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FACTORS IN THE DEVELOPMENT OF ACTIVE LEARNING SKILLS OF SUCCESSFUL SOFTWARE STUDENTS*

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Abstract

Against the background of the deepening integration of digital economy and software technology, new requirements have been imposed on the professional ability and comprehensive quality of software talents. As an important channel for software talents, computer majors at universities should cultivate students with sustainable learning habits, as well as strong problem-solving and active learning abilities. The goal of this study is to improve the quality of software talent training at universities and identify the influencing factors of the formation of active learning abilities in talents. Undergraduate students majoring in software engineering from Jiangxi Agricultural University are examined. The specific procedure followed a three-step process: Firstly, basic data is obtained using a questionnaire survey; secondly, Statistical Package for the Social Sciences (SPSS) is used to perform factor analysis of the data and Analysis of moment structures (Amos) is used to perform structural equation modeling; thirdly, from the two dimensions of students' internal and external environmental factors, the structural equation model of the influencing factors of active learning ability is obtained, including the five factors of cognitive level, learning motivation, personality quality, learning strategy, and environmental factors. The results not only enrich the connotation of active learning theory, but also help to better understand the changing law of the learning motivation of software students at universities. This will aid the scientific formulation of strategies to improve students' active learning ability.

Keywords: *higher education, active learning, software talents, e-learning, competency model.*

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1. INTRODUCTION

The rapid development of modern information technology — represented by artificial intelligence, cloud computing, big data, block chain, and the Internet of Things — has ushered in a new era of highly informationized science and technology. This development is a powerful driving force for industrial upgrading and the transformation of various countries. The software industry plays a pivotal role in the field of information technology, serving as a safeguard for network security, a catalyst for economic transformation, and a fundamental pillar of the digital society. As software technology becomes increasingly integrated across diverse industries and the digital economy continues to advance steadily, there emerges a demand for software professionals with enhanced knowledge, skills, and qualities. Consequently, university programs specializing in software engineering serve as a crucial conduit for nurturing and supplying the requisite software talent. The training of exceptional software talents has emerged as a crucial responsibility for universities in the contemporary era. In 2020, the Ministry of Education and the Ministry of Industry and Information Technology of Chinaissued Document No. 11, entitled "Guidelines for the Construction of Characteristic Demonstration Software Colleges (Trial)". This document emphasizes that it is necessary for higher education to align with industry needs. To achieve this alignment, the construction of the curriculum system needs to be actively examined, training models innovated, teaching content updated, and teaching methods reformed. These measures can ensure that high-quality software talents are cultivated who can advance the development of the industry. These talents not only need to have strong innovative thinking and solid engineering abilities, but they also need to possess the necessary learning ability to adapt to socio-economic developments. Anthony [1] examined two prevailing interpretations of "active learning": one pertains to a pedagogical approach wherein students are granted substantial autonomy and control over the trajectory of their learning activities, while the other refers to the cognitive engagement in active intellectual inquiry. Given the contemporary landscape characterized by technological advancements, individuals graduating from the software engineering discipline ought to cultivate a perpetual capacity for active learning, thereby enabling them to consistently enhance their professional competencies. Empirical evidence has demonstrated that the implementation of active learning strategies yields graduates who possess a competitive edge and are equipped to tackle the primary challenges prevalent in society [2]. Therefore, in addition to equipping students with knowledge related to software technology, teachers should also cultivate students' active learning ability so that they can transform the knowledge they have acquired into the needs of the industry. To achieve this goal, it is very important to improve the level of students' active learning ability. Such improvement provides the basis for the formation and development of self-education, fully meets the implementation requirements of software talent training in today's new era of science and technology, and considers the needs of universities to comprehensively improve the quality of talent training. How universities can train software talents to learn actively has also become a hot issue in the field of education.

In recent years, the proliferation of digital technology in the realm of education has led to an expansion in the variety of electronic learning (e-learning) resources. Consequently, the conventional "teacher-centered" classroom learning approach has been transcended, as digital technology is now employed to facilitate the dissemination of educational resources, the amalgamation of online and offline instruction, and the fusion of knowledge transmission and active learning [3]. Especially in practice-oriented engineering majors, the focus on teaching theoretical knowledge has limited the requirements for the cultivation of software talents, and more attention needs to be directed to the cultivation of students' active learning ability. Because e-learning is not limited by teaching time and space, it provides a good means for students to learn online [4].

Learning platform resources such as Coursera, EduX, and iCourse are used widely. However, it should be noted that in the face of a variety of online learning resources, students must have the ability to choose suitable learning resources according to their limited learning time. Higher requirements are imposed on students' active choice, active judgment, and self-assessment of learning resources, that is, higher requirements are imposed on students' active learning ability. In higher education, active ability has rich connotations, including self-learning awareness, self-learning goals, self-learning habits, self-monitoring, self-management, and critical thinking abilities. Related researcheshave shown that the combination of flexible and diverse teaching modes is not ideal. The primary cause for concern lies in the prevalent deficiency in students' active learning ability, which diverges from the anticipated standards set by educators [5]. Consequently, it becomes imperative to enhance students' active learning ability and investigate the factors influencing the development of such ability among exceptional software talents in higher education institutions. Nevertheless, the existing body of research on these factors remains relatively limited. Hence, the subject matter addressed in this paper holds significant research value.

This study aims to investigate the potential methods for enhancing the active learning ability of exceptional software talents by examining the formation mechanism of their training ability during their university education. The study employs various methodologies including questionnaire surveys, model building, and empirical analysis. This study undertakes a systematic examination of the development and enhancement of software talent cultivation ability, drawing insights from educational psychology and educational motivation theory [6, 7]. Additionally, this paper investigates the various factors influencing the acquisition of active learning ability among software talents in university settings. The goal is to form a strategy and suggestions for the whole process of improving and cultivating the active learning ability of software professionals at universities. This study provides the following three contributions:

1. A structural equation model of the influencing factors of the formation of active learning ability of software talents at universities is constructed.
2. The formation factors that affect the active learning ability of software talents at universities and the relationship between them are explored.
3. The data model is subjected to empirical analysis, and recommendations are offered regarding strategies to enhance the active learning capacity of exceptional software talents in academic institutions.

2. RELATED WORKS

The proposal of competency education poses a serious challenge to the traditional education model that focuses on imparting knowledge and cultivating intelligence. Competency education advocates that students should actively shoulder the responsibility of learning and ability cultivation, and carry out autonomous and exploratory learning; they should also cultivate the comprehensive ability to adapt to social production and life, and solve practical problems [8]. Active learning, a significant form of education aimed at enhancing abilities, has been present since classical times [9]. It encompasses the capacity to structure the process of acquiring knowledge, encompassing the establishment of educational objectives, the formulation of learning materials and strategies, the adoption of independent learning methods and techniques, the utilization of knowledge, and the assessment of self-education [10]. The concept of active learning garnered attention as early as the 1960s and 1970s [11]. With the globalization of competency education, opinions on the importance and relevance of the formation and development of the theory of active learning competence have gradually emerged. Robertson [12] proposed that the learning process employed in the active learning method should be managed by the learners

themselves to achieve a student-centered teaching method as well as specific goals. In other words, the implementation of active learning methods provides learners with more power and prompts them to become more responsible for the completion of learning tasks [13]. The use of autonomous learning enables learners to actively explore the topics and content of learning, as well as actively learn according to the needs of their personal development. Grandinetti [14] suggested that active learning can provide the foundation for lifelong learning, and showed that it is necessary to continuously improve the active learning ability. Stewart [15] conducted research on independent learning and project-based outcome output; the results showed that learners have strong learning motivation to work hard to complete the plan and gain work experience. Karimi [16] showed that learners who actively use modern information technology are most likely to learn actively. The Internet provides an interactive and engaging learning environment for independent scholars who can help students quickly improve their professional level and learning skills [17, 18]. MOOC, represented by the online teaching platform, forms an important basis for the implementation of active learning methods; it can help learners learn without being restricted by the teaching space and enables them to quantitatively evaluate their personal learning trajectory [19, 20]. In addition, by using mobile terminals to access learning content, students can actively choose the most suitable learning environment, thereby reducing the cognitive load caused by personality differences in traditional classroom settings. Consequently, the learning effect is improved.

China has been an early adopter in the exploration of active learning. In the 1980s, Lin [21] conducted empirical research to demonstrate the efficacy of independent learning and self-education in achieving favorable learning outcomes. In a comparativeresearch utilizing questionnaire surveys, Zhang and Li [22] examined Chinese students studying English in the UK and their Western European counterparts. The findings revealed that both Chinese and Western students exhibit robust learning motivation by employing active learning strategies. Nevertheless, Chinese students display limited integrative learning abilities and a lack of initiative in the selection of learning materials. Shang and Liu [23] mentioned the urgent need for teaching reform in the Internet era and provided students with a new learning experience; it can better support students' self-motivated learning through online course teaching, thus improving the teaching effect of higher education. In terms of software talent training, Lin [24] tried to apply a flipped classroom teaching method with an intelligent learning diagnosis system to support software engineering education; the experimental results showed that this method significantly mobilized students' autonomy and improved their active learning ability. To adapt to the demand for talents in the era of the knowledge economy, He and Liu [25] pointed out that cultivating students' active learning ability is the key content of education research, and expounded on the teaching reform and practice of active learning in computer courses at universities; the implementation results showed that teaching based on active learning can promote thestrengthen of students' personal knowledge structure and ability structure. Jian et al. [26] constructed a curriculum system to train computational thinking in computer courses at universities, and their practice results showed that students' active learning ability could indeed be enhanced. An active learning ability forms the basis for personal lifelong development. Liet al. [27] developed a goal-oriented active learning system to support students' active learning ability and promote motivation in extensive reading, which provided inspiration for researchers and educators.

Based on extant scholarly literature, it is evident that scholars from non-Chinese backgrounds predominantly concentrate on the establishment and progression of active learning competence, self-regulation, self-management, and lifelong education support. Conversely, Chinese scholars primarily emphasize the utilization of diverse pedagogical approaches to

augment students' active learning capacity, with active learning being merely an ancillary facet of their research. Strategies aimed at enhancing students' active learning ability are relatively broad, rendering the direct dissemination and implementation of the acquired methodologies challenging. Hence, it is imperative to undertake comprehensive research on the structure, content, implementation, and developmental mechanisms of the active learning capacity of software professionals, aligned with the training requisites for exceptional talents and market demands. This study endeavor can facilitate the efficient execution of personalized education, organizational strategies, and talent assessment for software professionals, fostering their cognitive engagement and broadening their intellectual perspectives. Consequently, a strategy is put forth for nurturing the active learning aptitude of exceptional talents in the contemporary era of science and technology.

3. STUDY HYPOTHESES

Student active learning refers to students' awareness of their active learning, their sense of responsibility for learning, and their initiative when learning [28]. According to [29, 30], the most popular metacognitive strategy in active learning is to bundle cognitive and metacognitive abilities into a comprehensive whole. This approach increases the accessibility of the true self of knowledge in the unified universe and the research results show that metacognitive strategies can improve learners' academic performance, self-confidence, and self-awareness [31]. Among relevant theories of education and teaching, motivational theory is indeed, a more general educational psychology theory. In the field of psychology, motivation is defined as the power that guides a person to act, and learning motivation can be defined as the value, meaning, and benefits learning tasks hold for learners [32]. Motivation plays an important role in the learning process, andvaries among students of different majors. Studying the learning motivations of students with software engineering majorat universities can enable the mastery of the main factors needed to enhance the active learning ability of software talents. The orientation of learning motivation is non-linear. In the dynamic structure of software talent training at universities, the level of software ability will be affected by multiple complex factors such as students' cognition and practice level. Furthermore, the active learning system dynamics model can support the formation and improvement of students' active learning ability. Kaplanet al. [33] pointed out that an important goal of the scientific work in educational psychology is the translation of theoretical understanding into educational practice; they also proposed the knowledge claims, challenges, and future directions the application of contemporary motivation theory faces in educational practice. Based on the above work, the hypothesis is proposed that the factors affecting the formation of active learning ability of software talents at universities are generally composed of two dimensions: the individual's own internal factors and factors of the external environment. As shown in Figure 1, the individual's own internal factors include four aspects: cognitive level, learning motivation, personality quality, and learning strategy; external factors include teaching model, teaching environment, humanistic environment, and e-learning platform. Specifically, the following hypotheses are proposed:

Hypothesis 1 (H1): The cognitive level of software talents at universities positively affects their active learning ability.

Cognitive level refers to the behavioral potential or tendency that people are born with, emphasizing the aspect that they are born with such a potential or tendency. Cognitive psychology emphasizes the central process (just as a baby is born with the knowledge on how to cry), which is an innate behavioral potential or tendency. Here, it refers to a person with a joyous mood for learning [34]. Their cognitive level positively affects the active learning ability of college students.

Figure 1. Theoretical research model diagram that illustrates the influencing factors of active learning ability among exceptional software talents in university settings

Hypothesis 2 (H2): The learning motivation of software talents at universities positively affects their active learning ability.

The behavior of an individual always has a specific purpose and tries to achieve something in a certain way, where the more attractive the goal, the greater the achievement motivation. The more college students aspire to achieve ideal results in a course, the more positive their attitude towards active learning. Therefore, the learning motivation of college students positively affect their ability to learn actively.

Hypothesis 3 (H3): The personality quality of software talents at universities positively affects their active learning ability.

An important connection exists between personality and self-regulation, where personality tendency is the source of students' self-regulation learning strategies [35]. Self-learning behavior is a behavior type that is bound by certain objective conditions, where the stronger students perceive their ability and conditions to conduct self-directed learning to be and the fewer obstacles they have, the stronger their intention to conduct active learning. Therefore, the personality qualities of college students positively affect their ability to learn actively.

Hypothesis 4 (H4): The learning strategy of software talents at universities positively affects their active learning ability.

According to the theory of planned behavior, people's attitude, subjective norms, and behavioral control towards learning all affect their willingness to learn actively. The successful learning experience and methods students used in the past positively impact the formation of their active learning ability.

Hypothesis 5 (H5): The teaching mode of higher education positively impacts the formation of students' active learning ability.

The students themselves form the main body of active learning. When learning under the traditional teaching model, students become accustomed to passively and mechanically accept knowledge. This is not conducive to the cultivation of students' active thinking ability and seriously hinders their all-round development. The innovative teaching model positively impacts the formation of students' active learning ability.

Hypothesis 6 (H6): The teaching environment of universities positively impacts the formation of students' active learning ability.

The teaching environment refers to the students' needs for time, learning venue, network conditions, learning materials, and other aspects of a mixed learning environment. When exter-

nal resources are met, students are more likely to engage in active learning behaviors. Therefore, the teaching environment of students positively impacts the formation of active learning ability.

Hypothesis 7 (H7): The humanistic environment of universities positively impacts the formation of students' active learning ability.

In this context, a humanistic environment refers to the role teachers at universities play in the process of independent learning by students. When teachers can effectively guide students to choose appropriate learning goals and establish exploratory learning tasks, active learning is more easily stimulated in students. Therefore, the humanistic environment in which students live positively impacts the formation of their active learning ability.

Hypothesis 8 (H8): The learning platform of universities positively impacts the formation of students' active learning ability.

The learning platform is divided into the two categories of online and offline, and it is an important carrier for students to learn actively. Universities should provide sufficient and diversified learning resources, as the more channels students have available for active learning, the more their willingness to learn actively will increase. Therefore, the learning platform of universities positively impacts the formation of active learning ability.

4. SCALE DESIGN AND INSPECTION

4.1. Definition of scale operation

This study focuses on a sample of software engineering students from Jiangxi Agricultural University in China. Initially, a questionnaire survey is conducted to gather basic data. Subsequently, factor analysis is performed using the Statistical Package for the Social Sciences (SPSS), while structural equation modeling (SEM) is carried out using the Analysis of Moment Structures (Amos) software. The specific versions utilized are SPSS 26 and Amos 23. Ultimately, the study aims to investigate the factors that contribute to the development of active learning abilities among exceptional software talents in university settings. Table 1 presents the scale that was designed for this study. It contains five background items and 23 scale items. The dimensions of these 23 independent variable items are reduced to five subscales of cognitive level, learning motivation, personality quality, learning strategies, and environmental factors.Here, the four external factors (i.e., the teaching model, the teaching environment, the humanistic environment, and the e-learning platform) were collectively analyzed as the concept of "environmental factors".

According to the theoretical research model diagram of the factors that influence the active learning ability of software talents at universities (see Fig. 1), this paper examines the influencing mechanism of the active learning ability of software talents from the two dimensions of their own internal factors and factors of their external environment. The composition structure of the questionnaire compiled in this study is divided into three parts: the opening sentence, the main part, and the background part. The background part collects five items such as gender, grade, major, the level of College English Test Band4 and Band6 in China. This part describes the attributes and characteristics of respondents, by assessing the basic information of the respondents through descriptive statistical analysis the results of which facilitate the subsequent analysis and comparison of different groups. The main part consists of subscale questions. This is a measurement scale designed from the five constructs that affect the formation factors of the active learning ability of software talents at universities based on the existing scale and professional theory. The literature was consulted and expert consultation and interview design were

Table 1. Variable and survey question descriptions

Variables	Item	Question number and content
Cognitive Level (CL)	CL1	Q6: The extent to which I understand the requirements for training software personnel in the new technological era.
	CL2	Q21: At present, I have a certain basic professional knowledge.
	CL3	Q28: Please self-evaluate your active learning ability.
Learning Motivation (LM)	LM1	Q7: What is your level of interest in this major.
	LM2	Q8: I will take the initiative to learn professional-related knowledge.
	LM3	Q9: I work hard to acquire this professional knowledge to find a good job.
	LM4	Q10: I believe I can understand what I am learning if I put enough effort into it.
Personality Quality (PQ)	PQ1	Q11: Facing the study of this major, I feel afraid and experience difficulties.
	PQ2	Q12: When encountering difficulties, I will take the initiative to seek solutions myself.
	PQ3	Q13: I will consciously arrange time to take the initiative to study.
	PQ4	Q14: I am more satisfied with my self-control.
Learning Strategy (LS)	LS1	Q15: Before I commit to a course, I like to make a study plan in advance.
	LS2	Q16: I think it is important to find a suitable learning method to improve the active learning ability.
	LS3	Q17: I pay attention to the ideal combination of work and rest to achieve the best learning results.
	LS4	Q18: In the learning process, I will often evaluate myself and summarize my experience.
	LS5	Q19: I am used to using learning software to record my learning situation to achieve self-management and self-regulation of the learning process.
Environmental Factors (EF)	EF1	Q20: For the study of this major, I think the e-learning resources provided by Coursera, EduX, iCourse, and other platforms provide good content for the improvement of my active learning ability.
	EF2	Q22: My university pays attention to the ideological leadership of students, and often invites advanced role models into the classroom.
	EF3	Q23: There are various forms of software science and technology innovation activities at my university.
	EF4	Q24: The university has a variety of lecture formats, focusing on the combination of theory and practice.
	EF5	Q25: The teaching model of teachers is novel, and teachers pay attention to the cultivation of students' abilities and qualities.
	EF6	Q26: Please describe the construction situation of the learning and practice places provided by your university.
	EF7	Q27: What is the atmosphere of active learning in your university?

combined. The questionnaire is scored by the Likert five-level semantic difference method; it sets five judgment criteria for each question, where “1” means “very inconsistent”, “2” means “inconsistent”, “3” means “relatively inconsistent”, “4” means “general”, and “5” means “very consistent” [36]. Respondents conduct self-assessments according to their actual situation, and the score statistics are used to better collect relevant data.

4.2. Pre-investigation and formal investigation

The questionnaire is distributed online via links published on WeChat, and the respondents are students of Jiangxi Agricultural University, China. To ensure the feasibility of the survey, this study conducted a pre-survey on a small sample before conducting the formal investigation on all samples. A sample of 80 students from various grades and classes at the School of Software of Jiangxi Agricultural University was selected for preliminary analysis. Upon examination of the data, two instances of invalid data were identified and subsequently removed. The collected data underwent pre-analysis, revealing that the questionnaire’s reliability and validity fell within an acceptable range. As a result, a widespread distribution of questionnaires was initiated for data collection, with a total of 682 questionnaires being successfully retrieved with the assistance of teachers and classmates. Two questionnaires are considered invalid due to issues such as respondents exceeding the survey scope and inadequate response time. Consequently, these questionnaires are excluded, resulting in a total of 680 valid questionnaires. The overall effectiveness rate of the questionnaires is 99 %. Following the data cleaning process, the collected valid data undergo preliminary processing and relevant examination using SPSS software. Then, data are imported into Amos software, and the models of each scale are established, analyzed, and verified, which was followed by a test of the model fit. The structural equation model is then optimized based on various indicators, and the model is corrected and adjusted. Finally, based on the results of path analysis, the proposed hypotheses are tested, and the corresponding conclusions and suggestions are drawn after completing the verification.

4.3. Reliability and validity test analysis of the scale

In statistics, hypothesis testing must meet the two quality standards of reliability and validity, which means that it must pass the reliability and validity test analysis [39]. Reliability and validity measure the quality of the designed questionnaire. Specifically, this measures whether the questionnaire title is reasonably set, the quality of the sample data, whether respondents are serious when providing data, and whether the final data obtained can be used for the next step of structural equation model analysis. The sample data are first analyzed to test if their pass the reliability test. The test of reliability and validity is actually a threshold test of previous questionnaire design and questionnaire data. Only after relevant tests are passed, the next analysis can be carried out. Without this prerequisite, the final results of the analysis are of little significance.

4.3.1. Reliability test

Reliability mainly refers to the reliability, consistency, and stability of the measurement results. The internal consistency coefficient i.e., Cronbach’s coefficient (Cronbach’s α), is used to measure reliability, which ranges between 0 and 1. The larger the coefficient, the higher the reliability. It is generally assumed that a coefficient below 0.6 indicates that the internal consistency of the scale is insufficient. When the coefficient reaches 0.7 or higher, the questionnaire has good reliability. In this study, the software SPSS was used to test the reliability of 23 scale items of the

questionnaire. Among them, non-scale items, i.e., the background information, are not analyzed. The results obtained are shown in Table 2.

Table 2. Overall scale reliability testing

Cronbach's α	Number of items
0.944	23

Table 2 shows that Cronbach's α of the entire questionnaire is 0.944, which is much higher than 0.7, indicating that the overall reliability of the entire questionnaire is very good. Next, the reliability of each component table would be tested, and the analysis of the results is shown in Table 3.

Table 3. Reliability analysis of subscale scores

Dependent variable	Independent variable	Number of items	Cronbach's α
Influencing factors on the formation of active learning ability of software talents at universities	Cognitive level	3	0.743
	Learning motivation	4	0.810
	Personality quality	4	0.570
	Learning strategy	5	0.833
	Environmental factors	7	0.930

The content of Table 3 shows that Cronbach's α of each potential variable in this study exceeds 0.7, except for the dimension of "personality quality". Therefore, the dimension of "personality quality" has been separately tested, and the relevant data are shown in Table 4.

Table 4. Personality quality data before correction

Cronbach's α of personality quality subscale	Title item	Average value of the scale after deleting the item	Scale variance after deleting the item	Corrected item with statistical correlation	Cronbach's α deleting the item
0.570	PQ1	10.3412	5.262	–0.051	0.811
	PQ2	9.5471	3.842	0.470	0.413
	PQ3	9.7926	3.302	0.620	0.273
	PQ4	10.2368	3.268	0.548	0.321

According to the data in Table 4, the question "PQ1: I feel afraid and experience difficulty in the study of this major" had been deleted, and the results are shown in Table 5.

Table 5. Personality quality data after correction

Variable	Cronbach's α	Number of items
Personality quality	0.811	3

As shown in Table 5, after the deletion of question PQ1, Cronbach's α of this subscale increased from 0.570 to 0.811, and the overall reliability of the subscale increased significantly. At this time, all Cronbach's α values of each potential variable in the measurement results exceed

0.7. These data show that the design of each subscale has good reliability and high internal consistency, thus meeting the requirements and passing the reliability test.

4.3.2. Validity test

Validity refers to the degree to which the measurement tool can accurately measure the characteristics to be measured, i.e., the measured results reflect the validity of the content to be examined. The higher the consistency between the measurement results and the content, the higher the validity. Structural validity specifically refers to the degree of consistency between the results of the questionnaire survey and expectation according to the study hypothesis. Validity analysis is commonly divided into exploratory factor analysis and confirmatory factor analysis. The specific operation of this study is divided into two stages as outlined in the following.

The first stage: Using SPSS software to perform exploratory factor analysis. Exploratory factor analysis is essentially a kind of dimensionality reduction process, the purpose of which is to group all topics into different dimensions. Commonly used measurement indicators include Kaiser-Meyer-Olkin (KMO), Bartlett's test of sphericity, cumulative variance contribution rate, and load coefficient. The premise is that the KMO is greater than 0.6, the Bartlett's test of sphericity is significant (i.e., the P value is less than 0.05), and the cumulative variance contribution rate of the factor interpretation is greater than 60 %. The evaluation criteria indicate that the correspondence between the questionnaire items and the factor conforms to professional knowledge; further, the load coefficient of each question item on the factor is greater than 0.4, i.e., it meets the validity test. This stage is mainly composed of the following two steps.

The first step consists of KMO and Bartlett's test of sphericity. This step is used to assess whether the data is suitable for exploratory factor analysis. The results are shown in Table 6. The KMO value is $0.957 > 0.9$ and the significance level is $0.000 < 0.001$. The KMO and the Bartlett's test of sphericity meet the requirements, indicating that the questionnaire is suitable for validity analysis, and the next step of dimensional reduction analysis can be conducted.

Table 6. Kaiser-Meyer-Olkin and Bartlett's test of sphericity

Kaiser-Meyer-Olkin measure of sample adequacy [38]		**0.957**
Bartlett's test of sphericity	Approximate Chi-square	11032.036
	Df	231
	Sig.	0.000

The second step employs the cumulative variance contribution rate and load coefficient. Factors were extracted by principal component analysis, and the number of fixed factors was 5; the results showed that the cumulative variance contribution rate reached 72.859 %, indicating the original data can be reflected more fully and have good structural validity.

The second stage: Using Amos software to perform confirmatory factor analysis. Confirmatory factor analysis is divided into three validity tests: structural validity, convergence validity, and discriminant validity. Structural validity refers to the degree to which the measurement tool reflects the internal structure, i.e., it tests the fit of the model. Structural validity mainly depends on the overall fitness of the structural equation model. If the fitness does not meet the requirements and if structural validity is relatively low, the measurement model and the relationship between latent variables need to be corrected and adjusted. In addition to structural validity, convergence validity and discriminant validity can also be tested. Convergence validity

tests the correlation of questions within dimensions, while discriminant validity refers to the relevance of questions in different dimensions in the same questionnaire, i.e., items are correlated, but they should be differentiated. To focus on the structural validity of this questionnaire, this stage mainly introduces the use of confirmatory factor analysis to test the structural validity of the scale. Then, the fitting degree of each measurement model is examined according to the fitting coefficients, to obtain the optimal model. The more commonly used fitting indicators mainly include CMI, DF, RMSEA, GFI, CFI, AGFI, and NFI. The measurement standards for each fitting coefficient and test results are shown in Table 7.

Table 7. Overall model fit indices

	CMIN/DF	RMSEA	GFI	AGFI	CFI	TLI	NFI
Evaluation criteria	<5and>3	< 0.08	> 0.8	> 0.8	> 0.9	> 0.9	> 0.9
Test results	4.886	0.076	0.919	0.890	0.950	0.940	0.938

Among them, the ratio between chi square and degrees of freedom is acceptable between 3 and 5, and less than 3 is better. If the approximate error RMSEA is less than 0.08, the adaptation is acceptable; if it is less than 0.05, the adaptation is good. In the test results, CMIN/DF ratio is 4.886, RMSEA is 0.076, less than 0.08, which is acceptable. The AGFI value is 0.890, greater than 0.8, which indicates ideal fit. In addition to the above indicators, the values of GFI, TLI, NFI, and CFI all exceed 0.9, suggesting that the model demonstrates a satisfactory fit. Consequently, it can be inferred that the established model is both reasonable and acceptable, enabling the analysis of factors influencing the development of active learning ability among exceptional software talents in universities across five dimensions: cognitive level, learning motivation, personality quality, learning strategy, and environmental factors.

5. RESULTS AND DISCUSSION

5.1. Hypothesis testing and analysis of results

To optimize this model, all relevant paths were removed and a residual term was added to each external dependent variable by setting the residual term. According to the model correction recommendations of Amos, non-conforming questions were deleted, and correlations were drawn between the five latent variables of cognitive level, learning motivation, personality quality, learning strategy, and environmental factors. Finally, the correction and adjustment of the model was completed. A graph of model estimation results was obtained as shown in Figure 2. Table 8 shows the standardized regression path table of the hypothesis model.

Table 8. Standardized regression weights for hypothesized model

Regression path	Estimate	p
Cognitive Level <—— Environmental Factors	0.700	***
Personality Quality <—— Cognitive Level	0.922	***
Learning Motivation <—— Cognitive Level	0.854	***
Learning Strategy <—— Personality Quality	0.964	***

Note: *** represents significant p value, $p < 0.001$.

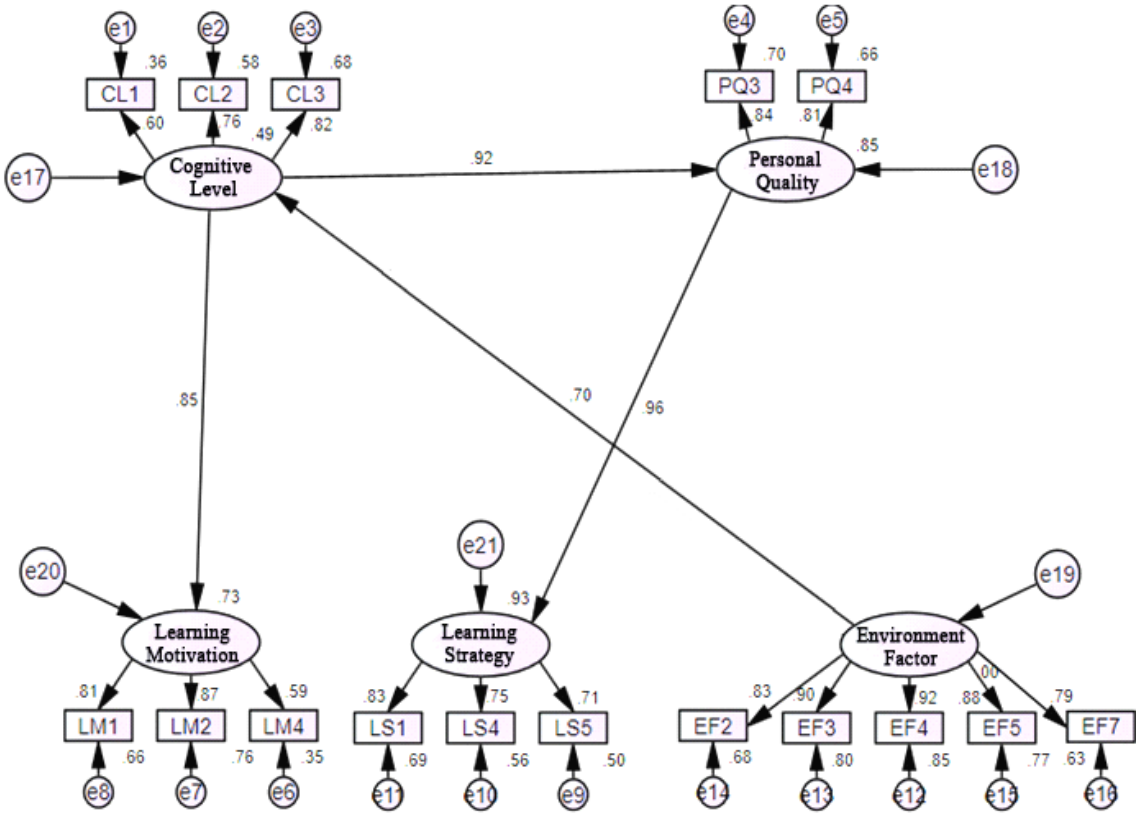

Figure 2. Standardized coefficient estimates for the model

As shown in Table 8, the path coefficient of environmental factors on cognitive level is 0.7, and $p < 0.001$; indicating that environmental factors significantly impact cognitive level. The influence path of cognitive level on personality quality is 0.922, $p < 0.001$, that is, cognitive level has significant influence on personality quality. The path coefficient of cognitive level on learning motivation is 0.854, $p < 0.001$, the influence path of personality quality on learning strategies is 0.964, and $p < 0.001$; cognitive level and personality quality significantly impact learning motivation and learning strategies. According to the empirical analysis of the structural equation model, it can be concluded that cognitive level, learning motivation, personal quality, learning strategy, and environmental factors impose different degrees of influence on software talents' active learning ability; the factor loading quantity after standardized coefficient is greater than 0.6, and most of them are greater than 0.7, which is ideal. Each path also has a significant positive influence. Therefore, from the above data analysis, the results of hypothesis testing could be derived and are shown in Table 9.

Cognitive level, learning motivation, personal quality, learning strategy, teaching mode, teaching environment, humanistic environment, and e-learning platform significantly positively impact the formation of active learning ability of university software talents. These are all important factors affecting the formation of active learning ability of software talents at universities, thus verifying the eight hypotheses proposed in this study. Through data analysis, it is found that the external environment can directly and significantly positively affect the development of the active learning ability of software talents in universities. This conclusion of this study confirms the research conclusion of Xu [37] that is, the factors that have a certain

Table 9. Hypothesis testing results

Content of study hypotheses	Test results
H1: The instinctive cognitive level of software talents at universities positively affects their active learning ability.	Supported
H2: The learning motivation of software talents at universities positively affects their active learning ability.	Supported
H3: The personality quality of software talents at universities positively affects their active learning ability.	Supported
H4: The learning strategy of software talents at universities positively affects their active learning ability.	Supported
H5: The teaching mode of higher education positively impacts the formation of students' active learning ability.	Supported
H6: The teaching environment of universities positively impacts the formation of students' active learning ability.	Supported
H7: The humanistic environment of universities positively impacts the formation of students' active learning ability.	Supported
H8: The learning platform of universities positively impacts the formation of students' active learning ability.	Supported

effect on the active learning ability not only come from the learners themselves, but also from the external environment where the learners live. Therefore, subsequent research on the path to improve the active learning ability of software talents at universities can start by exploring stronger influencing factors and make rational use of limited resources, for a continuous improvement.

5.2. Strategy suggestions

In the context of the era of the transformation and development of the digital economy, and with the continuous progress and upgrading of science and technology, the speed of knowledge renewal is gradually accelerated. The knowledge learned at school alone is gradually failing to meet the needs of individuals to adapt to the development of the times. Everyone, especially young students at contemporary colleges and universities, should develop a sense of lifelong learning. They should continue to study and strive to improve their comprehensive strength, so as to gain stronger competitiveness in the market to meet the challenges of social development and shoulder the mission of the times. The cultivation of active learning ability matches the actual needs of the sustainable development of college students, and it is a centrally important task of higher education. However, at present, the active learning ability of college students is generally weak. Therefore, as an important carrier affecting the formation of students' active learning ability, universities need to strengthen the guidance of teachers and change the traditional teaching mode. Moreover, universities also need to provide students with rich learning resources and a stable learning environment to create a good active learning atmosphere. A process-oriented active learning evaluation system should be employed in the teaching, to cultivate high-quality talents who meet the needs of social development. At the same time, college students themselves should develop a sense of active learning, actively use online resources, broaden active learning channels, and track active learning trajectories. Based on this, this study puts forward the following strategy suggestions for improving the active learning ability of software talents at universities.

1. Innovate the talent training model and form a student-centered teaching model. In the training of software talents at universities under the background of the transformation of modern digital economy, the unity and normative nature of their specifications and standards should not be overemphasized. Individual differences and personality characteristics of students should not be ignored, and the development of students' potential and the improvement of comprehensive quality should not be restricted. However, it is necessary to innovate the training model of software talents at universities, by adopting a student-centered teaching model. In this teaching model, students take the learning initiative as the protagonists in active learning, while the teachers' role is to assist students in mastering the strategies of active learning. Before the teaching process, teachers are encouraged to guide students to clarify their learning goals and establish learning tasks. Thus, the transformation of the role of teachers can be achieved to stimulate the possibility of active learning among students. In the teaching process, it is necessary to strengthen teamwork and interaction between teachers and students, as well as between students. Moreover, students' independent hands-on ability should be enhanced, their innovative thinking cultivated, and the traditional "cramming" teaching should be transformed into "participatory" teaching with students as the main body. After the teaching process, teachers can propose exploratory questions to encourage students to take the initiative to think, explore, and discover after class, which cultivates students' critical thinking and problem-solving abilities.

2. Provide a stable reserve force and form a process-oriented active learning evaluation system. The learning environment (including many aspects such as the natural environment, the humanistic environment, and the e-learning environment) greatly impacts the cultivation of students' active learning ability. Higher education disciplines, especially software engineering major, should focus on integrating information technology and teaching technology. Universities should provide students with firm power support based on objective conditions. Students should be provided with rich and diverse learning resources such as e-learning platforms, libraries, and tutors and they should have access to information sharing as well as free and stable learning spaces. This can create a good learning environment for cultivating students' active learning ability. The process-oriented teaching concept requires teachers not only to pay attention to students' academic performance, but also to comprehensively evaluate the whole process of students' learning. Colleges and universities should continuously improve their evaluation system. Unlike the traditional mode of evaluation in which teachers score students, a formative evaluation system for students' independent assessment should be constructed. This system should be based on continuous observation, and the recording and summary of multiple aspects of the student's entire learning process. This approach is conducive to prompting students to take the initiative in their learning, enabling them to conveniently and effectively monitor their own learning process. In response, they can adjust their learning attitude and choose suitable learning strategies in a timely manner according to real-time feedback obtained the learning process. Overall, students can better adapt to their evolving social environment, enhance their self-confidence in learning, and improve their self-efficacy. To a certain extent, such a strategy prompts students to change from the object of learning evaluation to the subject of active participation.

3. Clarify the self-learning motivation and develop a sense of active learning. From the perspective of the individual, in higher education, the formation of active learning ability is inseparable from the influence of students themselves. At the conscious level, learning motivation covers considerable content and can be divided into learning of intrinsic goals and extrinsic goals. Interest is the best teacher, and a strong curiosity is the inner motivation for promoting the start of a learning activity. In the contemporary era of abundant information, it is imperative for

students to augment the scope of knowledge acquired through their daily educational pursuits and personal experiences. It is incumbent upon them to proactively expand their intellectual horizons, particularly by immersing themselves in domains associated with the discipline of software engineering, while also demonstrating attentiveness towards pioneering and investigative accomplishments within the realms of computer science, technology, and other pertinent fields. Students ought to remain attuned to the exigencies of the present era, actively engage in the exploration and comprehension of subjects beyond conventional knowledge, foster their inquisitiveness, and unravel enigmatic phenomena. All this increases their interest in active learning, which is a good way to develop an active learning approach. With a strong inner goal, students in higher education should love learning, which will lead to the continuous establishment of learning confidence and a sense of accomplishment in learning. At this time, the sense of self-efficacy will be greatly increased, thereby promoting the improvement of active learning and establishing a virtuous circle. At the same time, consciously and purposefully establishing learning goals and clarifying external learning motivations are external motivators to improve students' active learning willingness. A relevant example is that studying hard avoids becoming redundant during the rapid renewal of society, and allows to find the ideal career.

4. Make full use of network resources and broaden active learning channels. The cultivation of active learning ability requires individual students to strengthen the dynamic interaction of self-management, self-regulation, and self-efficacy. It is important to note that students are not only able to manage such activities actively, but that they also have a certain ability to perceive and think. At the behavioral level, because of the important and direct impact learning strategies have on active learning, students are encouraged to use active learning software to record their own learning reality in a timely manner and monitor it in real time. They should establish their own dynamic learning images, to realize the trajectory of self-learning monitoring and self-evaluation. Consequently, students can constantly summarize and adjust their own learning strategies and methods in their learning. In addition to teachers using online resources in teaching thus enriching their teaching formats, students themselves can also use e-learning resources and multimedia technology to broaden the channels of active learning. They can learn a certain technology from other students in different schools or grades, and learn from successful learning experiences. Since e-learning platforms are not limited by time and space and offer a strong degree of autonomy, students can choose their own learning methods and formulate corresponding learning plans. Practice is the only standard for testing the truth; therefore, students are encouraged to reflect and summarize the process of practice to improve their ability to use learning strategies. For example, students should seize every opportunity to participate in hands-on software development training courses to improve their ability level. School-enterprise cooperation should be strengthened, industry-university integration should be promoted, and the active learning ability of software talents at universities should be continuously enhanced through more targeted and practical learning guidance.

6. CONCLUSIONS

The acquisition of active learning ability holds immense importance for the educational and professional growth of higher education students. Active learning facilitates the expansion of knowledge, enhancement of learning and research capabilities, as well as the cultivation of innovation and problem-solving skills. This study aims to investigate the factors influencing the development of active learning ability among exceptional software talents in university settings. The results imply that the cultivation of high-quality applied software talents for comprehen-

sive development of the industry needs to be achieved through the joint efforts of students and universities.

In the process of active learning, students need to have the ability of self-management, self-evaluation and self-regulation. These abilities are essential in learning and work. Through active learning, college students can improve their comprehensive quality and competitiveness, and lay a solid foundation for future professional development and personal growth. At the same time, active learning is also a long-term learning process, which requires students to continuously explore, practice and summarize, and continuously improve their learning and thinking abilities. In this process, students can participate in scientific research projects, competitions and other activities to further improve their ability and experience, and lay a good foundation for their future development.

In summary, active learning is of great significance to college students' study and future career development. In higher education, with the environment built by universities as the carrier, students can fully utilize their own strengths to establish the awareness and ability of active learning and continuous learning. They can develop a positive habit of lifelong learning, and lay a solid foundation for future career development and personal growth. However, there may be certain problems in the practical application of these theoretical suggestions, which need to be explored in future research.

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Факторы развития навыков активного обучения успешных студентов-программистов

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Аннотация

На фоне углубляющейся интеграции цифровой экономики и программного обеспечения к профессиональным навыкам и компетенциям талантливых программистов предъявляются новые требования. Университеты как важный инструмент подготовки успешных программистов должны воспитывать студентов с устойчивыми образовательными привычками, а также повышенной способностью к решению проблем и способностью к активному обучению. Цель этого исследования — повысить качество подготовки талантливых программистов в университетах и выявить факторы, влияющие на формирование навыков активного обучения у талантов. Исследуются студенты инженерно-программных специальностей Цзянсийского сельскохозяйственного университета. Конкретная процедура включала три этапа: во-первых, получение базовых данных с помощью анкетирования; во-вторых, факторный анализ данных с помощью статистического пакета для социальных наук (SPSS) и моделиро-

вание структурными уравнениями с помощью анализа моментных структур (Amos); в-третьих, получена структурная модель уравнения, отражающая факторы влияния на способность к активному обучению, включая пять факторов: когнитивный уровень, мотивация к обучению, личностные качества, стратегии обучения и факторы окружающей среды. Результаты не только обогащают содержание теории активного обучения, но и помогают лучше понять закономерности изменения мотивации к обучению студентов-программистов в университетах. Это поможет научно сформулировать стратегии по улучшению способностей студентов к активному обучению.

Ключевые слова: *высшее образование, активное обучение, талантливые программисты, электронное обучение, модель компетенций.*

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