The Effect of Classroom Teacher-Student Interaction Characteristics and STEM Teaching Models on Student Creativity

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Abstract. Schools worldwide are increasingly focusing on cultivating students' creative thinking due to the growing demand for creative talents. However, traditional education methods may not be effective in fostering creativity. This study uses literature research to investigate the impact of teacher-student interaction and STEM teaching models on student creativity. Research has shown that teacher-student interaction, specifically emotional support, teaching support, and classroom management, can have a positive impact on students' creativity during the learning process. Additionally, the STEM teaching mode has been found to enhance creative thinking to some extent. STEM education has a significant impact on enhancing creative thinking. It focuses on cross-disciplinary integration, stimulating students' innovative thinking and problem-solving abilities by guiding them to engage in the fields of science, technology, engineering, and mathematics. In the STEM classroom, students are required to integrate knowledge from various disciplines to solve problems. This interdisciplinary approach helps to break down traditional disciplinary boundaries and broaden students' cognitive horizons.

1 Introduction

The Ministry of Education and eighteen other departments have issued an opinion on strengthening science education in primary and secondary schools in the new era. The opinion emphasizes the importance of practical learning and stimulating interest. Meanwhile, it proposes to prioritize students and tailor teaching to their abilities. It also aims to promote science education based on inquiry and practice, stimulate curiosity and exploration in primary and secondary school students, cultivate their interest in science, and guide them to participate in a wide range of inquiry and practice. The goal is to achieve a combination of learning and thinking, make learning and teaching enjoyable, and consciously acquire scientific knowledge. Additionally, it aims to cultivate the spirit of science, enhance the quality of science, strengthen scientific and technological self-confidence and self-reliance, and foster a sense of family and national pride. Whereas the most effective type of talent for guided instruction relies primarily on the role of the teacher, the essence of the development of creative talent relies on schooling. Classroom teaching is an essential part of schooling, and teacher-student interaction remains one of the most important forms of classroom teaching for the collision of ideas and the promotion of creativity. The method of effective teacher-student interaction not only improves the quality of classroom teaching and guides student learning, but also promotes a positive classroom atmosphere, stimulates students' logical thinking, and fosters creativity. One of this article the impact of classroom management, pedagogical support, and emotional support on student creativity in relation to teacher-student interaction.

Currently, the lack of teacher-student interaction in classroom teaching which has three main characteristics, formalization, manifestation and superficiality. Then most of the teacher-student interactions in current classroom teaching appear to be flashy and insubstantial formalities. Its process lacks emotional communication and strong collision of ideas, and the primary reason for its characterization are considered to be the teacher's lack of relative emotional engagement and the students' lack of awareness of interaction. Secondary, most forms of classroom interaction show a state which the teacher dominates and the students in a secondary role, resulting in a low level of pedagogical support due to a single role in classroom management. Thirdly, teacher-student interaction is exposed to superficial - Teachers produce vicious competition which leads to the emergence of 'performance' teacher-student interaction.

Nowadays, there is an effectively increasing trend by SEMT around the globe. The '13th Five-Year Plan for Educational Information' - officially released by China's Ministry of Education in 2016, the planning regulations state that it should adapt to the demand for high-quality talents in the information age, and actively explore the application of information technology in new modes of education, such as 'crowd space' interdisciplinary learning (STEAM education) and creator education.

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Firstly, by research, China has explicitly stated in an official programme document that it will actively promote the development of STEAM education and other emerging education models. This decision is aimed at satisfying the necessity of innovative personnel and information. In the meantime, further strengthening the qualities of education and creativity capacity in the country. In China's current educational practice, to achieve universality and efficiency, the traditional education model inhibits students' creativity and imagination to a certain extent. With the current high degree of development of intelligence and information technology, coupled with the importance of cultivating students' innovation and creativity, the output of the STEM education model is adapted to the current form of education background.

This review of the independent variable of student creativity is based on the two dependent variables of classroom teacher-student interaction characteristics and the STEM teaching model, and the independent variable of student creativity is reviewed using the form of the literature method, to determine the impact of teacher-student interactions on creativity in STEM teaching.

2 Teacher-Student interaction and creativity

2.1 Overview of teacher-student interaction research

Classroom teacher-student interaction is the process of communication and interaction between the teacher and the students during the teaching and learning process. This interaction facilitates students' learning and understanding, aiding them in acquiring knowledge and skills more effectively. Teacher-student interactions are based on questioning, discussion, feedback, guidance, demonstration, modelling, individual counselling, and setting creative tasks and projects.

The specific modalities are as follows: Teachers can ask students questions to stimulate thinking and engagement, and students can answer questions to demonstrate their understanding and mastery of the course content. This interaction enhances students' thinking skills and self-confidence. Teachers can organize group or whole class discussions for students to share their views and experiences. This allows students to debate and gain a deeper understanding of the material they have learned. Teachers can give students timely feedback and guidance, which includes evaluating students' work, answers and performance to help them correct errors, improve and progress. Teachers can demonstrate specific skills or practices through demonstration and modelling, and students can observe and imitate the teacher's demonstration for better understanding and mastery of the relevant skills. Teachers can conduct one-to-one tutorials with students and provide extra help and guidance according to their individual needs, which can help students resolve confusion, fill knowledge gaps and enhance learning. Teachers can assign students with creative tasks and projects so that they can put what they have learn into practical use and innovation. Teachers can assign creative tasks and projects to students so that they can put what they have learned into practice and innovate, and such interactions can help to stimulate students' creativity and practical ability.

Overall, classroom teacher-student interaction is a positive pedagogical approach that promotes student engagement, comprehension, and learning outcomes. It encourages students to think proactively, interact with each other, and establish a good teacher-student relationship with the teacher. These factors together contribute to the effectiveness of teaching and learning.

2.2 Impact of instructional support and emotional support on student creativity

There is no unified understanding of the concept of teacher-student interaction, but many researchers will interpret it based on their own perspectives. For example, from a sociological perspective, some researchers have argued that teacher-student interactions encompass a system of interactions in a variety of contexts and with diverse forms and contents. Other scholars define classroom interaction from a pedagogical point of view that is "various forms of co-operation and influence occurring between teachers and students and between students and students in a particular classroom environment, covering a variety of ways such as explaining, questioning, answering, evaluating, and giving feedback." Other researchers have emphasis that teacher-student interaction is mainly reflected in the dimensions of subject equality, cognitive coordination, affective empathy and pedagogical complementary.

Based on the current research in the national literature and searching for the keyword 'teacher-student interaction', it was found that this type of research mainly uses measurement tools such as the Flanders Interaction Analysis System (FIAS), S-T analysis, and the Classroom Assessment Coding System, CLASS, for further research on the independent variable of teacher-student interaction. The CLASS system provides objective solutions for child development, aiming to improve children's academic performance and professionalism, in which teacher behaviour and student-teacher interactions play a key role in children's professional development. The 2015 CLASS annual report notes that the system is increasingly being used for teacher professional development and not only as an assessment tool [1]. Then it can be concluded that CLASS possesses good validity and reliability. Is found from the related literature，at the primary level, some scholars have observed the English classroom of the sixth grade of primary school based on the CLASS perspective and found that the teacher-student interactions in the primary school English classroom are well-behaved and at the middle to upper level. High-quality teacher-student interaction classrooms exhibit a positive emotional climate, a rich variety of classroom organization strategies and pedagogical support that contributes to higher levels of thinking [2]. Another

researcher observed the classrooms of 28 novice teachers in four primary schools in the urban area of S County, Hunan Province, and the study showed that the teachers were struggling to create a positive atmosphere, the students' opinions were not easily adopted, and the organization of teaching and learning activities was monotonous and boring [3].

The literature employs literature, observation, and case study methods to develop a testing scale for teacher-student interactions. The CLASS tool is used to observe emotional support, classroom organization, and pedagogical support in 30 quality primary school maths lessons. During the coding process, a large proportion of the teachers' schools are located in different regions of the country, providing a wider representation [4]. Currently, there is no formal concept of the concept of quality lessons, and some scholars believe that a quality programme should have the teaching characteristics of high mastery, good quality and excellence. Programme of this nature are interpretations of the educational philosophy, curriculum content, and teaching philosophy of researchers and teachers during a specific period. They also reflect the social values of that time. It is important to note that these interpretations should be objective and avoid subjective evaluations. The literature used descriptive analysis to determine that the mean scores for emotional support, classroom organization, and pedagogical support were between 5-6. The conclusion drawn was that teacher-student interaction has a significant impact on student creativity. Using correlation analysis, it was found that there was a correlation between emotional support, classroom organization, and pedagogical support - emotional support and classroom organization were most highly correlated, emotional support was highly correlated with pedagogical support, and classroom organization was also significantly correlated with pedagogical support [5]. A balanced system is constructed between these three which helps to promote the efficient implementation of classroom teaching and teacher-student interaction. Then based on the research shows that the current domestic research on teacher-student interaction is slightly limited, expanding the sample and the choice of research methodology are the primary issues to be addressed in the domestic research. For this literature study, it was found that teachers should clearly communicate classroom norms to ensure that every student understands them unambiguously. Secondly, three aspects supported the emphasis on student-classroom interaction to improve teaching acumen and the visualization of student thinking: emotional support, classroom organization, and pedagogical support. Meanwhile, this study shows that there is a relationship between teacher-student interaction on student creativity.

The study employed the whole group sampling method to randomly select six classes from three grades in the junior high school of a middle school in Nanning City. Two classes were selected from each grade, and a questionnaire was used to investigate the relationship between teacher-student interaction and creativity among the students. During this period, reference was made to Man Mu, Zhong Haiqing etc. Positive and Negative Feedback Frequency Questionnaire for Elementary School Students and Classroom Teacher-Student Interaction Questionnaire to consider the factors of teacher-student interactions, and combined with the Creativity Self-Efficacy Inventory compiled by Taiwanese scholars Hong Su-Ping and Lin Shan-Ru to examine the relationship between teacher-student interactions and creativity [6]. The study highlights that providing 'appropriate feedback to stimulate innovation', encouraging 'emotional interaction to promote development', and using 'reasonable questioning to stimulate thinking' can improve teacher-student interaction and foster creativity. The current related literature reflects that the current research methods and the number of studies in the study of teacher-student interaction and creativity have time constraints, with relatively short tracking lengths and intervals between each survey. Related studies also mention that future research could be designed with longer tracking times and longer intervals.

Based on the current research, the author believes that continuity research should be emphasis, especially on the aspect of emotional support and creativity in teacher-student interactions, as the factor of emotional support has been highlighted many times in the literature, and the development of creative self-efficacy in students does not happen overnight. Therefore, teachers should be more supportive and caring, and help students to correctly face the difficulties in the process of creation in the process of interaction with them, to achieve the purpose of promoting the development of students' creative self-efficacy. During classroom teaching, the interaction between teachers and students is expressed through behaviour. It is important to maintain clear and concise communication between both parties to ensure effective learning. At the same time, teachers need to be aware that the process of behavioral interaction also includes emotional communication. Therefore, teachers should pay attention to the construction of a harmonious and equal teacher-student interaction model, and promote the construction of positive interaction between teachers and students, so that classroom teaching becomes a way of teachers' performance, and also a carrier of positive emotional communication. During this process, the relationship between the teacher and student becomes more harmonious, and the teacher has a significant influence on the students. This not only helps to enhance the student's confidence in their own creative abilities but also improves their overall self-evaluation, promoting the overall improvement of their mental health.

3 Stem instructional models concerning creativity

3.1 Overview of the STEM teaching model

STEM education, as a systematic educational model, focuses on the deep integration of the four major areas of science, technology, engineering and mathematics. The core concept lies in the intersection of disciplines and the

organic integration of knowledge from these four areas to develop students' problem-solving skills and innovative thinking. STEM education focuses on multidisciplinary cross-fertilization, organically combining science, technology, engineering and mathematics. Interdisciplinary learning enables students to gain a comprehensive understanding of knowledge and skills in various fields, enabling them to better cope with complex real-life problems.

Firstly, STEM education focuses on developing students' problem-solving skills. Through rigorous project implementation and hands-on practice, students gradually acquire the ability to analyse problems in depth, creatively propose solutions, implement them and accurately evaluate the results. These skills play a critical role in the future development of students and are essential to their ability to make informed decisions and respond effectively to challenges and opportunities.

Secondly, innovation is an important goal of STEM education. Through in-depth research and discovery of cutting-edge ideas, technologies and methods, students can achieve significant innovations in their academic and personal growth. STEM education encourages students to come up with new ideas and try out new solutions to better solve real-world problems and create greater value.

Overall, STEM education is a hands-on and innovation-based educational model. By integrating knowledge and skills in the fields of science, technology, engineering and maths, STEM education can help students to improve their problem-solving and innovation skills, and develop their creative thinking and practical skills. This is important for the future development of students and provides them with more opportunities and possibilities.

3.2 The Impact of STEM instructional models on student creativity

According to current literature, some scholars suggest that common contexts in STEM education include 'project-based,' 'practice-based,' and 'design-based.' These contexts reflect the integration of rational and emotional thinking. The educational process aims to develop students' comprehensive literacy through creative practice. Creativity is essential for accomplishing creative tasks and avoiding non-creative products [7]. STEM education is considered more effective than traditional subject-specific teaching methods in cultivating students' innovative thinking and creativity, according to the latest educational concepts. STEM education emphasis interdisciplinary learning and encourages students to explore, discover and solve problems independently. It stimulates students' innovative spirit and creativity while also improving their practical skills and cultivating a collaborative spirit. Teamwork and practical operation are central to STEM education, qualities that are crucial in future society. Therefore, the researchers believe that STEAM education is an important direction in the current development of education and should be widely promoted and applied.

A search on the subject of 'STEM education' revealed that most researchers used literature research, survey research, and classroom observation methods to conduct observational studies on creativity. Test instruments commonly used to measure creativity include the Williams Creative Tendency Test, the Katana-Torrance Creative Perception Questionnaire, the Torrance Creative Thinking Test, Mednick's Distant Association Test, the Creative Reasoning Test, and the Science Creativity Test for Adolescents developed by Wei-Ping Hu.

The study employs a test approach to evaluate 50 children in an experimental and control classroom using the Graphic Creative Thinking Test from the Torrance Test of Creative Thinking (TTCT) translated by Jingji Wu etc [8]. It was found that the experimental group scored significantly better than the control group in the post-test of creativity, and it was inferred that the experimental group's creativity level was significantly higher than that of the control group. According to the data of this study, the pre-and post-test scores of creativity of children in the control group were 60.36 and 68.09 respectively, while the pre-and post-test scores of children in the experimental group were 65.77 and 74.50 respectively. The project-based learning activities based on the STEM concepts have a facilitating effect on the cultivation of creativity in 5-6-year-old children.

One study used a single-group pre-test and post-test experimental research method to investigate the changes in students' situational interest, STEM learning self-efficacy, and creativity after the implementation of a fourth-grade science and technology club class, with the aim of examining the impact of a curriculum guided by the design-based STEM teaching and learning framework on stimulating students' interest, enhancing their STEM learning self-efficacy, and fostering their creativity [9]. The study employed the Creative Thinking Evaluation Questionnaire to assess students' creative thinking in terms of novelty, flexibility, fluency, and refinement. The authors of this literature consider the use of creative outcomes as a crucial indicator for evaluating an individual's creativity, which is widely recognized as a method of assessment. Creativity, as a potential trait, is difficult to observe directly, but it can be demonstrated through creative activities, the most typical expression of which is the output of creative results. Based on the questionnaire data, it was found that students' creative thinking increased significantly students' creative thinking increased significantly after the class, especially in the aspects of fluidity and flexibility. In addition, students' ability to formulate creative questions increased significantly. Thus, it is concluded that design-based STEM teaching can effectively cultivate students' creativity, but there is also a drawback in this study - the lack of novelty. Based on this, the improvement of novelty and detailing should be emphasized in the context of enhancing creativity. This literature is based on the evaluation of a STEM programme designed around the development of student creativity in a junior high school in Shanghai, using a random sample of the school's Year 7 student population [10]. The 'Test of Scientific Creativity for Adolescents' scale, developed by

Hu Weiping etc was used to measure scientific creativity. Two sets of A/B test papers were used to measure pre-programme and post-programme segments. The study analysed the sample for creativity and differentiated the measures by three sub-dimensions and gender. This paper reports the results of the pre-test, post-test, and comparison of pre and post-tests on the level of scientific creativity of the students. The results indicate a significant improvement in the students' scientific creativity. Moreover, other studies also indicate the positive role of STEM models on individuals' creativity [11,12]. The results of the analysis indicate that five sub-dimensions(Subject, objectives, content, activities and evaluation) exhibited significant improvement, while the remaining two dimensions showed relatively insignificant improvement. Therefore, it can be concluded that the programme has a positive impact on the development of students' creativity.

Based on the current literature research, the author believes that the STEM education model does promote good creativity enhancement. However, the novelty and detailing under creativity are the problems that should be solved nowadays, and the one-size-fits-all creativity is not enough to achieve the good demand of innovativeness. For the details of the study, the researcher should increase the comparison of the control group and improve the curriculum design and strengthen the cooperation of the teachers across disciplines is conducive to enhancing the validity and completeness of the STEM curriculum model in the development of creativity.

4 Conclusion

This paper provides a literature review on whether teacher-student interaction characteristics and STEM have an impact on student creativity. Through the study of this paper, it was found that the characteristics of teacher-student interaction do have an impact on creativity, especially in the factor of emotional support, which has a large percentage impact on student creativity. However, the author found that two variables, teacher-student interaction and creativity, needed to be observed over a long period of time and measured with big data during the research process. It is important to note that these variables were identified as significant factors in the study. Additionally, the STEM education model has a clear impact on student creativity. However, the authors found that the increase in the number of students' creativity did not demonstrate an equal level of novelty. In this regard, the novelty behind creativity and ongoing teacher-student interaction observations of creativity effects are further research for the future.

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