

FEASIBILITY STUDY FOR THE USE OF STEAM EDUCATION IN CHINA'S EDUCATION REFORM

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Abstract

This research aims to analyze the use of STEAM (Science, Technology, Engineering, Arts, Mathematics) education and the principles of the second classroom in less developed regions, focusing on educators. The research objectives were: 1) To investigate and analyze the current understanding and implementation of STEAM education and the second classroom among educators, particularly in more backward areas, and identify the challenges and gaps in their theoretical and practical experience. 2) To explore students thoroughly and understand the current learning and teaching state in the context of bioscience education in STEAM Education. 3) To explore and develop practical teaching activities and interdisciplinary research cases that incorporate STEAM education and second classroom principles in high school biology education, to provide first-line teachers with practical examples and other researchers with case studies for further investigation, and 4) To examine the impact of integrating STEAM education concepts and second classroom activities on the professional development of teachers and the holistic growth of students, focusing on transforming teaching and learning styles and addressing the limitations of traditional teaching methods in promoting integrated student capabilities.

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The population is students in secondary schools in Shenzhen, China. The sample size was 323 students, selected by simple random sampling in 4 majors: Science, Technology, Engineering, Arts, and Mathematics.

The research result shows that 1) students in second-classroom activities can effectively complement conventional teaching methods, which often need more nurturing all-around abilities in students. 2) Teacher surveys and interviews conducted in a secondary school require a more profound comprehension of STEAM education's philosophy, even though there is a general agreement on its prospective advantage in classroom teaching. Furthermore, most students (74.04% and 85.1%) express a wish and requirement for more practical and experiential learning opportunities via second-class biology activities. 3) Feasibility studies, including environmental scans of the school and textbook content analyses, confirm the possibility of executing second classroom activities that align with STEAM education ideals in the selected school. 4) The integration of STEAM education in the study reveals that students exhibit more interest and positive attitudes towards the second classroom, with an increased interest rate of 81.5%. Teachers are encouraged to utilize the second classroom to support traditional classroom teaching. The research concludes that the fusion of STEAM education concepts into second-classroom activities can positively influence high school biology teaching, encourage teacher professional growth, and stimulate comprehensive student development.

Keywords: STEAM education, high school biology, the second classroom, Town High School

Introduction

As part of China's recent educational reform, the Ministry of Education advocates an integrated approach across disciplines and learning environments, emphasizing student training in innovation, practical skills, and social

responsibility. This involves weaving together various subjects, conducting cross-curricular thematic activities, and using social resources effectively for well-rounded student development. Biology, a natural science deeply intertwined with daily life, environmental protection, and healthcare, overlaps with other fields like physics, chemistry, and mathematics. It's also connected to information and engineering technology. Thus, the High School Biology Curriculum Standard (2017 edition) encourages teachers to incorporate diverse knowledge and skills, especially from STEM fields, and relate biology with daily life experiences. While the reform has led to a wide variety of biology classes and school-specific courses, challenges still need to be addressed in less developed or remote areas where implementation lags and student development requires enhancement. The need for tailored classroom strategies aligns with the STEAM education concept from the United States, which advocates interdisciplinary teaching for lifelong learning. However, the current college entrance system only partially supports STEAM courses in regular classes in ordinary town high schools. This issue could be addressed through a second Korean classroom approach, in which teachers arrange activities beyond average class time to supplement learning and develop student competence.

Therefore, this study aims to integrate the STEAM education concept into the secondary classrooms of ordinary town high school students in Shenzhen, China, designing and implementing locally appropriate teaching activities.

Research Objectives

1. To investigate and analyze the current understanding and implementation of STEAM education and the second classroom among educators, particularly in more backward areas, and identify the challenges and gaps in their theoretical and practical experience.

2. The explore students thoroughly understand the current learning and teaching state in the context of bioscience education in STEAM Education
3. To explore and develop practical teaching activities and interdisciplinary research cases that incorporate STEAM education and second classroom principles in high school biology education, to provide first-line teachers with practical examples and other researchers with case studies for further investigation.
4. To examine the impact of integrating STEAM education concepts and second classroom activities on the professional development of teachers and the holistic growth of students, focusing on transforming teaching and learning styles and addressing the limitations of traditional teaching methods in promoting integrated student capabilities.

Literature Review

The Concept of STEAM Education

STEAM education, gaining global popularity and accelerating in China, comprises diverse fields like drone technology, robotics, 3D printing, and LEGO education. However, it's often mistakenly equated with programming and robotics education alone. Unlike traditional education methods, STEAM is a cross-disciplinary approach that situates students in real-world scenarios. It relies on tool utilization and self-motivated problem-solving, encouraging group collaboration. It promotes learning through mistakes, encouraging varied perspectives and application of knowledge to real-life situations. Evaluation in STEAM is comprehensive, paying attention to learning results and processes.

Three primary teaching models in STEAM are:

5E Model: Based on constructivist theory, it includes five phases: Engage, Explore, Explain, Apply, and Evaluate. It puts students at the center, motivating them to explore and understand scientific concepts, link ideas, deepen their

understanding through the application, and perform self-assessment and teacher evaluations.

6E Model: An advancement of the 5E model, the 6E model incorporates 'Engineering' to better reflect the STEAM approach. It comprises Engage, Explore, Explain, Engineer, Enrich, and Evaluate stages. Students learn scientific exploration processes and use engineering techniques to solve problems, providing learning evidence using an engineering design manual.

PBL (Project/Problem-Based Learning) Model: Commonly used in STEAM education, the PBL model promotes the formation of diverse learning groups. Unlike traditional teaching, it is student-focused, with the teacher as a guide. The model divides into three stages: Pre-work, Process Implementation, and Summary Assessment. Teachers pre-identify projects or problems and provide resources. Students, working in groups, collaborate to address these projects or issues, culminating in presentations and comprehensive evaluations by the teacher.

The Concept of the second classroom

First mentioned by Chinese educationist Zhu Jiuhe in 1983, the “second classroom” concept has gained recognition. It refers to teaching activities related to the traditional curriculum but conducted outside the time and space boundaries of the typical classroom, hence named the “second channel.” The content, while stemming from teaching materials, is open to them. It doesn't entail exams but forms a critical component of quality education. Learning in the second classroom can occur anywhere - in the classroom, on the playground, within the school, in society, or at home. While the double classroom supplements and extends the first, it possesses distinctive features:

Practicality: The second classroom enhances students' comprehensive qualities through hands-on activities. Students apply their knowledge to real-world problems, learning and reshaping their knowledge structure.

Flexibility: The second classroom can be tailored to students' specific needs. Students can choose their activities and set their time and place. This flexibility extends to content, timing, and space, unlike in the traditional classroom.

Collaboration: Many activities in the second classroom necessitate team cooperation. They can involve parent and teacher participation, fostering a "home-school community." Successful partnership determines the effectiveness of the second classroom activities.

Engagement: Second classroom activities are designed to promote active student participation. These activities can range from cooking to performance arts, appealing to students' interests and stimulating their competitive spirit.

In conclusion, the second classroom shares similar developmental traits with STEAM education. Theoretically, it can be effectively integrated with the secondary school biology concept under the STEAM framework.

Research Methodology

Population and Sample

In this study, the researcher was interested in studying the students in secondary schools in Shenzhen, China. The main body of the second classroom is the students.

Population

The population of this research researcher is studying students in secondary schools in Shenzhen, China, with unknown people.

Sample Group

The sampling size in this research, the researcher used Cochran's formula (Cochran, 1977), is 323 samples.

Data collection tools

The survey was conducted by the QQ group of the top 1 and the second grade of the top 2. A total of 213 questionnaires were collected, of which five copies were invalid (all selected) (A), a good volume of 208 documents, and a valid questionnaire rate of 97.65%.

Research Result

1. The result of understanding and implementing STEAM education and the second classroom among educators, particularly in more backward areas, and identifying the challenges and gaps in their theoretical and practical experience.

Dimension 1: The student's attitude and understanding of biological subjects are as follows

Table 1 Students' attitudes And Understanding of Biological Subjects

Problem	Options			
Do you like biology?	A Love it 33.17%	B generally prefers 41.35%	C didn't feel 22.6%	D aversion 2.88%
You think creatures and others Interdisciplinary is much connected	A very many 9.62%	B more 33.65%	C less 51.92%	D No contact 4.81%

Table 1 indicates that 74.52% of students display a "very" or "general" positive attitude towards biological subjects, while 22.6% remain "indifferent," and 2.88% express "dislike." Therefore, while most W secondary school students have a

positive outlook towards bioscience, about a quarter show no interest or even an aversion, leaving room for improvement in fostering students' interest in the subject.

Regarding integrating biological content with other subjects, 43.27% of students recognize a high degree of overlap, 51.92% perceive less overlap, and 4.81% feel no connection between biology and other disciplines. Despite this, most students acknowledge the link between biology and other fields, offering a foundation for implementing STEAM education. Nonetheless, teachers must guide students to uncover connections with different subjects and encourage problem-solving using interdisciplinary knowledge during this implementation.

2 The result of practical teaching activities and interdisciplinary research cases incorporating STEAM education and second classroom principles in high school biology education provides first-line teachers with practical examples and other researchers with case studies for further investigation.

Dimension 2: Learning about student biometrics

This dimension includes four questions: Do you think high school biology is difficult to learn? What is your traditional learning style in biological lessons? Are you satisfied with how you teach your current physical classes? 4. will you learn about biology outside of the session? The answers to the questions are listed in turn as follows:

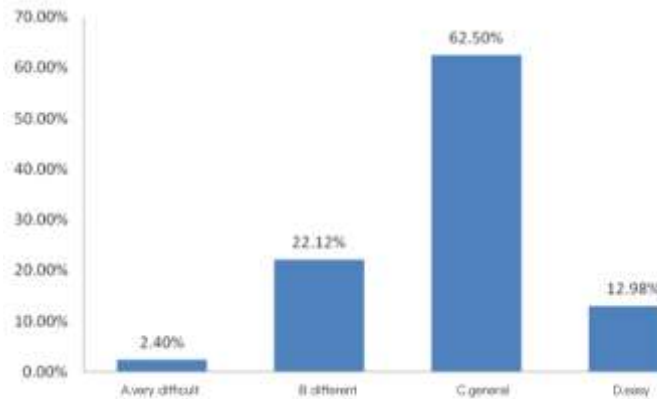


Figure 1 Students' Learning about Biological Knowledge

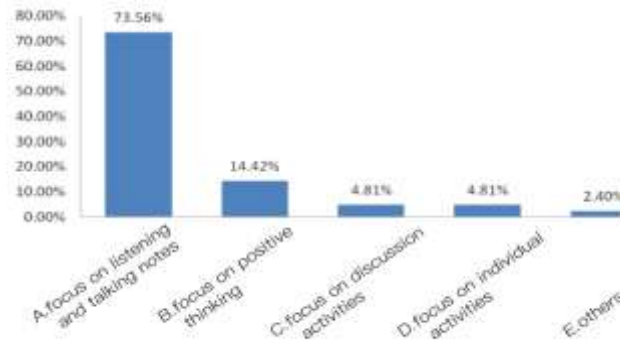


Figure 2 The main learning styles for student biology

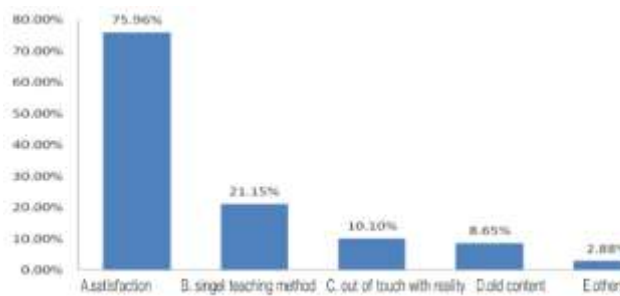


Figure 3 How Students Feel about Teaching Biology

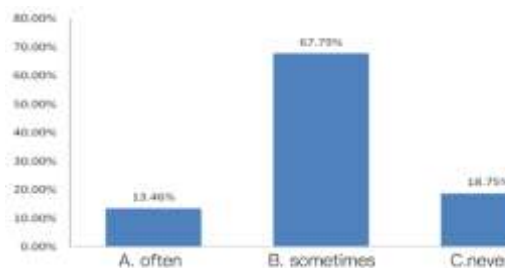


Figure 4 Biology of Student Extracurricular Learning

Figure 1 shows that most students consider bioscience knowledge a general difficulty; a few feel it difficult, and a few find it difficult. Regarding learning methods (Figure 2), 73.56% of students mainly listen and take notes, 19.23% are especially thinking and discussing, and 7.21% are mostly personal activities. Regarding teaching methods (Figure 3), 75.96% of students are satisfied, 24.04% are dissatisfied, and think that teaching methods are too single, away from reality, and the teaching content is slightly dull and outdated. As for extra-curricular learning (Figure 4), only 13.46% of students are learning biological knowledge, 18.75% are learning almost non-extracurricular, and the remaining 67.79% are occasionally studying. Most students in the school are generally still in a passive learning state. They are accustomed to the traditional teaching methods of teachers and the teaching of extracurricular studies; the emotional energy of the study needs to be more. Therefore, teachers must actively explore teaching methods adapted to the times and cultivate talented people who are active in learning, have innovative thinking and practical ability, and can adjust to the future social life.

3. The result integrating STEAM education concepts and second classroom activities on teachers' professional development and students' holistic growth, focusing on transforming teaching and learning styles and addressing the limitations of traditional teaching methods in promoting integrated student capabilities.

Dimension three: How well the students understand the second class

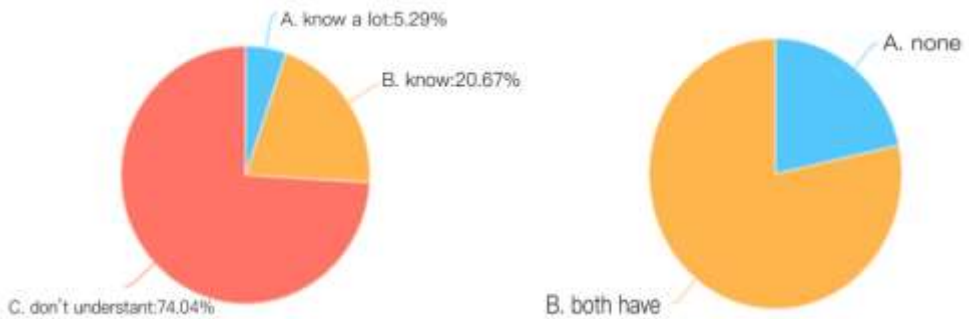


Figure 5 Students' knowledge of the second classroom activity

As shown in figures 4-5, most W secondary school students need to learn in the second classroom, and there are few similar second classes in previous schools in the event. Therefore, practical research for the second classroom activity in W secondary schools has some innovative and research value.

4. The result is the impact of integrating STEAM education concepts and second classroom activities on the professional development of teachers and the holistic growth of students, focusing on transforming teaching and learning styles and addressing the limitations of traditional teaching methods in promoting integrated student capabilities.

Dimension 4: Students' interest in conducting a second class in biology, Attitude, and expectations

Three questions are set up in this dimension: Do you think it is necessary to conduct the second-high school biology class? If you run a second-high school biology class, what form would you like the content to appear in the course? What do you want to get from the second class of high school

creatures? The first question is the survey results, which are as follows:

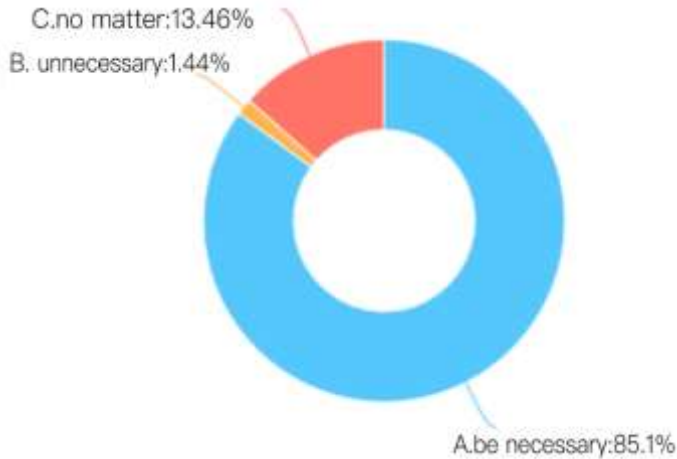


Figure 6 Students' attitude toward conducting a second class in biology

As can be seen from Figure 6, 85.1 percent of the students surveyed considered it necessary to conduct a second class of biology at the high school level, which was 13.46 percent of Students were not concerned about it, and only 1.44 percent of students felt they do not need to do it. Overall, students have a more positive attitude toward the second classroom and have shown greater interest. Teachers can try to conduct the second classroom to assist the first class. The second question was designed to understand the student's preferences for the content of the second class and therefore was set to select multiple options. The results are as follows:

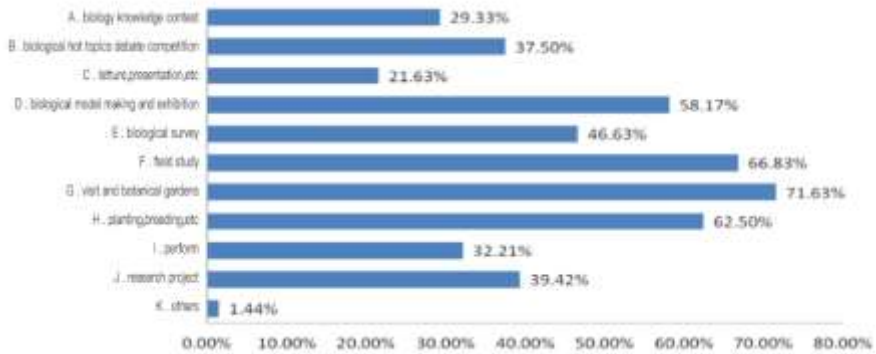


Figure 7 Students' preference for conducting a second class

According to Figure 7, students in W secondary schools tend to visit the movement, botanical gardens, field visits, cultivation, and culture; the second class, such as "modeling," also has a positive attitude toward the second class, such as "research," "probe," "performance," and so on. The second class, "lecture, report," and "knowledge contest classes," has the slightest interest in the second class. Explain that students are more interested in hands-on and hands-on second classes, which teachers can try to run on a practical basis. The third question was designed to understand the student's expectations for the second classroom, and the results are as follows:

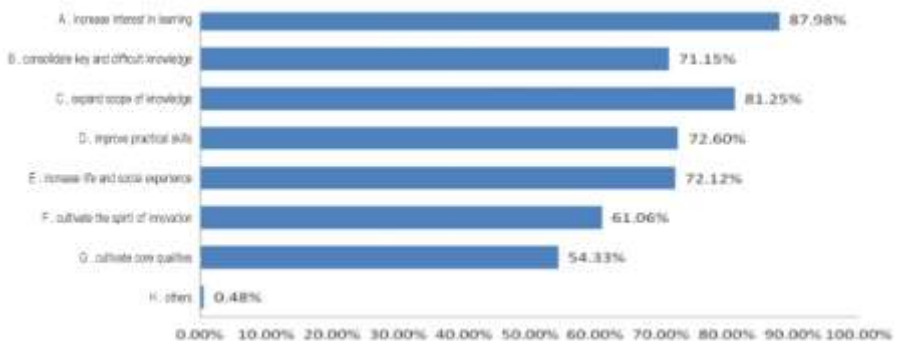


Figure 8 Students' expectations for the second classroom

As shown in Figure 8, students are primarily interested in “learning,” “developing knowledge of biology,” “Upgrading practical skills,” “increasing life and social experience,” and “consolidating heavy and difficult knowledge,” Second, we hope to “cultivate the innovative spirit” and “cultivate core culture” in the activities. From dimension 4, students have a high interest and higher expectations in developing secondary school biological classes, and teachers can actively engage in activities and Practice.

In summary, the content of the biological teaching materials of high school, the range of the teaching materials of W secondary school, Internal conditions, and student needs analysis show that the second class of high school life in W secondary schools and similar town schools is entirely feasible and necessary based on the steam education concept.

Conclusion

Summary of Finding

In the new college entrance exam and curriculum reform context, high school biology teaching needs to develop students' core and comprehensive abilities. Traditional first-class teaching in ordinary urban high schools may need to meet this training goal. However, STEAM education and second-classroom activities can promote learning, increase students' interest, and reinforce first-class content. After exploring suitable teaching methods, the study attempted to integrate STEAM education with the second classroom concept in high school biology. The findings are summarized as follows:

1. Understanding and Implementation of STEAM and Second Classroom Concepts Among Educators

Most educators, especially in more backward areas, still need help understanding and implementing STEAM education and the second classroom. Identifying these gaps in their theoretical and practical experiences is essential to devise effective

strategies. In addition, students' attitudes and understanding of biological subjects vary, with a significant number expressing indifference or even aversion. This variation presents an opportunity to develop research to foster students' interest in biology.

2. Implementation of Practical Teaching Activities and Interdisciplinary Cases

The study reveals that incorporating STEAM education and second-classroom principles in high school biology education can provide teachers with practical examples and researchers with case studies for further investigation. The survey responses also indicate dissatisfaction with the teaching methods, with students finding them too singular, detached from reality, and slightly dull. Only a few fractions of students pursue extracurricular learning of biological knowledge, suggesting the need for more engaging and relevant teaching methods.

3. Impact on Teachers' Professional Development and Students' Holistic Growth

Integrating STEAM education concepts and second classroom activities can transform teaching and learning styles. This approach can also address the limitations of traditional teaching methods in promoting integrated student capabilities. Most students at W secondary school see the value in the second classroom and view it as a necessary complement to the first class.

4. Impact on Professional Development of Teachers and Holistic Growth of Students

Most students believe in the necessity of second-classroom biology activities at the high school level. They show a more positive attitude towards such movements, indicating that teachers should consider implementing second-classroom strategies to supplement first-class teachings. Students also express interest in hands-on and experiential second-classroom activities like visits to botanical gardens, cultivation, and modeling. Teachers can take these preferences into account when planning second classroom activities.

From these findings, it's clear that students have high interest and expectations in implementing second-classroom biology classes. This suggests that teachers can actively engage in such activities and practices to promote holistic growth and a more integrated understanding of biology.

Discussion

The current study's discussion unveils various gaps and challenges in implementing STEAM (Science, Technology, Engineering, Arts, and Mathematics) education and second classroom activities. Teachers often need a deeper understanding of the philosophy behind STEAM education and its implementation, as it is still relatively new and primarily limited to large cities

1). This lack of understanding extends to the students who need help integrating interdisciplinary knowledge 2). While STEAM education aims to equip students to solve real-world problems using knowledge from various fields, current teaching practices often only incorporate this concept into single-disciplinary classroom teaching. As a result, students need help to apply secondary knowledge effectively in their activities. The second classroom activity's conduct should be more valued 3). Even simple activities require time and effort to plan and execute, which can be overlooked in the high-stakes environment of standardized testing. Adding to this challenge, the conditions necessary for second-classroom activities, such as financial support and resources, often must be improved 4). Finally, the current evaluation system for these activities needs to be completed and subjective as it is challenging to quantify the performance of the groups, and the evaluation dimensions need to be diversified. Overall, it is clear that the systems supporting STEAM education and second classroom activities need continuous exploration and refinement.

Recommendation

The study recommends strategies at both the school and teacher levels to enhance the effectiveness of STEAM education and second-classroom activities. Schools should bolster research and development of school-based courses, improve conditions for second-classroom activities, and provide financial and organizational support. They should enhance communication with families and society to promote a cooperative learning community. Schools should also offer training opportunities to address the shortage of STEAM educators and keep them updated on the latest STEAM concepts. Furthermore, they should respect teachers' autonomy in teaching and encourage them to carry out second-classroom activities.

As the direct promoters of teaching activities, teachers should adopt a lifelong learning mindset, actively participate in training, and embrace new teaching concepts. Teachers should design suitable second classroom activities based on their teaching content analysis, considering students' characteristics and abilities, resource availability, and balance between first classroom sessions and second classroom activities. Teachers should encourage students to be actively involved in learning, innovate, and be creative. Lastly, they should establish a comprehensive, diverse, and easily implementable evaluation system, and they should consistently reflect on the activities and address any issues for better planning in the future.

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