Discourse Analysis of Perceptions of STEM Education: A Virtual Dialogue Based on Multi-Interested Subjects

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Abstract. The debate over whether STEM education is worth promoting has always been an essential theme in research. There are differences in the perceptions of different subjects on this issue, but the current research is analyzed more from a single perspective. In virtual dialogue, this study constructs multiple rounds of dialogue among multi-interested subjects, focusing on the perceptions, consensus, and disagreement of the nature and dilemmas of STEM education, and their attitudes towards STEM education. It is found that the four subjects of interest, school administrators, teachers, parents, and out-of-school institutions, have a high consistency in many aspects of their perceptions. Still, there are also cognitive conflicts in some areas or more dispersed perspectives. In addition, they present differentiated attitudes and behaviors at the three levels of acceptance, commitment, and expectation.

Keywords: STEM education, discourse analysis, multi-interested subjects, virtual dialogue.

1. Introduction

STEM education is a coherent group of interdisciplinary and interdisciplinary courses, which includes STEM subject courses and integrated courses (Chen Kai et al., 2019), which means that STEM education has characteristics beyond a single subject, with a certain degree of innovativeness and ahead of its time. However, when STEM education is implemented in primary and secondary schools, different stakeholders have different perceptions of its nature and show differential support, which affects the implementation effect of STEM education. The previous study found that a significant proportion of teachers believe that STEM education is not pure, but rather the creative or advanced labor and technology course (Mao Gang & Bi Qiongyuan, 2023); some parents mistakenly believe that STEM seriously affects the balanced development of students, which ultimately leads to the elimination of children who cannot adapt to the society (Wang Dan, 2022). In-depth analyses of different stakeholders in the treatment of STEM education on the core issues, such as what exactly is STEM? Does it have the unique value of nurturing people? Is it necessary to be carried out in most schools that are deeply influenced by exam-oriented education? What are the specific forms in which STEM education can be carried out? How feasible is it to develop STEM education in primary and secondary schools? It is how it is expressed, which will help to understand the policy formulation, school conditions and concepts, teachers' implementation difficulties, and parents' needs and recognition. The above questions are interrelated and cannot be fully answered by a single prospective study.

Carrying out equal dialogue among multiple subjects, seeking specific conflicts between different cognitive perspectives, and the consensus they may form, is a critical event in understanding the current STEM education out of controversy and towards normal development. This study will create a virtual dialogue space that connects subjects of interest who would not otherwise be able to dialogue together as equals to explore the logic of their respective behavioral decisions around the core issues of STEM education. In that case, we can reveal the positional differences and contradictions between subjects of interest, which will help to understand the fundamental reasons for the dilemmas faced by the current development of STEM.

2. Literature Review

In recent years, the dilemmas arising from the localization of STEM education in China have attracted the attention of scholars. From the research perspective, Dong Zehua (2016) studies the localization dilemmas and countermeasures of STEM education from four aspects: teacher training, curriculum construction, curriculum support, and instructional innovation. Yang Kaicheng et al. (2020) explore STEM education curriculum, teaching, and ecological environment dilemmas based on STEM curriculum development and implementation. Si Jian et al. (2022) focus on the dilemma of rural STEM education and explain the dilemma from three perspectives: the gap in the so-called space justice, the shortage of cultural capital, and the habitus of simulation instead of creativity. Other scholars focus on STEM education dilemmas from the perspectives of different genders, different year groups, and disciplines (Liao, 2020; Zhang, 2022; Hu, 2022). It can be found that scholars' research perspectives on STEM education dilemmas have gradually shifted from the macro to the micro, and progressively focused on specific groups to carry out. In terms of research methodology, Jiang Fan et al. (2023) put forward suggestions regarding government policy formulation, participation of multiple subjects, and negotiation and co-management mechanism through a comparative study of the governance system of STEM education in the United States. Ma Yunmeng (2021), on the other hand, used a case study to examine the operating rules and outcomes of teacher community groups in interdisciplinary education. Other scholars conducted research through questionnaires and interview methods (Xia Ke, 2019). However, the research methods used in the above studies are more limited, either following logical analysis (ideal analysis) or adopting an empirical investigation model (reality analysis), and less able to achieve a combination of the two.

Virtual dialogue, which combines logical and realistic analysis, may help solve the above problems. The research method of virtual dialogue is mainly used in philosophy and literature to understand contemporary phenomena from the perspective of some ancients or to apply the theories of the ancients to new places. Among them, Zhang Jiliang et al. (2018) study Marx's criticism of classical utilitarianism through the virtual dialogue method and carry out three rounds of criticism and response in their study from the basic claims of classical utilitarianism and Marx's criticism of it, classical utilitarianism's response to Marx's criticism, and Marx's criticism of the Millian response respectively. Shobin (2005) designed a set of three rounds of virtual dialogues among participants in American constitutionalism around three central questions of the kind, importance, and necessity of polity. These studies maintain, to a large extent the independent character of logical analysis, but reasonably integrate the actual situation (incorporating more perspectives and viewpoints) into the analyses, and produce research results that are, to some extent, more valuable.

In summary, most current research perspectives focus on a single group to carry o. Still, STEM education, due to its comprehensive complexity, determines the diversity of stakeholders involved. There is an urgent need for research on the interaction perspective between multiple subjects of interest in STEM education. Therefore, this study applies virtual dialogue to the field of education, constructs an equal dialogue space for the stakeholders in different times and areas, and uses discourse analysis to study the existing dilemmas of STEM education.

3. Research Question

Some primary and secondary schools are already implementing STEM education, including but not limited to school-based curriculum development and integrated practice program development. Looking at the whole process of existing programs, the subjects of many programs are limited to teachers and students, but education involves not only teachers and students but is also affected by other factors such as parents and social groups. Due to the realities of the world, there is often a lack of space for these subjects to engage in an equal and effective dialogue. Therefore, this project focuses on multiple stakeholders in STEM education and constructs a multi-round dialogue scenario to effectively discuss the different perspectives of multiple subjects to promote consensus-building and

division of labor among different subjects. However, to promote consensus among subjects, the following questions must first be answered:

(1) The perceptions of different educational stakeholders about the nature and dilemmas of STEM education.

(2) The consensus and differences that can be reached through dialogue among other interest subjects.

(3) The attitudes of various educational stakeholders towards STEM education from their standpoints.

4. Research Design

4.1. Research Object

This study identifies four groups of people as research subjects who represent four types of key stakeholders in STEM education:

(1) School administrators: they are the developers of the school's philosophy and future planning, the approvers of the provision of facilities and equipment within the school, and the supporters of the teachers' development of STEM education programs. The importance and cognition they attach to STEM education will directly affect the implementation of STEM education in schools.

(2) Teachers: they are the key designers and developers of specific STEM education programs, as well as the ultimate implementers, who will be directly involved in the whole process of STEM education and promote the development of the programs. Teachers' understanding of the nature of STEM education will directly affect the effectiveness of STEM education. Therefore, understanding frontline teachers' perceptions of STEM education and their actual demands will help to understand the dilemma and future of STEM education.

(3) Parents: as indirect influencers on the development of STEM education, they can play a role in the implementation of STEM education by influencing the perceptions, attitudes, and behaviors of the educated or exerting public opinion pressure on teachers. Therefore, exploring parents' perceptions of STEM education will help reveal the conflicts between home and school that may be caused by STEM education and its root causes.

(4) Personnel of out-of-school STEM education organizations: STEM education, because of its characteristics such as broad knowledge, the need for specific resources and equipment support, and practical solid comprehensiveness, mainly requires the participation and support of social forces to address the limitations of schools in terms of financial resources, premises and facilities (Fan, Wenqiang & Zhang, Haiyan, 2019). Therefore, social groups' perception of STEM education, especially out-of-school STEM education organizations, will directly affect the opportunities and development of out-of-school STEM education.

4.2. Research Method

This study adopts Fairclough (2013)'s critical discourse analysis research model to carry out research. Critical Discourse Analysis (CDA) is a form of discourse analysis that studies the relationship between discourse, power, and ideology through the analysis of discourse forms. Norman Fairclough, a representative figure of CDA, put forward a conceptual framework that includes three dimensions: text, discursive practice, and social practice. Among them, the text is the product of discourse practice, focusing on linguistic analysis; discursive practice refers to the production, distribution, and consumption of texts. These are subject to specific social practice conditions, which provide the basis for interpreting discursive practice.

This study will apply this research methodology to explore the inter-discourse of STEM education stakeholders consisting of teachers, parents, and social groups in a cross-contextual context, and organize three rounds of virtual dialogues to build a space for equal and effective communication. Among them, the first round of dialogue will focus on factual questions about the perception of the nature of STEM education, the second round of dialogue will focus on the subject's agreement with

the viewpoints of other subjects from the same or different categories, and the third round of dialogue will explore the subject's behavior and its logic in STEM education.

4.3. Research Tools

The three rounds of dialogue in this study are specified below Table 1:

Table 1. Outline of three rounds of virtual dialogues

Round	Structure	Outline of the dialogue
Round 1	Factual questions	(1) How do you understand the nature of STEM education? (2) Do you think STEM education has a unique value in nurturing people? (3) What are the specific forms of STEM education you know? (4) Do you think it is necessary to develop STEM education in primary and secondary schools? (5) Do you think it is feasible to develop STEM education in primary and secondary schools?
Round 2	Recognition and Attitude	(1) Do you agree with the above views? What do you agree with, and what do you disagree with? (2) Has your understanding of STEM education changed because of learning about the views of others?
Round 3	Behavior and logic	(1) From your position, what measures and behaviors would you take toward implementing STEM education? (2) What is your level of commitment and endeavor in STEM education? (3) What are your expectations of STEM?

5. Data Analysis

5.1. Respondents' Highly Agreeable Views on Understanding of STEM Education

Based on the dialogue, school administrators, teachers, parents, and external agency personnel agreed on several points with a higher degree of focus. Among them:

(1) From the perspective of understanding the nature of STEM education, they agreed that STEM education is an interdisciplinary learning approach. Students can apply knowledge from different fields in practice and solve complex problems in an integrated way. The aim of the course is to enhance students' problem-solving and practical application skills, as well as their innovative thinking and integrative abilities, which are beneficial to their personal development and social contribution.

(2) From the perspective of the form of STEM curriculum development, they agreed that STEM education originates from students' lives, and students are guided to explore and practice through the project-based curriculum. Meanwhile, students are required to apply knowledge to solve problems and learn spontaneously with interest.

(3) From the perspective of the difficulties of STEM education, they agreed that the main challenges and difficulties of STEM education include: the incomplete match between the current educational evaluation system and the goals of STEM education, the lack of maturity of the STEM curriculum system, the lack of teaching resources, experimental equipment, and practice sites, and the lack of understanding and support from parents and the education sector.

Therefore, to promote STEM education, we need to reform and innovate in terms of policies, curricula, resources, evaluations, and so on, and increase the awareness and participation of students, parents, and society.

In addition, the four interest subjects have reached a certain consensus on other points of view, but there is a large difference in the degree of recognition among different identities. For example:

(1) Even though all the subjects mentioned that STEM education could adopt various forms, such as projects, experiments, clubs, school-based programs, science lessons, integration lessons, etc., to suit different teaching purposes and practical situations. However, school administrators and teachers

have severe doubts about implementing STEM education in China. They believe that STEM education still needs to consider the current domestic education status and the individual differences of students, and flexibly use different teaching methods and educational equipment, which is difficult to achieve with the existing resources.

(2) When expressing their understanding of the necessity of STEM programs, all four subjects believe that STEM education can cultivate students' unique abilities, which are very important for students' personal development and social contribution. Therefore, STEM education is necessary at all levels and fields. However, teachers are doubtful about cultivating students' abilities, believing that it requires a long period to see the effect. Therefore, it isn't easy to guarantee the effectiveness of education.

(3) Regarding the audience of STEM education, different subjects generally agree that all students should be treated equally. However, school administrators and teachers argue that even though different students have equal access to receive education, such a program is more suitable for top students. In contrast, low-achiever students are less suitable for such a course. This is because they lack basic knowledge and are unable to adapt to the integrated course.

5.2. Respondents' Moderately Agreeable Views on Understanding of STEM Education

Based on the dialogue, school administrators, teachers, parents, and external agency personnel held moderate agreement on several points with a higher concentration of views. Among them:

(1) They believe that although STEM education can promote the all-round development of students, it ignores the cultivation of humanistic literacy to some extent. It is better to develop humanistic emotions along with science and technology education.

(2) At the same time, STEM education is not in opposition or competition with education in other disciplines. We should actively integrate it with education in different disciplines to achieve interdisciplinary interaction.

(3) Humanistic elements can be introduced into STEM education, such as allowing students to know the historical and cultural background of science and technology, to cultivate their humanistic concern and interdisciplinary thinking simultaneously.

(4) Other disciplines can also learn practical and inquiry-based teaching methods from STEM education. For example, students can deepen their knowledge and understanding of science and technology through reading, writing, and creating in Chinese classes, to cultivate their innovative and practical abilities to achieve a win-win situation in multiple disciplines.

The four interest groups also hold moderate agreement on other views, but there are large differences in agreement across identities. Among them:

(1) Against the backdrop of the prevailing emphasis on immediate goals, explicit goals, and “double-base” in school education, schools, teachers, and parents would be more inclined to treat the main subject as a more important part of education, whereas external organizations would consider STEM education goals to be more important.

(2) In terms of expectations for the outcomes of STEM education, parents and school administrators have low expectations that STEM education will not be effective in the short term, while external organizations and teachers have high expectations.

(3) In addition, schools, teachers, and parents think that STEM education does not fit in with the current education evaluation system, while external organizations have a positive attitude, believing that it ultimately serves quality education.

5.3. Respondents' Behavioral Logic Towards STEM Education

Based on the behavioral level dialogue, the researcher analyzed the behavioral logic of the respondents at the three levels of STEM acceptance, engagement, and expectations. Among them:

(1) In terms of acceptance of participation in and implementation of STEM programs, all four-hold high motivation. School administrators will introduce such courses as a supplement to the main subjects and provide teaching resources and facilities. Teachers will design the course content, make

teaching plans and carry out activities in the classroom in the form of project experiments, and group discussions. Parents will be happy to send their children to extracurricular organizations or let their children take part in such activities within the school and give them moral support. The out-of-school STEM education organizations set up rich activity sessions for the ultimate purpose of making profits and attracting participants to take part in the course activities.

(2) In terms of the level of effort and commitment to STEM programs, the willingness to commit to STEM programs is strongest among the four subjects of interest, followed by the school administrators and parents, and finally the teachers. Among them, external organizations are willing to invest a lot of time and effort to maintain a stable student population, while school administrators and teachers are hesitant to invest time and effort due to the uniform evaluation standard, and they believe that the important factor in implementing such courses is not to interfere with students' main subject learning.

(3) In terms of expectations of STEM, parents, school administrators, and external organizations hold positive views. They believe that such courses can cultivate students' comprehensive qualities and can be used as a supplement to the main subject, thus stimulating students' interest in learning and providing them with valuable experiences that are difficult for them to obtain in other courses. However, teachers hold moderate expectations and doubt whether such courses, as a new type of course, can achieve the goal of cultivating students through a small number of lessons.

6. Conclusions and Discussion

6.1. Conclusion

The following four main conclusions are formed through the research in this paper.

(1) The four interest groups have a high degree of consistency in many of their perceptions but also have conflicting perceptions or more dispersed views in some areas. Among these:

a) There is a high degree of agreement on understanding the nature of STEM education, the form in which it unfolds, and the existing dilemmas, and the views are concentrated.

b) There is also a high degree of agreement on the necessity of STEM education, audience groups, and other aspects. However, there are significant differences in perceptions among different subjects, especially among school administrators and teachers who are more concerned about the issue's reality.

c)There is a medium level of agreement in recognizing the conflict between STEM education and other disciplines, the controversy over the lack of humanistic literacy, etc., and the views are concentrated.

d)There is a medium agreement on the conflict between STEM education and the current education system and the expectation of results, and the perceptions differences among different subjects are significant. In contrast, out-of-school STEM education organizations are more optimistic about the future of STEM.

(2) The four stakeholders have a high degree of acceptance of STEM education and play their roles and influence each other in their respective positions to build a STEM education community.

(3) There is a great deal of variation in the level of effort and commitment to STEM education among the four stakeholders, who have the strongest willingness to commit to STEM education is the out-of-school STEM education organizations, followed by the school administrators, parents, and teachers.

(4) Parents, school administrators, and out-of-school STEM education organizations hold high expectations goals for STEM, while teachers hold medium expectations for it.

6.2. Discussion

The equal dialogue among multiple subjects shows that although different subjects may reach a certain consensus at certain levels, complex cognitive differences do exist. Therefore, a certain unilateral viewpoint cannot simply be taken as the only truth when facing STEM education-related issues.

Adopting a virtual dialogue approach that balances logical and realistic analyses reveals some issues that traditional methods cannot explore, such as the consensus and disagreement among different educational interest subjects, the actions carried out by other topics for the same purpose, and the logic behind them. Therefore, this method can be used by a wide range of researchers to explore such issues as new curriculum dilemmas.

References

[1] Chen Kai, Xia Jing, & Chen Yue. (2019). A textual exploration of the White Paper on Chinese STEM Education. Journal of Schooling Studies, 16 (3), 14.

[2] Dong Zehua. (2016). On Dilemma and Solution of STEM Curriculum Implementation in China. Global Education, (12), 36 - 42+62.

[3] Fairclough, N. (2013). Critical discourse analysis. In The Routledge Handbook of discourse analysis (pp. 9-20). Routledge.

[4] Fan Wenqiang & Zhang haiyan. (2019). How to attract social forces to carry out STEM education - Analysis of the UK "STEM Ambassador" project. Modern Educational Technology, (06), 5 - 11.

[5] Hu Yuanlong. (2022). Research on Current Situation and Influencing Factors of STEM Education Understanding of High School Chemistry Teachers (master's thesis, Central China Normal University).

[6] Jiang Fan & Deng Li. (2023). Polycentric Governance: The Experience and Enlightenment of American STEM Education Governance Practice, (02), 66 - 78.

[7] Liao Quanyu. (2020). A look at the dilemma of women's careers in STEM fields from the book The Calculating Stars. Journal of Leshan Normal University, (10), 15 - 20+36.

[8] Ma Yunmeng. (2021). A Case study on the Forms of Collaboration among members of the interdisciplinary Teacher Community (master's thesis, Northeast Normal University).

[9] Mao Gang & Bi Qiongyuan. (2023). Explore the localization experience of teacher development from subject teaching to STEM education. Teacher Education Research, (01), 102 - 108.

[10] Si Jian & Zhang Lichang. (2022). STEM education in rural areas: possibility, dilemma, and solution. Distance Education in China, (08), 53 - 59+69+79.

[11] Wang Dan. (2022). Development of school-based curriculum in primary schools under the guidance of the Stem education concept. Information technology education in primary and secondary schools, (5), 3.

[12] Xia Ke. (2019). Research on STEM Teaching Implementation and Evaluation Ability of Science Teachers in Primary and Secondary Schools (master's thesis, Central China Normal University).

[13] Yang Kaicheng, Dou Lingyu, Li Bo & Gong Ping. (2020). The Dilemma of STEM Education and the Way Out of It. Modern Distance Education Research, (02), 20 - 28.

[14] Zhang Jiliang & Huang shuo. (2018). The Criticism of Sophisticated Classical Utilitarianism by Marx: A Virtual Dialogue. Expanding Horizons, (03), 24 - 29.

[15] Zhang Qidi. (2022). A Study of STEM Classroom Characteristics in Primary Schools based on Multiple Evaluation (master's thesis, East China Normal University).