INVESTIGATING TEACHERS' PEDAGOGICAL PRACTICES AND BELIEFS REGARDING DEVELOPING CREATIVE THINKING IN ELEMENTARY SCHOOL STUDENTS

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ABSTRACT

Teachers' pedagogical practices and beliefs as they pertain to learning through robotics is becoming increasingly important in education. However, these topics have received little scholarly attention. This study aimed to investigate teachers' pedagogical practices and beliefs regarding developing elementary-school students' creative thinking through robotics. Eleven elementary school teachers participated in this study. We used semi-structured interviews to collect data. A qualitative analysis of teacher interviews revealed that many teachers viewed themselves as facilitators in their class, prioritized the development of students' higher-level abilities, and placed their own emphasis on learning outcomes. This study has implications for teachers and researchers interested in helping students develop their higher-order competencies.

1. INTRODUCTION

The development of students' higher-order thinking skills, particularly creative thinking, is one of the goals of current educational practices. Many educators and policy-makers have called for schools to help students think creatively and produce creative outcomes.

Robotics education, a new form of learning and an emerging research subject, has great potential in terms of helping students develop creative thinking and creative design skills. This subject represents a multi-disciplinary form of education that incorporates computer science and integrates mechanical, electrical and electronic engineering (Nemire, Jill, Larriva, Ceser, Jawaharlal & Mariappan, 2017). Guided by teachers, students can develop their creative thinking by generating original solutions to solve authentic problems. Alimisis (2013) pointed out that robotics education can create an engaging, attractive, and interactive learning environment that facilitates interesting activities and hands-on experiences. Students can develop competencies such as creativity, teamwork and problem solving in the face of the challenging tasks (Gerecke & Wagner, 2007).

To embrace this new form of learning, the Chinese government has recently promoted various policies and projects. However, as robotics education in China is still at the initial stage, there is an urgent shortage of experienced and professional teachers, and little is known about the teachers' practicing in this area. Teachers' pedagogical practices and their beliefs about learning through robotics influence how students develop their creative thinking (e.g., Brickhouse, 1990; Clark & Peterson, 1986; Hashweh, 1996; Nespor, 1987). Moreover, understanding teachers' pedagogical practices and beliefs regarding robotics education is necessary for improving teaching practices and providing teacher training. This study focused on analyzing teachers' pedagogical practices and beliefs in terms of developing elementary-school students' creative thinking through robotics. Specifically, this study aimed to investigate the following two research questions:

(1) Is creative thinking an intended learning outcome in robotics education?

(2) Which pedagogical practices and beliefs are visible among elementary school teachers, and are they designed to help students develop creative thinking?

2. METHOD

2.1 Research Context and Subjects

This study was conducted in two districts of Wuhan, Hubei Province, China. Eleven elementary school teachers from 11 different elementary schools participated in the study. Table 1 details the participants' information.

Table 1. Background information of 11 teachers interviewed. ✓ means teacher graduated from key university. ✗ means not from key university. **N/A** means it is unclear.

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11
Gender	Male	Male	Female	Male	Male	Male	Female	Female	Female	Male	Male
Years of teaching	0.5 year	1.5 years	0.75 year	2.5 years	3 years	0.4 years	5 years	5.5 years	6.5 years	6.5 years	11 years
Key university	✗	✓	✗	✗	✓	✗	✓	✗	✗	✗	✗
Degree	Master	Master	Associate	Bachelor	Bachelor	Bachelor	Master	Bachelor	Associate	Bachelor	Bachelor
Major	Material Science	N/A	Information Technology	Mathematics	Business Administration	English	Educational technology	Educational technology	Computer Education	Science Education	Computer Education

2.2 Data Collection and Analysis

Semi-structured interviews were used to examine teachers' pedagogical practices and beliefs regarding robotics education. The interviews were conducted either face-to-face or by telephone, and each interview lasted approximately 1 hour. All of teachers were asked the questions according to a pre-designed outline consisting of four parts. Part one was primarily about the teaching content of robotics classes. Part two concerned the teachers' basic information and their understanding of the essence of robotics education. In part three, the teachers were asked to describe their teaching process and methods. Part four addressed their perceptions regarding creativity in robotics education. The interviews were audio recorded and transcribed verbatim. After a preliminary analysis of the interview data in the first round, we conducted supplementary interviews with some teachers to obtain missing information.

We adopted and refined the themes developed by Sawyer (2017, 2018) to analyze the interview data. The teachers' responses in each section of the interview were classified according to these categories: pedagogical practices, learning outcomes, and practices and beliefs regarding creativity. We first conducted a thorough analysis of each interview, followed by a comparison between all of the teachers.

3. FINDINGS: EMERGENT THEMES

Six themes emerged from the interviews and were grouped into three clusters: pedagogical practices (3 themes), Learning outcomes (1 theme), and beliefs and practices related to creativity (2 themes). Table 2 presents a detailed analysis of each interviewed teacher in all six aspects.

Table 2. Each Teacher's Practices and/or beliefs associated with themes. ✓ means matched. ✗ means unmatched. **N/A** means it is unclear

Description of the themes	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11
1. Many classes are structured and its contents are predefined	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. The teacher facilitates and guides students.	N/A	✓	✓	✓	✓	N/A	✓	✓	N/A	✓	✗
3. The teacher focuses on summative assessments.	✗	N/A	✓	N/A	✓	✓	✓	N/A	✓	✓	N/A
4. The teacher believes that robotics education leads to higher-level abilities.	N/A	N/A	✓	N/A	✓	N/A	✓	✓	✓	✓	✓
5. The teacher believes that student creativity is primarily constrained by traditional school pedagogy or influenced by family.	N/A	N/A	✓	✓	✗	N/A	✗	N/A	N/A	✓	✓
6. The teacher fosters student creativity by encouraging their own ideas.	N/A	N/A	✓	✓	✓	✗	✓	✗	✓	✓	✓

3.1 Pedagogical Practices

Many classes are structured and its contents are predefined (Theme 1). In most of the robotics classes under consideration, learning was structured and based on the textbook and syllabus. For example, one teacher commented, "The content is based on the textbook" (T5). At the beginning of the class, teachers often opened with questions such as: "What shall we do in this class?" "What's the assignment today?" "Which sensor shall we learn?" and "What's the function of this?" (T3). There were also some classes in which learning activities were prepared for specific contests. For example, as one teacher mentioned, "We mainly refer to the tasks of the contests. It's all about fulfilling the task within the rules, and we train according to those" (T2).

Most teachers serve as facilitators (Theme 2). In most cases, the teachers encouraged the students to first try by themselves. The teachers only offered help when the students encountered difficulty. Some teachers also helped to "figure out what was wrong" (T3). Others occasionally provided "some tips" (T10) or "appropriate guidance" (T7). One of the teachers emphasized giving general directions about how to reach the goal and then let the students elaborate on those" (T2).

Some teachers realized that the students could help one another. Some teachers informally encouraged students to help their classmates surmount problems and "help them out," while other teachers directed certain students "who perform better to help them" (T8). One of the teachers explained that "the way we used to think when we were young is different than the way students think today. Furthermore, we can no longer understand how we thought back then. So other students might help them understand better" (T5). Only one teacher mentioned that she preferred to instruct the students on how to finish a task "step by step" (T11).

Most teachers primarily use summative assessments (Theme 3). In our interviews, the majority of teachers preferred to assess their students with "the completed level of the artefact" (T3; T5) and "the performance for the assignment" (T9). The former compared the classroom robots with the design manual or with similar criteria and stated that "the more complete, the better" (T1). "For instance, if we are going to make a robot sweeper, you have to know that you should use the touch sensor" (T9). These statements suggest that teachers often evaluate performance with task criteria: "Just take the robot car as an example. It will be expected to make a 90-degree turn when it hits an obstacle. If you perform this task well, you can get 3 or 4 points. If you don't, let's say you can't make your robot turn enough degrees or your robot just hits the obstacle and can't turn at all, then your program is wrong, and you only get 1 point" (T3).

3.2 Learning Outcomes

Most teachers believe that robotics education leads to higher-level abilities (Theme 4). When talking about the meaning of robotics education, many teachers took for granted that it can improve students' abilities in terms of logical thinking, practices, problem solving, and collaboration. For example, one of the teachers mentioned that robotics education, which calls upon programming skills, can improve students' "logical thinking" (T9). Another said the following: "I think that cultivating the problem-solving capacity is the most significant part of teaching robotics" (T3). Simultaneously, he emphasized cooperation: "In my class, there are only 10 robot suits, so a group may probably have two or three children. They have to resolve the problem together, and in this case how they cooperate and collaborate is extremely important. In my opinion, only in robotics education can students face these problems and improvise." The teacher continued with this explanation: "If you provide an open and error-free environment, the students can develop their creativity".

3.3 Beliefs about Creativity

The teachers believe that student creativity is primarily constrained by traditional school pedagogy or influenced by the family (Theme 5). Some teachers commented on the traditional pedagogy: "Children basically just follow the teachers' instruction" (T3), "there aren't really any good strategies for cultivating creativity" (T4), and "school constrains students' creativity" (T11). Some teachers believed that the family restricts students' creativity, and made statements such as the following: "Most of the family focuses on examinations, instead of letting the children create more." However, the teachers also recognized that some families "intentionally cultivate children's creativity" and "broaden their horizons."

The teachers foster student creativity by encouraging their own ideas (Theme 6). Some teachers mentioned the importance of "letting students to come up with their own solutions according to the tasks, rather than giving them the standard program" (T10) and they believed that teachers "shouldn't provide directions to students or interfere in how they fulfill tasks" (T9). Still other teachers emphasized to students that "they shouldn't refer to the book all the time, they should make something different" (T5).

4. CONCLUSION

In this study we found that teachers' beliefs and practices in the area of robotics education were reasonable and positive. Many teachers viewed themselves as facilitators in their class (Theme 2), emphasizing the development of students' higher-level abilities, particularly logical thinking and practical skills (Theme 4). However, this study noted some deficiencies, especially in the area of fostering of creativity. For example, only two of the eleven teachers identified creativity as being a significant learning outcome (Theme 4), which suggested that many of the participating teachers did not realize the essential goal of robotics education. This may relevant to their belief that the primary influence on student creativity comes from traditional school pedagogy or the family (Theme 5), and such influence is difficult to counter. This study, which used interviews to examine teachers' practices and beliefs, provides a foundation for our continuing research into how robotics education can foster students' creative thinking.

ACKNOWLEDGEMENT

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