

# Research on challenges and solutions in elementary schools' STEAM education promotion in rural China

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**Abstract.** Science, technology, engineering, art, and mathematics (STEAM) education is one of the effective ways to enhance students' science literacy, and the ability to innovate. Cultivating innovative talents is important for a country to become the world's science and technology powerhouse. Currently, the proportion of China's scientifically literate population is still relatively low, with an imbalance between different demographics, age groups, and economic statuses. To spot more innovative talents, solving the imbalance of STEAM resources is necessary to improve the scientific literacy of students in rural and remote areas. Through field research in Ganzhou, Jiangxi, China, the challenges of the development of STEAM education in rural primary schools were discovered. The lack of teachers, funds, awareness, and guidance in rural primary schools are the main factors that significantly add to the educational inequality between urban and rural areas. This research tries to balance STEAM educational resources, narrow the educational inequality gap between urban and rural areas, and work out some feasible solutions to improve technology and innovation education. The "Rural-urban STEAM Education Teaching Platform" takes advantage of the urban STEAM educational resources to support elementary schools in remote areas.

**Keywords:** STEAM education; Rural education; Elementary education; Education equity; Technology and innovation; Online teaching.

## 1. Introduction

General Secretary Xi Jinping has pointed out: "Science and technology (S&T) innovation and science popularization are the two wings for achieving innovation and development, and we should attach equal importance to science popularization and S&T innovation. Without broad-based improvement of the scientific literacy of all the people, it would be difficult to establish a large high-quality and innovative workforce, and it would be difficult to achieve rapid conversion of S&T achievements into practical applications." [1] Cultivating innovative talents is important for China to become the world's S&T powerhouse. Building scientific literacy in elementary schools is conducive to educating more technological experts. STEAM education is focused on enhancing students' scientific literacy and innovative thinking, scientific inquiry, problem-solving, and practical abilities. Guiding rural students to carry out activities such as invention, scientific experiments, and hands-on exercises can equip more students with innovative scientific literacy, which would promote scientific and technological innovation and help cultivate more innovative talents.

"National Action Plan for Scientific Literacy 2021-2035" mentioned that China has made remarkable progress in improving scientific literacy, but the proportion of the nation's scientifically literate population is still relatively low, with an imbalance between different demographics, age groups, and economic statuses [1]. Compared with urban areas, the STEAM educational resources in rural areas of China are far from satisfying. Schools in remote areas lack STEAM laboratory facilities, equipment, activities, and related courses. The uneven distribution of STEAM educational resources has widened the rural-urban education gap. The lack of teachers, funds, awareness, and guidance in rural primary schools significantly adds to the educational inequality between urban and rural areas. This paper investigates the challenges faced in the promotion of rural STEAM education and tries to work out some feasible solutions to reduce the rural-urban educational disparity.

Building an free online "Rural-urban STEAM Education Teaching Platform" to connect urban high schools and rural primary schools could be a good choice, which takes advantage of the urban STEAM educational resources to support elementary schools in remote areas. The platform integrates

STEAM facilities and innovative teaching methods while recruiting online teaching volunteers from urban high schools and tech clubs. Additionally, the platform needs to cooperate with charitable foundations, tech and education enterprises, universities, and scientific institutions for more resources to ensure the sustainable development of the platform.

## **2. Research Methods and Case Study**

This paper uses the literature research method, questionnaire surveys, personal interviews, and conducted a field research in rural elementary schools in Ganzhou county, Jiangxi province, China. Ganzhou county is a mountainous area covered by forest and regional economic disparities. It has a significant educational inequality gap between urban and rural areas. This study created surveys for students in urban and rural areas and outlined interviews with teachers, principals, and ministry of education executives. Questionnaires were collected from 229 rural primary school students in 2 counties, 1 township, and 5 village schools. Third and fourth graders in these schools experienced a 90-minute innovation class. At the same time, face-to-face interviews were conducted with 8 principals, 4 teachers, 5 students, and some relevant education executives. First, an urban primary school student survey was conducted with 77 students from 52 urban primary schools to compare differences with rural primary schools. Second, an urban secondary school student survey was conducted among 104 students from 61 urban secondary schools to collect urban schools' STEAM resource data and students' interest in participating in online teaching. Finally, the survey results were analyzed by SPSS and excel statistical tools. This study summarizes the current situation of STEAM education in rural areas and proposes solutions for the challenges faced by the promotion of STEAM education in primary schools.

## **3. Current Situation of STEAM Education in Urban and Rural Schools**

### **3.1 Teachers**

The lack of teachers in rural schools makes it difficult for small-scale schools to have specialist teachers in all subjects. In the 6 village primary schools investigated, more than 80% of the teachers in all schools have to teach more than one subject, causing them often to have a large workload. Additionally, all of the science and technology teachers were majoring in adjacent subjects such as mathematics or physics, which means they were not skilled in all subjects they taught. Moreover, most teachers in rural primary schools do not pay attention to the importance of science, technology, and innovation course, making them less willing to carry out STEAM courses in schools.

### **3.2 Facilities**

STEAM laboratory/maker space is an important facility for carrying out STEAM courses and activities. The STEAM laboratory equipment includes 3D printers, laser cutters, CNC machines, soldering irons, and other hands-on materials. In 8 rural primary schools investigated, only 1 county primary school has a STEAM laboratory with insufficient equipment, but offers a few programming and innovation courses, while the other seven elementary schools have neither labs nor related courses. However, the urban student survey shows that 66% of primary schools and 83% of secondary schools in urban areas have different scales of STEAM laboratories and abundant diverse STEAM courses. STEAM laboratories and courses are often equipped and offered in urban schools.

### **3.3 Awareness**

Most parents in rural areas lack understanding of STEAM concepts. Therefore, parents pay less attention to innovative education for their children. A teacher from the country primary school tech club reported that parents' awareness is the main factor in selecting their children's activities and courses. Since most primary school students are not enough to make decisions, parents or guardians help them choose the classes and activities they will attend. However, some rural parents may attach

less importance to STEAM education or have biases toward technology, so they tend to choose activities or courses related to student test scores rather than science literacy. In this case, STEAM activities and courses in rural schools could not attract enough students, not to mention to find potential innovative talents.

### **3.4 Guidance**

To students, the school and family are the main providers of technological and innovative resources. In areas with a high rate of left-behind children, families have insufficient understanding of scientific literacy, making local schools the main guider of STEAM education. Thus, the support of local education executives and school principals can create more opportunities for the development of STEAM education in rural areas. The 90-minute innovation class contains the introduction of innovation, practical activity, and robot performances. It was conducted in 7 rural elementary schools with a survey. The survey shows more than 93% of the students like the class, and about 88% of the students express their interest in continue taking similar courses. Also, 89% of the students believe practical activity is interesting and 83% of the students think learning technology knowledge is important. Based on these results, most rural primary school students are interested in the innovative class, which indicates a high interest and willingness to learn relevant courses. However, the lack of technology and innovation activities and courses in schools made it difficult to satisfy their needs.

## **4. Analysis of the Current Situation of STEAM Education in Rural Schools**

### **4.1 Insufficient Teachers and Training Programs**

Currently, there is an institutionalized barrier to recruiting teachers in rural areas. School teachers are allocated according to the total number of local students, making a lack of teachers in rural schools [2]. Urbanization aggravates the loss of the total number of students in rural areas, further limiting the number of teachers that can be allocated to rural schools. Due to this policy, no additional teachers cannot be recruited, so teachers in rural schools often teach as many subjects as possible. Therefore, rural teachers are not fully competent in all of the subjects. As a result, teachers may be unaware of newer, more applicable methods and educational topics, especially in science and mathematics [3]. Additionally, the remoteness prevents teachers from receiving new concepts and teaching methods, making it difficult to teach students these new concepts effectively. Training projects are an effective way for teachers to solve problems. However, in the 8 primary schools instigated, most rural schools do not provide science or technology education training for teachers. Therefore, most teachers do not have access to professional training in technology or innovative courses, while a minority of science or computer science teachers gain expertise through self-study. This will bring more difficulties to teachers of STEAM classes in rural schools.

### **4.2 Lack of Funds and Facilities**

The construction of the STEAM laboratory facilities requires certain funding. Likewise, STEAM laboratory also requires funding for purchasing equipment, tools, consumable materials, and maintenance costs later on. Additionally, specialized teachers are required to use and teach the use of equipment in the laboratory. Since schools in remote areas generally receive less funding and financial support than urban schools, rural schools are less likely to invest in STEAM laboratories. In the field survey, 6 principals said that their village primary school did not have enough funds to invest in the construction of STEAM laboratories. Moreover, some executives of rural schools do not attach much importance to STEAM education. They are more inclined to invest limited funds to improve students' test scores or physical activities, ignoring the demand for science, technology, and innovation activities.

### 4.3 Lack of Awareness and Support

People who lived in rural and remote areas generally have less information access and low income and educational experiences. Especially in low-income rural areas in China, many children have been left in the care of elderly relatives because their parents go to work in cities. Data show that 56% of students in Ganzhou are cared for by their grandparents. The educational experiences of rural families have shaped their views on the subjects they believe are crucial for their children to learn in school. The caregivers in rural areas, especially the elders, still consider students' grades and test scores as the main measurement of understanding knowledge. STEAM education is the opposite; it mainly focuses on enhancing students' scientific thinking and the ability to innovate, which are usually presented in projects and designs. STEAM education required time, guidance, and some financial investment. Therefore, it is hard for parents to see the result or significant achievement in a short period, and their doubts might cause some parents to drop courses and activities, leaving children with a lack of support from parents and family in learning STEAM.

### 4.4 Absence of Access to STEAM Education

Rural primary school students have little access to STEAM activities. Schools lack in providing innovative courses that can trigger students' interest. The survey result from rural primary schools shows that 58% of students prefer learning by doing, 25% of schools offer science and technology after-school activities, and 28% of schools offer computer courses. Overall, the data reflect that more than half of students show interest in lessons that involved hands-on activities, rather than just studying from textbooks. Less than a third of rural primary schools have science and technology courses or activities. On the contrary, 95% of urban primary schools have science, technology, and innovation activities or courses. Also, urban primary school students mainly learn about STEAM by participating in regularly held science activities, and competitions, and by watching technology videos online. Urban students have more opportunities to learn STEAM courses and innovation activities in different ways.

## 5. Solution for the Development of STEAM Education in Rural Schools

### 5.1 Online Teaching to deal with Teacher Shortage

Online teaching enables rural students to study without limitation to time and place. Online teaching also reduces the financial burden on students and improves accessibility in rural areas [4]. Rural students can take STEAM online courses through multi-media devices in schools. In recent years, the construction of informatization infrastructure and equipment in primary and secondary schools in China has been further improved. Investigation shows that all 8 rural primary schools in Ganzhou had access to the internet, multi-media teaching devices, and the online education system "Ban Ban Tong", which is available for online teaching. Recruiting online teaching volunteers from urban high schools could be a good choice. Urban high school students are capable to teach technology and innovation courses after learning and training. A survey of urban secondary school students showed that 74% of the students had participated in technical courses or activities, indicating that urban secondary school students have relevant knowledge and experience in STEAM education. Additionally, 91% of students have contributed to their schools through community services. 20% of students have volunteered for teaching in local rural primary schools, and most of them are from high school. These data imply that urban high school students have the potential to qualify for being STEAM online teaching volunteers after training. Moreover, the survey investigated students' interest in being online teaching volunteers. 85% of students would like to participate in online teaching and 95% of students are willing to attend teaching training. The shortage of rural teachers can be alleviated by introducing more high school volunteers to online teaching. The "Rural-urban STEAM Education Teaching Platform" recruits urban high school student volunteers as teacher resources. The high school teachers and clubs are responsible for the selection and training of teaching

volunteers and establishing a standardized STEAM online teaching system and curriculum. Adopting the short-term rural teaching activities into a more sustainable online teaching to ensure adequate STEAM teachers of rural primary schools.

### **5.2 Sharing Resources to make up for Facilities Shortage**

Compared with rural schools, urban schools have more STEAM laboratories, advanced equipment, and experienced teachers. The survey shows that 83% of the urban secondary schools have fully equipped STEAM laboratories or maker spaces that allow students to innovate, learn, and explore STEAM activities. Besides, urban secondary school students use STEAM laboratory equipment for various courses and clubs including computer science, robotics, model aircraft, innovation, artificial intelligence, and other technological and innovative activities. Volunteers can help rural students to make teaching tools or prototypes using STEAM equipment and then deliver them to rural schools, allowing rural students to materialize their ideas during online learning. At the same time, the platform needs to cooperate with charitable foundations, tech and education enterprises, universities, and scientific institutions for sponsorship of consumable materials, and teaching tools. These sponsors can ensure the sustainable development of the platform by providing operation funds.

### **5.3 Popularize STEAM Competitions to Attract Participants**

Competitions can better develop students' science literacy and enhance their STEAM skills. In September 2021, the Ministry of Education in China announced the national competition list of 36 competitions for primary and secondary school students [9]. Most of the competitions focus on enhancing students' scientific thinking and the ability to innovate. The Chinese government is cultivating the comprehensive ability of young people through competition, especially in the field of scientific and technological innovation. Currently, most of these competitions are hosted by regions with a comparatively prosperous economy, which makes it difficult for rural students to attend due to financial burdens. This has resulted in lower participation of students in remote areas, which continues to widen the disparity in STEAM education for urban and rural students. Therefore, by promoting STEAM competitions in rural areas and encouraging more participants, more innovative talents can be discovered from competitions. Competition awards and achievements can attract more attention toward STEAM education from local education executives, school leaders, and parents which attracts more participants to technological and innovative activities.

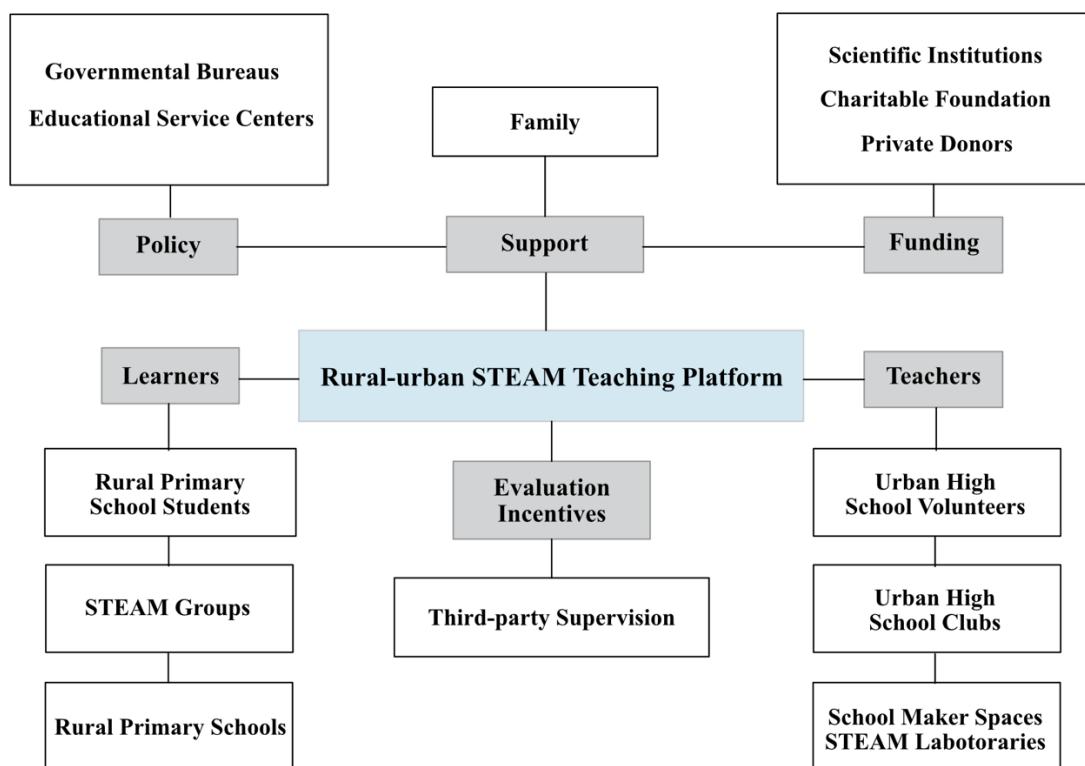
### **5.4 Innovative Teaching Methods to Improve Engagement of Learning**

Different from traditional teaching methods, innovative teaching methods can better encourage students to participate actively and interact with classmates and teachers. On one hand, online teaching allows volunteers to teach in several ways such as videos, pictures, animations, and models. Using colorful and catchy content and real-time communication can facilitate students to concentrate more in the class and make them more interested in the subject. Asking questions and giving course feedback in the group chat can also improve the interaction and teaching quality. On the other hand, the project-based learning method can promote students to explore the unknown and overcome problems through group discussions, cooperation, investigation, innovation, and iteration, arousing students' intrinsic motivation for learning [5]. In order to maintain students' long-term teaching satisfaction, a general evaluation and incentive mechanism should be established.

### **5.5 Additional Explanations and Suggestions**

To ensure the high-quality teaching, safety, and sustainability of the "Rural-urban STEAM Education Teaching Platform", establishing a long-term management mechanism is needed. Details are as follows: 1) For rural primary schools, an adult assistant is needed in the classroom to manage and supervise students during online teaching. First, assistants should ensure that students use tools safely during hands-on activities. Second, assistants need to collect students' feedback, work, and designs and upload them on the platform. 2) For urban high schools, high-quality teaching and long-

term enthusiasm for volunteers can be ensured by establishing a selection and training mechanism and meanwhile providing students with incentives such as service hours, credits, and certificates. For the sustainability of the teaching program, senior volunteers can share their teaching experience and resources with young volunteers before graduation, allowing young volunteers to continue to develop and improve teaching while promoting the platform. 3) With regard to safety, the platform needs to invite third-party professionals and form a group to evaluate the teaching content with an evaluation mechanism. Inviting public organizations, scientific institutions, or schools to endorse the platform and supervise the legitimate operation of the platform. Overall, the platform provides two-way free learning and benefiting multiple stakeholders. Volunteers can gain social experience and enhance their teaching, communication, organizational, and other skills during online teaching while rural primary school students can improve their scientific literacy.



**Fig. 1** Rural-urban STEAM Teaching Platform Diagram

## 6. Conclusion

To further promote the cultivation of innovative talents, it is necessary to solve the uneven distribution of STEAM resources by narrowing the educational inequality gap between urban and rural areas. This study investigates the main factors of the challenges in the development of primary school STEAM education in rural China and proposes to build the online "Rural-urban STEAM Education Teaching Platform". This platform might be a workable solution for tackling the challenges of STEAM education in rural primary schools across the country.

The "Rural-urban STEAM Education Teaching Platform" integrates existing resources in rural and urban areas, moving forward with the goal of benefiting stakeholders. Tilting urban high-quality educational resources toward rural areas to achieve the sharing of rural-urban STEAM educational resources. Thus, the platform can effectively alleviate the imbalance in educational resources, and better promotes STEAM education in rural areas.

In addition, the research has been conducted in only 8 primary schools in Ganzhou, Jiangxi, China. More potential challenges to the development of primary school STEAM education in rural China could be found. The proposed solution is still in the research stage and the platform has not been set up yet. Therefore, the platform needs to be verified and updated before being implemented.

With the promotion of technology and innovation education across the country, the STEAM education system for primary and secondary schools will be better in the future. Therefore, tackling the challenges to the promotion of STEAM education in rural schools is significant in reducing the rural-urban educational imbalance, which would educate more innovative talents to further enhance China's future scientific and technological development. Finally, because the platform is a non-profit organization, more support from the government and social organizations is needed to make a greater impact and promote STEAM education in more schools in rural China. Overall, the platform aims to accelerate China's independent innovation and strengthen its tech-driven and innovation-driven development.

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