Exploration on the Integration Strategy of lifelong learning and Specialized Innovation for electronic majors in Higher Vocational Colleges in the Digital Era

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Abstract. At present, the state vigorously promotes the development of vocational education teaching reform, and focuses on cultivating high-quality technical and skilled personnel. Electronic specialty in higher vocational colleges belongs to the important professional category in the field of information, and it is necessary to further explore and dig out effective methods to improve students 'lifelong learning ability and innovation ability. In terms of curriculum setting, we should consider how to combine professional course teaching with innovation and entrepreneurship education, build a teaching curriculum framework with the purpose of "practical and effective", focus on promoting the development of innovation and entrepreneurship education and teaching mode, and actively use teaching methods and strategies in teaching, such as modularization, project-based teaching and other diversified teaching methods. Fully mobilize and give full play to students' classroom learning motivation and enthusiasm for innovation and creative thinking, create a rich variety of practical training platforms and channels for innovation and entrepreneurship skills, and actively develop and realize practical operation and innovation and entrepreneurship opportunities inside and outside the school, aiming to cultivate compound talents with comprehensive lifelong learning, development ability and creative and innovative practice ability. To meet the needs of high-quality innovative and skilled talents in the field of electronic information.

Keywords: Digitization, Lifelong learning, Integration of specialization and innovation

1 Introduction

With the development of information technology, the digital education of electronic majors in higher vocational colleges should be changed based on the development of technology. The Internet of Things, artificial intelligence and other related fields of knowledge have been widely promoted and applied. Under the background of Internet

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+, the development cycle of electronic related knowledge is shortened, and the traditional single education mode causes a long cycle of knowledge update, resulting in the disconnection between knowledge and industry skill requirements. Intelligent personalized learning customization is an important technical support for the sustainable development of lifelong education. Based on intelligent platform, personalized learning customization can accurately match learners 'knowledge iteration needs and form a dynamic iterative learning closed loop.

On the demand side, due to the influence of digital technology, the demand structure of electronic information related majors will also change. The new teaching mode, which combines practical teaching with theoretical teaching and cultivates students 'comprehensive ability, is the key task of the talents training of electronic majors. However, in the process of digital technology and digitization, there are also some new problems, such as the expansion of the digital divide and the problem of technology dependence, which requires teachers to be able to skillfully use digital products, but also need to fully integrate information technology and instructional design, and have the ability of integration and innovation[1].

If the traditional electronic professional teaching is "using others to build the teaching building for us", and in the face of the impact of the Internet is to build their own "learning to improve" building. However, the bricks and tiles used have not yet been digitized, the building still faces the defects of "insufficient apprenticeship", the "foundation" construction is still the learners' information literacy level is different, and the "structure" still has the problems of weak informationization teaching ability of full-time teachers and backward office information facilities, and the construction of informationization learning needs to be further explored and practiced.

The realization of the concept of continuing education needs to establish a complete learning system composed of resources, ability and achievement recognition. According to practice, the design of continuous education applied to the curriculum to realize continuous learning is conducive to the self-management of learning, so as to promote the deep integration of education chain and industry chain, and is an effective channel for young technical talents to improve themselves.

2 The Implementation Path of lifelong Learning in Higher Vocational electronics Specialty

In the education of electronic majors in higher vocational colleges, the implementation of the concept of lifelong learning requires collaborative optimization from three dimensions: the curriculum system, the teaching team, and students' self-study ability.

2.1 Dynamic Optimization of the Curriculum System

The traditional "static curriculum" can not keep up with the technical upgrading and changes in the industry, and "dynamic adjustment" is imperative. A dynamic adjustment mechanism based on industry application requirements is constructed, so that the course content is synchronized with the application changes of industry technology. Modularization can solve this problem. It decomposes the knowledge module into several independent and complete sub-modules, and integrates each module into the professional curriculum system organically to ensure the openness and flexibility of the curriculum system. The basic knowledge units are interconnected, and the improvement of ability is mainly reflected in the combination of each link. In this process, a module can be enriched or the content of a module can be changed, which avoids the dogma and formulation of content and effectively realizes the dynamic adjustment of curriculum. "Dynamic curriculum" achieves dynamic, systematic and effective quality control and assurance of curriculum through the closed-loop management process from industry demand analysis to curriculum optimization as shown in Figure 1.

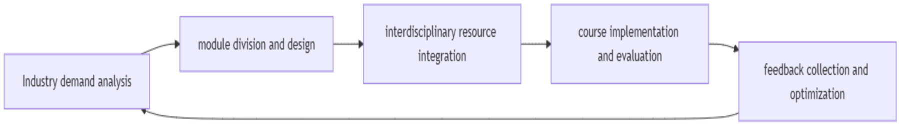

Fig. 1. The closed-loop management process from industry demand analysis to course optimization

In terms of class hour allocation, Figure 2 presents the time allocation plan for the teaching content of each module in the pilot class and the target requirements for each stage. This not only enables students to gradually master various skills by following scientific steps, but also reserves sufficient time for teachers to do a good job in the preparatory work and conduct effective control. Meanwhile, the implementation of many related teaching examples has also verified the powerful role of modular teaching in improving teaching quality and teaching efficiency[2].

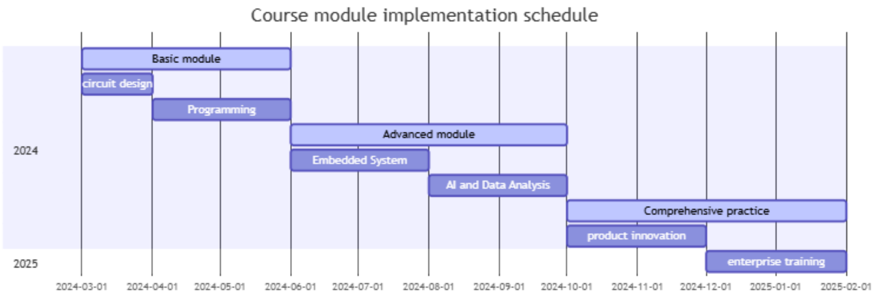

Fig. 2. The implementation schedule of the course modules

2.2 The Continuous Cultivation of the Teaching Staff

In the era of rapid development of electronic information technology, teachers need to constantly improve their own ability and quality, and strive to meet the relevant industry norms and adopt teaching methods that combine professionalism with innovation and entrepreneurship. Only by organizing a clear system framework and coordinating the relationship between schools and enterprises can teachers' working abilities be refined under the complementary technical guidance and theoretical support of enterprises and schools, as shown in Figure 3.

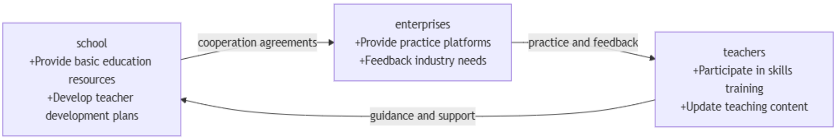

Fig. 3. The framework of teacher training based on school-enterprise collaboration

In the integration and cultivation of schools and enterprises, the comprehensive scores of teachers have indeed risen significantly. From this perspective, the integration and cultivation of schools and enterprises have indeed played a remarkable role. As for the improvement of teachers' capabilities, a measurement model can be established to assess the dynamic changes in teachers' ability levels within a certain time limit. This model is evaluated through three dimensions: theoretical knowledge learning situation (T), proficiency in technical operation (P), and creative teaching (I). The formula is: $S = 0.42T + 0.27P + 0.31I$. As shown in Figure 4, during the nearly one-year teaching cycle, the comprehensive score of the teachers has developed from 82 points previously to 96 points. Especially after the intervention of enterprise mentors, there have been significant improvements in the teachers' operational proficiency and creative teaching.

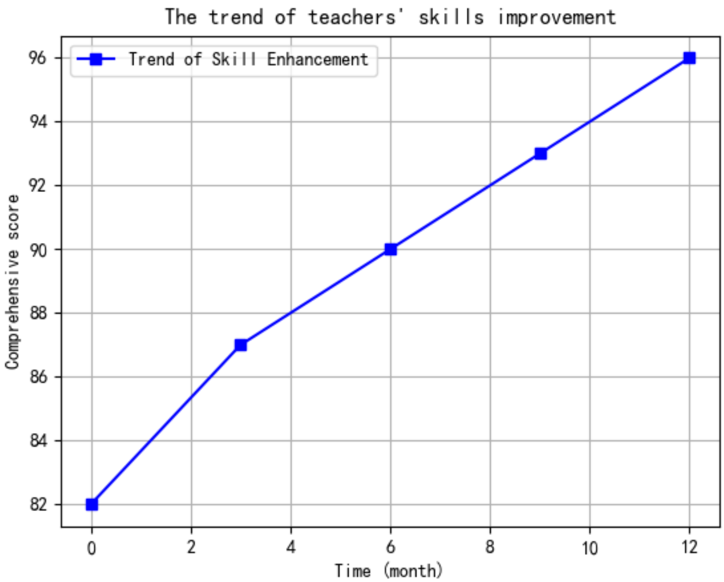

Fig. 4. The data on the skill improvement of professional teachers

Sustainability is the main reliance for cultivating "lifelong learning" in electronic majors in higher vocational colleges, and it is also a powerful guarantee for achieving the goal of "integration of specialized education and innovation". Through the training model and quantitative assessment, teachers can take all aspects into account, provide high-quality services to students, and offer practical learning content.

2.3 Cultivation of Students' Autonomous Learning Ability

with abundant learning resources and various learning methods, and truly cultivates students' autonomous learning ability through reasonable curriculum design.

After using the online learning platform, the learning forms of the students in the pilot class have changed. The data analysis of learning through the platform found that the distribution of learning resources has affected the efficiency of students' autonomous learning. In the distribution map of learning resources shown in Figure 5, the correlation between video and document materials is the highest, indicating that the largest number of students study video and document materials. Generally, students study by associating video and document materials together to enhance their understanding and memory of the knowledge they have learned. The high correlation between the test section and the forum indicates that students want to deepen their consolidation and improvement of the knowledge they have learned through specific exercises. Such a distribution means for students a learning environment with rich levels of environmental dimensions[3].

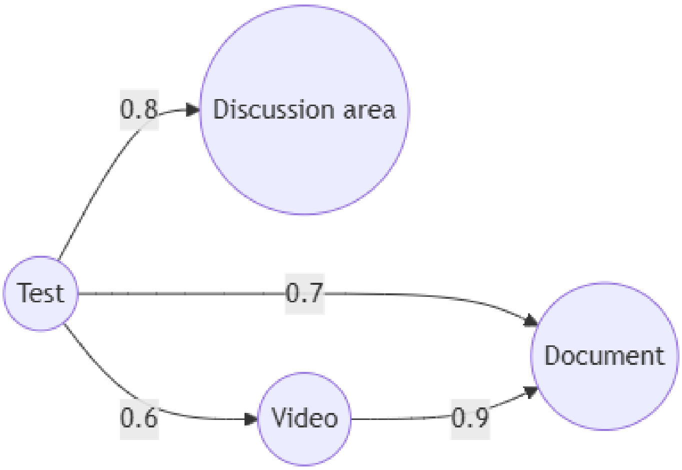

Fig. 5. Distribution Map of learning Resources

3 Theoretical Basis and Practical Value of Integration of Specialization and Innovation

The integration of professional education and entrepreneurship education refers to an educational concept that combines professional education with entrepreneurship education and innovates teaching on the basis of this integration. The educational model of integrating professional education and innovation in higher vocational education reflects that a major requires systematic, complete and solid accumulation of professional knowledge, as well as the utilization of innovative concepts to enhance the application ability and practical operation ability of knowledge. The convergence point where professional education and innovation promote each other is the integration of professional education and innovation. This is not only a concrete manifestation of the application of innovative concepts in a major, It is also a manifestation of professional concepts in the specific application and innovation[4], as shown in Figure 6.

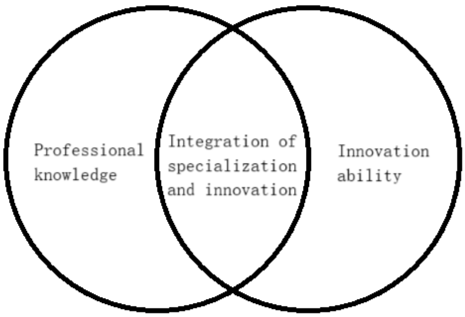

Fig. 6. The relationship between Professional Knowledge, Innovation Ability and the Integration of specialization and innovation fields

From the perspectives of knowledge dimension, ability dimension and value dimension, "integration of specialized knowledge and innovation" encompasses the integration of professional knowledge, the integration of technical application ability and innovative problem-solving ability, as well as the integration of lifelong learning awareness and social responsibility awareness. These dimensions form an organic whole, interrelated and interacting with each other, as shown in Figure 7. The research results of the pilot class also indicate that through the integrated professional knowledge course teaching, students have a clearer understanding of professional knowledge and a deeper mastery of it during the process of professional knowledge learning, thus achieving good course learning effects.

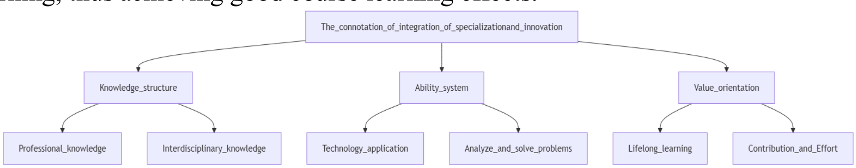

Fig. 7. The composition of the connotation of the integration of specialized and innovative industries

From the perspective of individual student growth, the integration of specialized education and innovation can help students transform their cognitive model from "passive indoctrination" to "active creation". The integration of disciplines provides conditions for this transformation. From the perspective of the cross-integration of electronic-related majors with emerging technologies such as artificial intelligence and the Internet of Things, it can help students open up broader personal development channels[5].

4 Strategy Design for the Integration of Specialized Education and Innovation in Electronic Specialties of Higher Vocational Colleges

In today's digital age, to promote the integration of professional education and innovation in electronic majors in higher vocational colleges, it is indispensable to establish an innovation practice platform and apply project-driven teaching methods, etc.

4.1 Construction of an Innovative Practice Platform

The practice platform is an indispensable and important platform for implementing the integration of professional training and innovation in electronic majors in higher vocational colleges. Schools and enterprises jointly establish laboratories and maker Spaces to create a practical hands-on platform for students that is close to real working scenarios, which is conducive to promoting the integration of disciplinary professional knowledge and innovative technical skills. The construction of the practice platform should pay attention to modularization, ease of expansion and openness in terms of technical architecture. Generally, it has three modules: data acquisition, data processing and data feedback. This technical architecture approach is conducive to the high-speed operation of signal transmission and facilitates the dynamic adjustment and optimization of resource allocation.

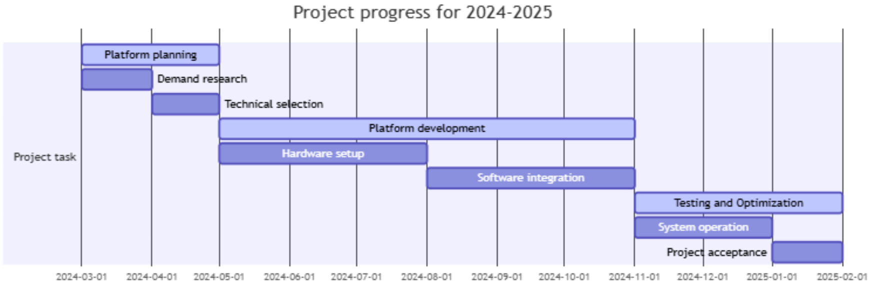

Fig. 8. Time Planning for Platform Construction

Based on the innovation practice platform, create a platform construction schedule, divide the task division and completion time for each stage of the platform construction, make reasonable time arrangements and requirements for the platform, and ensure that the project is completed within the predetermined time, as shown in Figure 8. The school-enterprise cooperation and co-construction model is an important support for the sustainability and extensibility of platform construction. The local enterprises of the pilot schools have become high-quality cooperation partners for platform construction. The enterprises provide equipment and professional support and guidance, while the schools are responsible for content construction, student management and guidance. The interaction between schools and enterprises makes the platform more professional and enhances students' professional practical abilities[6].

4.2 Project-driven Teaching Mode

Project-based teaching method takes projects as the main line, focuses on the cultivation of practical hands-on ability and innovative thinking ability, integrates theoretical knowledge points into the process of analyzing and solving actual problems, and enables them to complete the transformation from "passive acceptance" to "active learning". Design a flowchart of the implementation steps of the project links well to make the project process clear at a glance, reduce the cognitive difficulty for students of complex projects, and at the same time provide evaluation results to ensure the relearning of feedback and optimization links, as shown in Figure 9.

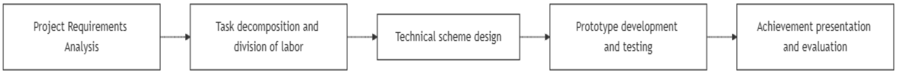

Fig. 9. Flowchart of Project implementation Steps

The pilot class completed the project based on the development of the smart home system. Through the development project, students mastered the basic principles of embedded system design, and improved their team communication skills and innovative consciousness through group collaboration. Meanwhile, the precise matching of the difficulty coefficient of teaching projects by teachers and the enhanced ability of students is also an important prerequisite for the successful realization of project-based teaching. Teachers set up task modules in the smart home project according to the students' technical levels, enabling each student to achieve growth in their abilities. Third-party professional experts are invited to review and evaluate the students' achievements, recognize their efforts, and stimulate their enthusiasm for learning and creative thinking[7].

5 Application of Digital Tools in Lifelong Learning and Integration of Specialized Innovation

In the digital age, for higher vocational electronic majors to carry out lifelong learning and the integration of professional education and innovation, the core lies in the integration of online learning platforms. The key is to rely on the application of big data, learning analysis technology and VR/AR simulation practice.

5.1 Integration of Online Learning Platforms

Moocs and virtual simulation experiment tools, as core digital learning resources, diversify the platforms for students' lifelong learning. Through MOOC platforms, flexible and diverse learning paths are provided to enhance students' knowledge levels. Emphasis should be placed on the resource correlation among platforms and the optimized design of user interactive scenarios, as shown in Figure 10. This helps students promote the connection between theoretical knowledge and practical operation paths by integrating systematic platform resources, thereby achieving good learning outcomes.

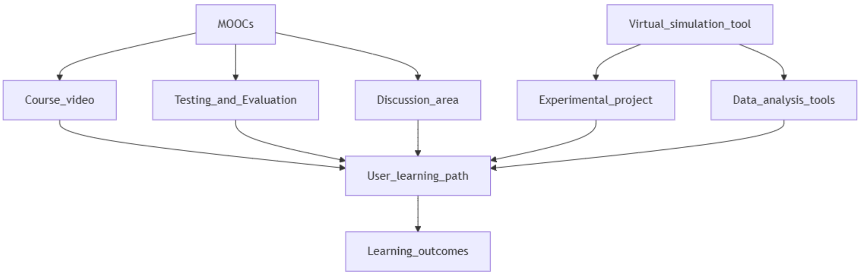

Fig. 10. The integration diagram of online learning platform resources

5.2 Big Data and Learning Analytics Technology

The academic performance data of the students in the pilot class is shown in Table 1. By integrating learning analysis techniques and big data mining, the data is processed and handled, collected, and preprocessed.

Table 1. Academic Performance Data of 35 Students in the Pilot Class (Unit: points, full Score 100)

Student number	basic module score	advanced module score	comprehensive practical score		Student number	basic module score	advanced module score	comprehensive practical score
1	85	80	88		19	93	90	83
2	78	75	76		20	69	78	73
3	90	88	92		21	79	79	71
4	65	60	63		22	86	83	89
5	72	70	75		23	79	76	81
6	88	85	90		24	91	89	93
7	92	90	95		25	73	70	77
8	70	68	72		26	60	63	61
9	68	65	70		27	84	81	87
10	82	78	85		28	76	73	79
11	75	72	78		29	89	86	91
12	80	78	82		30	89	84	68

13	95	92	98		31	66	61	68
14	89	89	68		32	81	78	84
15	61	63	69		33	70	67	72
16	83	80	86		34	94	91	96
17	74	70	76		35	77	74	80
18	87	84	89					

Feature selection and standardization of performance data:

The basic module scores, advanced module scores and comprehensive practice scores were selected as features, and these features were standardized, and the Z-score standardization method was used: standardized data =(original data - feature mean)/standard deviation of the feature set. The mean and standard deviation of each feature are calculated as shown in Table 2.

Table 2. Mean and Standard deviation of each feature

Characteristics	Mean	Standard deviation
basic module score	79.71	9.63
advanced module score	77.43	9.18
comprehensive practical score	80.14	9.76

The standardized data is shown in Table 3 (only the top 5 students are displayed).

Table 3. Standardized Data Table

Student number	Standardized basic module scores	Standardized advanced module score	Standardized comprehensive practical score
1	0.55	0.28	0.80
2	-0.18	-0.26	-0.42
3	1.07	1.16	1.22
4	-1.53	-1.90	-1.76
5	-0.80	-0.81	-0.53

Clustering is carried out using the K-means algorithm: Students are divided into 3 clusters (k=3) (high group, medium group, and low group), and the specific steps and formula derivation process are as follows.

(1) Initialization

Randomly select three students as the initial clustering centers (centroids). Suppose Student 1, Student 4 and student 10 are selected as the initial clustering centers, as shown in Table 4.

Table 4. Initial Clustering Centers

Clustering center	Standardized basic module scores	Standardized advanced module score	Standardized comprehensive practical score
1	0.55	0.28	0.80
4	-1.53	-1.90	-1.76
10	0.23	0.07	0.49

(2) Iterative process

In the first iteration, for each student, calculate the Euclidean distance from them to each cluster center:

$$d(x_i, c_j) = \sqrt{(x_{i,\text{basic module}} - c_{j,\text{basic module}})^2 + (x_{i,\text{advanced module}} - c_{j,\text{advanced module}})^2 + (x_{i,\text{comprehensive practical}} - c_{j,\text{comprehensive practical}})^2}$$

Assign students to the cluster where the nearest clustering center is located and update the clustering centers of each cluster:

$$c_j = \frac{1}{n_j} \sum_{x_i \in \text{cluster}_j} x_i$$

After calculating the distances of all students to each cluster center and assigning the students to the nearest cluster, the cluster allocation shown in Table 5 is obtained.

Table 5. Cluster Allocation

Student number	Allocated cluster		Student number	Allocated cluster		Student number	Allocated cluster
1	cluster1		13	cluster1		25	cluster2
2	cluster2		14	cluster2		26	cluster3
3	cluster1		15	cluster3		27	cluster1
4	cluster3		16	cluster1		28	cluster2
5	cluster2		17	cluster2		29	cluster1
6	cluster1		18	cluster1		30	cluster2
7	cluster1		19	cluster1		31	cluster3
8	cluster2		20	cluster2		32	cluster1
9	cluster3		21	cluster3		33	cluster2
10	cluster1		22	cluster1		34	cluster1
11	cluster2		23	cluster2		35	cluster2
12	cluster1		24	cluster1			

Calculate the new clustering centers of each cluster, as shown in Table 6.

Table 6. New Clustering Centers

Clustering center	Standardized basic module scores	Standardized advanced module score	Standardized comprehensive practical score
cluster1	0.53	0.28	0.76
cluster2	-0.52	-0.55	-0.58
cluster3	-1.53	-1.77	-1.78

In the second iteration, the distance from each student to the new cluster center is recalculated and the clusters are redistributed. Update the clustering centers. After multiple iterations, until the cluster centers no longer change or the change is less than a certain threshold (the threshold is set at 0.01), the cluster allocation and cluster centers shown in Table 7 are finally obtained.

Table 7. Final Clustering Centers

Clustering center	Standardized basic module scores	Standardized advanced module score	Standardized comprehensive practical score
cluster1	0.65	0.32	0.85
cluster2	-0.60	-0.63	-0.65
cluster3	-1.50	-1.70	-1.75

The final cluster allocation is shown in Table 8.

Table 8. Final Cluster Allocation

Student number	Allocated cluster		Student number	Allocated cluster		Student number	Allocated cluster
1	cluster1		13	cluster1		25	cluster2
2	cluster2		14	cluster2		26	cluster3
3	cluster1		15	cluster3		27	cluster2
4	cluster3		16	cluster1		28	cluster1
5	cluster2		17	cluster2		29	cluster2
6	cluster1		18	cluster1		30	cluster3
7	cluster1		19	cluster1		31	cluster2
8	cluster2		20	cluster2		32	cluster1
9	cluster3		21	cluster3		33	cluster2
10	cluster1		22	cluster1		34	cluster1
11	cluster2		23	cluster2		35	cluster2
12	cluster1		24	cluster1			

Analyze the clustering results and formulate personalized learning paths:

Cluster 1 (High Group) : The scores of the basic module, advanced module, and comprehensive practice are all relatively high. They have strong learning abilities and can be provided with more challenging learning resources and projects, encouraging them to conduct in-depth research and exploration.

Cluster 2 (Medium Group) : Their academic performance is at a medium level. They have a positive learning attitude but may need to improve their learning efficiency. Targeted tutoring and learning suggestions can be provided to help them enhance their learning efficiency.

Cluster 3 (Low Group) : They have relatively low academic performance and a weak learning foundation. Basic courses and more practice opportunities can be provided to help them lay a solid foundation.

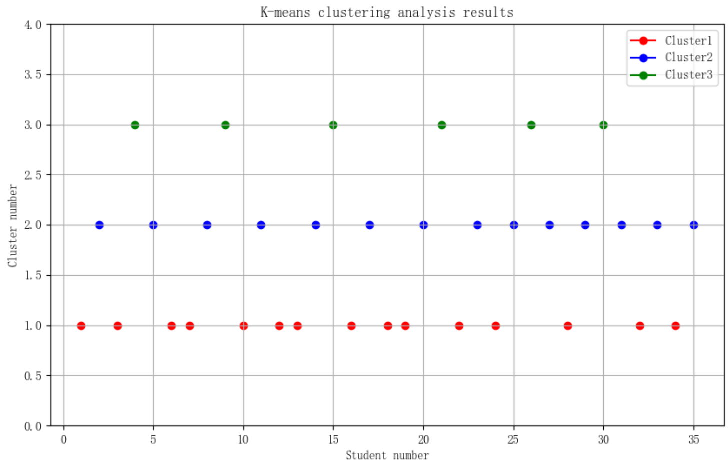

Fig. 11. Distribution of student clusters

As shown in Figure 11, by conducting cluster analysis on students' learning behavior data through the K-means algorithm, the learning characteristics and demands of students can be accurately understood, providing a favorable reference for further adjusting teaching methods and making the rationality of its teaching more explicit[8].

5.3 Virtual Reality and Simulation Technology

In the practical teaching of electronic-related majors, the use of virtual reality technology and software such as Proteus to simulate practical teaching requires students to be closer to real scenarios, greatly saving students' practical expenses and improving their learning efficiency. For example, in the virtual laboratory constructed by using virtual reality technology, students' operations such as circuit design, operation debugging and troubleshooting are all completed in a virtual three-dimensional space. The working principle of real circuit systems is simulated by using simulation software such as Proteus to help students learn and practice the methods and processes of intelligent circuit design and debugging. Empirical research shows that students who use virtual reality technology and simulation software to assist in learning and practice have much higher practical skill levels compared to those who do not adopt them[9].

6 Implement the Guarantee and Evaluation System

In the digital age, the implementation of lifelong learning and the integration of professional and innovation in electronic majors in higher vocational colleges must be guaranteed in terms of policies and systems, resource input and allocation, dynamic assessment and feedback, etc.

Policy and institutional guarantee is an important support for the development of electronic majors in higher vocational colleges. The collaborative mechanism among the government, schools and enterprises is the core element in building a policy and institutional guarantee mechanism. The government provides support such as policies for lifelong learning and the integration of professional education and innovation. Schools are responsible for specific education and teaching and are the main body of education. Enterprises can meet the industry's demand for the integration of professional education and innovation by participating in the design of talent cultivation plans and providing practical projects[10], as shown in Figure 12.

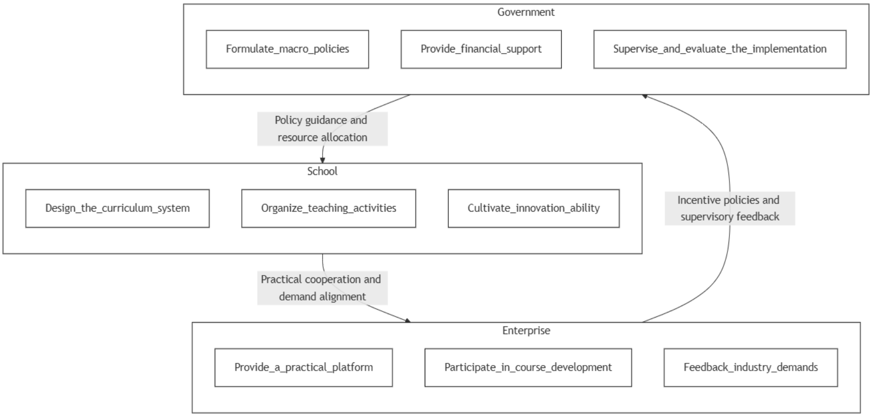

Fig. 12. Tripartite Collaborative Organizational Structure Diagram

The lifelong learning and integration of professional and innovation in electronic majors in higher vocational colleges emphasize the optimization of resource input and allocation, achieving a transformation from static to dynamic in input and allocation. At the same time, the proportions of the three fundamental elements of teachers, equipment, and practical environment in the lifelong learning and integration of professional and innovation in electronic majors should be allocated. Teachers 30%, equipment 20%, practical environment 50%, as shown in Figure 13. The allocation of these resources is used to ensure the training of teachers integrating professional education and innovation, the renewal of practical equipment, and the expansion of students' practical environments. Under normal circumstances, the improvement of teachers and equipment for the integration of specialized and innovative education is carried out in the first and second quarters of the semester, while the practical environment is implemented in the third quarter of the current semester. Following the staggered arrangement can achieve the optimal allocation of resources and ensure the construction effect and goal realization at each stage[11].

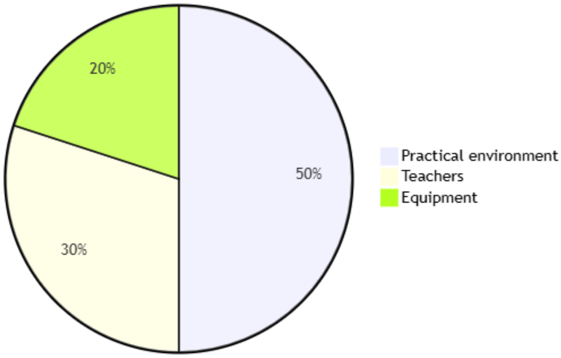

Fig. 13. Resource Allocation Diagram

Construction of dynamic evaluation and feedback mechanism. Based on multi-dimensional evaluation indicators, the lifelong learning situation of the pilot classes and the implementation quality of the integration of professional education and innovation are quantified, and timely and dynamic monitoring and adjustment are carried out, so as to effectively control the implementation. Figure 14 shows the dynamic trends of the survey data on student satisfaction and employment quality related to the pilot work from 2021 to 2024. It indicates that by following the model, students' satisfaction and employment quality have improved, demonstrating the effectiveness of the model[12].

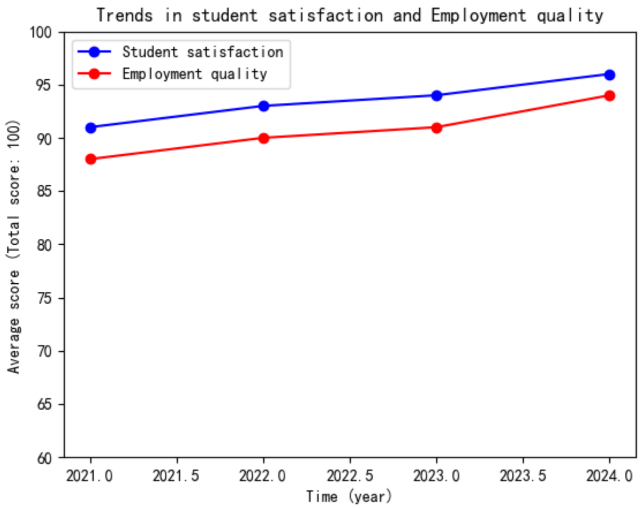

Fig. 14. Dynamic Evaluation and Feedback Mechanism

7 Conclusions

Based on the above research, this paper conducts a study on how to achieve the integration of professional education and innovation, lifelong learning for electronic majors in higher vocational colleges in the digital age, and thereby promote the high-quality development of vocational education. It aims to gradually transform the education model from the traditional one to the digital and lifelong education model, and meet the social demand for compound talents. Through practical research and analysis of the classes in the pilot institutions, it was found that students have a distinct awareness of autonomous learning. This is because the learning and content in the teaching design have changed, that is, from the previous "teaching" to "learning", and from the previous "transmission" to "creation". The integration of professional expertise and innovation is consistent with lifelong learning. Lifelong learning provides an inexhaustible source of power for the integration of professional expertise and innovation, while the integration of professional expertise and innovation gives lifelong learning a practical environment and a carrier of value. It is hoped that the research and practice of this article will contribute to the establishment of a lifelong learning system in the digital age, thereby promoting the high-quality development of vocational education.

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