Study on risk hierarchy and transmission path of technical transformation project of primary and secondary school classroom based on FISM

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Abstract. Nowadays, advanced information technology and education are gradually integrating. Technology-based instruction is the basic practice of primary and secondary education informatization. However, the application of it still faces many aspects of risks, such as the uneven distribution of technical equipment and high-quality information personnel resources, the immaturity of emerging technologies and operation pattern, the difficulty of raising funds and promotion, etc. Hence, this study identified the list of risks that the project might face, invited experts to score the risk relationship and established the FISM risk hierarchy model. Then, MICMAC method was used to analyze the category distribution of risk factors, and three transmission paths of capital risk, technical risk transmission and policy risk were made.

Keywords: schools classroom teaching; technical reconstruction; FISM-MICMAC; Risk hierarchy.

1. Introduction

Under the era of the information and intelligence, advanced information technology is constantly penetrating into all walks of life, which also promotes the teaching tools increasingly scientific and digital, teaching methods increasingly diversified and teaching environment increasingly intelligent. As early as the end of the 20th century, countries around the world began to promote the application of information technology in education, and China also paying more attention to using technology to empower education. China's Education Modernization 2035 clearly states that it is necessary to lead education modernization with the support of information technology and accelerate education reform in the information age.[1]

Primary and secondary education is a key part of basic education in China, and its informatization is related to the foundation and future of educational informatization to a great extent. As the main front of primary and secondary education, the technologization of classroom is the basic practice to implement the integrated development of high-technology and education. Wang Yang et al. illustrate that classroom is a complex system consisting of subjects (teachers and students), objects (knowledge, teaching materials), fields (time, space), activities (interaction, language, experience) and other elements and links.[2] Based on this, the authors believe that technological transformation projects embed information technology in primary and secondary school classrooms, which can change the space-time field of the classroom and enrich the object resources, thus changing the way the subject presents and recognizes the object, and making teaching and management activities more efficient and intelligent.

Today's technological transformation of primary and secondary school classroom is not only satisfied with laying campus network and supplying multimedia equipment, promoting "Three Supplies and Two Platforms" and building digital campuses, but also combining artificial intelligence, big data, Internet of Things and other emerging technologies with classroom instruction. However, at present, there is still a big gap in the teaching technology, equipment and high-quality information technology talents resources of primary and secondary schools between different segments, regions and urban and rural areas. Moreover, the combination of emerging technologies and classroom teaching is still in the pilot stage, and the technology and operation are not fully mature, requiring a large amount of funds, so it is difficult to promote at present. Therefore, the technical transformation project still needs to be paid attention to and promoted for a long time.

The interior of the education system involves many subjects and links, while the exterior is closely related to many fields. Although most existing studies have considered the complexity of educational risk factors and the mutual conversion and integration between endogenous and exogenous factors, there is a lack of analysis on the specific relationship between specific links and factors and the risk transmission path. In order to reduce the difficulties of risk management in primary and secondary schools and reduce the obstacles in local implementation and unified promotion, it is necessary to clarify the correlation of many risk factors involved in the technical classroom transformation project in primary and secondary schools and systematically master the transmission path to ensure the effectiveness of risk management.

In view of the shortcomings of existing studies, on the basis of investigating the technological classroom transformation project in primary and secondary schools, this study uses the risk hierarchy established by FISM model and deduces its conduction path to clarify the complex logical relationship of risk in the technological classroom transformation project with visual structure. To some extent, it provides reference and relevant suggestions for the construction of intelligent campus and the promotion of Informa ionization of primary and secondary education.

2. Identification of project risk factors

To obtain initial risk list of technical transformation projects, this study uses the method of literature research, survey and expert interviews. Dividing the educational risk into 5 perspectives：policy risk and

Economic risk before transformation, technical risk and operational risk during the project, social risk after the transformation, 15 risk factors of technological classroom transformation in primary and secondary schools are finally determined, as shown in Table 1.

Table 1. List of risk factors

Policy risk	Economic risk	Technical risk	Operational risk	Social risk
Policy volatility S1 Policy standardization S2	Capital input S3 Capital output S4	Technology supply S5 Technical feasibility S6 Technology application S7 Technology of inertia S8 Technological updating S9	Operation Administration And Maintenance S10 Relevant training S11 Unpredictable factor S12	Social ideas S13 Scientific and Technological ethic S14 resource allocation S15

2.1. Policy Risk

Policy risk includes 2 specific indicators. Policy volatility (S1) refers to the large fluctuation and instability of macro education policy, which is easy to impact the combination of technology and education. Policy standardization (S2) refers to the lack of perfect and unified norms of policies in various regions and the lack of specific guidance standards in the process of technological transformation.

2.2. Economic Risk

Economic risk includes 2 specific indicators. Capital investment risk (S3) means that the construction, application, maintenance and personnel training of technical transformation projects need funds investment guarantee mechanism and multiple financing channels. Benefit output risk (S4) is because technology equipment allocation will consume a large amount of input but the benefits are usually not immediately visible and are difficult to quantify.

2.3. Technical Risk

Technical risk includes 5 specific indicators. On the one hand, the risk of technology supply (S5) refers to the fact that technology is floating on the surface and difficult to integrate with education; on the other hand, it is difficult to support the development of technology with incomplete infrastructure. Technical feasibility risk (S6) means that the application prospect of some technologies is not clear, which may be accompanied by difficult operation and unsafe use. The risk of technology application (S7) refers to the possibility of unreasonable use and abuse when technology is combined with education, blindly pursuing the use of technology while ignoring the essence of education. The risk of technology inertia (S8) means that the variety and complexity of technology will cause the problems of adaptability and dependence in teaching. The risk of technological renewal (S9) comes from the rapid development of electronic information industry. Some technological products may be replaced by new products at any time due to technological innovation.

2.4. Operational Risk

Operational risk includes 3 specific indicators. Operation administration and maintenance risk (S10) means that the new teaching method has spawned a new management mode, and the daily maintenance and monitoring of products are difficult to some extent. Related training risks (S11) refer to the uneven ability of teachers, uneven distribution of information talents, and unclear training effects for relevant personnel after technical transformation. Unpredictable risks (S12) refer to the unpredictable risks associated with the introduction of new technologies, for instance, the impact of the epidemic.

2.5. Social Risk

Social risk includes 3 specific indicators. The risk of social concept (S13) refers to the controversy over the technical transformation of primary and secondary education, for some people praise the exam-oriented education more highly than the innovation-oriented education. Scientific and technological ethical risk (S14) means that the possibility that technological products may violate and reveal the private information of teachers and students. The risk of resource allocation (S15) stems from the imbalance of talents and technology, which may lead to problems such as asymmetric access to information, data monopoly and aggravating education inequality.

3. Establish the hierarchy model of risk factors

Interpretative Structural Modeling Method is a valid way to analyze and uncover the complex relationship structure, for it is able to analyze the complicated and disorderly relationship between the elements of the system into a distinct multi-level hierarchical structure model, so as to improve the understanding of the problem.[5]

However, ISM can merely reflect the existence of the influence relationship, but not the degree of the influence. Therefore, this paper adopts FISM model and uses binary fuzzy relation[6] to reflect the interaction degree of different risk factors, and studies the risk levels and transmission path of technical transformation project of primary and secondary school classroom. The chart is as follows:

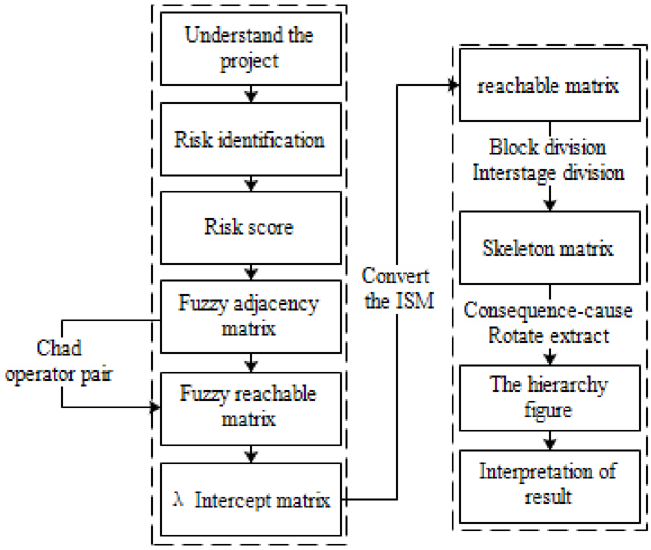

Figure 1. system flowchart

3.1. Established the fuzzy adjacency matrix

After risk factor identification is completed, fuzzy adjacency matrix needs to be established first. Therefore, it is need to blur the influence degree between project risks. Thus, 11 scholars engaged in information and education technology industry and 4 experts in education management were specially invited to score, arithmetic average was taken as the final score, and fuzzy adjacency matrix was obtained, indicating the influence degree of risk elements on risk.

Table 2. The fuzzy adjacency matrix *A*

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15
S1	0.00	0.18	0.02	0.24	0.26	0.13	0.44	0.09	0.26	0.45	0.00	0.80	0.04	0.05	0.42
S2	0.39	0.00	0.06	0.05	0.55	0.10	0.56	0.36	0.24	0.22	0.22	0.45	0.07	0.12	0.36
S3	0.04	0.25	0.00	0.89	0.01	0.37	0.19	0.43	0.05	0.46	0.60	0.82	0.35	0.03	0.07
S4	0.05	0.18	0.19	0.00	0.70	0.27	0.00	0.32	0.16	0.62	0.34	0.03	0.47	0.26	0.26
S5	0.41	0.33	0.36	0.58	0.00	0.97	0.41	0.42	0.10	0.56	0.36	0.27	0.16	0.33	0.10
S6	0.04	0.00	0.11	0.15	0.13	0.00	0.12	0.12	0.20	0.26	0.13	0.63	0.43	0.35	0.11
S7	0.03	0.21	0.03	0.35	0.24	0.14	0.00	0.25	0.40	0.04	0.31	0.20	0.32	0.77	0.06
S8	0.16	0.17	0.18	0.38	0.44	0.15	0.46	0.00	0.04	0.24	0.02	0.26	0.63	0.21	0.18
S9	0.14	0.21	0.45	0.68	0.37	0.43	0.10	0.31	0.00	0.25	0.14	0.04	0.05	0.21	0.19
S10	0.01	0.17	0.34	0.12	0.88	0.99	0.28	0.14	0.06	0.00	0.12	0.35	0.36	0.17	0.11
S11	0.11	0.30	0.50	0.50	0.21	0.03	0.29	0.36	0.35	0.68	0.00	0.48	0.17	0.08	0.05
S12	0.95	0.47	0.16	0.22	0.30	0.41	0.15	0.28	0.19	0.39	0.20	0.00	0.48	0.15	0.80
S13	0.17	0.46	0.39	0.01	0.38	0.10	0.14	0.31	0.46	0.47	0.39	0.38	0.00	0.39	0.35
S14	0.20	0.08	0.19	0.47	0.06	0.10	0.43	0.47	0.15	0.47	0.09	0.39	0.97	0.00	0.26
S15	0.28	0.16	0.04	0.42	0.17	0.39	0.02	0.15	0.45	0.06	0.33	0.07	0.44	0.49	

3.2. Fuzzy reachable matrix

The fuzzy reachable matrix R can be calculated by the method of serial multiplication, might as well make $A+I=B$, When $B_{(k-1)} \neq B_k = B_{(k+1)} = R$, the fuzzy reachable matrix R is obtained. In this case, the Chad operator pair is used to calculate the matrix, where the fuzzy multiplication operator is $\odot$ and the fuzzy addition operator is $\oplus$.

Table 3. The fuzzy reachable matrix R

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15
S1	1.00	0.47	0.45	0.47	0.47	0.47	0.47	0.47	0.46	0.47	0.45	0.80	0.49	0.49	0.80
S2	0.55	1.00	0.45	0.55	0.55	0.55	0.56	0.47	0.46	0.55	0.45	0.55	0.56	0.56	0.55
S3	0.82	0.47	1.00	0.89	0.70	0.70	0.47	0.47	0.46	0.62	0.60	0.82	0.49	0.49	0.80
S4	0.63	0.47	0.45	1.00	0.70	0.70	0.47	0.47	0.46	0.62	0.45	0.63	0.49	0.49	0.63
S5	0.63	0.47	0.45	0.58	1.00	0.97	0.47	0.47	0.46	0.58	0.45	0.63	0.49	0.49	0.63
S6	0.63	0.47	0.45	0.47	0.47	1.00	0.47	0.47	0.46	0.47	0.45	0.63	0.49	0.49	0.63
S7	0.47	0.47	0.45	0.47	0.47	0.47	1.00	0.47	0.46	0.47	0.45	0.47	0.77	0.77	0.47
S8	0.47	0.47	0.45	0.47	0.47	0.47	0.47	1.00	0.46	0.47	0.45	0.47	0.63	0.47	0.47
S9	0.63	0.47	0.45	0.68	0.68	0.68	0.47	0.47	1.00	0.62	0.45	0.63	0.49	0.49	0.63
S10	0.63	0.47	0.45	0.58	0.88	0.99	0.47	0.47	0.46	1.00	0.45	0.63	0.49	0.49	0.63
S11	0.63	0.47	0.50	0.58	0.68	0.68	0.47	0.47	0.46	0.68	1.00	0.63	0.49	0.49	0.63
S12	1.00	0.47	0.45	0.47	0.47	0.47	0.47	0.47	0.46	0.47	0.45	0.80	0.49	0.49	0.80
S13	0.55	1.00	0.45	0.55	0.55	0.55	0.56	0.47	0.46	0.55	0.45	0.55	0.56	0.56	0.55
S14	0.82	0.47	1.00	0.89	0.70	0.70	0.47	0.47	0.46	0.62	0.60	0.82	0.49	0.49	0.80
S15	0.63	0.47	0.45	1.00	0.70	0.70	0.47	0.47	0.46	0.62	0.45	0.63	0.49	0.49	0.63

3.3. λ intercept selection

λ intercept numerical selection directly influence the result of the hierarchy, so we combine the fuzzy of matrix R, select all possible values of λ to calculate and draw level topology, get elected to take λ = 0. 49. It makes for the best risk hierarchy diagram, and reduce the difficulty of risk management.

$$r_{ij} = \begin{cases} 0, & \text{when } m_{ij} < \lambda \\ 1, & \text{when } m_{ij} \geq \lambda \end{cases}$$

The fuzzy reachable matrix A is transformed into 0-1 reachable matrix according to the above formula.

Table 4. reachable matrix R_λ

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15
S1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1
S2	1	1	0	1	1	1	1	0	0	1	0	1	1	1	1
S3	1	0	1	1	1	1	0	0	0	1	1	1	0	0	1
S4	1	0	0	1	1	1	0	0	0	1	0	1	0	0	1
S5	1	0	0	1	1	1	0	0	0	1	0	1	0	0	1
S6	1	0	0	0	0	1	0	0	0	0	0	1	0	0	1
S7	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0
S8	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
S9	1	0	0	1	1	1	0	0	1	1	0	1	0	0	1
S10	1	0	0	1	1	1	0	0	0	1	0	1	0	0	1
S11	1	0	1	1	1	1	0	0	0	1	1	1	0	0	1
S12	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1
S13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
S14	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
S15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

3.4. Build FISM model

Step1 Tag element: For the accessibility matrix established by project risk factors, we can divide risk factors into two sets, reachable set $P(S_i)$ and antecedent set $Q(S_i)$. The intersection of the reachable set and the antecedent set is the common set $T(S_i)$. When the antecedent set and the common set have the same elements, the element is recorded as the target element. $P(S_i) = P(S_i) \cap Q(S_i) = T(S_i)$

Step2 Block division: The set obtained through the intersection operation of the reachable set of all target elements is non-empty, so there is no need to divide regions and all risk factors are connected.

Step3 Interstage division: The same element in the reachable set and the common set is extracted using the result-cause rotation of this element are deleted. Iterate until all elements are extracted. The first level L_1 element is $S_2, S_3, S_8, S_9, S_{11}$, the second level L_2 element is S_4, S_5, S_7, S_{10} ,the third level L_3 element is S_6, the fourth level L_4 element is S_1, S_{12}, S_{14}, and the fifth level L_5 element is S_{13}, S_{15}.

Step4 Reduction computation: The extracted elements are rearranged according to the hierarchical order, the new reachable matrix is established, and the general skeleton matrix M is obtained by the reduction operation.

Table 5. General skeleton matrix M

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15
S1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
S2	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
S3	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
S4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
S5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
S6	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
S7	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
S8	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
S9	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
S10	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
S11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
S12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
S13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S14	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
S15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Step5 Map the risk hierarchy

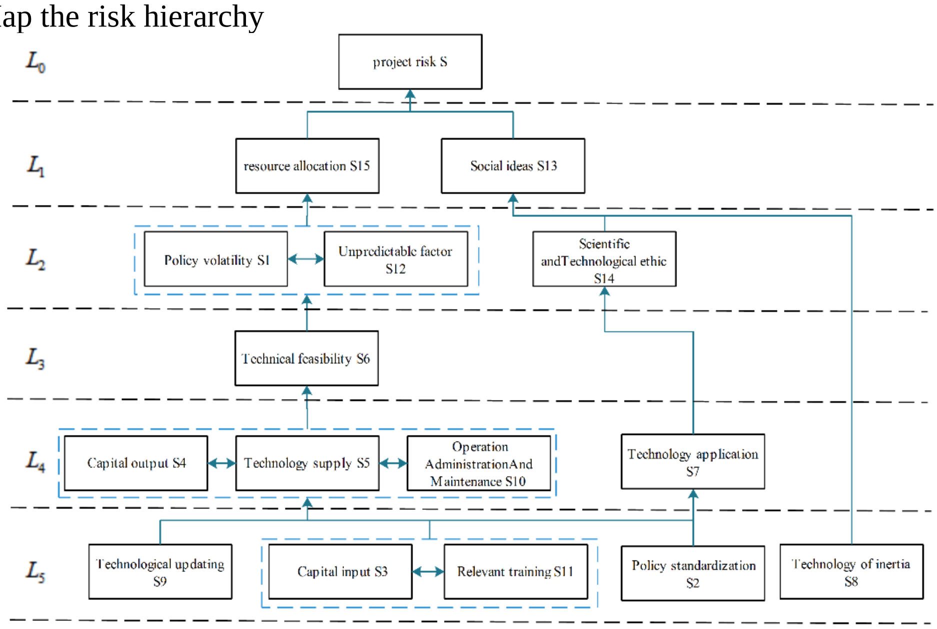

Figure 2. Topology of the risk hierarchy

4. Analysis of model results

4.1. MICMAC analysis

MICMAC model is a method used to analyze the relationship and interaction between factors in the system, and is commonly used to identify factors with high dynamic and high dependence in the system[7]. When using MICMAC analysis, the driving force and dependence of each influencing factor need to be calculated, which can be determined by the number of "1" in the row and column corresponding to each factor in the reachable matrix respectively[8].

According to the results of calculation, the data is visualized and the risk factors are divided into four categories: independent cluster, autonomous cluster, linkage cluster and dependent cluster. The driving force of risk

factors -- dependence distribution diagram is drawn as follows:

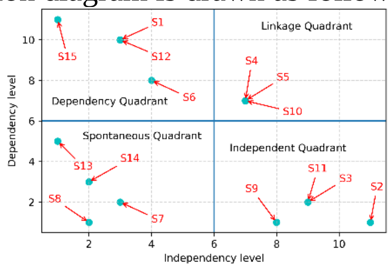

Figure 3. Analysis of MICMAC

Risk factor $\{S_2, S_3, S_9, S_{11}\}$ belongs to independent cluster with strong driving force

and weak dependence; risk factor $\{S_1, S_6, S_{12}, S_{15}\}$ belongs to dependent cluster with strong dependence and weak independence; risk factor $\{S_4, S_5, S_{10}\}$ belongs to linkage cluster with strong driving force and dependence; risk factor $\{S_7, S_8, S_{13}, S_{14}\}$ belongs to autonomous cluster with weak driving force and weak dependence.

4.2. Risk transmission path analysis

By studying the risk hierarchy diagram and combining relevant research data, the risk transmission path is divided into capital risk transmission path, technology risk transmission path and policy risk transmission path. These paths are as follows:

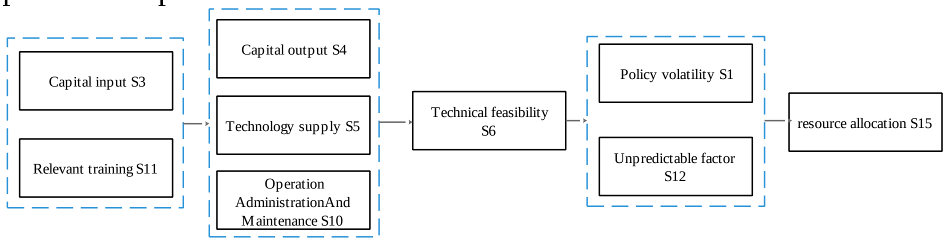

Figure 4. Capital risk transmission path diagram

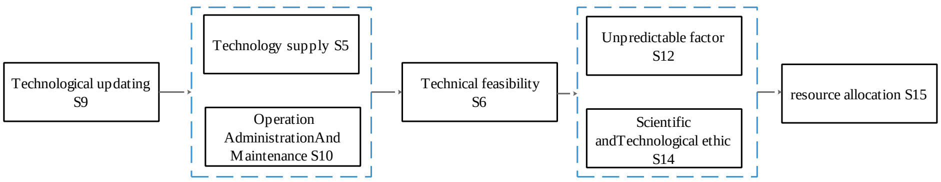

Figure 5. Technical risk transmission path diagram

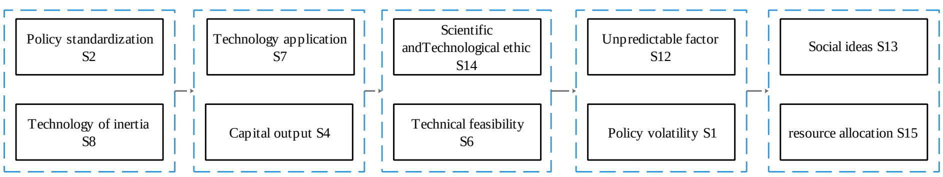

Figure 6. Policy risk transmission path diagram

5. Conclusions and Suggestions

Through FISM model, this paper analyzes the risk level and transmission path of technical classroom transformation project in primary and secondary schools, accurately identifies and studies the possible risks in the project market, lays a foundation for the follow-up of the project, and then reduced unnecessary project risks. Finally, the conclusions and suggestions are as follows:

The technological transformation project of classroom in primary and secondary schools can be divided into five levels, among which the technology renewal risk, capital investment risk, related training risk, policy standard risk and technical inertia risk are located in the deepest layer of the model, namely the fifth level. Other risk factors are affected by these risks. Therefore, we need to have a full understanding of the current status of relevant technologies and pay continuous attention to the adjustment of relevant national policies in China, broaden the channels for capital investment. We can also make use of the advantages of talents and resources in local colleges and universities to help transform classroom technology in primary and secondary schools. For the application of technology, we should fully consider whether it is legitimately integrated with the education, so as to avoid blindly pursuing of technology while ignoring the essence of education.

As middle risks, benefit output supply, technology risk, management risk, technology risk maintenance, technical feasibility, risk, policy risk, science and technology ethics risk are located in the 2nd, 3rd and 4th floors. They act as intermediate conduction manifest as intricate relationship structure. Therefore, in the process of project promotion, the causal relationship of these risks needs to be fully considered. Technology application and selection should be deployed in advance to empower technology education. Formulate different norms and technologies in the light of the different knowledge structure and students' cognitive psychology in primary, middle and high school. We should pay attention to the essence of education, avoid the waste of educational resources caused by the upgrading of educational hardware and beware of students indulging in mobile phones or Internet.

Resource allocation risk and social concept risk are superficial risks, located in the first layer of hierarchy, which are easy to be ignored but play a crucial role. Therefore, the issue of equity in education is non-negligible. More attention should be paid to the infrastructure and technical transformation of rural primary schools, and the gap might be narrowed through dual-teacher classes and education informatization. It is also necessary to take the changes in the social environment into account and conduct sufficient research on the market environment. A certain number of demonstration areas can be established to improve the level of information in China's education.

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