

The Current Situation of STEAM Education for Youth and Research on the Operation Mode of the Industry

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Abstract

STEAM education, as a comprehensive education integrating science, technology, engineering, art and mathematics, is an innovative education model in today's information age. STEAM as a new education concept started late in China and has not yet formed a comprehensive education ecosystem because of its short development time. This paper takes the current development status of STEAM education in China as the starting point, analyzes and studies the model and characteristics of STEAM education in China, the development trend and the three business models (to B, to C and to S) of STEAM education operating in the Chinese market, and combines the relevant education policies and education reform measures in China in the new era to make sustainable development of STEAM education in China. The study will also be combined with China's education policies and education reform measures in the new era, and will provide an outlook on the sustainable development of STEAM education in China.

Keywords

STEAM education curriculum system; Business operation mode; Educational institutions; STEAM education in schools.

1. Background

The prototype of STEAM education is STEM education, which stands for Science, Technology, Engineering, and Mathematics, and was proposed by the National Science Board in the 1980s and recommended to be developed into a national strategy to enable more students to higher education to choose STEM-related disciplines in order to maintain the U.S. leadership in science and technology innovation and international competitiveness. The STEM education philosophy emphasizes breaking down disciplinary boundaries and developing students' integrated literacy [1] meets students' creative and personalized learning needs by integrating and applying disciplinary literacy to solve real-world problems while fostering complex talent. In 2016, the Georgette Yakman et al. address the lack of creativity and innovation among American college students and the lack of emphasis on the humanities and arts and sciences in school education to form a STEAM model based on STEM education by integrating the humanities disciplines (Arts) including art and music into STEM, to stimulate students' creative inspiration and teach them to use , to stimulate students' creativity and teach them to use "design thinking" to solve problems in the actual curriculum, as well as to increase the fun, contextual and artistic aspects of the curriculum, and to promote cultural change by revitalizing education [2-4].

At present, many countries in the world have formulated relevant policies and launched STEAM education, covering a wide range of subjects, among which STEAM education in the United States is the most typical. The U.S. STEAM education model forms an ecosystem of STEAM education for youth jointly constructed by government, family and society, with the three

parties jointly promoting the implementation and implementation of STEAM and providing perfect after-school training services for youth. The federal government and state governments' special grants are one of the important sources of funding in STEAM education, providing strong financial support and guarantee for the development of STEAM education. In the U.S., teaching for fun is the core learning method of STEAM teaching in the U.S. After-school services, community schools, and summer camps are the main scenes of STEAM learning. This student-centered, multi-participant education model not only provides rich STEAM resources and after-school services for youth, but also builds a good STEAM learning platform for youth [5]. As a large education country, China has introduced the STEAM teaching concept late and developed for a short period of time, and the education model is still based on examination-based education. At present, the existing STEAM education and learning in China is only for some educational technology, products and service provision. The main course providers in the market are educational institutions and corporate companies, etc. Basic education general colleges and universities have not yet formed a comprehensive teaching and education training system, weak teachers, lack of corresponding education assessment mechanism, more interest-oriented, focusing on knowledge teaching, hardware facilities still need to be improved. With the support of policies, the business models of these course providers are being improved and developed in practice. In the future, more efforts are needed in the use of technology to provide youth with convenient and easy-to-use STEAM learning tools and to seize the opportunity of education reform for continuous development [6–7].

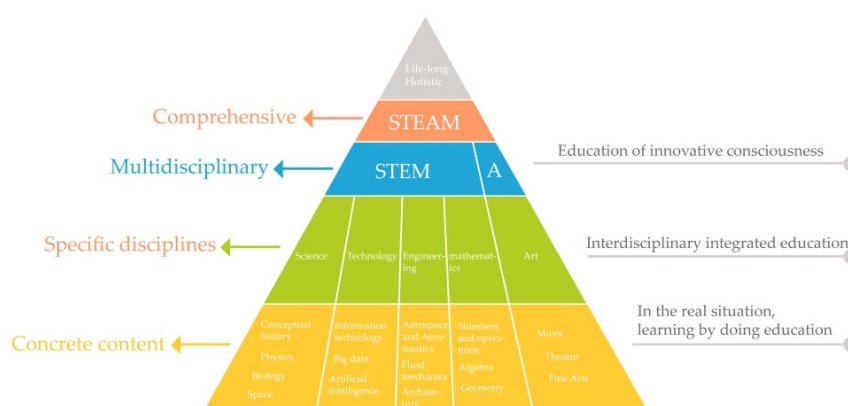


Figure 1. STEAM Education Pyramid

2. Overview of the Development of STEAM Education in China

In China, STEAM education has gone through a long journey from the nascent stage to the formation of a Chinese STEAM education ecosystem and various business models of STEAM education. The influencing factors include not only the implementation of relevant education policies and the improvement of economic consumption level, but also the change of the new generation of parents' philosophy towards their children's education.

2.1. The Development of STEAM Education in China

In order to cultivate new socialist people who can adapt to the needs of modernization in the 21st century, in 1999, the Decision of the State Council of the Central Committee of the Communist Party of China on Carrying Out Deepening Education Reform and Promoting Quality Education Comprehensively was introduced, and improving national quality became a requirement of the new era, providing good social conditions for the development of STEAM education in China.

In 2000, LEGO entered the Chinese market, starting the nascent stage of science and innovation quality education in China, and some robotics manufacturers began to deliver robotics products to schools. 2006, the first LEGO activity center was opened in Shanghai, and science and innovation quality education gradually came into people's view. 2010, LEGO and China's Ministry of Education reached a cooperation, and jointly launched the "Technology Education Innovation Talent Training Program", so that LEGO robotics teaching aids gradually entered primary and secondary school classrooms, and robotics education institutions represented by LEGO also began to launch related robotics courses [8–9]. 2014-2015, the concept of STEAM education gradually entered primary and secondary school classrooms. From 2014 to 2015, the concept of STEAM education began to be introduced into China, as shown in Figure 2, in 2014, the curriculum of science and technology education in China started from the beginning A single hardware (programming) class was added to the science literacy class, and sports, art, and technology programs were introduced, making science literacy products enter the campus. Subsequently, software programming classes were developed based on the science literacy classes, and this period became an important stage in the development of STEAM education in China [10]. In September, Premier Li Keqiang clearly put forward the call of "mass entrepreneurship and innovation" at the Summer Davos Forum, attaching importance to cultivating the quality of science and technology culture for all people, promoting the vigorous development of China's science popularization, focusing on enhancing the youth's innovation awareness and practical ability, and thus setting off a boom in the development of science and innovation education in China, promoting the national [11].

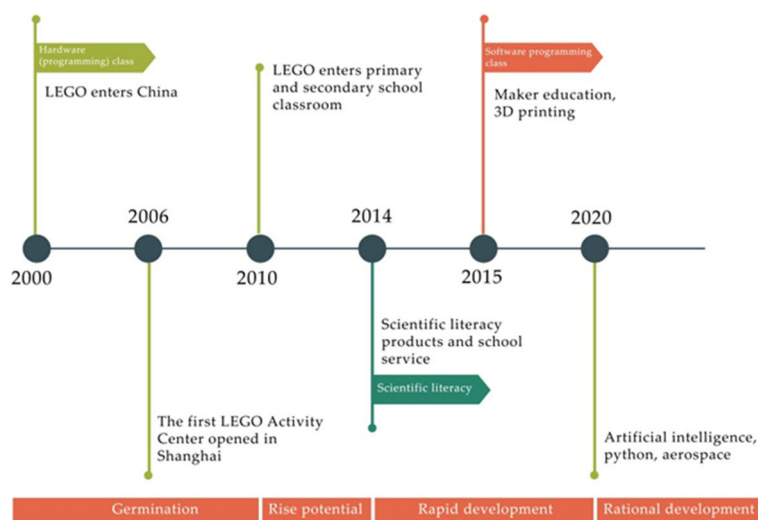


Figure 2. History of STEAM education development in China

In 2015, the Ministry of Education of the People's Republic of China clearly pointed out in the "Guidance on Comprehensively and Deeply Promoting Education Informatization during the 13th Five-Year Plan" (hereinafter referred to as the "13th Five-Year Plan") that the study of Explore STEAM teaching, creative education and other new curriculum education models, and become the core driving force for the development of STEAM education, in which "3D printing" was included in the "13th Five-Year Plan" national important outline, emphasizing the importance of "3D 3D printing" is included in the "13th Five-Year Plan" national outline, which emphasizes the importance of "3D printing technology". The integration of "3D printing" and the education model advocated by STEAM, which has a high degree of independent innovation, has promoted the rapid development of STEAM education in China [12]. Along with the rapid development of online education, software programming has emerged, and the influx of

entrepreneurs and capital has continued to increase the popularity of artificial intelligence and Python, which has led to a rapid growth of STEAM education in China. Zhejiang Province will include information technology into the optional subjects. In 2021, the introduction of the "double reduction" policy and after-school services will promote the two-way expansion of STEAM education supply and demand in China, and the new curriculum reform and enrollment evaluation reform will make people turn their attention to STEAM education. The new curriculum reform and enrollment evaluation will shift people's attention to STEAM education, from the traditional education model to improving the scientific literacy and comprehensive quality of youth, providing opportunities for the development of STEAM education. As the times continue to progress, the STEAM education model in China will also usher in a rational development stage in the following years, and the integration between science literacy, robotics programming and software programming courses will become more and more advanced.

2.2. Opportunities for the Development of STEAM Education in China

The rising level of education consumption ability of Chinese residents provides opportunities for the development of STEAM education. According to the official website of the National Bureau of Statistics of China (Figure 3), the per capita consumption expenditure and per capita consumption expenditure on education, culture and entertainment have been increasing year by year, and the consumption ability of residents has been increasing. Although, in 2020, education consumption expenditure has decreased due to the impact of the new crown epidemic, the overall trend is still up, so STEAM education still has ample room for development.

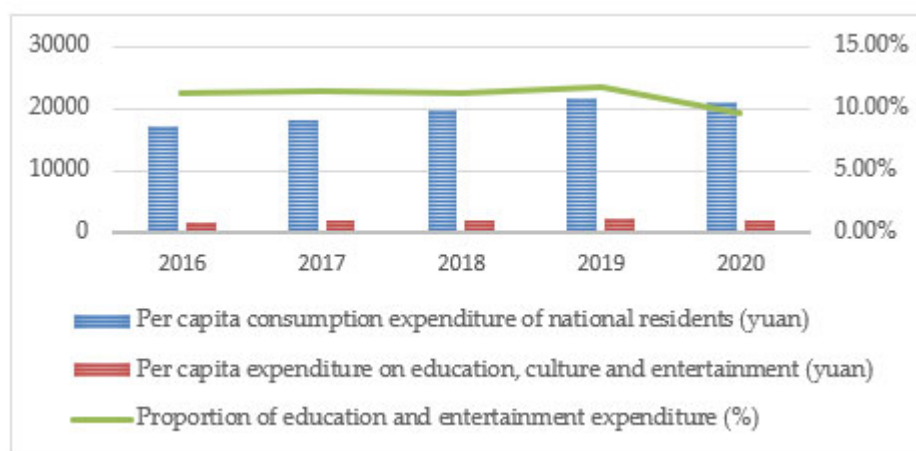


Figure 3. National per capita consumption expenditure and per capita consumption expenditure on education, culture and entertainment, 2016-2020

The change of Chinese parents' concept of education is another opportunity for the development of STEAM education. Along with the economic and social development, the future education pays more attention to children's comprehensive ability, innovation ability and practical ability of problem solving, and China's frequently launched education policies and innovative ideas affect more and more young parents' groups, promoting the change of Chinese parents' traditional education concept to STEAM education, and STEAM education has ushered in a new stage of development. According to the results of the 2020 China Urban Family Child Survey (Figure 4), more than 20% of kindergarten and elementary and middle school students take STEM (excluding art) courses, indicating that Chinese parents have already started to train their children in STEM-related courses. In order to further understand Chinese parents' awareness of STEAM education, an online questionnaire survey was conducted among 3200 Chinese parents, and the data showed (Figure 5) that parents who know about STEAM education and have their children participate in STEAM courses account for 55% of the overall

sample, with 88% of the post-80s and post-90s parents accounting for the number of those who know (Figure 6) [13]. This indicates that the post-80s and post-90s parents with advanced education concepts are more educated, more receptive to innovative teaching methods, and pay more attention to the cultivation of their children's interests, and gradually become the main force in the STEAM education consumption market.

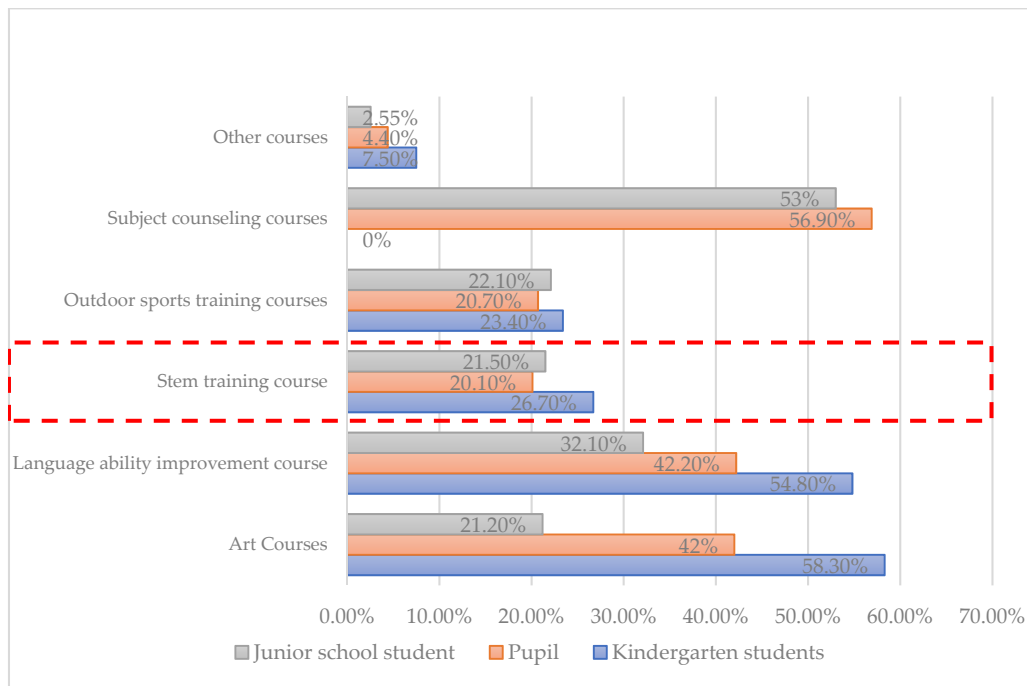


Figure 4. Children's Program Participation of Parents at Different Stages in China

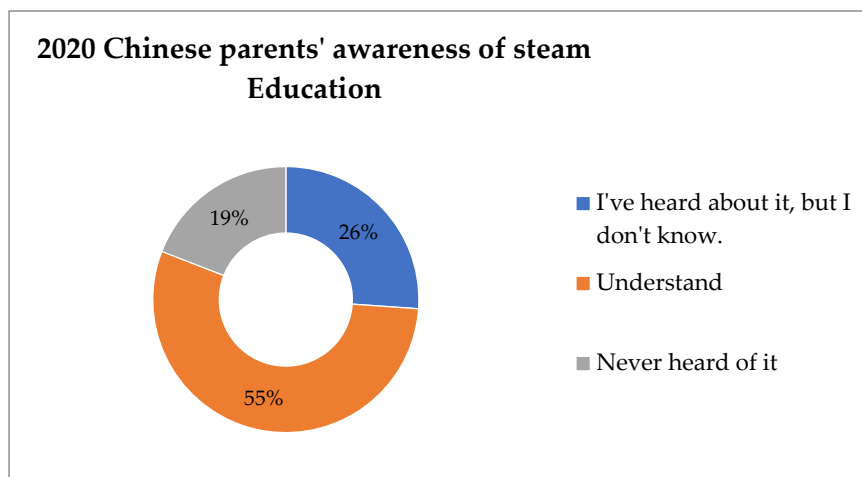


Figure 5. 2020 Chinese parents' awareness level about STEAM (Sample size N=3200)

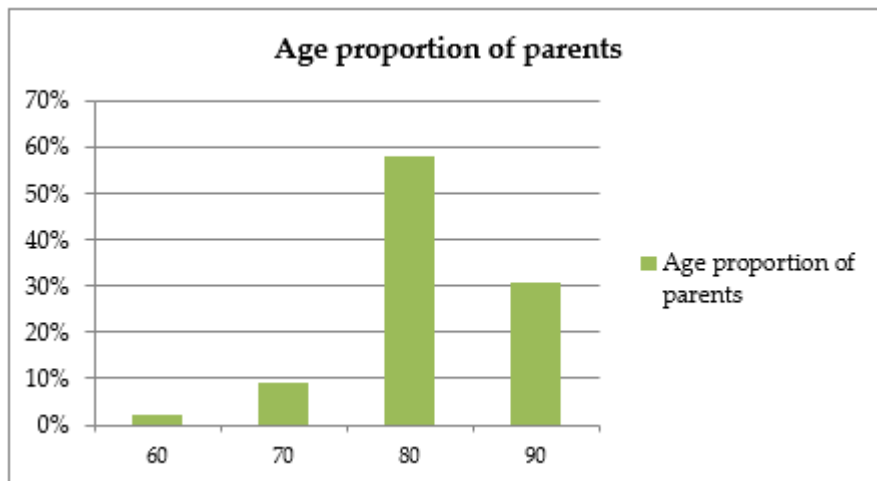


Figure 6. Distribution of parents' age ratio

2.3. The Ecosystem of STEAM Education in China

In China, the curriculum providers of STEAM education include kindergartens, basic education general schools, families, communities, streets, children's palaces, international schools, off-campus training institutions and online creative communities. Among them, schools and training institutions are the core providers of STEAM courses. Depending on the providers of the courses, not only the difficulty level of the courses differs, but also the way of course delivery, the subject of instruction and the source of funding. These course providers are, in descending order of difficulty level: initiation stage - popular, popular stage - advanced stage - advanced, advanced stage (Figure 7-Figure 8).

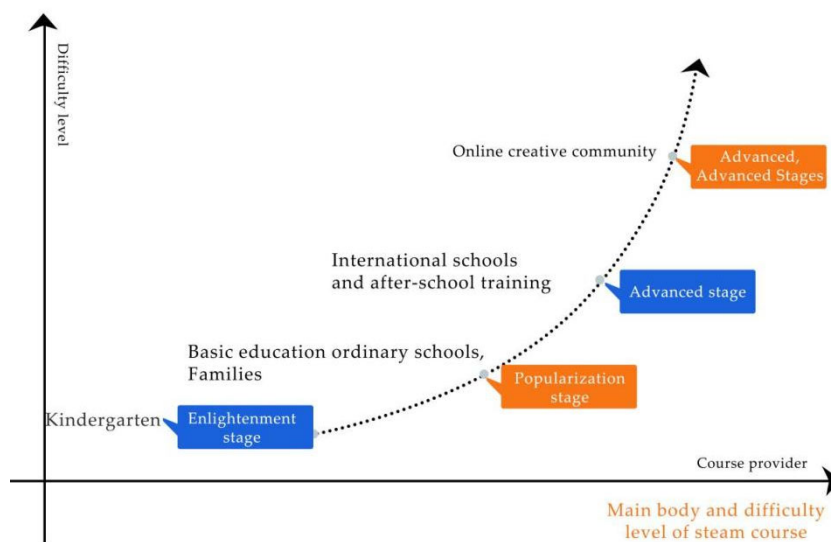


Figure 7. Difficulty levels about different STEAM course providers

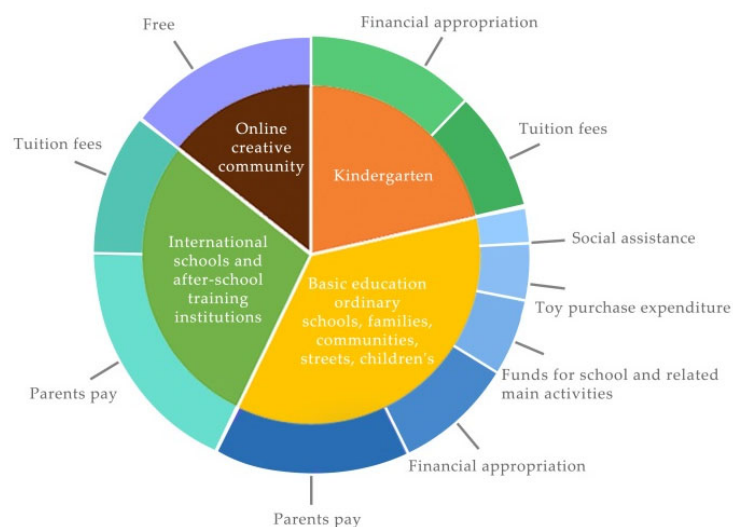


Figure 8. STEAM Education Eco-Providers and Funding Sources in China

Among them, kindergarten is the initiation stage of STEAM education, and in China, school teachers and extracurricular service providers are the main subjects of instruction, stimulating children's interest in STEAM courses by teaching regular courses. Depending on the nature of kindergartens, they can be divided into private kindergartens, which are mainly funded by tuition fees, and public kindergartens, which are mainly funded by financial allocations; basic general education schools, where after-school services are the mainstay, and a few schools include them in their regular curriculum, and where teachers or extra-curricular providers are the main subjects of instruction, belong to the popularization stage of STEAM curriculum. The regular curriculum of basic general education schools is financed by financial allocations, while after-school services require financial support from school funds and parental fees; families, communities, streets and youth palaces belong to the popularization stage of STEAM education. In the context of exam-oriented education, out-of-school training institutions, as one of the core providers, offer courses of relatively higher difficulty level and are mainly taught by teachers of training institutions, which belongs to the advanced stage of STEAM education, and the source of funding is mainly paid by parents. The online creation community, mostly free of charge, requires children to use programming tools for independent exploration, which is the advanced and advanced stage of STEAM education. These diverse curriculum providers not only provide a good platform for youth to learn STEAM education, but also provide guarantees and abundant resources for youth to learn STEAM at each stage.

2.4. Introduction of STEAM Education Market in China

According to the Ariadne Research Report (Figure 9), the market size of STEAM education in China is 42.2 billion yuan in 2021, and the impact of the epidemic in 2020 led to the impact on the STEAM education market in China, and the market returned to a year-on-year growth rate of 35.4% in 2021, STEAM education still has a very large development space in China, and it is predicted that within the next three years the market The market size will continue to grow, and the GAGR will remain at around 16% [14].

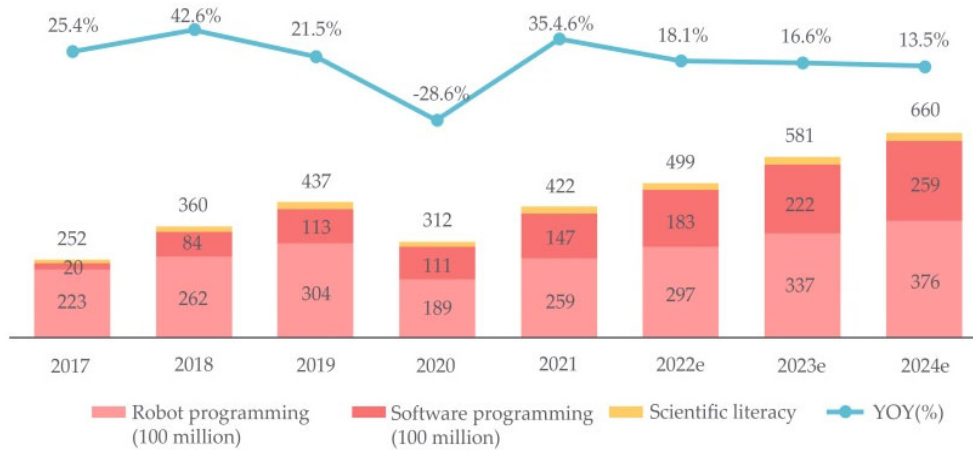


Figure 9. STEAM Education Market Size in China, 2017-2024

STEAM education in China can be divided into three categories according to business models: to C (Customers), to B (Business) and to S (Schools). to B: mainly provides educational equipment, curriculum services or brand franchising to educational training institutions. to B, compared with the other two business models, places great importance on the cost performance of educational equipment, services and teachers. to C: the main service subjects are C students, mainly education training, providing STEAM education consumer products to families or individual students; to S: after-school service STEAM education teaching aids, multimedia information technology products, curriculum services and courseware handout content for schools (including kindergartens); for example, Ubiquity provides students with Wukong, smart pens, uKit AI and RoboGO and other products. According to the Avery Data Report (Figure 10), the market size of to C, to S, and to B in 2021 is 93%, 5%, and 2%, respectively. to C business is still the core market of STEAM education products in China, and the to B and to C education market is still in the budding stage, but according to the analysis of the development potential and change trend of to C, to S, and to B in 2021 Chinese market However, according to the analysis of the development potential and change trend of to C, to S and to B in China market in 2021, more and more schools start to pay attention to the quality education cultivation of students, therefore, the market of to S is expected to develop faster in the future.

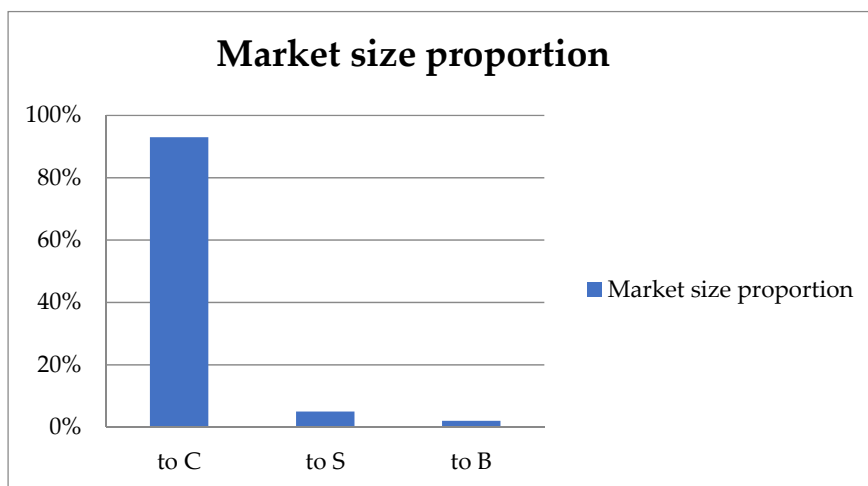


Figure 10. to C, to S, to B market size ratio

3. STEAM Education in Practice in China

The types of STEAM education courses are divided into science literacy, robotics programming and software programming according to the different focus of practice see Figure 11. The three types of courses are integrated education of science, technology, engineering, mathematics, art and other interdisciplinary disciplines, focusing on cultivating students' practical skills and problem-solving abilities, so as to achieve the goal of improving the overall quality of youth, of which robotics programming accounts for 60%, accounting for the majority of China's STEAM education market in China.

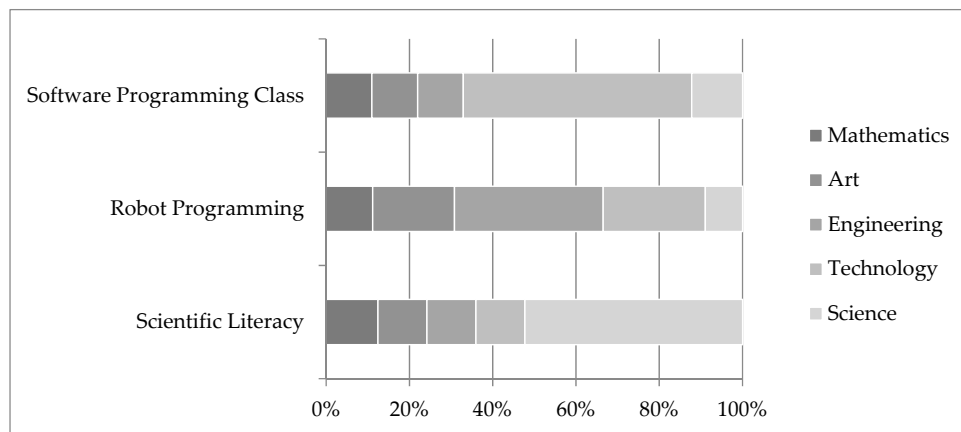


Figure 11. Distribution of STEAM education curriculum types in China

As shown in Figure 11, science literacy courses focus more on scientific literacy, because the curriculum of the literacy class is mainly from daily scenarios, learning and exploring in the form of scientific experiments; robotics programming classes focus more on engineering literacy, robotics programming classes with blocks, robots and other core teaching equipment, highlighting students' hands-on skills; software classes focus more on information technology literacy, learning computing Programming language to develop students' computer programming thinking, common computing programming software are graphical programming (Scratch, etc.), Python and C++, etc.

3.1. The Industry and Development of Science Literacy Courses in China

Science literacy courses are science experiments as a means to understand and explain the world, and science literacy course types occupy an important position in the STEAM education market in China(Figure 12). Science literacy courses require children to learn more than just knowledge; more importantly, they allow children to understand the scientific method of learning. Learning how to use scientific knowledge to explain real-world phenomena and how to use scientific knowledge to create new inventions. In China's STEAM education market, there are many companies that focus on developing children's science literacy and create science teaching aids and curriculum [15–16], such as Martian Club, Shark Park and Playtronics Lab. The Martian Club was founded in September 2014 by Liu Yang, a master's degree student from Peking University, to develop youth creative education, and with the mission of "making science fun", its own production factory to produce teaching aids.

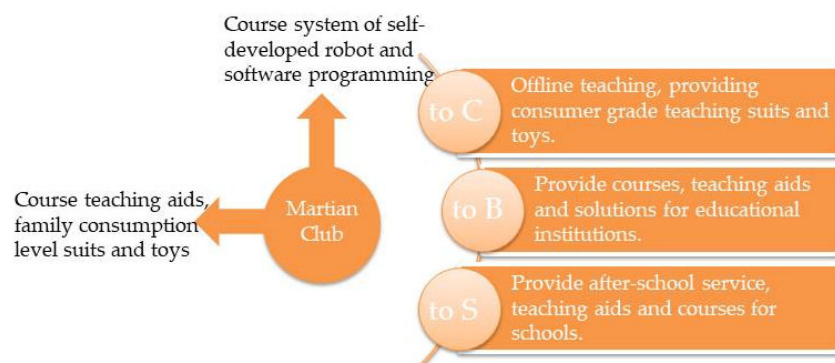


Figure 12. Martian Club operation mode

At present, Martian Club has two major product systems: the first is the self-developed curriculum system of robotics and hardware and software programming; the second is the teaching aids supporting the curriculum system; in 2014, when Martian Club was first established, the main business type was mainly to C business, carrying out C-terminal offline education services (Figure 12); with the development and continuous changes of the Internet, Martian Club has provided good opportunities for the development of the "Martian Club". In 2018, we launched the "Mars Science Box" brand to carry out to B business, i.e., to provide teaching aids, curriculum and STEAM education solutions for STEAM education institutions, so that consumers can purchase quality knowledge products through third parties; in 2021, the "double reduction" policy and the family education policy will be implemented. With the implementation of the "double reduction" policy in 2021 and the increasing consumption power of families, the original K12 subject training is transforming into STEAM education, and the demand for after-school training services is booming, so Martian Club is cooperating with many educational training institutions to offer science literacy courses and provide them with corresponding teaching aids and courses, which makes the to B business develop rapidly; the scale of educational institutions with science literacy courses is increasing in the market. The increasing scale of science literacy courses in the market also represents a new explosion of STEAM education in China.

3.2. The Industry and Development of Software Programming Courses in China

Software programming courses are a new market that has emerged in recent years, with a rich variety of learning formats, among which youth software programming education mainly uses advanced programming languages such as Python, C and visual graphical programming to write programs so that youth can independently use programming to achieve simple animation design, game creation and drive robots to complete set actions [17]. At present, in the Chinese educational context, different types of software programming courses complement each other. On the one hand, education companies popularize programming knowledge to children more systematically through live/animated/live/recorded teacher, etc. to cultivate children's programming mindset, while on the other hand, companies with game backgrounds such as Tencent and Minicraft are responsible for providing a platform for children's creation and communication through [18]" The new generation of children will be interested in learning through the "fun and education" approach. The new generation of children live in a world full of digitalization and virtualization from birth, and the Mini Programming developed by Minicreation is a mini-programming learning software bred from the sandbox game "Mini World", which provides children with a low threshold and more interesting way to create, and stimulates the new generation's creative energy and problem-solving ability in the digital world with PBL fun teaching experience. Mini Programming is different from most programming

education products on the market, Mini Programming is a 3D scenario-based programming creation tool that can improve learning immersion, its mini programming learning is divided into two major learning systems (Figure 13), one is the teaching segment - learning and creation through AI recorded courses and teacher stage review delivery model to make learning more efficient; the second is mini programming in building, creating works after sharing in the community platform This makes learning programming as easy and fun as building blocks and playing sandbox games. Through a series of mini-programming learning and creation, not only can stimulate children's problem-solving ability, creativity, teamwork and self-drive, but also enhance children's self-confidence and interest in learning.

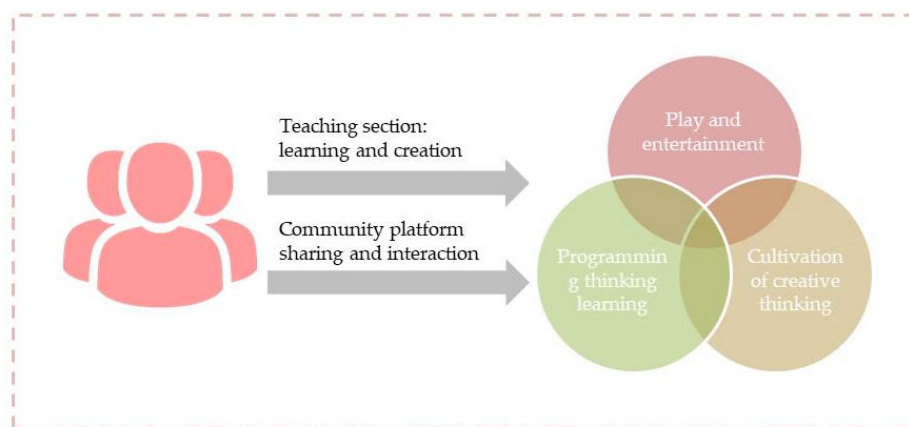


Figure 13. "Mini Programming" course system

3.3. The Industry and Development of Robotics Programming Courses in China

Robot programming course is the advanced stage of children's toys, this kind of course is in line with children's nature, for different stages of children to develop different difficulty teaching aids, a wide range of applications, the curriculum system covers the entire youth stage. The course system covers the whole youth stage. It extends downward to the large particle building blocks and realistic programming courses for children aged 3-4, and upward to the programming robot application development courses for high school students, with a wide range of user groups, mainly to develop students' "programming thinking" and cultivate students' hands-on ability by linking theory with practice [19].

At this stage, the Chinese robotics programming category market not only contains toy companies that initially provide corresponding home teaching aids for families, with Lego toy companies as an important way to participate in developing the to C business. In recent years, many commercial robotics companies have also started to promote robotics products and related courses for youth. In addition, LEGO-based educational training institutions have also emerged to cultivate students' creative thinking, while providing classroom-oriented teaching aids and systematic STEAM education solutions for various training institutions to promote the continuous development of the to B business. 2018 saw the birth of "Elman", which focuses on STEAM teaching and learning. According to 36 Krypton, Elman has more than 10 directly operated and franchised schools in Guangdong and Hunan, with about 2,000 paying students and a renewal rate of 90%. Its teaching method is based on the Lego curriculum, forming the Lego blocks, robotics and programming three categories of teaching, respectively for kindergarten teaching, post-school age and programming special learners, focusing on the third and fourth line of the sinking market to carry out online and offline education [20]. The online education is conducted in face-to-face video classes or recorded classes, allowing teachers and parents to use physical materials to guide students through basic STEAM content. The teaching concept of "teaching for fun" cultivates children's interest in STEAM. The offline teaching

focuses on the quality of teaching services, providing students with situational interaction, gradually guiding students to reflect and internalize the process of acquiring problem-solving skills, bringing mechanical enlightenment to students, and focusing more on practical operations [21].

4. Business Model and Characteristics of STEAM Education in China

STEAM education has a very large potential for development in China, and the participation of various industries, enterprises and education companies has led to a wider coverage of the STEAM education field, with the globalization of the market, the development of information technology and the development of a wide variety of software to develop the B- and C-side market in China. 2021, the implementation of the "double reduction" policy and the new curriculum reform and enrollment evaluation reform have also advanced STEAM education towards schools.

4.1. Business Model and Development of to B Business in STEAM Education Market

The main customers of STEAM education to B are STEAM education training institutions, whose business prospects are closely related to the business development of STEAM education institutions. to B equipment, course content and teacher business all focus on cost-effective products and services, with high requirements for teachers. Although these three businesses have low gross profit, they have strong economies of scale; for the to B franchise business, it requires the brand side to have strong market influence; it focuses more on the light model, which often requires directly operated demonstration schools as a prerequisite, but there is the problem of difficult brand control for franchisees.

As shown in Figure 14, the development of to B business model can be divided into three segments: upstream, midstream and downstream. The upstream mainly focuses on educational institutions and teaching aids institutions, providing B2C educational institutions and brand franchisees in the midstream with product teaching aids and branded machine course services, and charging franchise fees and equipment procurement fees. Finally, the midstream educational institutions and brand franchisees provide teaching services to the downstream C users and charge course fees. In recent years, the development of to B has been influenced by various factors, making the development of to B business fluctuate. According to Avery data (Figure 15), in comparison with previous years, the market size of to B business plummeted in 2020 while a negative growth rate was observed. As can be seen, China's economic development was somewhat affected by the outbreak of new coronavirus pneumonia, which led to a decrease in the level of spending power of Chinese households; the ban on aggregated activities caused a large number of offline educational institutions to be hit, shrinking the market size of the to B business. According to the chart, the market size of STEAM education in 2021 is about RMB 860 million, partly due to the influence of national policies to promote the development of to B business. The "14th Five-Year Plan" (hereinafter referred to as the "14th Five-Year Plan") was issued, emphasizing that comprehensive deployment should be made in terms of improving top-level design, enhancing teaching quality, and innovating school modes, with emphasis on enhancing the adaptability of vocational education and continuously improving the international competitiveness of the publishing industry [22].

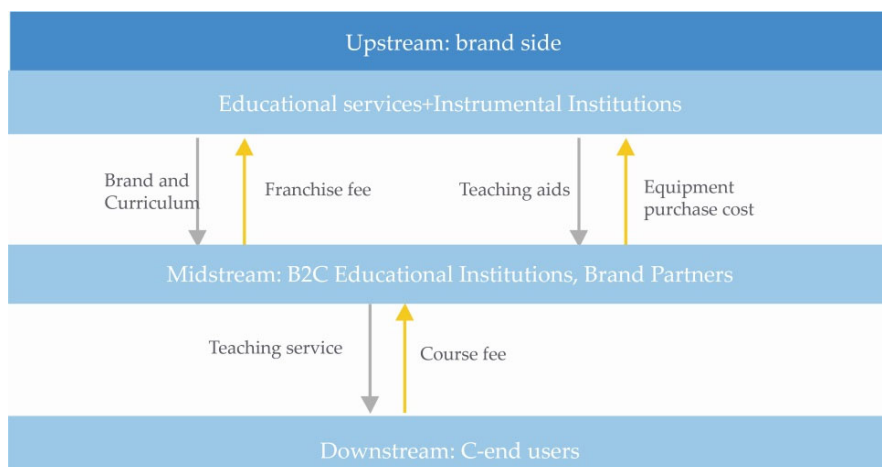


Figure 14. to B business development model

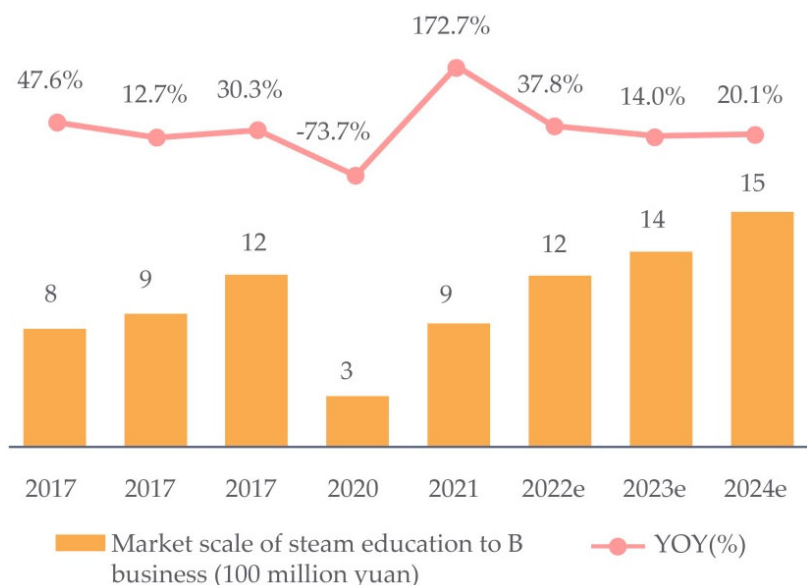


Figure 15. China STEAM Education to B Business Market Size, 2017-2024

Ensure that "publishing goes global to achieve greater results" by strengthening cultural exchanges and multi-level civilizational dialogues with foreign countries, and innovating to promote the internationalization of publishing. The company will also strengthen cultural exchanges and dialogue among civilizations at multiple levels, and innovate to promote international communication. In this context, companies providing STEAM teaching aids are turning their attention to emerging overseas markets and launching a large number of overseas online courses, thus promoting the development of new markets for to B business abroad. At the same time, parents' awareness of STEAM education will increase, which will gradually revive the market of to B business. Combining both positive and negative factors, the to B business has great potential for market development and the overall market size will maintain a steady growth trend.

4.2. Business Model and Development of to C Business in STEAM Education Market

From the overall market size structure, to C business is still the core market, according to the Ariadne system accounting (Fig. 16), the market size of 39.1 billion yuan in 2021, accounting for 93%. to C business focuses on the target group of C-terminal customers and primary and

secondary school students, providing them with related course services and creation tools, the main source of revenue is the use of online live/offline teaching business model to earn lesson fees.

The to C business is growing fast in the Chinese market, but relies on publicity and promotion, and secondly, the market maturity of educational products for Chinese family scenarios is not high due to factors such as parents' time and their own knowledge reserves, so there is still a lot of room for development. According to the business model of to C institutions as shown in Fig. 17, the development and operation of to C education and training institutions need to acquire the corresponding support of content, services, technology and brand effect. Therefore, to C education institutions need to pay subscription fees to software platforms such as management, marketing SaaS, and live SaaS to acquire potential customer demand, and on the other hand, they need to spend a certain amount of money to procure teaching materials, cloud services, AI technologies, and communication technologies to meet the quality of their course services.

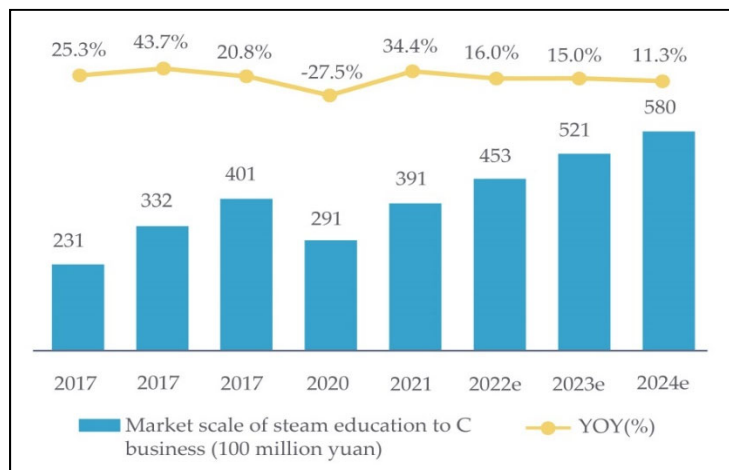


Figure 16. China STEAM Education to C Business Market Size, 2017-2024

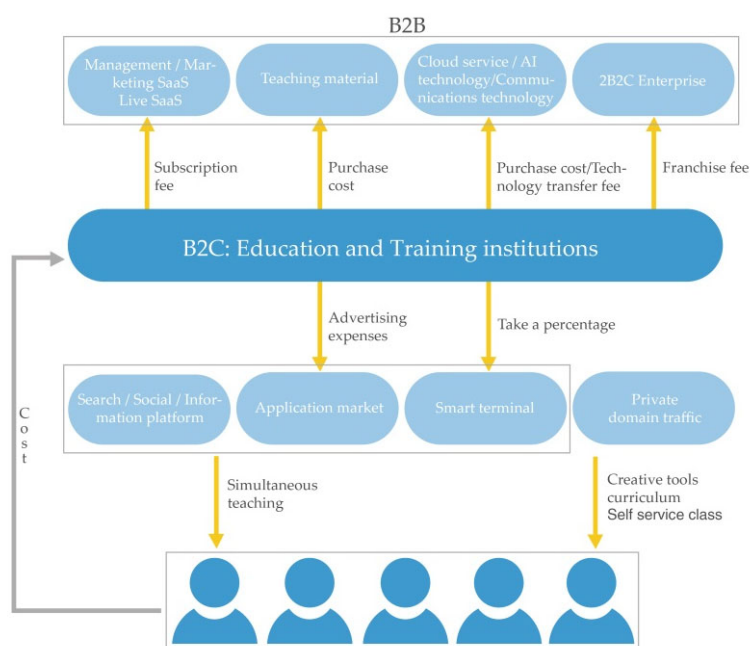


Figure 17. to C organization business model

In addition, to C education institutions also need 2B2C companies to pay franchise fees to enhance their brand recognition. to C business can be financed by two models, one is that to C education institutions need to pay certain advertising fees to a large number of media communication flat, application market smart terminals and other traffic platforms, which will vary according to the nature and content of the courses (Synchronous teaching courses, independent courses and creative tools)The other is that users can directly pay to C education institutions to access learning content according to different charges such as class fees, membership fees and content fees. In 2021, the implementation of the "double reduction" policy has comprehensively reduced the total amount and length of homework for students, thus increasing the after-school homework burden of students. With the improvement of family education level and the rising education level of new generation parents, parents also pay more attention to their children's comprehensive quality education, it is expected that the market scale of to C business will continue to expand in the next five years, and the market of family education products will also open [23].

4.3. Business Models and Development of to S Business in STEAM Education Market

As a new education model, STEAM and creative education are expected to cultivate innovative and complex talents in the 21st century, and are also considered an effective way to develop students' communication skills, cooperation, innovation and critical thinking. to S as a business model to provide products and services to schools, the business types include: industrial cooperation and large-scale bidding, resource integration and equipment sales, and Teacher content and output [24–25].Industrial cooperation and large-scale bidding business is highly policy-dependent, with large single project amounts, and large and medium-sized enterprises with resource advantages can use the joint efforts of government and enterprises to carry out regional project construction, while small and medium-sized enterprises need to use single-school expansion to develop their own main business; resource integration and equipment sales (creative classroom construction, teaching equipment) and teacher content and output service projects Generally, the single item amount is low, the service is heavy and the profit margin is also low, and the regional characteristics are obvious, so the channel dependence is strong; the regularized curriculum, after-school services and science and technology activities in schools are the main objects of to S business output(Figure 18).

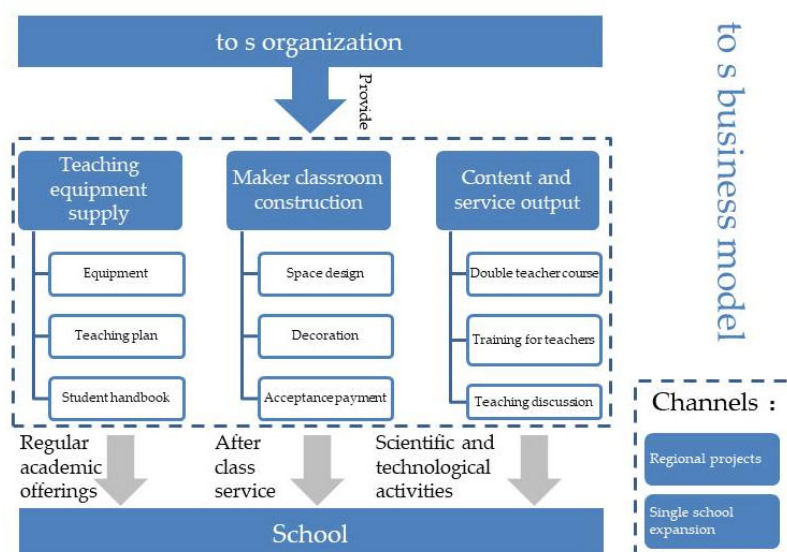


Figure 18. to S organization business model

In recent years, STEAM and creative education have been developing rapidly under the background of the national policy of encouraging science education and promoting after-school services in schools, and hardware equipment is the core revenue source of to S business [26]. Along with the corresponding technical environment has basically matured, in order to strengthen the in-depth integration of information technology and teaching applications, primary and secondary schools around the world through a variety of forms to optimize the educational environment, more and more STEAM classroom teaching aids and equipment into the classroom, to help improve the quality of teaching. According to the "Primary and Secondary School Teachers' Informatization Teaching and Learning Data Report (XIVO 2021)", as of the second quarter of 2021, XIVO has entered more than 2 million classrooms nationwide, serving millions of teachers and students, with more than 3.5 million active teacher users [27]. According to Avery data (Figure 19), the market size of STEAM education to S in China has reached 2.3 billion in 2021, with teaching aids as the core to provide the corresponding equipment and the construction of creative classrooms, the market size within the next few years is expanding operation trend is getting better and better, the annual growth rate gradually tends to stabilize, the hardware and software procurement ration will be more balanced; with the encouragement and support of national policies, schools for With the encouragement and support of national policies, schools are paying more attention to information technology, improving hardware facilities to provide students with a good educational environment, to s institutions themselves should also continue to expand the corresponding channels to strengthen cooperation between the government and enterprises; the market is increasingly on the software programming began to provide services for schools, bringing opportunities for the development of to s business, therefore, to s business market growth rate will continue to accelerate, and is expected to 2024 market size will reach \$6.3 billion.

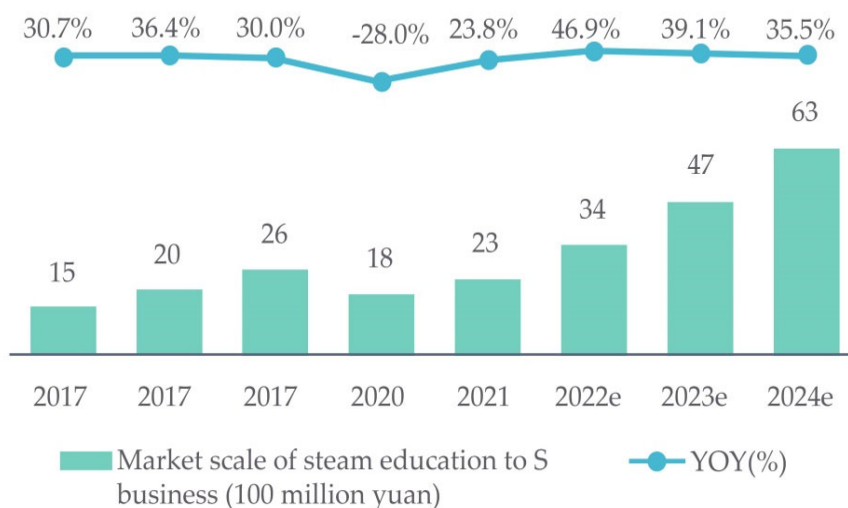


Figure 19. China STEAM Education to S Business Market Size, 2017-2024

4.4. To B, to C, to S Business Model Summary and Outlook

To sum up, the business operation mode analysis of STEAM education market in China market, to B business focuses more on the cost performance of the products, aiming at more durable and repeated use of teaching aids and related hardware facilities by educational institutions; to S business development relies more on the corresponding channels and government funding policy support, with fast growth rate in future development; to C, on the other hand, focuses more on teachers and service level, meanwhile, in the In the future, under the environment of

rapid development of information technology, the market of to C family education products will also be opened. Along with the introduction of a large number of education policies and the continuous change of education mechanism, it brings opportunities for the development of STEAM education, while ensuring the sustainable development of STEAM education in the Chinese market.

5. Opportunities and Prospects for STEAM Education in China

5.1. "Double Reduction" Policy to Promote the Transformation of the Former Subject Education Training Institutions

In 2021, the implementation of the "double reduction" policy, on the one hand, to promote the original subject education training institutions to STEAM education transformation, for example: the new Oriental to C business to recruit robotics, programming teachers, robotics and other courses; homework help to C business launched Xiaolu programming; good future to S business launched STEAM education products into the school business. These former subject education institutions will provide more high-quality teachers, after-school services, educational equipment and programming software platforms for STEAM education, and also increase the training of teachers in STEAM education, thus promoting the development of STEAM education industry [28–29]. On the other hand, the implementation of the "double reduction" policy has reduced the pressure of students' schoolwork and increased the demand for after-school services, providing better ground for the development of STEAM education in China. However, there are many pain points in the development of STEAM education institutions. Article 20 of the Opinions on Further Reducing the Burden of Students' Homework and Off-Campus Training in Compulsory Education, which guarantees the conditions of after-school services in schools, clearly states that measures should be developed to ensure the funding of after-school services in schools, with clear standards, and financial subsidies, service fees or fees on behalf of schools, to ensure that funding is in place. However, the specific funding source depends on the local financial situation and related service policies, so there is instability in the funding source of STEAM education. Secondly, independent STEAM education after-school services in the current Chinese market cannot support a larger volume of after-school services, so education and training institutions are needed to continuously improve themselves [30–31].

5.2. New Standards, New Curriculum Reform and Reform of the Enrollment and Evaluation System Drive the Development of STEAM Education In Schools

Since the twenty-first century, China has been advocating quality education. With the rapid development of the economic level, it has not only brought about the innovation of science and technology, but also prompted the continuous development and optimization of teaching philosophy. With the curriculum reform in 2018 as an important symbol, the new curriculum changes have brought new norms and requirements to the design of the basic education curriculum, the standards of teaching, the structure of teaching, the management of curriculum evaluation, and the methods of curriculum research [32]. The education and teaching model with quality training as the core will increasingly emphasize the learning process and curriculum implementation, while along with the international boom in the development of literacy research, quality education is gradually moving towards a new form of quality teaching, and the basic literacy framework for students' overall development and the increasingly refined curriculum core literacy system will provide a new impetus for the development of quality education and lay the foundation for the realization of education modernization. In the process of teaching and examinations, emphasis is placed on the cultivation of the ability to use comprehensive knowledge to analyze and solve practical problems, changing the past

development concept of exam-oriented education, facing all students, focusing on cultivating students' innovative thinking, gradually changing the previous attitude of passive learning, and effectively reflecting students' sense of independent exploration [33–34]. In the major changes of education in the information environment, more attention is paid to students' individual development and diversified learning needs, and efforts are made to develop students' core literacy. The overall plan of national education evaluation reform in the new era clearly proposes to "deepen the reform of examination and enrollment system", which in essence is to break the current phenomenon of "labeling with scores" in various admissions and selection examinations, and to "establish a system that focuses on students' moral, intellectual, physical, aesthetic and social development". "focus on the development of students' moral, intellectual, physical, aesthetic and comprehensive process, value-added and comprehensive education assessment and evaluation system. Therefore, for the reform of the enrollment evaluation system, whether STEAM courses will be included in the school assessment system will be a key driver for the development of STEAM education in China [35–36].

5.3. A New Outlook for STEAM Education in China in the New Era

As human society becomes more digital and intelligent, modern computer technology is increasingly becoming an efficient tool like a computer, so there is no way to explore the specific technical details, but one needs to be familiar with its functions in order to master the ability to use computational thinking to think and complete tasks [37]. In the process of STEAM education for youth, at the school level, courses related to STEAM learning should be offered. In addition to teaching the basics, students should be provided with appropriate STEAM learning tools so that they can create and realize their ideas through the tools, and develop their computer thinking and creativity. At the same time, a classroom evaluation of the lesson is needed at the end of the class to assess the quality of the lesson. At the societal level, since STEAM teaching is currently more about teaching the basics, more efforts must be made to apply knowledge in the future. Therefore, educational institutions and corporate companies are needed to develop and provide more user-friendly programming tools for young people (including children), as well as to provide high-quality STEAM learning opportunities for students [38–39]. At the family level, families, as co-learners and connectors in the STEAM education ecosystem, should connect their children to the diverse teaching and learning scenarios of STEAM education and help inspire their children's interest in STEAM learning. Therefore, family, society and home should work together to create a good STEAM education environment for young people and promote their overall development.

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