate in the behavioral attributes to evaluate the students comprehensively. For each student, through the results of comprehensive evaluation, students can be found to be inadequate and the differences between students in order to take timely and effective measures to intervene. The specific process of student behavior engagement calculation is as follows: Firstly, data without tempering. This paper use extreme value method to process data without tempering. The

calculation formula as following: $X'_{ij} = \frac{x_{ij} - m_j}{M_j - m_j}$, ($i=1,2,\dots,n; j=1,2,\dots,m$), x_{ij} is raw data, X'_{ij} is

Standardized data, $m_j = \min_i X_{ij}$ is the minimum of j index, $M_j = \max_i X_{ij}$ is the maximum.

Secondly, calculate behavioral engagement. The calculation formula as following: $\Pi = \sum_{i=1}^n x_i g_i$

, x_i is the standardized values, g_i is the weight of i index, Π stands for the student behavior engagement score, then caculate the single behavior engagement and behavior engagement in a single dimension. The caculation formula is $BE = \sum_{j=1}^n \left(\sum_{i=1}^m x_{ij} g_{ij} \right) \times g_i$, $BE_i = \sum_{j=1}^m x_{ij} g_{ij}$.

(2) An Analysis of students' cognitive engagement degree based on gray partial correlation. The data obtained by coding statistics can only quantify how much students are involved in the various dimensions of cognitive engagement, but cannot fully reflect the overall cognitive engagement of students, but also use statistical data to analysis. Firstly, using the partial correlation analysis method to calculate the cognitive engagement dimension weight. We should make sure the expert evaluate matrix. We supposed the k expert evaluation answer about the cognitive engagement dimension B_j is C_{ij} , then we conclude the evaluate

matrix C:
$$C = \begin{bmatrix} c_{11} & c_{12} & c_{13} & c_{14} & c_{15} & c_{16} & c_{17} \\ c_{21} & c_{22} & c_{23} & c_{24} & c_{25} & c_{26} & c_{27} \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ c_{k1} & c_{k2} & c_{k3} & c_{k4} & c_{k5} & c_{k6} & c_{k7} \end{bmatrix}$$
, based on the above formula, this paper

calculate the simple correlation coefficient:
$$\rho_{xy} = \frac{\sum_{i=1}^k x_i y_i - \frac{1}{k} \sum_{i=1}^k x_i \sum_{j=1}^k y_j}{\sqrt{\sum_{i=1}^k x_i^2 - \frac{1}{k} \left(\sum_{i=1}^k x_i \right)^2} \sqrt{\sum_{i=1}^k y_i^2 - \frac{1}{k} \left(\sum_{i=1}^k y_i \right)^2}}$$

, then we caluate the partial correlation coefficient:
$$\rho_{yxx_1x_2\dots x_n} = \frac{\rho_{yxx_1x_2\dots x_n} - \rho_{yx_nx_1x_2\dots x_{n-1}} \rho_{xx_nx_1x_2\dots x_n}}{\sqrt{1 - \rho_{yx_nx_1x_2\dots x_{n-1}}^2} \sqrt{1 - \rho_{xx_nx_1x_2\dots x_{n-1}}^2}}$$

, based on the above ccaculation, we can conclude the partial correlation coefficient matrix P:

$$P = \begin{bmatrix} \delta_{11} & \delta_{12} & \delta_{13} & \delta_{14} & \delta_{15} & \delta_{16} & \delta_{17} \\ \delta_{21} & \delta_{22} & \delta_{23} & \delta_{24} & \delta_{25} & \delta_{26} & \delta_{27} \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ \delta_{k1} & \delta_{k2} & \delta_{k3} & \delta_{k4} & \delta_{k5} & \delta_{k6} & \delta_{k7} \end{bmatrix}$$
; Secondly, use the gray comprehensive evaluation

method to calculate the students' cognitive engagement. The analysis process as **Figure 3** shows.

(3) Analysis of Students' Emotional Experiences Based on Cloud Model. Firstly, this paper analysis the cloud model character and parameter. We proposed there are m index evaluate item, then we equally distributed m sector area, as **Figure 4** shows.

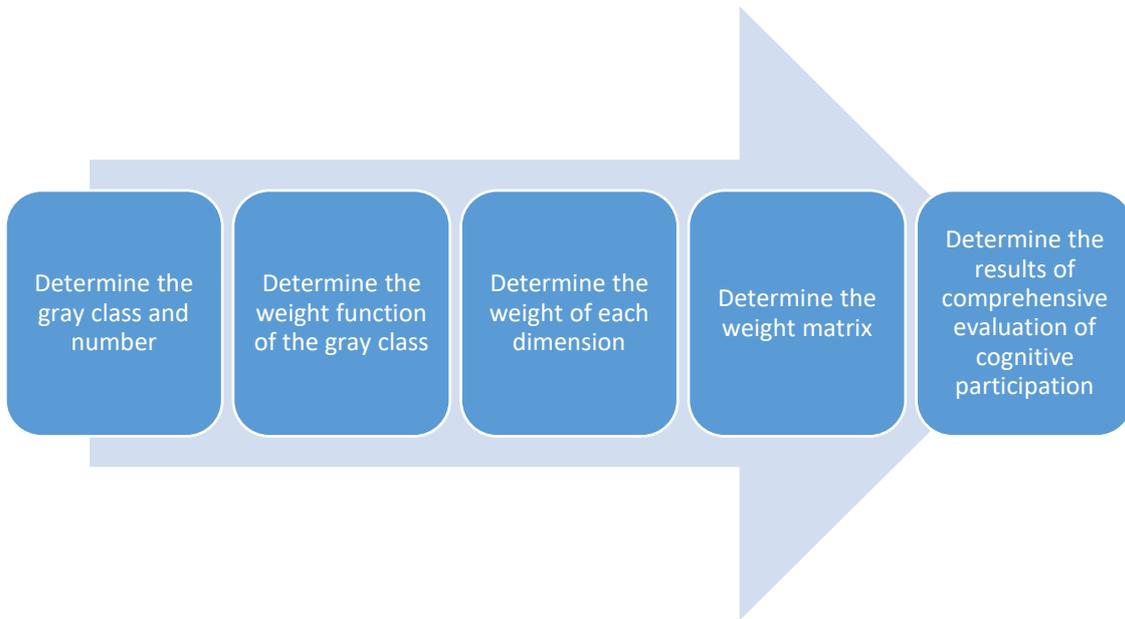


Figure 3. Gray comprehensive evaluation process

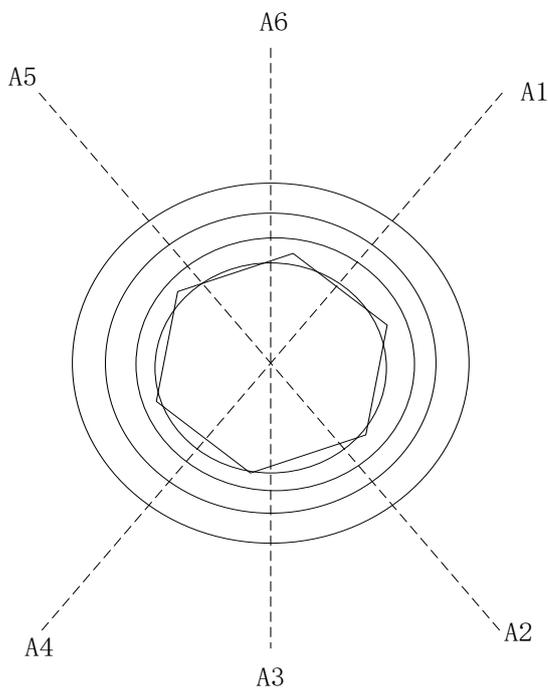


Figure 4. Cloud containing six metrics

In the use of cloud model for evaluation, the general use of the cloud area and the circumference of two variables, the larger the area of the cloud, the greater the overall advantage of the evaluation object, the smaller the area, the smaller the overall advantage. When the area of the cloud is constant, the smaller the circumference, the more the shape of the cloud closer to the circle, indicating that the more balanced indicators. Then cloud area and

perimeter calculate formula is $S_i = \sum_{j=1}^m \frac{1}{2} x_{ij} x_{i(j+1)} \sin a$, $L_i = \sum_{j=1}^m \sqrt{x_{ij}^2 + x_{i(j+1)}^2} - 2x_{ij} x_{i(j+1)} \cos a$,

then use area answer S and perimeter answer L to construct evaluate vector $v_i = [v_{is}, v_{il}]$, the

calculate formula of v_{is} and v_{il} are $v_{is} = \frac{S_i}{S_{\max}}$, $v_{il} = \frac{S_i}{\pi(L_i / 2\pi)^2} = \frac{4\pi S_i}{L_i^2}$. Finally, this paper

construct the evaluate function $f(v_{is}, v_{il})$, Then use geometric mean method to construct the

evaluation function: $f(v_{is}, v_{il}) = \sqrt{v_{is} v_{il}}$. Secondly, research on cloud model of emotional

experience. The calculate process of student emotional experience model as following introduced. The first step is to deal with the initial data. Use z-score standardized processing method to process six dimensions data of the student's emotional experience. In order to be able to experience the emotional value of the students with a limited two-dimensional graphics

representation of the standardized data after the transformation: $v_{ij} = \frac{2}{\pi} \arctan a_{ij} + 1$. The

second step is to empowerment of each indicator. Then sort the weights from large to small, and get the sorted weight values $w = (w_1, w_2, w_3, w_4, w_5, w_6)$, considering j dimension, the

fan angle answer of the corresponding in the sector model is $\theta_j = 2w_j\pi$, set S1 student as an

example, the length vector of the dots within each dimension is $r_i = (r_{i1}, r_{i2}, r_{i3}, r_{i4}, r_{i5}, r_{i6})$. The

third step is to determine the index axis. According to the dimensions of the fan-shaped angle

from large to small in order to make the adjacent angle of the remaining five rays, The final

step is to determine the comprehensive assessment of the student emotional experience cloud.

According to the size of each dimension in order to mark the corresponding point on the index

axis, we have the $r_i = (r_{i1}, r_{i2}, r_{i3}, r_{i4}, r_{i5}, r_{i6})$ corresponding answers are $F_1', F_2', F_3', F_4', F_5', F_6'$

Followed by connecting the 6 points, students can get the emotional experience of the comprehensive evaluation of the cloud, as **Figure 5** shows.

Thirdly, we calculate the student emotional experience cloud answer, use the area and

perimeter of student emotional experience cloud model, to calculate the student emotional

experience quantify value. We proposed benchmark cloud area F_1, F_2, F_3, F_4, F_5 are S, the

perimeter is L, the student emotional experience cloud perimeter $F_1', F_2', F_3', F_4', F_5', F_6'$ are S1,

the calculate formula is $S = 2 \times \left[\sum_{i=1}^5 \sin\left(\frac{w_i + w_{i+1}}{2} \pi\right) + \sin\left(\frac{w_1 + w_6}{2} \pi\right) \right]$,

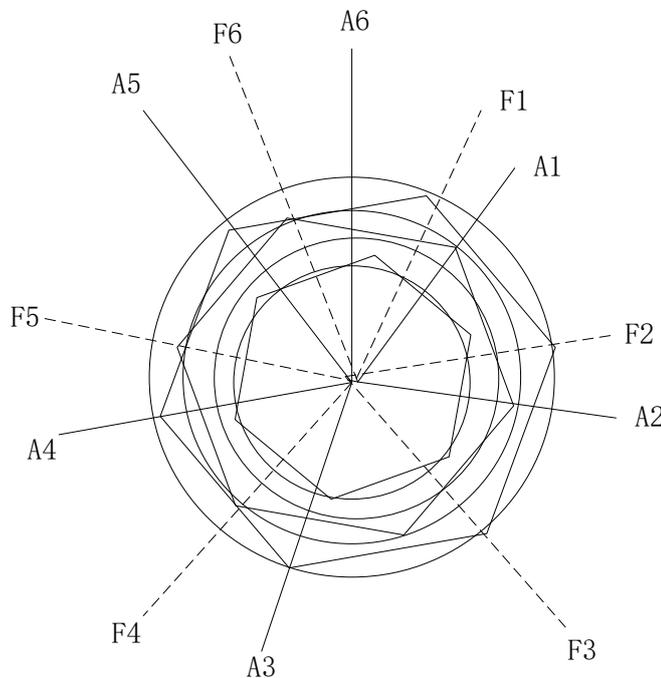


Figure 5. Student emotional experience cloud

$$L = 2 \times \left[\sum_{i=1}^5 \sqrt{2 - 2 \cos\left(\frac{w_i + w_{i+1}}{2} \pi\right)} + \sqrt{2 - 2 \cos\left(\frac{w_i + w_6}{2} \pi\right)} \right],$$

$$S_1 = \frac{1}{2} \left[\sum_{i=1}^5 r_i r_{i+1} \sin\left(\frac{w_i + w_{i+1}}{2} \pi\right) + r_1 r_6 \sin\left(\frac{w_1 + w_6}{2} \pi\right) \right],$$

$$L_1 = \sum_{i=1}^5 \sqrt{r_i^2 + r_{i+1}^2 - 2r_i r_{i+1} \cos\left(\frac{w_i + w_{i+1}}{2} \pi\right)} + \sqrt{r_1^2 + r_6^2 - 2r_1 r_6 \cos\left(\frac{w_1 + w_6}{2} \pi\right)},$$

based on the above calculate process, then we construct the evaluate vector $f(a_1, a_2)$, $a_1 = S_1 / S$, $a_2 = 1 - |s' - s_1| / S'$.

(4) Application Analysis of Student Engagement Model. Firstly we analysis the behavior of student engagement. **Table 1** is the statistical results of the overall engagement of all students in the class.

Using the behavioral engagement data and the related calculation methods in the learning platform, we calculate the degree of engagement of each student. As **Figure 6** shows.

Table 2. Descriptive analysis of cognitive engagement

Attributes	Minimum value	Maximum value	The difference answer	Average value	Standard deviation
B ₁	5	36	31	19.46	6.9082
B ₂	4	36	32	17.58	7.0627
B ₃	3	13	10	8.16	2.3935
B ₄	1	13	12	6.54	2.6512
B ₅	1	11	10	5.88	2.6545
B ₆	1	14	13	5.26	2.6940
B ₇	3	18	15	8.46	3.5063

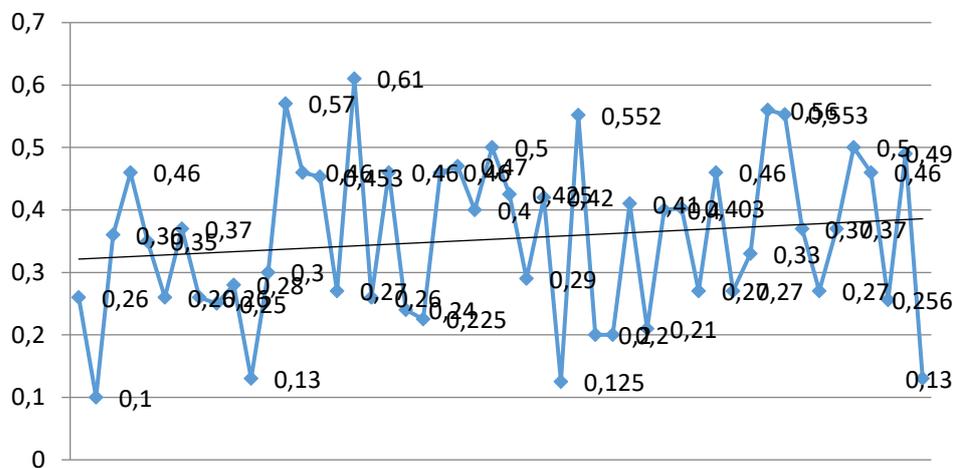


Figure 7. Cognitive engagement degree of the whole class

of the dimensions of cognitive engagement data, **Table 2** is the statistical results of the overall cognitive engagement of all students in this class.

It can be seen from **Table 2** that in the seven dimensions of cognitive engagement, the mean and standard deviation in the dimension from the hierarchy are small, indicating that students in the online discussion published less number of high-level awareness of the posts. Then used the cognitive engagement in the learning platform data and related computing methods, we calculated the results of the comprehensive evaluation of each student's cognitive engagement, as **Figure 6** shows.

Thirdly, analysis of Students' Emotional Engagement. According to **Table 3**, students' emotional experience dimension can be used to analyze the dimensions of experience data. **Table 3** is the result of the overall emotional experience of all the students in this class.

As can be seen from **Table 3**, in the six dimensions of the emotional experience, the difference between the mean and the standard deviation of each dimension is not large. Indicating that students in the online learning have six dimensions of basic emotional

Table 3. Descriptive analysis of emotional experience data

Attributes	Minimum value	Maximum value	The difference answer	Average value	Standard deviation
u ₁	0.8333	4.0000	3.1667	2.1467	0.6474
u ₂	0.2000	3.2000	3.0000	1.5160	0.6738
u ₃	0.2000	3.4000	3.2000	1.6640	0.7300
u ₄	0.2857	3.8571	3.5714	1.8914	0.8084
u ₅	0.2857	3.1429	2.8571	1.9543	0.7495
u ₆	0.2500	3.2500	3.0000	1.6550	0.7404

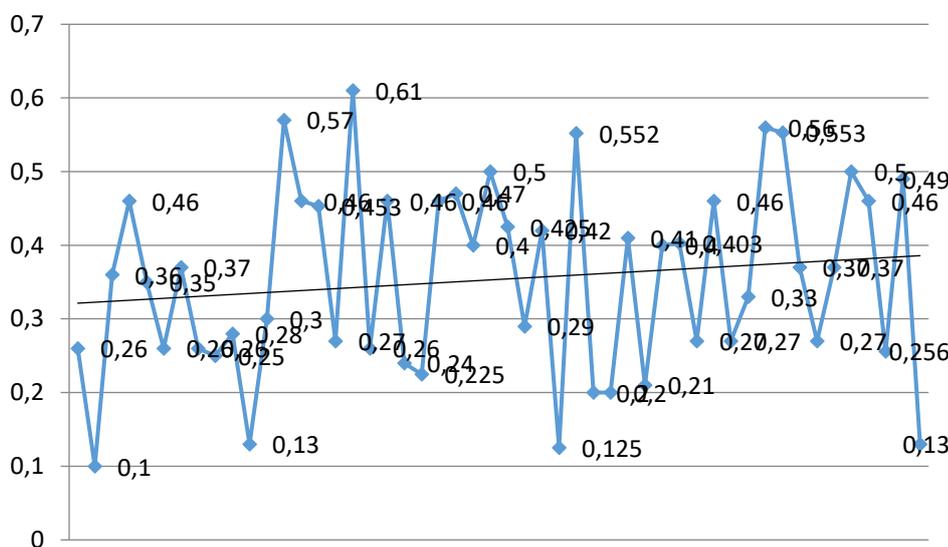


Figure 8. The emotional experience degree of the whole class

experience. Then used the self-report scale method to collect students' emotional experience data and related computational methods, we calculate the comprehensive evaluation of each student's emotional experience degree, as **Figure 8** shows.

CONCLUSION AND RECOMMENDATION

Engagement is an indispensable part of learning, and active engagement can promote student learning. With the development and popularization of online learning, the problem of low level of student engagement in online learning is becoming more and more obvious. Student engagement in online learning refers to the engagement of students in the learning platform, including behavior engagement, cognitive engagement, and emotional engagement from three aspects. Due to the lack of a unified quantifiable analysis of the student engagement model, Therefore, this paper mainly from the model construction, analysis methods, model application of three aspects to research the core problem. Firstly, we constructed student engagement model. In view of the shortcomings in the relevant models, according to the student-centered constructivist learning theory, the elements of online learning and

influencing factors, the factors that affect student engagement, we proposed S-TEC student engagement model. Combined with the behavioral characteristics of online learning process, the paper puts forward the "three dimensions and four degrees" analysis framework of student engagement model; Secondly, used different methods to analysis three dimensions of student engagement. The weight of each attribute engagement attribute is determined by the combination of subjective weighting and objective segmentation. This paper used the linear weighting method to calculate the behavior of each student engagement degree. Considered the character of the mutual influence of cognitive engagement in low-level and high-level dimensions of each dimension, this paper used partial correlation analysis method to research the weights of the dimensions. Based on Ekman's six basic emotions, we divided the student's emotional experience dimension. Then used Self-report scale method to measure students' emotional experience degree. In view of the deficiency of the cloud model, the students 'emotional experience cloud model is used to analyze the students' emotional experience degree.

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