International Journal of Modern Education
EISSN: 2637-0905
Volume 5 Issue 18 (September 2023) PP. 10-23
DOI: 10.35631/IJMOE.518002

INTERNATIONAL JOURNAL OF MODERN EDUCATION (IJMOE)
www.ijmoe.com

AN EMPIRICAL RESEARCH ON THE INFLUENCE OF STUDENT ENGAGEMENT ON UNDERGRADUATE STUDENTS' ACADEMIC ACHIEVEMENT IN THE FLIPPED CLASSROOM ENVIRONMENT

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Article Info:

Article history:
Received date: 21.06.2023
Revised date: 16.07.2023
Accepted date: 22.08.2023
Published date: 15.09.2023

To cite this document:

Yan, J., Tan, C. K., & Kifle, D. N. (2023). An Empirical Research on the Influence of Student Engagement on Undergraduate Students' Academic Achievement in The Flipped Classroom Environment. *International Journal of Modern Education, 5* (18), 10-23.

DOI: 10.35631/IJMOE.518002

Abstract:

High quality student engagement is an important goal in the pursuit of flipped classroom teaching and learning and is a necessary process element to ensure student achievement. **Purpose:** The main purpose of this research was to analyse the relationship between dimensions of student engagement and student achievement in the flipped classroom at a China university by surveying data from 507 university students from Longdong University, China. **Methods:** Data were elicited via a survey approach and analyzed quantitatively to support the investigation. Student engagement is measured using The Flipped Learning Student Engagement Scale (FLSES) and student achievement is represented by the student's C language programming composite score. **Results:** The results of the analyses revealed significant positive relationships between students' academic achievement and student engagement. In addition, the research found that cognitive, behavioural and relationship with the faculty member had a direct impact on student achievement, and peer relationship had an indirect impact on student achievement in the flipped classroom. **Conclusion:** The research provides a basis for improving student achievement from the perspective of improving student engagement.

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Keywords:

Student Engagement; Student Achievement; High Education; Flipped Classroom

Introduction

In June 2018, China's Ministry of Education proposed for the first time to effectively "increase the burden" for university students by turning "water courses" into "gold courses" with depth, difficulty and challenge (p.2) (Ministry of Education, 2018a), Universities should comprehensively sort out the teaching content of each course, eliminate "water courses", create "gold courses" and effectively improve the teaching quality of the courses (p.2) (Ministry of Education, 2018b).

The influence of flipped course quality on student achievement has been supported by theory and empirical evidence (Baepler *et al.*, 2014; Shatto *et al.*, 2017). An important aim of improving the quality of teaching in flipped courses is to motivate students to actively and efficiently engage in their learning (Gross *et al.*, 2015), thereby facilitating students' acquisition of appropriate knowledge and skills, comprehending of ideas and methods, developing of positive emotional attitudes and values. Student engagement is an important factor influencing academic achievement and teaching reform (Fredricks *et al.*, 2004) and is a way to evaluate the quality of teaching and learning (Early *et al.*, 2014). Steen-Utheim and Foldnes (2018) found that students in flipped classrooms had more significant emotional and cognitive engagement compared to traditional teaching models.

Student engagement refers to the quality of student participation in a learning activity or situation (Christenson *et al.*, 2012). Fredricks et al. (2004) and Lee (2008) define student engagement as a meta-construct that includes behavioral, emotional, and cognitive engagement and state student engagement occurs in three areas: Cognitive engagement focuses on students' use of learning strategies and self-monitoring and self-regulating of learning in the curriculum. Emotional engagement focuses on the student's emotional experience of learning in the course, both between teachers and students, and among peers. Behavioral engagement focuses on students' active participation, effort and persistence, and interaction in the learning of the course. On this basis, Gunuc and Kuzu (2015) divided emotional engagement into peer relationship (emotional engagement-I) and relationship with the faculty member (emotional engagement II). Therefore, the scale structure of this research is proposed (see Figure 1).

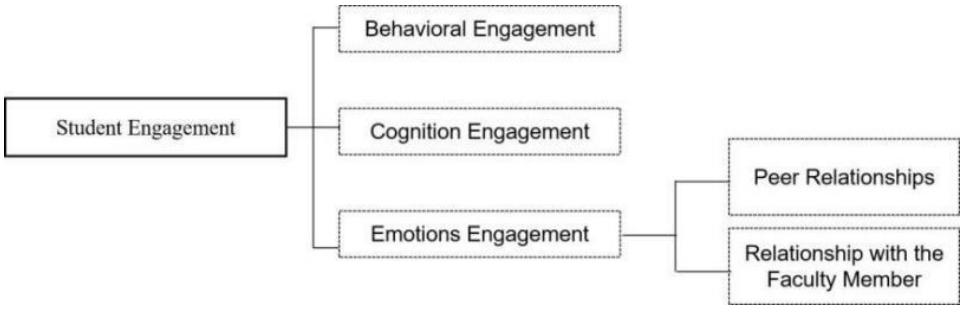

Figure 1: Structure of the Flipped Learning Student Engagement Scale (FLSES)

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It has been shown that student engagement has a significant positive impact on student achievement (Fung *et al.*, 2018), and that student engagement is positively associated with high quality learning outcomes and academic achievement (Carini *et al.*, 2006). A lack of engagement can threaten students' grades and performance. Student engagement can be used to predict achievement and, of course, achievement can be used as an indirect measure of student engagement (Fredricks *et al.*, 2004). Although there is extensive empirical research on the relationship between student engagement and student achievement, the results so far have been inconsistent (Lei *et al.*, 2018), and only a few studies have discussed the impact of student engagement on student achievement in the context of flipped classrooms and MOOCs (Kim *et al.*, 2019; Lo & Hew, 2021). Therefore, further research needs to be done to investigate how the components of student engagement can influence students' achievement. The research questions are as follows:

1. What is the relationship between student engagement and student achievement in the flipped classroom?
2. Which factors in the student engagement dimensions are more dominant in influencing the students' achievement scores using the flipped classroom method?

Literature Review

Initial research on flipped classrooms has focused on changing learning tasks across time and space, rather than student engagement (Baker, 2000; Strayer, 2007). With the deepening of flipped classroom research, many studies began to regard student engagement as the learning process or learning result of the flipped classroom. Adopting a flipped classroom not only increases student engagement but improves the way students engage. It helps students move from an environment with less communication and interaction to one that emphasizes full interaction with other students (Clark, 2015). In a flipped classroom, students are more engaged and support teachers to achieve more effective outcomes (Galway *et al.*, 2015). The flipped classroom provides opportunities for students to actively participate in classroom activities (Galway *et al.*, 2015).

Educators use flipped classrooms because they see the impact it has on student interaction and engagement (Salifu, 2016). Bond and Bedenlier (2019) found that in 93% (n = 99) of the studies, the flipped learning approach had a positive impact on at least one dimension of student engagement. Research in educational and developmental psychology over the last three decades has indicated that behavioral engagement in learning is an important predictor of student academic achievement (Downer *et al.*, 2007). Student engagement is positively associated with high-quality learning outcomes and academic achievement (Carini *et al.*, 2006). According to Pekrun (2011), emotions can affect "many types of cognitive processes that support learning, including perception, attention, memory, decision-making, and cognitive problem-solving" (p. 26). Additionally, Skinner and Pitzer (2012) offer a potent comparison: "Emotions are likely to be the fuel for behavioral and cognitive engagement that leads to high-quality learning" (p. 33).

The flipped classroom influences students' emotional engagement most (Chen *et al.*, 2016). In a flipped classroom, students' emotional engagement, behavioral engagement, and cognitive engagement promote active learning, among which emotional engagement is the most important, followed by behavioral engagement and cognitive engagement (Jamaludin & Osman, 2014). When students find the class interesting, they increase their emotional

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engagement, are willing to learn new content, feel good, and have fun. This in turn affects behavioral engagement, increased attention, increased effort, and participation in classroom activities. However, based on a meta-analysis of 69 independent studies, Chinese scholars found that student engagement had a positive effect on academic achievement as a whole, with behavioral engagement having the highest average effect, followed by cognitive engagement and emotional engagement (Lei *et al.*, 2018). In conclusion, Findings from different studies on the importance of dimensions of student engagement in the flipped classroom are inconsistent.

Methods

Students are the subjects and participants of flipped classroom teaching, and they are one of the important subjects in the evaluation of classroom teaching quality, and their voices should be valued in the evaluation of classroom teaching quality. For this reason, this research collects data for evaluation through the perception of students.

Sample

In this research, the sample was randomly sampled (Creswell & Guetterman, 2019) from 28 classes taking the "C Language Programming" course in the autumn semester of 2022 at Longdong University in Gansu Province, China. 507 students were selected. Male students were 227 (44.8%), and female students were 280 (55.2%). Quantitative data were analysed using statistical test via SPSS Version 26 and AMOS Version 24.

Instrumentation

The Flipped Learning Student Engagement Scale (FLSES)

The Flipped Learning Student Engagement Scale (FLSES) is composed of four sub-scales: cognitive engagement, peer relationship (emotional engagement-I), relationship with the faculty member (emotional engagement-II) and behavioral engagement. The study used a 5-point Likert format scale. The cognitive engagement sub-scale was 10 items, the peer relationship (emotional engagement-I) sub-scale was 3 items, the relationship with the faculty member (emotional engagement-II) sub-scale was 4 items and the behavioral engagement sub-scale was 4 items. Their internal consistency coefficients were 0.961, 0.901, 0.926 and 0.926 respectively, all above 0.9 (DeVellis & Thorpe, 2021), the Kaiser-Meyer-Olkin (KMO) values were 0.965, 0.726, 0.839 and 0.847 respectively.

The results of the Confirmatory Factor Analysis were χ^2/ df=3.733, Within 5 (Kline, 2023), RMSEA=0.073, SRMR=0.0368, below 0.08 (Brown, 2015; Hooper *et al.*, 2008), NFI=0.937, NNFI=0.946, CFI=0.953, GFI=0.877, all indicators are above 0.9 except for GFI (Hu & Bentler, 1999; Tabachnick & Fidell, 2007; Thompson, 2004), combined with the model fit indicator judgment criteria, this indicates that the scale has good construct validity. In summary, the scale has good reliability and validity.

Student Achievement

The student achievement scores in this study referred to the student's C language programming course comprehensive academic performance. In the blended teaching practice of "MOOCs + Flipped Classroom" at Longdong University, the total score of the course evaluation consists of 60% online score and 40% offline score. The online course grade is the final online exam (60%). The offline course grade is the final project (40%). Among them, the final project adopts the method of combining teacher assessment and peer assessment, with teacher assessment

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accounting for 60% and peer assessment accounting for 40%, and the students are evaluated in an all-around and multi-angle way. The evaluation and grading criteria of this course are formulated by the course teaching and research group of C language programming based on the evaluation and grading criteria of Arano-Ocuaman (2010) and Miller et al. (1996).

Results and Discussion

Analysis of Data Normality

The collected data fulfilled the assumption of normal distribution (Field, 2013). Inferential statistics analysis can go on. Normality was determined by examining the skewness-kurtosis values, histogram, and P-P and Q-Q graphics (Huck, 2012). Figure 2 shows that the Histogram of regression-standardized residuals was normally distributed. Figure 3 shows the normal P-P plot of regression standardized residual of the sample.

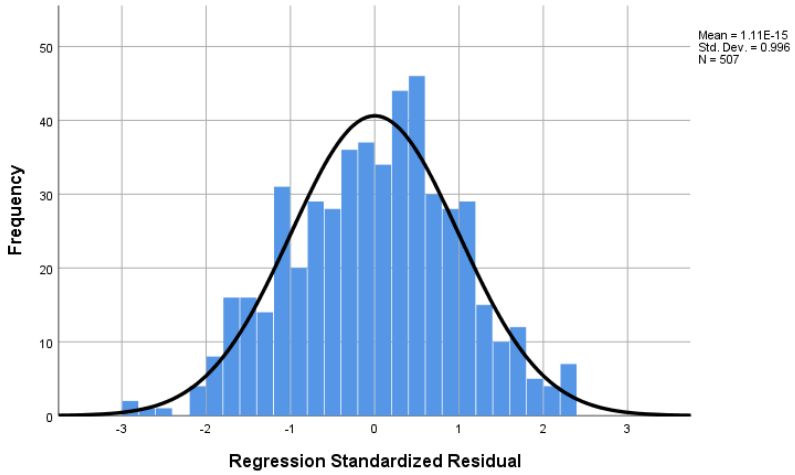

Figure 2: Histogram for Regression-standardized Residuals

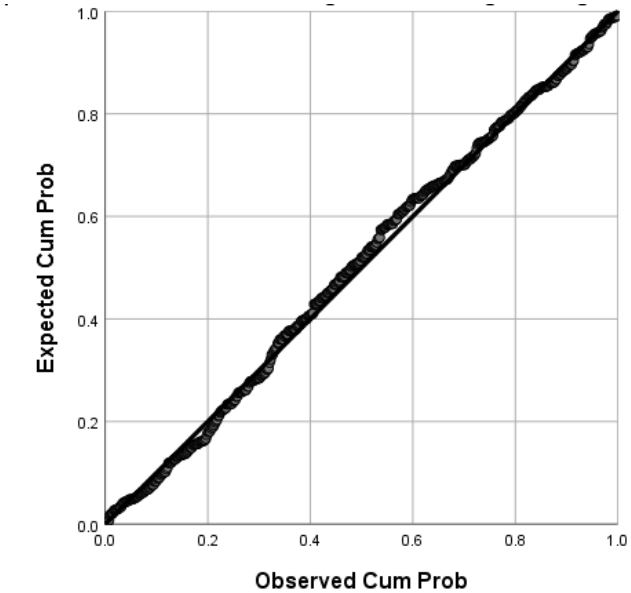

Figure 1: Normal P-P Plot of Regression Standardized Residual

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Analysis of Student Engagement

Based on the total score obtained by the student engagement from the FLSES, the K-Means Cluster was conducted. In this way, student engagement scores were grouped as low, moderate, and high levels.

Table 1: K-Means Cluster Analysis Regarding the Student Engagement Scores (N=507)

Group	n	Total %	Mean	Min.	Max.	SD
High (1)	72	14.20	102.50	93.00	105.00	3.71
Low (2)	177	34.91	65.62	46.00	73.00	5.09
Moderate (3)	258	50.89	81.66	74.00	92.00	4.36

As can be seen in Table 1, 14.2% of the research sample (n = 72) had high levels of student engagement. 34.91% of the research sample (n = 177) had low levels of student engagement.

Analysis of Student Achievement

Table 2 demonstrates the descriptive statistics regarding the student achievement scores. The minimum value of student achievement was 48 and the maximum value was 95, with a mean of 73.33 and a standard deviation of 8.122, which is within 10, and the scores roughly satisfied a normal distribution (Figure 4).

Table 2: Descriptive Statistics Regarding the Student Achievement Scores

	n	Minimum	Maximum	Mean	SD
Achievement	507	48	95	73.33	8.122

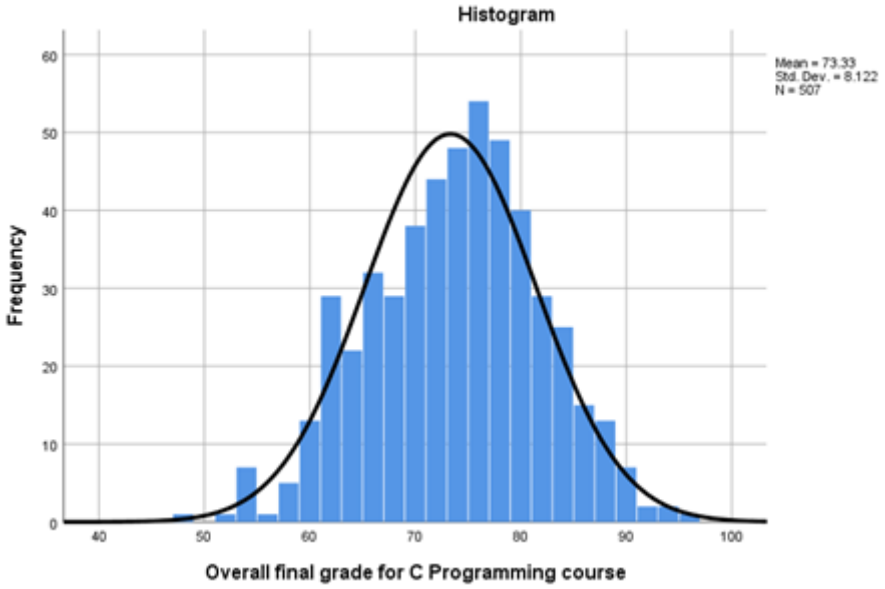

Figure 4: Histogram for Academic Achievement Scores

Table 3 shows the distribution of student achievement scores, with 15 people (3%) scoring 90-100 (Excellent), 145 people (28.6%) scoring 80-89 (Good), 225 people (44.4%) scoring 70-79 (Moderate), 116 people (22.9%) scoring 60-70 (Pass) and 6 people (1.2%) scoring less than 60 (Fail).

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Table 3: Distribution and Proportion of Stage Student Achievement Scores (N=507)

	Student Achievement Distribution	No.	%
Student Achievement Distribution	90 ~ 100	15	3.00
	80 ~ 90	145	28.60
	70 ~ 80	225	44.40
	60 ~ 70	116	22.90
	<60	6	1.20

Low and high achievers among the students were determined by the students ' course total scores during their studies. Here high achievers were defined as having course total scores of "Excellent" to "Good", while low achievers were defined as having course total scores of "Pass" to "Fail" (Nouri, 2016) (see Table 4).

Table 4: Group Descriptive Statistics Analysis Regarding the Student Achievement Scores (N=507)

Group	n	Total %	Min.	Max.	Mean	SD
High (1)	122	24.1	80	95	83.62	3.41
Moderate (2)	225	44.4	70	79	74.48	2.62
Low (3)	160	31.6	48	69	63.86	4.24

As can be seen in Table 4, 31.6% of the research sample (n = 160) were low achievers, and 24.1% of the research sample (n = 122) were high achievers.

The Relationship Between Student Engagement and Student Achievement

Table 5 shows that there was a significant positive relationship between cognitive engagement, peer relationship (emotional engagement-I), relationship with the faculty member (emotional engagement-II), behavioral engagement and student achievement. This is similar to the findings of Diseth *et al.* (2010), Hu and Hui (2012), and Murillo-Zamorano *et al.* (2019): university students' academic achievement and student engagement have a positive correlation. This is also similar to the findings of Furrer & Skinner (2003) that the positive relationship between behavioral engagement and academic performance was more significant than the relationship between emotional and cognitive engagement and academic achievement. Furthermore, most empirical studies have found that students who perform better can construct their learning strategy framework, so there is a positive correlation between learning strategies and learning outcomes (Thiessen & Blasius, 2008). This leads to the assumption that students with good learning strategies can be expected to be excellent in terms of academic performance.

Table 5: Pearson Correlation among Student Achievement, Student Engagement Total Scores, and Student Engagement Sub-scales

		CE	EES	EET	BE	Total-scale
Achievement	Pearson (r)	0.266**	0.168**	0.271**	0.307**	0.309**
	p	0.00	0.00	0.00	0.00	0.00

Note: Correlation is significant at the 0.01 level (2-tailed).
CE: Cognitive Engagement, EES: Peer Relationships (Emotional Engagement-I), EET: Relationships with the Faculty Member (Emotional Engagement-II), BE: Behavioral Engagement

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High scores (group-1) and low scores (group-2) of student engagement were analyzed with independent samples t-test according to their academic achievement scores.

Table 6: Comparison of the Group-1 and Group-2 of Student Engagement According to Their Academic Achievement Scores

	Levene's test		t-test				
	F	**p (Levene)**	**t**	**df**	**p**	**Mean Difference**	**Std. Err. Difference**
Equal variances assumed	0.30	0.58	4.08	247.00	0.00	4.78	1.17
Equal variances not assumed			3.92	121.39	0.00	4.78	1.22

When Levene's test findings presented in Table 6 were examined, it was seen that the group variances were equal; in other words, there was no significant difference between the group variances ($p = 0.58$). Therefore, the values in the upper line were taken into consideration. According to these values, a significant difference was found between the academic achievement scores of the groups ($p = 0.00 < 0.05$). Again, as can be seen from Table 6, the mean difference was found positive. Thus, it was found that the students with high student engagement scores had higher levels of academic achievement scores and that those with low student engagement scores had lower levels of academic achievement scores.

In addition, it was found that student engagement can improve in academic achievement of students whose grades have been poor. This result is consistent with those of Mo and Singh (2008) and Lei et al. (2018). It can be seen that students' academic achievement is closely related to their student engagement, the better the academic achievement of students, the higher the level of student engagement, or the higher the level of student engagement, the better the academic achievement of students. The reasons for this are that students with high academic achievement are more motivated to learn, are more likely to use various cognitive and meta-cognitive strategies, receive more praise and attention from teachers, and have a stronger sense of belonging and a greater sense of academic achievement. Students are more likely to experience the joy of learning and are therefore more willing to devote time and energy to the behavior of learning, which in turn leads to higher levels of engagement in learning and further enhances academic performance, creating a virtuous cycle. Conversely, students with poor academic performance do not experience the pleasure of learning success, and are likely to lose interest in learning, forming a learning burnout, or even seriously doubt their learning ability and become averse to learning.

The engagement identity model of student engagement explains this phenomenon (Finn, 1989). According to this theory, it is argued that sustained behavioral engagement leads to successful academic performance, which in turn leads to greater recognition of the importance of school (Finn, 1989). This recognition has a positive feedback effect and students are thus motivated to engage further in learning activities as a result their academic performance increases, thus starting a new cycle (Finn, 1989). This suggests that the flipped classroom is effective in increasing student engagement by increasing the level of challenge in the course, organizing regular collaborative learning based on learning communities, designing diverse learning activities, and guiding students to participate in a wide range of activities, which in turn

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increases the overall student achievement and can effectively contribute to the development of students' multiple competencies.

Which Dimensions in Student Engagement Are More Dominant in Influencing the Students' Achievement?

Structural equation modeling (SEM) is a systematic approach that combines multiple regression analysis, factor analysis, and path analysis. The objective of SEM is to find the most parsimonious and accurate interrelationships between variables based on the observed data (Kline, 2023). This study used AMOS version 24 software to perform structural equation modeling. It is to verify "*Which factors in the student engagement dimensions are more dominant in influencing the students' achievement scores using the flipped classroom method*". Based on the hypothesis of this study, the full structural equation model to be validated was developed using AMOS version 24.

Table 7: Structural Equation Model Path Coefficients

Path Relationships	Unstd.	S.E.	Z	P	Std.	Hypothetical Result
Cognitive Engagement → Student Achievement	1.61	0.62	2.59	0.01	0.14	Support
Peer Relationships → Student Achievement	-1.20	0.64	-1.88	0.06	-0.11	Not supported
Relationships with the Faculty Member → Student Achievement	1.66	0.64	2.60	0.01	0.15	Support
Behavioral Engagement → Student Achievement	2.31	0.68	3.41	***	0.20	Support

Note: *** indicates p<0.001; ** indicates p<0.01; * indicates p<0.05.

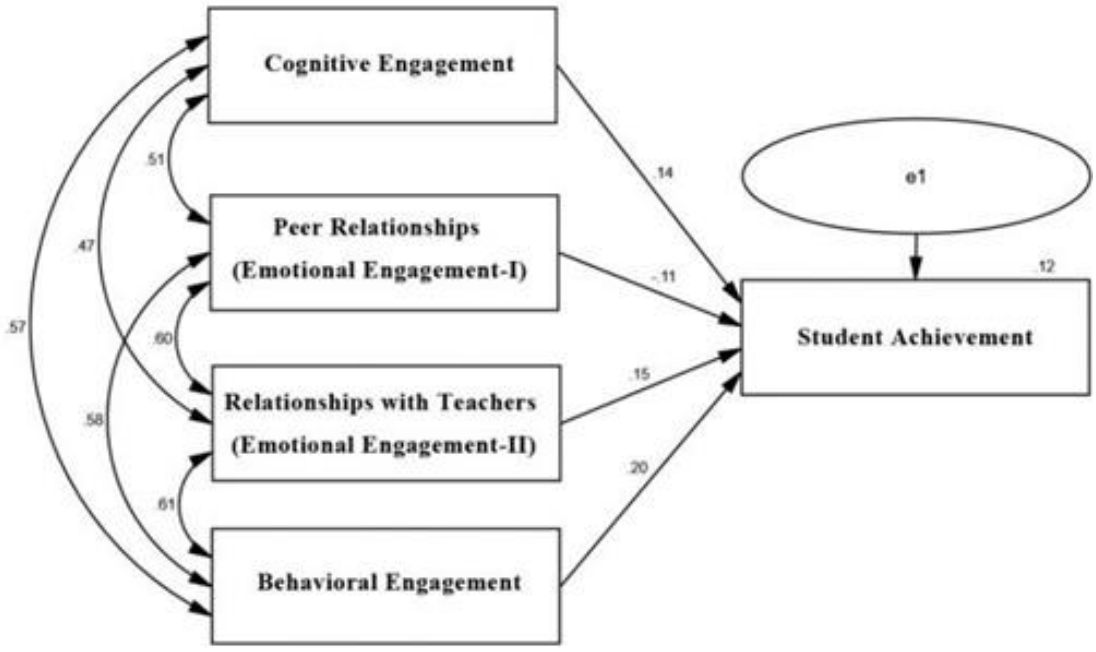

Figure 5: Standardized Fitting Results of Structural Model

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EISSN: 2637-0905
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The results of the model hypotheses are shown in Figure 5 and Table 7. All the hypotheses are valid except the hypothesis that peer relationships (emotional engagement-I) affect student achievement, which does not pass the hypothesis test. The hypothesis that behavioral engagement affects student achievement is significant at the p=0.001 confidence level, and the hypothesis that cognitive engagement and relationships with the faculty member (emotional engagement-II) affect student achievement is significant at the p=0.05 confidence level.

This shows that cognitive engagement, relationships with the faculty member (emotional engagement-II), and behavioral Engagement (z-values are 2.59, 2.60, 3.41 respectively) have a significant positive effect on student achievement. In order of importance, behavioral engagement (standardized coefficient of 0.2) had the most significant effect on student achievement, followed by a relationship with the faculty member (emotional engagement- II) (standardized coefficient of 0.15) and cognitive engagement (standardized coefficient of 0.14) had the lower effect on student achievement.

This leads to the conclusion that cognitive engagement changed by one standard deviation, student achievement changed by 0.14 standard deviation, relationships with the faculty member (emotional engagement-II) changed by one standard deviation, and student achievement by 0.15 standard deviation, behavioral engagement by one standard deviation, and student achievement by 0.20 standard deviations. Although peer relationships (emotional engagement-I) are not a direct factor in student achievement, they achieve a significant positive correlation with students' academic performance ($r=0.168$, $p=0.00<0.05$) and are an important guarantee for improving students' performance. Moreover, there may be an indirect relationship between academic achievement scores and the peer relationships (emotional engagement-I) sub-factor, as there is a significant correlation between this variable and the other variables.

Conclusion

This research investigated the relationship between student achievement and the dimensions of student engagement. In accordance with the purpose of this research, student engagement was first categorized into high and low-engaged learners using the K-Means Clusters methods, and student achievement was categorized into high and low achievers by a distribution of the student achievement scores. Correlation analyses, t-tests and path analyses were then conducted on the dimensions of student engagement and student achievement. The results of the analysis showed that there were significant positive correlations between student achievement and student engagement and the sub-factors of student engagement. It can be concluded that lowly engaged learners had low levels of cognitive, peer relationships (emotional engagement-I), relationships with the faculty member (emotional engagement-II) and behavioral engagement, the converse is also true.

Cognitive engagement, relationship with the faculty member (emotional engagement-II), and behavioral engagement had a significant, positive and direct impact on student achievement in the flipped classroom. Behavioral engagement had the most significant impact on student achievement, followed by a relationship with the faculty member (emotional engagement-II), and finally cognitive engagement. Peer relationships (emotional engagement-I) had an indirect relationship on academic achievement.

Student engagement is both an important observation indicator of student learning and an important predictive Indicator of student academic achievement, playing a key role in learning.

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Therefore, it is recommended that universities and the corresponding departments should give an appropriate tilt to flipped classroom teaching in terms of policy, human, financial and material resources, and provide moral and material encouragement to individual teachers who carry out flipped classroom teaching to facilitate the conditions for teaching. Moreover, teachers should strengthen the design of teaching and learning resources for the flipped classroom to meet students' needs for personalized learning Resources and create a relaxed and enjoyable classroom atmosphere.

This study only surveyed 507 learners, a slightly smaller sample size, making the generalizability of some of the findings potentially difficult to extend to a larger whole. At the same time, this study focuses on a group of university students (mainly freshmen and sophomores) in science and technology at Longdong University, without taking into account differences in grade level, school level, ethnicity, place of birth, school location, discipline classification (arts, science, and technology, etc.) and country of nationality, which is insufficient in terms of the diversity of the study population. It is therefore expected that the sample size will be expanded subsequently to consider fully the diversity of sources and types of learners and to analyze in depth their level of engagement and behavioral patterns, etc., to enhance the adaptability and transferability of the findings. In addition, longitudinal studies should be conducted to clarify the long-term impact of student engagement on student achievement in the flipped classroom.

Acknowledgements
I would like to express my thanks and gratitude to the respondents who are students from Longdong University for participating in this research.

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