An Analysis of Academic Master's Students' Types of Learning Engagement and Its Relationship with Mental Health from a Big Data Perspective

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Abstract: This study aims to explore the types and characteristics of academic master's students' learning engagement from a big data perspective, integrating mental health insights to provide a comprehensive understanding of students' learning states. As graduate education expands, leveraging big data to capture students' diverse characteristics has become crucial for enhancing educational quality. The research sampled 3,112 academic master's students, employing learning engagement theory and second-order cluster analysis to examine behavioral, cognitive, and emotional engagement, alongside mental health indicators such as anxiety, self-esteem, and resilience. Behavioral engagement was measured by learning time, academic discussion participation, and resource usage; cognitive engagement by thinking patterns and learning strategies; and emotional engagement by learning attitudes and academic enthusiasm. The analysis revealed five distinct engagement types: comprehensive, emotion-driven, moderate, passive avoidance, and limited participation. Comprehensive engagement students excelled across all dimensions with strong mental health; emotion-driven students exhibited high emotional investment driving their engagement; moderate engagement students showed balanced performance; passive avoidance students scored low on all engagement metrics with high anxiety and unmet psychological needs; and limited participation students demonstrated weak cognitive and emotional engagement with partial involvement in learning activities. In conclusion, academic master's students exhibit significant variations in learning engagement types, some of which are closely tied to mental health challenges. Universities should recognize these differences, prioritize mental health support, and implement tailored interventions to foster positive changes and improve graduate education quality.

Keywords: Academic Master's Students; Learning Engagement; Cluster Analysis; Mental Health; Big Data

1. Introduction

In the context of the continuous expansion of graduate education, accurately capturing the diverse characteristics of students using big data has become a core element in promoting the high-quality development of graduate education [1]. In the era of AI, effectively integrating information technologies such as the internet, big data, and artificial intelligence into graduate education management is an important driving force for improving the quality and efficiency of education management [2]. In China, academic master's students have unique characteristics. Unlike in Western countries such as the UK and the US, where the master's degree serves as a transitional stage, China's academic master's education is a distinct and independent training phase with a longer duration and higher academic requirements. It emphasizes a solid foundation in theory and specialized knowledge, as well as the ability to conduct research or engage in specialized technical work [3]. It can be said that academic master's students are potential scientific research talents in China [4] and a reserve force for doctoral candidates [5]. The high-quality development of doctoral education relies on the further education of academically promising master's students [6]. In

recent years, the rapid expansion of graduate education has posed severe challenges to the quality of graduate training. Coupled with factors such as degree inflation and increased employment pressure, the current state of research activities among academic master's students is concerning. Issues such as insufficient research vitality and unsatisfactory research outcomes are becoming more prominent [7]. According to relevant research, a significant proportion of academic master's students experience varying degrees of anxiety, depression, and other psychological distress. Poor mental health not only affects their daily lives but also creates significant barriers to their research and learning engagement. Previous studies have shown that student learning engagement reflects students' learning and personal growth characteristics and influences their learning outcomes [8]. Classifying academic master's students based on their learning engagement helps scientifically understand the learning characteristics of different types of students, enabling targeted support strategies to improve the quality of academic master's education. At the same time, psychological health factors are closely linked to learning engagement. A good mental state is a critical safeguard for maintaining high levels of learning engagement, while the level of engagement in turn affects students' mental health status.

Existing scholars have conducted student type research based on the perspective of learning engagement. For example, Wang Shu classified Chinese research university undergraduates' learning engagement into four types: active engagement, self-reliant engagement, interpersonal interaction engagement, and passive engagement, based on individual activities and interpersonal interactions [9]. Wang categorized students in general education courses into three types based on differences in learning strategies: comprehensive type, autonomous type, and disengaged type [10]. Fu et al. divided university students' learning states into six types: excellence type, social type, research type, reading type, disengaged type, and lazy type, pointing out that these types show different characteristics in learning, and the effect of school resources on these students varies [11]. Li's research based on a survey at an undergraduate institution found that there are six types of student learning participation: mediocre type, academic type, entertainment type, efficient type, scattered type, and traditional type, with efficient and entertainment types being rare, while the proportion of mediocre and scattered types is too large [12]. Wei further incorporated cognitive indicators of student engagement and classified students into six types—excellence, follow-up, balanced, high-demand, social, and disengaged—based on their engagement behavior and expectations for future development [13]. While some scholars have started to focus on the study of student types from the perspective of learning engagement, there are still some shortcomings: in terms of research subjects, most empirical studies focus on students from "Double First-Class" universities in the eastern and central regions, and research on academic master's students in western universities still lacks specific empirical analysis; in terms of indicator construction, few studies comprehensively evaluate academic master's students' learning engagement from behavioral, emotional, and cognitive dimensions, while incorporating mental health indicators. Therefore, it is necessary to further study academic master's students' learning engagement from a holistic perspective that integrates psychological health factors.

In conclusion, this study will focus on answering the following questions: Are there differences in the learning engagement types of academic master's students at universities in western China from the perspective of learning engagement theory? What is the relationship between these differences and students' mental health? What are the pathways to promote academic master's students' learning engagement and improve their mental health in western China?

2. Research Subjects and Methods

2.1 Research Subjects

A stratified sampling method was used to select 4,660 students from eight academic master's degree programs in X Province, western China, across different grades. The sample included 1,160 first-year students, 1,021 second-year students, and 941 students from the third year and beyond. This sample covered academic master's students from various disciplines and grades, making it relatively representative. In March 2024, a total of 4,660 questionnaires were distributed through Wenjuanxing, and after eliminating invalid questionnaires based on the

lie detection questions, 3,112 valid questionnaires were collected, resulting in a valid response rate of 66.78%.

2.2 Research Tools

In the current academic environment, the quality of academic master's education has garnered significant attention. As a key factor influencing graduate students' academic development, learning engagement has long been a focus of educational research. This study follows the classification method proposed by Fredricks [14], which categorizes learning engagement into behavioral engagement, cognitive engagement, and emotional engagement. However, with the deepening of research into graduate education, scholars have found that mental health is closely related to learning engagement. Mental health not only affects graduate students' daily learning states but also plays an important role in behavioral engagement, cognitive engagement, and emotional engagement.

Based on the doctoral research engagement scale developed by Cai [15] and the undergraduate learning engagement scale developed by Xu [16], this study considered the specific learning characteristics of academic master's students. The questionnaire was revised through extensive qualitative interviews. In the revision process, special attention was given to incorporating aspects related to mental health. In the behavioral engagement section, a question was added about exercise time because good physical health is the foundation of mental health, which in turn positively affects learning engagement. In the cognitive engagement section, a question was included on how students cope with learning pressure, to reflect the role of psychological adjustment on cognitive engagement. In the emotional engagement section, questions about whether learning causes anxiety, depression, or other negative emotions were included, directly assessing the impact of mental health on emotional engagement. This questionnaire design aims to more comprehensively and accurately capture the learning engagement status of academic master's students, providing strong data support for subsequent research. Apart from basic information, all items were measured using a five-point Likert scale. The Cronbach's Alpha coefficient was 0.984, with the Cronbach's Alpha coefficients for each dimension ranging from 0.957 to 0.975. These reliability test results indicate that the questionnaire has good reliability.

3. Research Results

3.1 Determination of the Number of Academic Master's Student Types

This study employed second-order clustering analysis to identify the learning engagement types of academic master's students in universities. The second-order clustering analysis method has a high degree of automation, enabling the quick identification of different subgroups and their classification into different clusters. The advantage of this method is that it can automatically uncover hidden patterns and structures in the dataset, without requiring researchers to predefine the number of clusters, thus ensuring objectivity [17]. Furthermore, this method offers good interpretability, helping researchers better understand the inherent structure and characteristics of the data, laying a foundation for proposing more targeted improvement strategies later.

In the selection of clustering categories for this study, SPSS software was used to automatically record the BIC values and other relevant indicators for clustering the original sample into 1 to 15 categories. As the number of clusters increased, the BIC values showed a tendency to decrease. The process of determining the effectiveness of clustering analysis in the second-order clustering model is shown below (see Table 1):

From Table 1, it is evident that after the 5th cluster, the reduction in the BIC value becomes smaller with each increase in the number of clusters. Therefore, selecting five clusters as the clustering result is more reasonable, aligning with the system's optimal number of clusters. The distribution of the five clusters is as follows: 14.2% for Cluster 1, 37.1% for Cluster 2, 22.8% for Cluster 3, 2.4% for Cluster 4, and 23.5% for Cluster 5.

3.2 Naming of Academic Master's Student Types

Based on the different types of learning engagement displayed in the behavioral, emotional, and cognitive dimensions in Table 2, the five student learning engagement types were named as follows:

"Comprehensive Engagement Type": There are 442 students in this category, accounting for 14.2% of the total sample. These academic

master's students scored above 4.5 in all three engagement dimensions (behavioral engagement: M=4.75, cognitive engagement: M=4.85, emotional engagement: M=4.83), indicating that students in this group show a high level of engagement across all areas.

Table 1. Automatic Clustering Table

Clustering Number	Schwarz Bayesian Criterion (BIC)	BIC Change (a)	BIC Change Ratio (b)	Distance Measurement Ratio (c)
1	-229.264			
2	-3024.569	-2795.305	1.000	2.827
3	-3982.009	-957.440	.343	1.582
4	-4569.435	-587.426	.210	1.385
5	-4980.269	-410.834	.147	3.914
6	-5049.283	-69.014	.025	1.164
7	-5101.761	-52.478	.019	1.090
8	-5145.878	-44.117	.016	1.052
9	-5185.399	-39.521	.014	1.221
10	-5209.055	-23.657	.008	1.062
11	-5228.500	-19.445	.007	1.072
12	-5243.381	-14.881	.005	1.342
13	-5242.168	1.213	.000	1.057
14	-5238.416	3.752	-.001	1.068
15	-5231.817	6.599	-.002	1.174

a. The change is based on the previous clustering number in the table.
b. The change ratio relative to the dual clustering solution.
c. The distance measurement ratio is based on the current clustering number rather than the previous clustering number.

Table 2. Distribution of Total Samples across the Five Clusters

		Case Count	Percentage of Cluster	Percentage of Total
Cluster	1	442	14.2%	14.2%
	2	1158	37.1%	37.1%
	3	712	22.8%	22.8%
	4	75	2.4%	2.4%
	5	735	23.5%	23.5%
	combine	3122	100.0%	100.0%
Total		3122		100.0%

"Emotion-Driven Type": This group consists of 1,158 students, making up 37.1% of the total sample. These students scored lower in behavioral engagement (M=3.95) compared to cognitive engagement (M=4.01) and emotional engagement (M=4.91), suggesting that while their behavioral and cognitive engagement are moderate, their emotional engagement is the highest.

"Moderate Engagement Type": This category includes 712 students, accounting for 22.8% of the total sample. Students in this group scored around 3.50 in all three dimensions of engagement (behavioral engagement: M=3.42, cognitive engagement: M=3.50, emotional engagement: M=3.59), indicating balanced engagement across the dimensions.

"Passive-Avoidant Type": There are 75 students in this category, making up 2.4% of the total sample. These students scored below 2.0 in all three engagement dimensions (behavioral engagement: M=1.85, cognitive engagement: M=1.91, emotional engagement: M=1.87), indicating that their engagement in research and learning is very low and requires significant improvement.

"Limited Participation Type": This group includes 735 students, comprising 23.5% of the total sample. These students scored higher in behavioral (M=3.04) and cognitive (M=3.04) engagement compared to emotional engagement (M=2.99), suggesting that while their behavioral and cognitive engagement are relatively high, their emotional engagement needs improvement.

4. Conclusion

4.1 Academic Master's Students' Learning Engagement Can Be Divided into Five Types

Based on the categorization of academic master's students by their learning engagement, five types are identified: "Comprehensive Engagement Type," "Emotion-Driven Type," "Moderate Engagement Type," "Passive-Avoidant Type," and "Limited Participation Type." Further

analysis of the data shows that, apart from the "Comprehensive Engagement Type" and "Emotion-Driven Type," academic master's students in the remaining three types score below the median in all dimensions of engagement, including behavioral, emotional, and cognitive engagement.

4.2 Mental Health and Learning Engagement Are Closely Related

The study found a significant correlation between mental health status and the learning engagement types of academic master's students. The "Passive-Avoidant Type" group generally experiences higher levels of anxiety, depression, and other psychological issues. Their scores on mental health-related indicators are much lower than those of other types of students, which directly leads to poor performance in all dimensions of learning engagement. In contrast, students in the "Comprehensive Engagement Type" not only excel in learning engagement but also maintain relatively high levels of mental health. Their positive psychological state provides strong support for sustained and effective learning engagement. This conclusion further confirms that mental health is one of the key factors influencing academic master's students' learning engagement.

5. Discussion and Recommendations

5.1 Increasing Attention to the Passive-Avoidant Academic Master's Students

Among the five types of academic master's students, the Passive-Avoidant students have lower levels of behavioral, emotional, and cognitive engagement compared to other types. These students remain outside the scope of learning engagement and struggle to adapt to the demands of academic master's education. In this study, Passive-Avoidant students account for 2.4% of the total student sample. Krause once stated, "Policymakers and accreditation bodies increasingly require higher education institutions to ensure and demonstrate that they have improved the quality of the student educational experience" [18]. Rogers proposed that the "student-centered" educational philosophy has had a profound impact on global higher education and has gradually infiltrated all educational stages, emphasizing the quality of the learning process in higher education [19]. Universities should focus on tracking the learning engagement of Passive-Avoidant academic master's students and intervene in a timely manner. Special attention should be given to their mental health, as these students often experience higher levels of anxiety, depression, and other psychological issues. Universities could arrange professional counselors to regularly communicate one-on-one with these students, helping them alleviate negative emotions, resolve psychological distress, and guide them in overcoming difficulties in their learning and research. This will gradually help improve their learning engagement levels.

5.2 Promoting Positive Transformation in Learning Engagement Types among Academic Master's Students

With the continuous expansion of graduate education, the diversity of academic master's students has significantly increased. While universities are concerned with the overall learning engagement of academic master's students, it is also crucial to gain a deep understanding of the distribution, behavioral characteristics, and underlying reasons for different student types in order to assess the quality of education and training. As James Richard pointed out, "Current school education faces real challenges that need to accommodate student diversity and new expectations, and it is necessary to understand the new participation patterns of university students" [20]. Universities need to abandon the one-size-fits-all approach to talent cultivation and, based on the characteristics of different types of academic master's students, make improvements within the institution. They should build a multi-layered, networked support system for academic master's students' research and learning engagement, providing active guidance to help students in different types transition positively. At present, academic master's students not only bear heavy academic pressure but also face enormous employment pressures. These issues lead some students to regret their decision to pursue graduate studies and feel uncertain about their career paths, which is detrimental to the growth of high-level talent. Graduate students' mental health problems have become a major issue affecting their healthy development, and addressing mental health is an essential part of graduate talent cultivation [21]. Therefore, universities should help academic master's students establish correct academic values,

develop a positive learning mindset, and guide various types of students to transition into the Comprehensive Engagement Type. On one hand, for passive students, universities should focus on enhancing the learning motivation, interest, and satisfaction of Moderate and Limited Participation academic master's students. On the other hand, for Passive-Avoidant academic master's students, in addition to improving learning motivation, interest, and satisfaction, universities should also aim to enhance students' sense of learning significance, development expectations, and life satisfaction. Meanwhile, universities should integrate mental health education into daily teaching and student management, offering courses and lectures on mental health, helping students master psychological adjustment techniques, and strengthening psychological resilience. This will enable students to engage in learning and research with a better mental state, facilitating a positive transformation in their learning engagement types.

This study, from a big data perspective, explores the learning engagement types of academic master's students and their correlation with mental health. The research found that academic master's students' learning engagement types can be classified into five categories: "Comprehensive Engagement Type," "Emotion-Driven Type," "Moderate Engagement Type," "Passive-Avoidant Type," and "Limited Participation Type." The study also found a significant correlation between mental health status and the learning engagement types of academic master's students. The results contribute to enriching and improving the graduate education theoretical framework, providing a new classification framework and empirical basis for future scholars to explore the graduate student group from the perspective of learning engagement. This will help advance academic discussions and research in this area. From an educational practice perspective, the study provides precise guidance for the management of graduate education. Universities can develop differentiated cultivation strategies and educational interventions based on the characteristics of different types of students, achieving optimal allocation of educational resources and improving the quality of graduate education. However, there is still room for further expansion and deepening of this research. The intervention strategies proposed for students with different types of learning engagement, especially for the Passive-Avoidant type, need to be further refined with the support of big data. By analyzing students' behavioral patterns, interests, and changes in mental states, universities can develop personalized intervention plans, such as "one person, one plan." Furthermore, by using big data to continuously monitor the effectiveness of interventions, a scientific evaluation system can be constructed, allowing timely adjustments to the intervention strategies. This will ensure that mental health education and strategies for improving learning engagement are effective, promoting the overall development of academic master's students and improving the quality of graduate education.

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