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RESEARCH ARTICLE

CHALLENGES TO STEM EDUCATION IN PRIMARY SCHOOL IN ETHNIC MINORITY AREAS OF CHINA

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Abstract

The development of modern education increasingly relies on the advancement of science and technology and STEM education has quickly occupied a place on the educational stage. STEM education brings opportunities, but due to its different teaching methods from traditional subject areas, it also brings many challenges. This study investigates the challenges to STEM education from a unique perspective of ethnic minority areas in China. The majority of the population in China is Han. The remaining 55 ethnic groups with smaller populations are called ethnic minorities. The areas where these ethnic minorities gather alone are ethnic minority areas. There are 12 ethnic minority areas in China, and all of them are relatively backward in economy and education. This study took Yunnan Province, one of the ethnic minority areas, as the research object. Semi-structured interviews were adopted and according to the purposefully sampling method, 10 teachers of STEM courses from 5 public primary schools in this area were selected. The data were analyzed through topic coding. It was discovered that there were challenges in this ethnic minority area, such as insufficient professional quality of teachers and the teaching content not conforming to the local culture. The research results were discussed in combination with the local characteristic culture. Among them, the most notable one is the C-STEAM education concept: Based on STEM, A (Art) and C (Culture) have been added. This concept is to guide with the culture of ethnic minorities and design STEM courses with the humanities and arts familiar to local students, providing a new approach for the development of STEM education in ethnic minority areas in the future.

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Introduction:-

STEM stands for Science, Technology, Engineering, and Mathematics. At present, STEM education has become a hot topic in the field of basic education reform worldwide. It has not only completed the evolution from educational

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trends to physical courses in just three decades, but also leaped to become the "most guiding educational reform discourse of the 21st century" recognized worldwide (Chesky & Wolfmeyer, 2015). STEM education has been successfully implemented in some countries, such as the United States, Australia and other Western countries (Du, 2020). STEM education brings both opportunities and many challenges. For instance, Margot and Kettler (2019) analyzed teachers' views on STEM education and revealed six major challenge areas that teachers face, namely pedagogical challenges, curriculum challenges, structural challenges, concerns about students, concerns about assessments, and lack of teacher support. With the rapid development of STEM education in China, many cities with advanced economic development have integrated STEM with primary education very well and achieved some results, such as Beijing and Shanghai (Tian, 2019; Yao, 2019). However, STEM education is still in a difficult state to develop in ethnic minority areas (Li, 2021). China is a multi-ethnic country. In most areas, ethnic minorities live together with the Han people, but there are also some areas where only ethnic minorities gather alone. These are ethnic minority areas. There are 12 ethnic minority areas in China. Affected by factors such as unbalanced economic and social development, educational resources and achievements in remote ethnic minority areas are relatively backward (Tong, 2023). Therefore, this study takes one of the ethnic minority areas - Yunnan Province as an example to explore the challenges to STEM education in ethnic minority areas.

Materials and Methods:-

STEM education in China started late, but has developed at a relatively fast pace. However, many problems are still emerging in the implementation and effectiveness of the course. Through the review of literature, the common problems of STEM education in primary schools in China can be summarized into four aspects: lack of systematicness in the curriculum, low quality of teachers, insufficient teaching resources, and single evaluation of teaching achievements.

From the perspective of curriculum systematicness, Li (2022) investigated the STEM situation in primary schools in China through interviews. She found that the curriculum lacks systematicness, and the grades are separated from each other, making it impossible for students to obtain a long-term development plan. Huang et al. found through interviews with Professor Lyn English, an academician of the Australian Academy of Social Sciences, that in actual school teaching, STEM teaching in primary schools in China has not received due attention, and there are no systematic curriculum books and plans (Jiang & Huang, 2020).

In terms of teacher quality, Xing (2019) conducted an investigation and research on the current situation of STEM teachers in primary schools through interviews. It was found that the majority of STEM teachers in primary schools graduated from physics, chemistry and other related majors. In some places, the number of STEM professional teachers is insufficient, and teachers from other subjects in the school teach STEM subjects. These teachers have not received systematic STEM professional knowledge learning and lack teaching experience in STEM courses, making it difficult for them to grasp the right measure for delivering a good STEM class.

Summarizing from the perspective of teaching resources, Han's (2021) research found that only a portion of primary schools in China have STEM laboratories and STEM activity rooms, but the number of equipment in the laboratories is insufficient for every student to engage in STEM experimental activities. Basically, the experimental method of students being grouped or even the way of teachers demonstrating and students observing is adopted, making it difficult for every student to participate in practical activities. Some schools are unable to set up laboratories due to economic reasons, and students can only watch experimental activities through videos.

From the perspective of teaching outcome evaluation, STEM education has not been incorporated into the school curriculum system at present. Teachers and students only offer a few comments on teaching outcomes and have not adopted scientific evaluation tools and methods (Jia, 2020). The evaluation method for STEM teaching in primary schools still mainly relies on examinations, emphasizing grades. Scores remain the primary means to measure students' STEM learning outcomes, while the assessment of the learning process is neglected. The unreasonable evaluation methods of STEM teaching directly lead to low participation and enthusiasm of students in the classroom (Tang, 2022).

The above are the common problems existing in STEM education in China at present. This study conducts research from a unique perspective of ethnic minority areas in China. As of 2020, education in ethnic minority areas of China has reached the national recognition standards in terms of school construction, financial guarantee and the organization of characteristic activities, and has basically achieved balanced development. However, there are

relatively few theoretical and practical studies on STEM education in ethnic minority areas, and the development of STEM education is not ideal. So, what challenges does STEM education in ethnic minority areas face nowadays? This study adopts a qualitative research design (Huang & Cai, 2007) to gain an in-depth understanding of the experiences and beliefs of primary school teachers in STEM education, as Barrett & Twycross(2018) mentioned Semi-structured interviews enable researchers to directly obtain unique and original data from sources according to the requirements of the research.

Contexts:-

This study investigated five public primary schools in Yunnan Province to understand the challenges faced by STEM education in primary schools in ethnic minority areas. In China, the status of STEM courses in primary schools is as important as that of mathematics, Chinese and English. In 2017, the Ministry of Education of China stipulated that the STEM courses, which were previously implemented from the third grade, would be changed to be implemented from the first grade, and the number of STEM courses arranged in the weekly curriculum should not be less than one class hour.

Participants:-

The participants were 10 teachers from 5 public schools and the participants were selected based on a purposive sampling method (Sun and Luo, 2002). As can be seen in Table 1, the participants were 5 males and 5 females. that all 10 participating teachers taught STEM programs and their ages ranged from 32 to 41 years old (Mean = 36.2). And they were all experienced teachers with 7 to 16 years of teaching experience in elementary schools, but some of them had always taught STEM courses and some of them had previously taught other subjects such as math and science before switching to STEM courses. To ensure confidentiality, all teachers used pseudonyms.

Participants	Name	Gender	Age(years)	Teaching experience(years)
T1	LYD	Male	35	12
T2	HJJ	Female	41	15
T3	ZH	Male	32	7
T4	JYT	Female	33	10
T5	WYG	Female	38	14
T6	WWZ	Male	41	16
T7	ZW	Female	35	11
T8	QTY	Male	35	9
T9	XX	Male	40	14
T10	CFJ	Female	32	8
Range			32–41	7–16
Mean			36.2	11.6

Table 1:- List of the participants background.

Data Collection and Analysis:-

Data for this study was collected through semi-structured interviews with questions that referenced Jia's (2019) interview outline on the same research topic. The interviews were conducted online through Zoom for 30-40 minutes each and all interviews were audio-recorded for subsequent data transcription and analysis. Finally, the interview data were thematically coded through NVIVO11. According to Saldana's study (2009) thematic coding systematically organizes the data and reveals the core concepts and relationships in the data.

Results:-

Through the thematic coding of 10 interview materials using Nvivo11, three themes were obtained: Lack of resources, Localized models, Professionalism teacher. And 7 sub-themes: Financial support, Hardware facilities, Software resources, suitable teaching model, Teaching content, Major of teacher and Teacher training. It can be intuitively seen from the hierarchical structure in Figure 1 that there is a relationship between the themes and the sub-themes. From the thematic analysis, it can be seen that the three biggest challenges currently faced by STEM education in ethnic minority areas are: lack of resources, lack of localized models, and lack of professional teachers. The following will provide a detailed analysis of these three challenges.

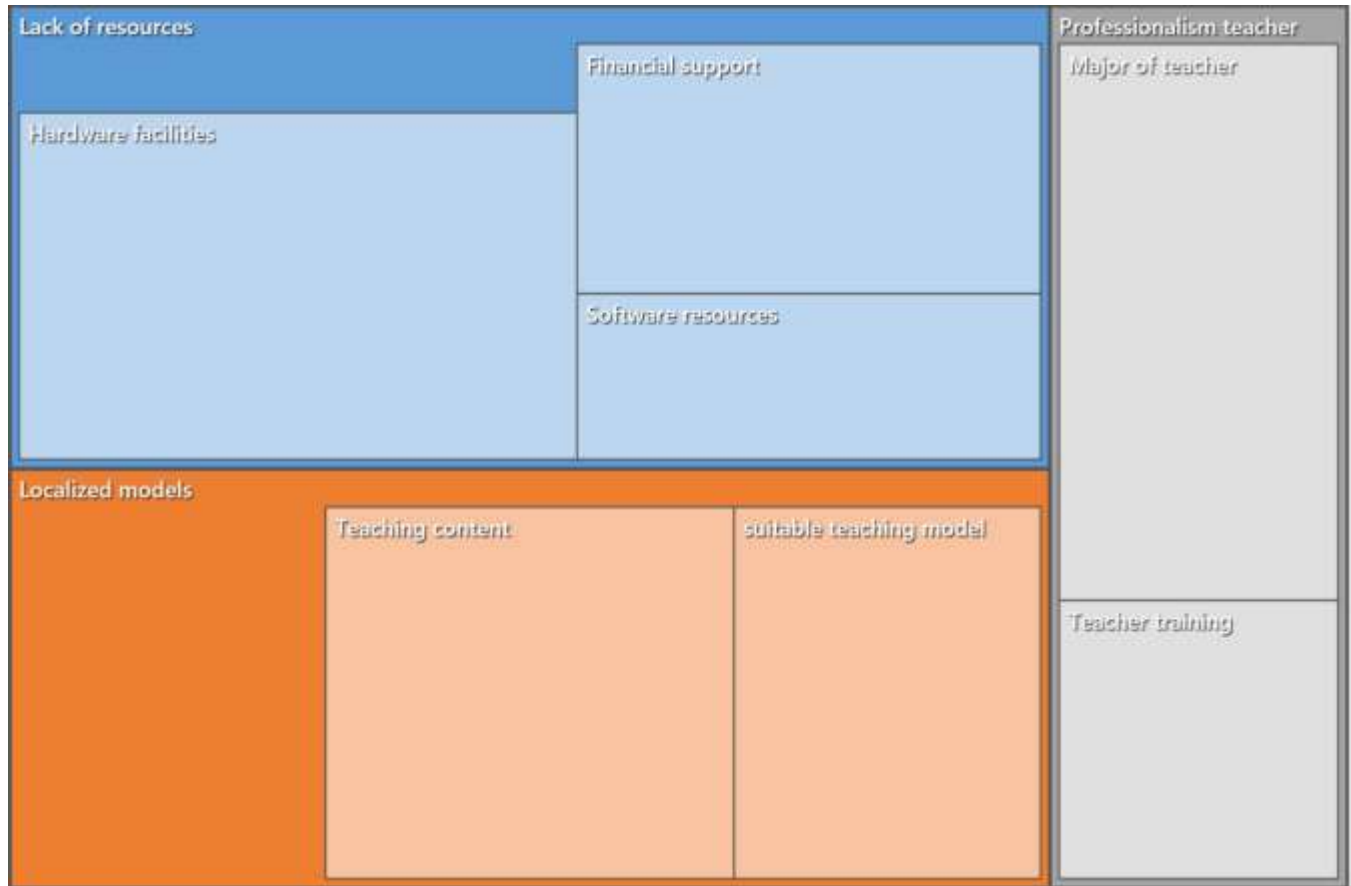


Figure 1:- Hierarchical diagram of thematic coding.

Lack of resources for STEM education

As shown in Figure 2, the most frequently mentioned issue by the 10 interviewees is the Lack of resources. There has always been an economic backwardness in ethnic minority areas, and thus teaching resources are relatively scarce. In the interview, it was mentioned that the lack of resources mainly includes these three aspects: Financial support, Hardware facilities, and Software resources.STEM teaching needs to be carried out in conjunction with hardware facilities, such as laboratories, innovation platforms, science operation rooms and other platforms.Through the interviews, we learned that the hardware facilities in most schools in this ethnic minority area could not meet the needs of STEM education, and students had little access to hardware facilities such as robotics, 3D printing technology, and curriculum labs, for example, participant (T2) mentioned: There was only one 3D printer in the school, which made it difficult to satisfy the needs of all students in teaching and learning.Also participant (T9) said that the existing equipment in the school limited the development of the curriculum, and sometimes there were some interesting teaching designs but the school lacked the equipment, resulting in the curriculum not being able to be carried out.Participant (T8)mentioned: the school lacks financial support for STEM education. For instance, teachers need to purchase relevant software but cannot receive support from the school.

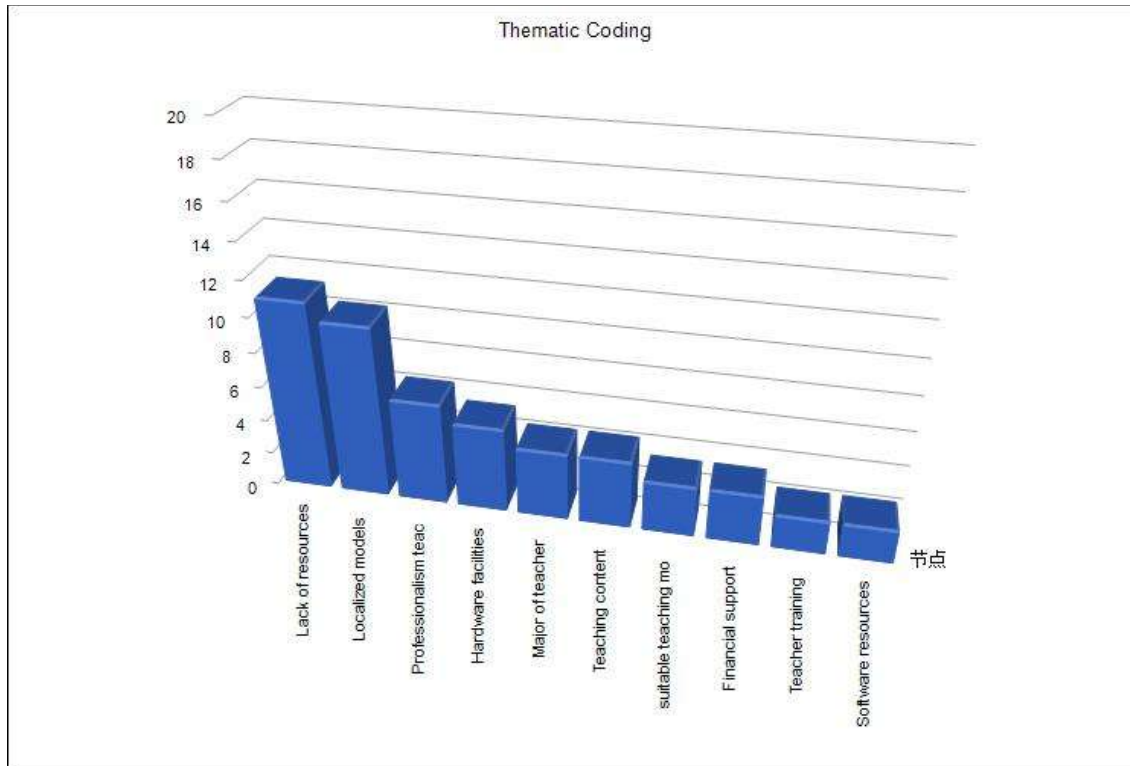


Figure 2:- The frequency of coding by Nvivo 11.

Low professionalism of STEM teachers

Professionalism of teacher is an important organic part of teaching. The lack of teachers in STEM education in this ethnic minority region is one of the main influencing factors for the low quality of STEM education in this region. Participants in the interviews mentioned the professionalism of teachers many times, and many teachers are not satisfied with their professionalism, as T1 mentioned: STEM teachers in our school do not have the right skills mastery, and their interdisciplinary literacy and knowledge integration are low. Although all teachers have participated in STEM vocational training, the number of trainings and the effectiveness of the trainings are unsatisfactory, as mentioned by participant (T10): STEM courses are not the same as traditional courses, and many teachers are not majoring in STEM but transferred from other courses, for example, I taught science courses before, so if the trainings are not in place, the teachers will lack professional skills and professionalism. Participant (T7) also expressed her views on the effectiveness of the training, she said: Our school has several trainings on STEM courses every year, but the trainings are mostly about theories and there is very little practical experience, which leads to a very bad training effect. In fact, the most difficult part of STEM curriculum is integration. Teachers' integration ability cannot be improved by just a few trainings, but requires teachers' own understanding and practice accumulation. Participant (T6) mentioned: There is a lack of curriculum frameworks and instructional materials for STEM education, so teachers can only design the curriculum according to their own understanding, and sometimes they are not sure whether their design is suitable for the students or not, which makes him have a headache in preparing for each lesson.

Lack of localized models of STEM education

Ethnic minority areas are most lacking in successful experiences of localized teaching models and practice models of STEM education. Currently, education models in ethnic minority areas tend to borrow successful teaching models and teaching experiences from other well-developed areas, for example, T8 mentions: I usually refer to some excellent cases to design the curriculum, but these cases come from developed cities such as Beijing and Shanghai, and sometimes these experiences can not be well used in outside schools. For example, programming knowledge is used for modeling in 4th grade, but students in our school don't have this foundation yet. In addition, these STEM teaching models cannot be combined with the unique cultural background of ethnic minority areas, which leads to insufficient combination of theory and practice in the implementation of STEM education, and even the emergence of confusing patterns of STEM education models. Participant (T5) mentioned a meaningful example: there was once a reference

case of the construction of a wheel boat, but our students in Yunnan Province seldom saw a wheel boat, which led to a low level of student interest. Later, I changed the wheel boat into a dragon boat of Yunnan's ethnic minorities, and the familiar cultural context made the students very interested. This example of integrating the local cultural context into the curriculum content and enhancing students' interest is localizing STEM education.

Discussion:-

In order to solve the challenges of STEM education in ethnic minority areas, the first step is to solve the problem of hardware and equipment in schools in ethnic minority areas, which requires strong support from the government. Secondly, from the teachers' point of view, in order to improve the professionalization of STEM teachers, it is necessary to cultivate the lifelong learning concept of STEM teachers. STEM teachers should continuously improve their STEM teaching methods through multiple learning paths and increase the participation of students in STEM teaching activities.

What is most lacking in STEM programs in minority areas is the case of combining STEM with local culture. John Dewey, the famous American pragmatist educator, put forward the concept of education that highlights the outstanding value of contextualization in the education process. STEM education in schools in ethnic minority areas should highly reflect the situational characteristics, so that students can actually feel that STEM education is embodied in their lives. Teachers in the STEM teaching process should be fully integrated with the students' existing national culture and living environment to carry out the teaching, and should not present abstract and isolated STEM knowledge to the students. To this end, the authors found a way to enhance STEM education in ethnic minority areas through literature review - C-STEAM.

On the basis of STEM and STEAM education, Chinese scholars (Zhan, 2020) proposed C-STEAM education in combination with traditional Chinese culture, where C stands for culture, the main purpose is to use local culture to lead education and make the model more adaptable to local STEM education. In Zhan's C-STEAM theory, there is a 6C model that guides the curriculum, which consists of six links, namely Contextual Experience (C1), Connotation Comprehension (C2), Characteristic Inquiry (C3), Create Artifact (C4), Connect Society (C5), and Conclusive Reflection (C6). As shown in Figure 3, there is a somewhat gradual relationship in the sequence from Perception, Understanding, Inquiry, Creation, Extension, to Evaluation, but more emphasis is placed on the interactions and iterations between the activities: there is a kernel-most interaction between C3 and C4, and C2, C3, C4, and C5 form a ring of iterations in the intermediate levels; moreover, C5 provides new opportunities for C1, and C6, the final one, can be the starting point of a new round of C2. The 6C model can guide STEM courses in minority areas. Minority areas have rich and unique cultures. By integrating these C into STEM courses and using the cultural background familiar to students to guide STEM courses, students can learn in an interest. Therefore, in the future, teachers in ethnic minority areas can design STEM courses suitable for local cultures based on the C-STEAM concept.

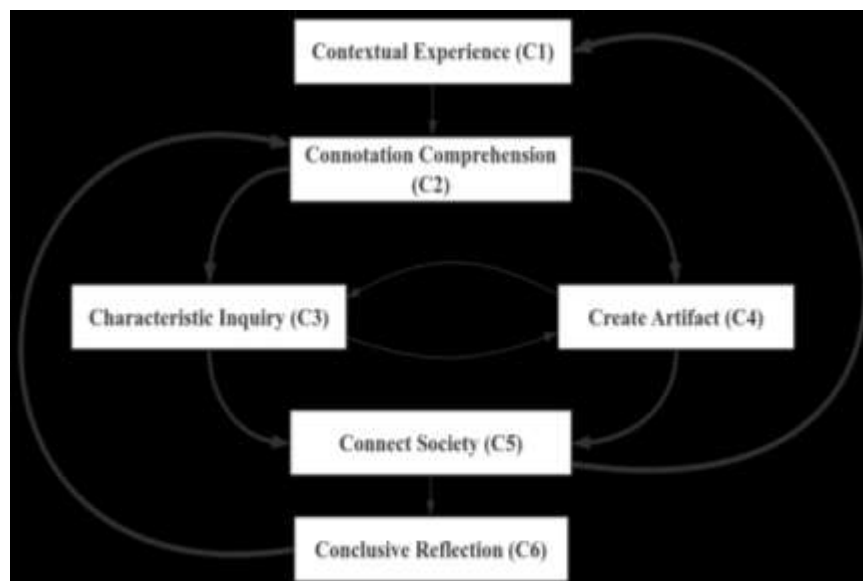


Figure 3:- The 6C model of C-STEAM education.

Conclusion:-

This study interviewed ten experienced STEM course teachers from five public primary schools in Yunnan Province to investigate that STEM education in ethnic minority areas of Yunnan Province is facing challenges such as the scarcity of STEM educational resources, the low professional quality of STEM teachers, and the lack of a local model of STEM education. The educational level in ethnic minority areas of China is relatively backward. In order to promote STEM education in these ethnic minority areas, the author proposed the C-STEAM education theory and explored the use of the unique culture (C) of ethnic minority areas to develop cases and practice STEM courses. Using the culture of ethnic minorities as the core to develop STEM programs is the innovation of this study, and future research directions will also focus on the practical research of the 6C model of the C-STEAM concept.

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