CSCanada
Canadian Social Science
Vol. 18, No. 2, 2022, pp. 11-16
DOI:10.3968/12502

ISSN 1712-8056[Print]
ISSN 1923-6697[Online]
www.cscanada.net
www.cscanada.org

Maker Education Empowers Core Competences for Chinese Students Development Cultivation: Relation and Path

Runze Shang[a]*

[a] M. A. Student, Institute of International and Comparative Education, Beijing Normal University, Beijing, China.
*Corresponding author.

Received 12 January 2022; accepted 20 March 2022
Published online 26 April 2022

Abstract

Maker education is an active choice for the future development of Chinese education in the information age, it is closely related to the core competences for Chinese students development. This article clarifies the connotation, characteristics and objectives of maker education by summarizing the related researches on maker education at home and abroad, proposes the four-objective theory of the implementation of maker education based on theoretical analysis, and further analyzes the correlation between core competencies and the objectives of maker education. Finally, On the basis of the existing analysis, the practical path of maker education empowering core competences for Chinese student's development cultivation is obtained.

Key words: Maker education; Core competencies for Chinese student's development; Chinese students; Implementation path

Shang, R. Z. (2022). Maker Education Empowers Core Competences for Chinese Students Development Cultivation: Relation and Path. *Canadian Social Science, 18*(2), 11-16. Available from: http://www.cscanada.net/index.php/css/article/view/12502
DOI: http://dx.doi.org/10.3968/12502

Implementing the "Innovation-driven Development Strategy" is a strategic choice for China's future development, and the cultivation of innovative talents is an important foundation for the implementation of China's Innovation-driven Development Strategy. At the same time, in order to better cope with the opportunities and challenges brought about by the development of the informatization and globalization era, and cultivate talents who can adapt to the future social development, the Chinese government proposes the development of core competencies for Chinese students. Maker education aims at cultivating learners to form the knowledge required for continuous learning, creatively use various technical and non-technical means, discover problems, deconstruct problems, find solutions through teamwork, and form creative abilities through continuous practice, it is consistent with the basic connotation of core competences for Chinese students development. This article puts forward the 4 objectives of maker education by sorting out the connotation and characteristics of it, then analyzes the internal relationship between maker education and the core competences for Chinese students development, finally starts with 6 aspects of "planning and decision-making" "environmental construction" "teacher training" "curriculum construction" "Teaching plan design" "whole process evaluation" to construct the practical path of maker education empowering core competences for Chinese students development cultivation.

1. THE OVERVIEW OF MAKER EDUCATION

1.1 Connotation of Maker Education

The understanding of the connotation of maker education has so far been inconclusive, which can be roughly divided into two perspectives: one point of view emphasizes the cultivation of maker talents, and the other point of view emphasizes integrating the ideas and methods of makers into regular education (Pang, 2017). Most Chinese scholars tend to the latter, believing that maker education inherits the concept of innovative education, emphasizes the cultivation of young learners' innovative literacy, aims at cultivating students' innovative consciousness, innovative thinking and innovative ability,

and truly cultivates innovative talents with innovative consciousness, thinking and ability (He, 2016; Zhu & Sun, 2015). This article believes that maker education should be an educational mode with the core objective of cultivating innovative talents and the cultivation of students' innovative consciousness and thinking as the direction, it reconstructs the teaching mode through project learning and experiential learning, and students can improve their innovative ability through hands-on creation.

1.2 Features of Maker Education

Martinez and Stager (2014) pointed out that maker education should have eight key characteristics: Stimulate students' enthusiasm for creativity, provide sufficient time, have certain difficulties and challenges, integrate interdisciplinary knowledge, multi-dimensional interconnection, diversify information channels, form an atmosphere of collaboration and sharing, and have innovative project tasks (Martinez & Stager, 2014). Based on the analysis of the characteristics of makers. G. Yang (2016) analyzed the ability characteristics of makers, and proposed that the main feature of maker education pointed to the cultivation of innovative talents and the creation of maker culture。This article believes that maker education should have the following five characteristics：

Firstly, completing a realistic task. The design of maker Education project tasks should first be related to the actual life of students, so as to stimulate students' enthusiasm for participating in maker education, and make students interested in project tasks and willing to participate in creation.

Secondly, challenging mission objectives. The design of the task of maker education project needs to be difficult and challenging, that is, it can attract students to invest for a long time and with high intensity, so as to fully stimulate students' potential and maximize their enthusiasm.

Thirdly, cultivating students' innovative ability. The development of the times requires capable talents. First of all, we should make it clear that any ability is "made" in the field of practice, rather than "certified" by honorary certificates. Maker education advocates learning in creation, requires students to break the mindset, give full play to the spirit of innovation, and comprehensively use multi-disciplinary knowledge to complete project tasks, which is conducive to the cultivation of students' interdisciplinary knowledge application ability, problem-solving ability, and innovative practice ability. The development of the times requires talents with sufficient ability, and this ability should be "done" in the field of practice, rather than "certified" by honorary certificates. Maker education advocates learning in creation, requires students to break the mindset, give full play to the spirit of innovation, and comprehensively use multi-disciplinary knowledge to complete project tasks, which is conducive to the cultivation of students' Interdisciplinary knowledge application ability, hands-on practice ability, problem-solving ability.

Fourth, completing tasks through teamwork. Maker education takes maker space as the basic carrier, and maker space is a workspace where makers communicate, cooperate with each other and share technology and resources. This means that promoting teamwork among students in maker education is a crucially, students complete maker project tasks by sharing resources, knowledge, and results with others, while improving their teamwork skills. This means that it is crucial to foster teamwork among students in maker education courses, students share resources, knowledge, and achievements with others to complete maker project tasks, and improve their teamwork ability.

Fifth, forming a realistic work. Maker education emphasizes the cultivation of students' innovative ability, and students should design and produce their own works or products as the output of learning (Yang & Ren, 2015). By giving full play to their creativity and completing actual works as the output of maker learning, students gain psychological satisfaction and exercise their innovative thinking, expressive ability and hands-on operation ability.

1.3 Four-Objective Theory of Maker Education

"In foreign countries, the objective of maker education is to cultivate teenagers into creators who can use various technical means and methods to create products to solve practical problems, that is, makers who can use the Internet, 3D printers and various desktop devices and tools to turn their creativity into practical products" (He, 2016). Obviously，foreign maker education objective has not been theorized，Chinese scholars' understanding of the objective of maker education does not stay at the level limited by Western values, but links it with the concept of innovative education, expands it and puts forward a series of theoretical viewpoints. Zhu and Luo (2015) believe that the objective of maker education should be to cultivate the maker competencies of learners, especially young learners; Fu (2017) proposed the progressive objectives of maker education: cultivating innovative practical ability, stimulating willingness to collaborate and sharing and shaping healthy personality. Dong and Jiao (2018) believes that maker education should take "whole person development" as the ultimate objective, which can be divided into 3 dimensions: meta-value objective, instrumental objective and expressive objective.

Based on the previous empirical research results (Wang & Shang, 2019), this article proposes the four-objective theory of maker education: "technology acquisition and practice" "cooperation and sharing" "formation of maker awareness" "self-evaluation", the four objectives run through the whole process of students receiving maker education, complement each other and integrate into a whole. Specifically, "technology acquisition and practice" points to the acquisition of students' scientific

and technological knowledge and cultivation of their application ability, "cooperation and sharing" points to guiding students to actively participate in collaboration and helping them understand the importance of accountability, "formation of maker awareness" points to students' problem-solving awareness, innovation and creativity awareness and spirit of persistence. "Self-evaluation" points to the cultivation of students' meta-cognitive awareness and ability.

2. THE INNER RELATIONSHIP BETWEEN MAKER EDUCATION AND THE CORE COMPETENCIES FOR CHINESE STUDENTS DEVELOPMENT

As an effective way to enhance core competencies for Chinese student's development, maker education is highly consistent with core competencies in terms of value orientation, theoretical basis, background and core content. Its essence is developing the students' creative thinking in the creation process under the guidance of core competencies based on the integration of interdisciplinary knowledge and the level of tool application. We believe that there is a close inner connection between the four-objective theory of maker education and core competencies for Chinese students development.

Base on our theory, the first objective of maker education is "technology acquisition and practice", it mainly refers to the scientific and technological competence and practical operation ability that students need to possess to complete maker activities, specifically, scientific and technological competence includes students' mastery of scientific knowledge and basic technology, as well as their awareness and ability to seek higher-level science and technology. The realization of "technology acquisition and practice" is conducive to the cultivation of students' hands-on practical ability, scientific and technological knowledge reserve, learning interest and self-learning ability, which consistent with "correctly understand and understand the value of learning, having a positive learning attitude and strong interest in learning" "developing good study habits, master the learning methods suitable for oneself" "Possessing the ability to learn independently" "interest and willingness to learn and master technology" emphasized by core competencies for Chinese students development.

The second objective of maker education is "cooperation and sharing", it mainly refers to Students' ability to share, communicate and collaborate during maker activities, and it requires students to actively communicate with collaborators and instructors, listen to and understand the ideas of others, share experiences, technologies, resources, processes and results through physical and digital spaces, coordinate collaborators, and collaborate with others to complete a maker activity. The realization of "cooperation and sharing" is conducive to the cultivation of students' communication skills, listening awareness, expression ability and information competencies, it also can increase students' awareness of responsibility, which consistent with "having a team spirit and a spirit of mutual assistance, be able to take the initiative, perform duties responsibly, and be responsible to self and others" " formation of the thinking and ability to realize digital survive" "awareness and ability of actively participating in communication" emphasized by core competencies for Chinese students development.

The third objective of maker education is "formation of maker awareness", it mainly refers to the cultivation of innovative and creative awareness, rational thinking awareness, problem-solving awareness, proactive awareness and perseverance awareness. Specifically, the innovative and creative awareness is manifested as the awareness of actively seeking innovative points, forming the idea and actively putting it into practice, the rational thinking awareness is manifested as being able to use scientific and logical thinking to think independently, the problem-solving awareness is manifested as having the problem awareness and willing to solve problems, the proactive awareness manifested as actively using various methods to enrich and improve oneself, the perseverance awareness manifested as possessing the perseverance and determination to face and solve difficulties positively. Therefore, the cultivation of "good at finding and asking questions, with interest and enthusiasm for problem-solving" "able to choose and formulate reasonable solutions according to specific situations and have the ability to act in complex environments" "sound personality" "able to use scientific way of thinking to understand things, solve problems and guide behavior" required by core competencies for Chinese students development can be embedded in the process of realizing the objective of "formation of maker awareness" .

The forth objective of maker education is "self-evaluation", it mainly refers to cultivation of students' meta-cognitive ability and critical thinking, it is manifested as the psychological readiness, willingness and inclination to consciously judge the activity process, and can accurately grasp, reasonably infer, examine from multiple perspectives, assess value, and predict consequences during maker activity (Wang et al., 2017). "self-evaluation" requires students to correctly recognize and evaluate themselves, critically reflect on their own status, then adjust strategies and methods according to their own reality, which consistent with "having the awareness and habit of examining one's own learning state, be good at summarizing experience, adjusting learning strategies and methods according to different situations and their own reality" "able to think critically" emphasized by core competencies for Chinese students development.

In summary, the inner relationship between maker education and the core competencies for Chinese student's development is mainly manifested as the high consistency of the 4 objectives of maker education and the connotation of core competencies. Therefore, we believe the implementation of maker education can effectively empower the cultivation of the core competencies for Chinese students development.

3. THE IMPLEMENTATION PATH OF MAKER EDUCATION

Based on the four-objective theory of maker education, this paper proposes the implementation path of maker education. First, incorporating the four goals of maker education into the the construction of maker environment, the cultivation of maker tutors, the development of maker courses, and the design of maker teaching. At the same time, through top-level system design, the scientific and standardized implementation of maker education will be promoted.

3.1 Formulate Government Plans for the Implementation of Maker Education

The development of maker education is inseparable from the support of corresponding policies. The reason why the current level and achievements of maker education in the United States far exceed China is closely related to the fact that the US government attaches great importance to the overall planning design of maker education (Zheng, 2015). The Chinese government should learn from the successful experience of the development of maker education in the United States, formulate a comprehensive plan on the development goals, scale, speed and realization of maker education.

Specifically, the plan should include the number, scale and layout of maker education institutions at all levels and types of schools, maker competitions, the direct management department of maker education and other supporting measures, investment budget plan, annual development speed, implementation indicators, methods, procedures and steps, etc.

3.2 Building the Maker Space to Provide Environmental Support for Maker Education

Maker space is an individual-collective interactive learning space formed by the integration of online virtual space and offline physical space. The physical space turns to the completion of the maker project, and the virtual space provides various support services around the physical space (Luo & Zhu, 2015). Therefore, in the process of building a maker space, schools not only need to be equipped with 3D printers, open source hardware, laser cutting machines, maker machine tools and other hardware facilities to facilitate students to convert ideas into works through hands-on creation. At the same time, they should also pay attention to construction of online platforms, actively explore the creation of an online shared maker platform based on "Internet +". Through the platform, students can obtain the information they need, share their own experiences and achievements, participate in communication and collaboration with makers around the world through the Internet in the process of complete the maker project.

3.3 Cultivate Maker Mentors

With the vigorous development of maker movement in China, the construction of maker space in Chinese schools is also in full swing, but the specific implementation of maker education is not satisfactory. In many schools in China, the teaching of maker education is mostly carried out by library teachers or teachers of information technology subjects, the lack of professional maker education tutors has become a practical problem faced by the implementation of school maker education. We think on the one hand, schools need to hire makers with professional backgrounds from the society, and on the other hand, they need to hire experienced teaching-research officers. The teaching experience of the teaching-research officers and the experience of makers in maker activities can fully complement each other, laying a solid knowledge foundation for the training of maker mentors. Besides, maker tutors can be selected from existing comprehensive practical education teachers.

3.4 Develop Maker Courses based on the Essence of Maker

At present, the themes of the school's maker courses mainly include the following categories: logic programs, electronic machinery, structural creativity, and artistic creation (Zhang et al., 2017), it seems to be conducive to the establishment of the maker curriculum system and the implementation of maker education, but in fact it ignores the essential characteristics of maker courses, which is not desirable in the long run. The development of maker courses should be based on curriculum theory (X. Yang, 2016), therefore, the development of a maker course cannot be separated from the design of course objectives, content organization, activity methods and course evaluation.

The first is the design of curriculum objectives, When designing maker curriculum objectives, the core should be shoddy problems, which are problems closely related to daily life practice. In the process of solving such problems, students need to define problems and use multidisciplinary knowledge to solve them. The indeterminate and unbounded characteristics of shoddy problems can help to exercise students' innovation, the interesting characteristics make students willing to actively analyze and solve problems and the complex and challenging characteristics help students to persevere in the exercise of the spirit of incomprehension.

The second is the design of content organization, maker education should not be limited to traditional teaching methods, teachers can adopt problem-oriented teaching and design specific teaching based on students' interests, connect various teaching links with projects, and use courses as a carrier to promote the organic combination of maker education ideas, content, methods and specific subject teaching. Through autonomous, cooperative and inquiry-based learning activities, students' innovative thinking, awareness and ability can be effectively cultivated.

The third is the design of activity methods. Maker education emphasizes the sharing and creativity of maker activities and encourages collaborative creation. Thus, maker education tutors can actively guide students to master how to communicate, share and cooperate, such as teaching students how to use network platforms to acquire resources, learn skills and share results, and how to listen and express opinions during discussions. Besides, the tutors should also play a good role as mentors in the teaching process, guide students to actively communicate, rationally divide labor, and cooperate to accomplish goals and tasks, finally achieve crowd-creation and sharing.

The fourth is the design of course evaluation. Maker education emphasizes the output and evaluation of the learning process. That is, evaluate the works created by the students after completing the tasks assigned by the tutor and the whole process of creating the product. In addition to external evaluation, student self-evaluation is also extremely important. In the teaching process, teachers should first awaken students' self-awareness, actively evaluate themselves, Secondly, it is to create a situation of conscious thinking, to achieve this goal, teaching can be divided into four stages: understanding problems, making plans, implementing plans, and evaluating and reflecting. Finally, it is to train students to learn to reflect, to look at problems comprehensively and accurately, to guide students to consciously judge the process and value of activities, and to cultivate students' ability to predict.

3.5 Build a Maker Teaching Mode

Maker education is based on constructivist learning theory and integrates various educational concepts such as problem-based learning and project-based teaching (Li et al., 2016). Constructivist learning theory emphasizes the need to provide learners with a specific learning environment to help them complete knowledge construction, problem-based learning emphasizes that teaching should be based on the proposition of problems, the project teaching method is that under the guidance of the teacher, a relatively independent project is handed over to the students themselves, the information collection, program design, project implementation and final evaluation are all the responsibility of the students themselves, students will understand and grasp the basic requirements of the whole process and each link through the implementation of the project (Wang, 2011).

Maker teaching should integrate the above teaching concepts. Therefore, in maker teaching, teachers should first create problem situations for students, guide students to ask questions around the situation, determine learning goals, and form collaborative learning groups. Then, they should supervise students' learning and practical operation so as to provide necessary guidance in a timely manner. Finally, they should help students publish their results, ask students to report on what they have learned in the process of completing maker projects, evaluate students' learning and practical process, make prototypes and report.

REFERENCES

Dong, L., & Jiao, B. (2018). The research on the goal and implementation path of maker education from the perspective of core competencies. *China Educational Technology,* (9), 48-55. Retrieved from https://doi.org/10.3969/j.issn.1006-9860.2018.09.007

Fu, Q. (2017). A review of objectives of maker education: From innovative practice to personality cultivation. *e-Education Research, 38*(6), 41-46. Retrieved from https://doi.org/10.13811/j.cnki.eer.2017.06.006

He, K. (2016). On maker education and innovation education. *Educational Research, 37*(4), 12-24, 40. Retrieved from https://kns.cnki.net/kcms/detail/detail.aspx?FileName=JYYJ201604003&DbName=CJFQ2016

Li, H., Yang, Y., & Tan, M. (2016). Interpretation of "maker education". *Journal of Sichuan Normal University (Social Sciences Edition), 43*(5), 26-33. Retrieved from https://doi.org/10.13734/j.cnki.1000-5315.2016.05.004

Luo, L., & Zhu, Z. (2015). Makerspace 2.0: Designing makerspace based on the O2O architecture. *Open Education Research, 21*(4), 35-43. Retrieved from https://doi.org/10.13966/j.cnki.kfjyyj.2015.04.004

Martinez, S., & Stager, G. (2014, June 30). *8 Elements of a good maker project*. We Are Teachers. Retrieved from https://www.weareteachers.org/hot-topics/special-reports/how-themaker-movement-is-transforming-education/8-elements-of-agood-maker-project

Pang, Y. (2017). The value potential and controversy of maker education. *Education Modernization, 4*(32), 199-200. Retrieved from https://doi.org/10.16541/j.cnki.2095-8420.2017.32.093

Wang, M., & Shang, R. (2019). An empirical study on the mechanism of action of maker education on the development of core competencies of junior high school students. *Global Education, 48*(10), 44-58. Retrieved from https://doi.org/10.3969/j.issn.1009-9670.2019.10.004

Wang, Y. (2011). Practice and exploration of the new teaching mode of "three-element segmentation" in secondary vocational schools under the conditions of school-enterprise

cooperation. *Academic Forum, 34*(10), 218-221. Retrieved from https://doi.org/10.16524/j.45-1002.2011.10.049

Wang, Y., Wang, X., & Bao, X. (2017). Being a maker: Maker literacy and development in crown innovation age. *China Educational Technology,* (4), 10-16. Retrieved from https://doi.org/10.3969/j.issn.1006-9860.2017.04.002

Yang, G. (2016). Maker education: The new path to the development of creative education in China. *China Educational Technology,* (3), 8-13, 20. Retrieved from https://doi.org/10.3969/j.issn.1006-9860.2016.03.002

Yang, X. (2016). The construction of maker course: Connotation, characteristics and the design of "maker course" framework. *Journal of Distance Education, 35*(3), 3-14. Retrieved from https://doi.org/10.15881/j.cnki.cn33-1304/g4.2016.03.001

Yang, X., & Ren, Y. (2015). STEM education and maker education in the digital age. *Open Education Research, 21*(5), 35-40. Retrieved from https://doi.org/10.13966/j.cnki.kfjyyj.2015.05.004

Zhang, W., Liu, B., Xia, X., & Wan, S. (2017). The design of maker curriculum under the perspective of curriculum theory: Components and cases. *Modern Distance Education Research,* (3), 76-85. Retrieved from https://kns.cnki.net/kcms/detail/51.1580.G4.20170525.1602.020.html

Zheng, Y. (2015). Path analysis for the lmplementation of maker education in colleges and universities in USA. *Open Education Research, 21*(3), 21-29. Retrieved from https://doi.org/10.13966/j.cnki.kfjyyj.2015.03.003

Zhu, Z., & Luo, L. (2015). From maker movement to maker education: Cultivating maker culture. *e-Education Research, 36*(7), 5-13. Retrieved from https://doi.org/10.13811/j.cnki.eer.2015.07.001

Zhu, Z., & Sun, Y. (2015). Maker education: A practical field of ICT-enabling innovation education. *China Educational Technology,* (1), 14-21. Retrieved from https://kns.cnki.net/kcms/detail/detail.aspx?FileName=ZDJY201501004&DbName=CJFQ2015