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Reconstruction Of Primary and Secondary School Science Education System Based on Steam Education Concept

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Abstract: As a project-based learning model, STEAM education aims at cultivating innovative talents with interdisciplinary thinking skills. This paper will introduce the STEAM education concept into the reconstruction of our country's primary and secondary education system. The purpose is to make up for the gap between knowledge and application under traditional exam-oriented education, and to train students' exploration thinking and application of engineering technology. The STEAM education concept can handle and analyze many practical problems in real life, and it has been applied in primary and secondary school teaching. This paper introduces the teaching concept of STEAM into the learning of primary and secondary schools, so that the teaching model can be further promoted in primary and secondary schools, and at the same time it can help teachers and students to carry out innovative research and learning.

Keywords: STEAM Education; Primary and Secondary School; Education System, Reconstruction

1. Introduction

As a further development of STEAM education in the United States, STEAM education includes five major contents of science, technology, engineering, and mathematical. the goal of training is to enable students to solve real problems through innovative thinking, critical thinking, effective communication and collaboration, and cross-disciplinary methodologies. the STEAM education concept can strengthen the links between various disciplines, and is conducive to the development of students' hands-on ability and overall development [1-5]. STEAM curriculum is characterized by practical issues, based on project learning, allowing students to independently complete projects of interest or issues that need to be addressed. Teachers provide students with learning resources and techniques, and guide students to ask questions and design solutions, and attract students to participate in project activities, and learn to divide labor and cooperation, and stimulate students' thirst for knowledge, so that they can build and improve their own knowledge systems in continuous exploration and learning. Allow students to develop problem-solving and innovation skills in the project. In 2015, STEAM was ranked as one of the most prominent educational methods in the rising trend of attention in basic education in the United States [6-14].

2. Reconstruction of Science Education System in Primary and Secondary Schools Based on Steam Education Concept

2.1 Analysis of STEAM Education Concepts and Methods

For STEAM education concept, American expert Thomas first put forward this theory. the characteristics of this theory are the combination of the characteristics of qualitative and quantitative analysis. At the same time, it has the characteristics of level and systematization. the law should be used in accordance with the following process:

(1) Build the STEAM education concept. This means that first of all, we must fully analyze the actual problems, and based on this, according to the unique attributes of each actual element, we must decompose problems from top to bottom, so as to obtain various STEAM education concepts with their own characteristics;

(2) Build a comparison matrix. the starting point is the second floor of the STEAM education concept model built in the first step. This paper uses the scales from the first to the ninth of the comparison method to establish a paired comparison matrix, which will be used

for all factors that are affiliated with or affect the upper level.

(3) Use the consistency method to check the calculation weight vector. the eigenvectors and maximum eigenvalues of each STEAM evaluation matrix can be calculated by pair wise comparisons. the consistency ratio, random coherence elements, and coherence elements are used in the consistency check.

(4) the weight vector is calculated and verified using the combined consistency method. We can calculate the combined weight vector contained in the lowest level and perform this check according to the formula. the method and steps for determining the weights of STEAM evaluation indicators used in this paper and the application process are shown in Table 1 for the 9-dimensional STEAM weight scales adopted and their meanings, as **Table 1**.

Table 1. STEAM Metrics and Their Meaning

Scale	Meaning
1	1 indicates that two factors are equally important.
3	3 indicates that the STEAM indicator is slightly more important than another STEAM indicator.
5	5 indicates that the STEAM indicator is significantly more important than another STEAM indicator.
7	7 indicates that the STEAM indicator is more important than another STEAM indicator.
9	9 indicates that the STEAM indicator is absolutely more important than another STEAM indicator.
2, 4, 6, 8	2, 4, 6, and 8 are the median values of the above two adjacent judgments

(5) Build a comparative STEAM evaluation matrix

We can build the STEAM evaluation matrix, and because the upper-level target will be affected by different levels of the relevant influencing factors of each problem, we must choose the general standard, and that is, we can use the same factors to compare each factor, so as to obtain the STEAM evaluation matrix A, i. e. the target is affected. the weight STEAM evaluation matrix of the influence degree of each element is as follows:

$$A = \begin{bmatrix} {}^{w_1}/_{w_1} & \cdots & {}^{w_1}/_{w_n} \\ \vdots & \ddots & \vdots \\ {}^{w_n}/_{w_1} & \cdots & {}^{w_n}/_{w_n} \end{bmatrix} \quad (1)$$

(6) Calculate the weight of each STEAM index factor for the arithmetic mean value of each row, make the following judgment as follows:

$$\overline{W_i} = \frac{1}{n}\sum_{i=1}^{n} {}^{w_1}/_{w_n} \quad (2)$$

(7) Consistency check after completing this step, and the eigenvectors will be used to sort the vectors. the consistency formula $AW=n_w$ is calculated and n represents the characteristic root in A. According to the above content, we can solve the problem of eigenvalues, and the importance degree weight of the i-th factor related to the goal can be obtained. the normalized feature vectors can be calculated and the consistency check can be performed as follows:

$$\mathrm{CI} = \frac{\lambda_{max} - n}{n - 1} \quad (3)$$

CI will increase with the parameters. We can compare CI and RI to get a ratio CR. Through this value, the consistency of STEAM evaluation matrix can be evaluated, as **Table 2**

Table 2. Average Stochastic Consistency Steam Index

Order	3	4	5	6	7	8	9	10
RI value	0.54	0.93	1.5	1.6	1.7	1.8	1.5	1.2

When the CR ratio is less than 0.10, it means that the consistency check is passed by this STEAM evaluation matrix. When the CR is greater than 0.10, the result must be fed back to the scoring team to recalculate the importance of each STEAM indicator. the final step is to substitute the questionnaire information into the formula, and calculate the combined weights of all sub-goals, and then rank all the results according to the order. If the score of a certain factor is higher, it proves that the greater it affects the goal.

2.2 The Weighting of STEAM Indexes in The Science Teaching System in Primary and Secondary Schools

(1) Description of weight calculation

The calculation method of this weight is determined by the STEAM education concept

mentioned above. In determining the five items mentioned in the STEAM indicator mentioned in the STEAM indicator system, the weights of each STEAM indicator are calculated. First, a group of experts consisting of one authoritative expert, two professionals, and 12 senior science education systems was established. Then, after a series of scientific teaching systems with many years of work experience were discussed together, scientific judgments were made, and a score table was filled out. Based on this, the comparison results were expressed by way of score values, and the STEAM evaluation matrix was finally obtained. Finally, through the accurate calculation, the weight distribution corresponding to the first level STEAM index is obtained, and the score value of the importance comparison is obtained. Among them, all professional teachers are very familiar with the situation of their grades. However, each year the teaching plan goals developed at the grade level is not exactly the same as those of full-time teachers. Therefore, during the process of statistical evaluation, the evaluation expert group has 12 senior scientists. the teaching system scored 70%, and the authoritative experts scored 15%, and the two professionals scored 15%.

(2) Weight calculation process

According to the above steps, the available data results are as follows **Table 3**.

Table 3. Omparison of Importance of Level 1 STEAM Indicators

u	u1	u2	u3	u4	u5
u1	1	5	3	3	3
u2	1/4	1	3	3	3
u3	1/6	1/6	1	1	1
u4	1/6	1/6	1	1	1
u5	1/6	1/6	1	1	1

A STEAM evaluation matrix was established. the maximum eigenvalue λ_{max} of the STEAM evaluation matrix was 4.7, and the STEAM evaluation matrix index weight W is calculated by the STEAM education concept. Substituting the consistency test STEAM index CR=CI/RI=0.12 reached the consistency test. Therefore, for the science teaching system, the STEAM indicators account for 0.14, 0.12, 0.13, 0.04, and 0.3, respectively. Then, for the scientific teaching system, the above indicators are determined by the STEAM educational philosophy method. the eigenvalue of the STEAM evaluation matrix is λ_{max}=3.3. the STEAM evaluation matrix A1 is calculated by the STEAM education concept with the weight of each indicator W1, and the consistency test of the substitution STEAM index with CR=0<0.5 have reached the consistency test.

Therefore, the performance dimension secondary STEAM index weight V1 is through the comparison of the importance level to obtain the lower STEAM index. the maximal eigenvalue λ_{max} of the STEAM evaluation matrix is 4.2, and the STEAM evaluation matrix A2 calculated by the STEAM education concept weights each indicator weight W2, and the consistency test STEAM index has CR=0.08, which has reached the consistency test. Therefore, for the second-dimension index of potential dimension V2, the lower-level STEAM index is obtained through the comparison of the importance degree. the maximal eigenvalue λmax of the STEAM evaluation matrix is 4.3, and the STEAM evaluation matrix A3 is calculated by the STEAM education concept with each index weight W3, and the consistency test STEAM index having CR=0.008 have reached the consistency test. Therefore, the capability dimension two-level STEAM index weight V3 obtains the subordinate STEAM index through the comparison of the importance degree, and the maximum eigenvalue λ_{max} of the STEAM evaluation matrix is 3.2.

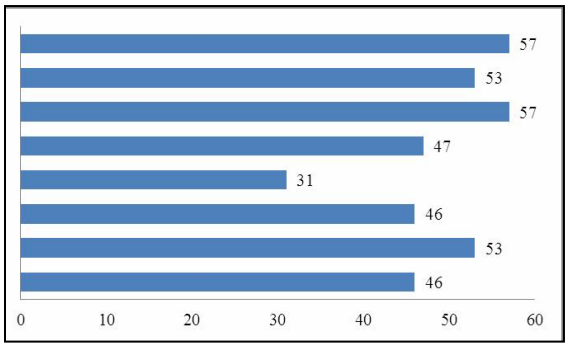
2.3 The Reconstruction Process of The Science Education System for Primary and Secondary Schools in The Steam Education Model

The STEAM education model has duration of 24 days and is divided into three modules. In the first month of each year, the first module is studied in the TSEM of primary and secondary schools. the topic of primary and secondary education is the best teaching in the grades of primary and secondary schools. Content covers teaching innovation and other aspects, and the second month is the second module of CEIBS for primary and secondary schools, and the theme is system innovation teaching, and the third month is the third module of HBS for primary and secondary schools, and the theme is organizational ability etc. the target of the course is the high-level teaching staff of primary and secondary schools. the course is coordinated with a large number of teaching cases. It requires students to fully prepare

personally and actively participate in group discussions, fully communicate with teachers in the classroom, and collide with ideas.

(1) STEAM education model primary and secondary education object model

Figure 1. Analysis of the Number of Students in the STEAM Model

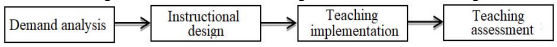


The STEAM education model is a student-oriented primary and secondary education curriculum jointly developed by TSEM, HBS, CEIBS, and three well-known primary and middle school students at home and abroad, forming a set of curriculum teaching systems specifically for high-level teaching staff. Looking at the number of students, there is an overall upward trend in the number of students. With the exception of the relatively small number of classes affected by the teaching model, the number of students in the remaining classes is more than 45. the number of students is shown in **Figure 1**. Full understanding of the composition of primary and secondary education objects helps the course organizers to be more targeted in the design of the course system. It also involves more attention and attention to the courses that constitute the students' concerns and their learning, while ensuring the inherent curriculum system. Through in-depth excavation of student characteristics and needs to meet the needs of primary and secondary education in the development of the organization's needs, the primary and secondary school education curriculum can achieve the educational objectives and the educational objectives of the school's expected educational goals.

(2) STEAM education primary and secondary school operation framework

The design, development, operation and feedback of the STEAM education model were jointly completed by three primary and secondary schools. Three primary and secondary schools are equipped with specialized head teachers and curriculum teaching teams. the experimental class teacher of the course selects experienced senior teachers from each primary and secondary school. the three head teachers are responsible for the design and development of the curriculum, teacher equipping, and quality supervision. In addition, the enrollment and management of the curriculum are also jointly undertaken by three primary and secondary schools. Therefore, each primary and secondary school is equipped with one enrollment and management teacher each responsible for the enrollment and management of the course of the year, forming an enrollment and management team for the curriculum. the admissions working group is composed of admissions supervisors selected by each hospital. It is mainly responsible for the recruitment of students in the course of the year and completes the recruitment STEAM indicator. It assists the management team in the teaching of the course during the course; the management team is assigned by each school management teacher. It is mainly responsible for the management of the modules of each primary and secondary school, and cooperates with the organization and management of the cooperative institutions. the STEAM education model has also formed its own management teaching process in the past nine years. It is mainly divided into four stages: curriculum design, course enrollment, course management, and course evaluation. Each stage consists of the special responsibility of the three schools by the head teacher personally check. the current teaching system of the STEAM education model can be divided into the following four basic modules, which are actually the main stages of the operation of the entire primary and secondary education system as **Figure 2**.

Figure 2. The Basic Modules of the STEAM Primary and Secondary Education System



① Demand analysis. the analysis of primary and secondary education needs is the starting point of primary and secondary education activities. the organization of primary and secondary education can only carry out the design and implementation of education and assessment of primary and secondary schools after fully analyzing and understanding the educational needs of primary and secondary

education. the effective and adequate analysis of primary and secondary education needs will have a direct impact on the implementation of primary and secondary education. Since the STEAM education model is an open enrollment project for the cooperation of the three schools, the design of the course must be completed before the enrollment of the course. Therefore, an accurate and systematic analysis of student needs cannot be made before the course starts.

② Primary and secondary education design. Since the inception of the STEAM curriculum, the HBS classic case teaching method has been used, but the innovation in the curriculum content is not enough. In contrast, the annual update rate of primary and secondary school students is more than one third. the head teachers of the three schools will optimize the curriculum design and match the appropriate teacher according to the feedback of the students in the previous year. There will be fine-tuning every year, but no major adjustments have been made to the overall design of the contents of the three modules. Compared with the case construction of primary and middle school students, this update frequency obviously cannot adapt to the high-speed development and changes in the education market for senior executives.

③ The implementation of primary and secondary education. the implementation of the STEAM curriculum is divided into three modules. Each module consists of a host school responsible for the implementation of the primary and secondary education curriculum. Based on the accumulation of HBS's primary and middle school students for many years and the rich experience in senior and middle school education, the implementation of primary and secondary education is led by HBS, and the other two are jointly completed. Each module's management team is mainly hosted by the host school, and the other two schools have management team support. the enrollment team of the course is mainly responsible for the maintenance of student relations, and the management team is responsible for the logistical arrangements during the implementation of the curriculum.

④ Elementary and middle school education assessment. the feedback assessment of the course mainly depends on the evaluation table after each module. Each module evaluation sheet is sent to HBS for collection and feedback to the head Teachers of the three schools in a unified manner, so that the head teacher can refer to and discuss the next year's curriculum. the contents of the assessment form are as follows:

Table 3. STEAM Course Module Evaluation Form Contents

Evaluation content	Focus on aspects	Evaluation method
The overall content and form of the module	Advice on expected levels of satisfaction, most benefited courses, course content and format	The validity of the impact was scored on a 5-point scale, with 1 being not achieved and 5 being important.
Each course content assessment	The value of topics and materials, the effectiveness of teacher teaching	
Course teaching	Course teaching team, course website	

Table 3 considers the STEAM indicators. the setting of the STEAM indicator is rather extensive. There is no detailed subdivision STEAM indicator to explain or guide, so the subjectivity of students' answers is larger. the STEAM indicator does not design students' basic wishes. That is to say, they do not ask students any specific knowledge, experience, or learning orientation in teaching. They are merely assessments of subjective teaching contents and forms set by the school, and we can build a module that is close to the needs.

3. Conclusion

The STEAM education system is dynamic and open. Each element will have an impact on the science education system in primary and secondary schools, and promote or inhibit its healthy development. In the process of advancing STEAM education, it is necessary to integrate government, researchers, teachers, and social organizations to promote the sustainable development of the STEAM education system. the government should provide support in the formulation of plans, improvement of systems, and education for teachers in primary and secondary schools. Researchers and teachers should play a leading role in the exploration of STEAM teaching models and construction of evaluation systems, and social organizations should lead informal STEAM education. Collaborative development

provides sites and resources for off-campus learning and activities.

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