Promoting students' deep learning by focusing on problem design: An explorative study

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BACKGROUND

- Problems are considered as the heart of mathematics; the quality of problems designed by teachers in their teaching plan will significantly influence the quality of students' learning.
- Students in junior high school are at the formal operational stage. It is especially crucial for them to work on learning material in order to understand abstract ideas and use deductive reasoning.
- Although most teachers consider geometric topics, such as the relationships between lines and circles, are appropriate material for training students' mathematics thinking, it does not mean they know how to design problems and questions that have potential to promote students' deep learning.
- Textbook analysis is helpful for identification if opportunities of deep learning are provided (Shield & Dole, 2013), and textbooks are the most important and familiar resources for Chinese teachers.

RESEARCH QUESTION

How in-service mathematics teachers in junior high schools design problems and questions in order to promoting students' deep learning by investigating different textbooks used in various regions of China?

METHOD

- **Participants**: three female teachers worked in different schools.
  all having teaching experience of more than five years.
  all have taught the relationships between lines and circles.
- **Process**: Each teacher chose one textbook series used in China and focused on the central questions or problems posed.

According to their knowledge about students' learning, especially their misconceptions and errors, teachers design and map sub-questions, teachers' followed up questions and corresponding hints.

Levels of questions	Explanations
Core questions（CQ）	The leading questions corresponding to the key phases in a lesson
Sub-questions（SubQ）	Around each leading question, several aspects need to be discussed will be collected and organized as questions
Followed up questions and hints（FQ）	Map out different types of answers students might provide and what teachers can ask further

Every two weeks, a meeting was organized to discuss each teacher's design and the reasons behind.

RESULTS

- **QUESTIONS DESIGNED FOR TEACHING**

CQ1: How many types of relationships exist between a dot and a circle?

CQ2:How to explore the relationships between a line and a circle?

***FQ1*:** What experience of exploration do you have?

***FQ2*:** What have you investigate when examining the relationships between a dot and a circle? How have you investigated?

SubQ 1: Can you classify the relationships between a line and a circle? Draw the pictures and think about your criteria.

SubQ 2: For these three types of relationships, how can we express them by using the language of mathematics?

FQ1: How did we do when describing the relationships between a dot and a circle? Why did we chose such quantities?

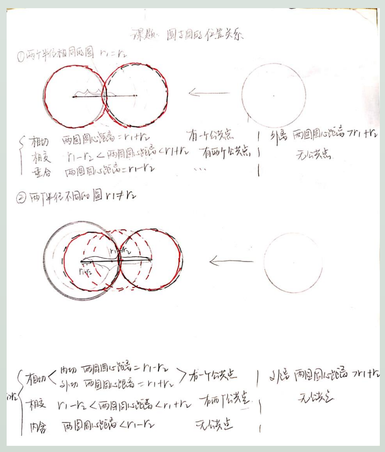
FQ2: How about the relationships between a line and a circle? What quantities shall we choose? And why?

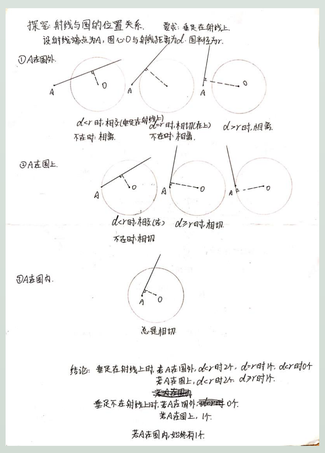
FQ3: What if we know the mathematical expression between *d* and *r*? Can we decide what relationship between a line and a circle?

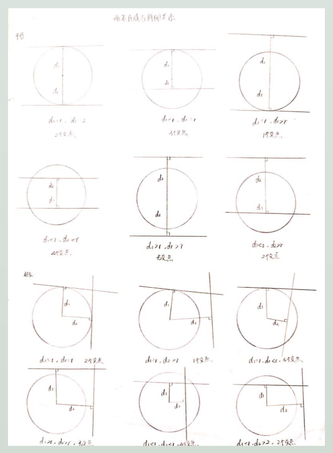
SubQ 3: What are the similarities and differences between the dot-circle relationships and the line-circle relationships?

CQ3:How else questions would you like to explore? And how?

- **STUDENTS' WORK EXAMPLES**







CONLUSIONS

- Core questions → Sub-questions → Followed up questions and hints, design such question series can help teachers to have a better understanding of the mathematics topics and their lesson.
- Design question series can promote students' deep learning.

Reference：

Shield, M., & Dole, S. (2013) Assessing the potential of mathematics textbooks to promote deep learning. Educational Studies in Mathematics, 82, 183–199