APPLICATION OF METACOGNITION SKILL TO METHODS PROBLEM SOLUTION FOR SECONDARY SCHOOL STUDENTS

APLICAÇÃO DA HABILIDADE DE METACOGNIÇÃO EM MÉTODOS DE SOLUÇÃO DE PROBLEMAS PARA ESTUDANTES DO ENSINO MÉDIO

APLICACIÓN DE LA HABILIDAD DE METACOGNICIÓN A MÉTODOS SOLUCIÓN DE PROBLEMAS PARA ESTUDIANTES DE ESCUELA SECUNDARIA

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ABSTRACT: Currently, policy makers around the world are trying to reform the educational system in general and Mathematics education in particular to create a fundamental change in the content, curriculum and students' methods of learning Mathematics. Innovative efforts in Mathematics education focus on helping students develop the core competencies of the 21st century to create more educational and career choices for students in the future. Metacognition or thinking about thinking refers to an individual's ability to control his or her thinking processes, especially the perception of choosing and using problem-solving strategies. To find solutions to the problems mentioned, a number of studies have focused on understanding the role of metacognition in problem solving activities in the teaching process of Mathematics. In this study we will explore some metacognitive models in Mathematics education, therefor, we research "Application of metacognition skill to methods problem solution for secondary school students".

KEYWORDS: Metacognitive skills. Math problems. Secondary school students.

RESUMO: *Atualmente, os formuladores de políticas em todo o mundo estão tentando reformar o sistema educacional em geral e a educação matemática em particular para criar uma mudança fundamental no conteúdo, no currículo e nos métodos de aprendizagem de matemática dos estudantes. Esforços inovadores na educação em Matemática concentram-se em ajudar os estudantes a desenvolver as competências centrais do século 21 para criar mais opções educacionais e de carreira para os estudantes no futuro. Metacognição ou pensar em pensar refere-se à capacidade de um indivíduo de controlar seus processos de pensamento, especialmente a percepção de escolher e usar estratégias de resolução de problemas. Para encontrar soluções para os problemas mencionados, vários estudos se concentraram na compreensão do papel da metacognição nas atividades de resolução de problemas no*

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processo de ensino de Matemática. Neste estudo vamos explorar alguns modelos metacognitivos na educação matemática, por isso, pesquisamos "Aplicação da habilidade de metacognição em métodos de solução de problemas para estudantes do ensino médio".

***PALAVRAS-CHAVE**: Habilidades metacognitivas. Problemas matemáticos. Alunos do ensino médio.*

***RESUMEN**: Actualmente, los responsables políticos de todo el mundo están tratando de reformar el sistema educativo en general y la educación matemática en particular para crear un cambio fundamental en el contenido, el plan de estudios y los métodos de aprendizaje de las matemáticas por parte de los estudiantes. Los esfuerzos innovadores en la educación matemática se centran en ayudar a los estudiantes a desarrollar las competencias básicas del siglo XXI para crear más opciones educativas y profesionales para los estudiantes en el futuro. La metacognición o pensamiento sobre el pensamiento se refiere a la capacidad de un individuo para controlar sus procesos de pensamiento, especialmente la percepción de elegir y utilizar estrategias de resolución de problemas. Para encontrar soluciones a los problemas mencionados, una serie de estudios se han centrado en comprender el papel de la metacognición en las actividades de resolución de problemas en el proceso de enseñanza de las matemáticas. En este estudio exploraremos algunos modelos metacognitivos en la educación matemática, para ello investigamos "Aplicación de la habilidad metacognitiva a métodos de solución de problemas para estudiantes de secundaria".*

***PALABRAS CLAVE**: Habilidades metacognitivas. Problemas matemáticos. Estudiantes de secundaria.*

Introduction

Researchers in different fields have come up with different models of metacognition. Flavell was the first to define the term *metacognition*. The metacognitive model proposed by Flavell serves as the foundation for later metacognitive research. Meanwhile, the metacognitive model proposed by Brown (1984) includes two components: knowledge of perception and cognitive adjustment. The hierarchical metacognitive model of Tobias and Everson (2002) has been used in the study of teaching process.

Flavell's model of metacognition

Flavell introduced the components of metacognition and stated their characteristics, including: Metacognitive knowledge; Metacognitive experiences; Cognitive goals; Activities and strategies. Each individual's ability to tailor cognitive outcomes depends on the interactions between components of cognitive strategy, cognitive experience, metacognitive knowledge, and metacognitive experience.

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Brown's metacognitive model

Ann Leslie Brown (1943-1999) was an American educational psychologist. Her studies focus on human memory and memory development strategies. Brown (1978) divided metacognition into two components, knowledge of perception (a conscious reflection of one's cognitive abilities and activities) and cognitive adjustment (self-adjustment in problem solving). These two components have their own characteristics, but they have a mutual relationship, supporting each other and promoting learners' cognitive activities.

The model of metacognition by Tobias and Everson

According to Tobias and Everson (2002), metacognition is a combination of factors such as skills, knowledge (understanding of perception), monitoring learners' cognitive process as well as controlling that process. Planning: The student's first task in a metacognitive activity is planning, including defining learning goals, learning time and expected results; Choice of strategy: After making a plan, learners need to choose an appropriate strategy and method to perform that learning task; Learning assessment: When completing a learning strategy, learners need to evaluate their learning including an evaluation of the process and the results achieved in comparison with set goals. Assessment is an important activity that gives students a basis to adjust their learning. Understanding monitoring: Tracking their own understanding at each stage, monitoring the effectiveness of the strategies used to choose the optimal one.

The reality of the activities of training metacognitive skills in the process of students' Math learning

The data obtained from the survey are related to the Math results of 100 9th graders participating in the survey of 50 boys and 50 girls, at Phan Thiet, Ỷ La, Le Quy Don Secondary school , Tuyen Quang province had given the following summary table:

Table 1 – Math results of students who participating in the survey

Math results	Poor	Normal	Good	Excellent
Quantity (ratio)	3 (3%)	58 (52%)	34 (40%)	5 (5%)

Source: Prepared by the authors

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Students' metacognitive skills in the process of solving Math problems

The description of students' metacognitive skills in the process of problem solving will be conducted with each group from solving simple situations to complex situations in the survey.

Metacognitive activities in the process of problem solving of students

First problem*:* This is a familiar problem for students, so these students did not have difficulty in reading comprehension and problem solving:

- *Step of reading the problem*: Students read the problem silently and do not take time to recognize the requirements that the problem poses (perception).
- *Step to understand the problem*: Students quickly grasp the requirement of the problem to compare the area of two shapes.
- *Planning step*: Students easily transfer the request to compare the area of two shapes to compare the area of the insets contained in the given shapes. The students in this group divided each given picture into two insets and compared the areas of the small shapes with each other.
- *Exploratory step (perception and metacognition):* Students realize that comparing the area of two large shapes can be done by subdividing those large shapes into component shapes, then comparing them. area of each pair of forming components to draw conclusions about the area of the original two pictures. This area comparison process will help them to successfully solve the problem posed at the beginning.
- *Implementation step*: Students have divided picture A and picture B into 2 small pictures. Then, based on the number of squares on each inset, they realized that the areas of the corresponding insets in picture A and picture B are equal. From that, they conclude that picture A and picture B have the same area. The following image shows how to solve problems of students:

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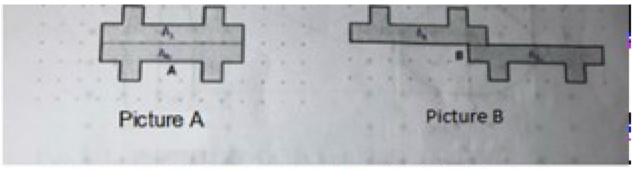
Figure 1 – Compare the area of picture A and picture B of student



- Area of shapes A and picture B are the same

- Because, when we divide both shapes A and B in half, we get shapes A1, A2 and shapes B1, B2

+ Based on the proportions of the cells on the picture, we can see the following:

$S_{A1} = S_{B1}$

$S_{A2} = S_{B2}$

+And: $S_A = S_{A1} + S_{A2}$

$S_B = S_{B1} + S_{B2}$

⇨Conclude: $S_A = S_B$

Source: Authors' collection

- *Confirmation step:* Students completely believe in the problem solving plan that they themselves give because they are built on the idea of dividing large shapes into small shapes of equal area. This is a way of efficiently comparing the areas of shapes when they are partitioned into correspondingly equal areas.

Second problem*:* This is a problem that is not too familiar to students, so they were initially confused in orienting how to solve the problem:

- *Step of reading the problem*: Students read the problem silently and do not take time to recognize the requirements that the problem poses (perception).
- *Step to understand the problem*: Students quickly grasp the requirements of the problem to find and compare the area of two shapes.
- *Planning step*: Students notice that picture A and picture B both have oval shapes. This is a familiar pattern in their daily life but the children do not know how to calculate the area of these shapes. At first, students thought about estimating the area to compare the area of picture A and picture B. They divided the area of picture A and picture B into 6 parts. Then they compare the area of the corresponding parts. Similar to when solving problem 1, the method of partitioning large shapes into corresponding small pictures of equal area was used by students when solving this problem. Then they went online to search for

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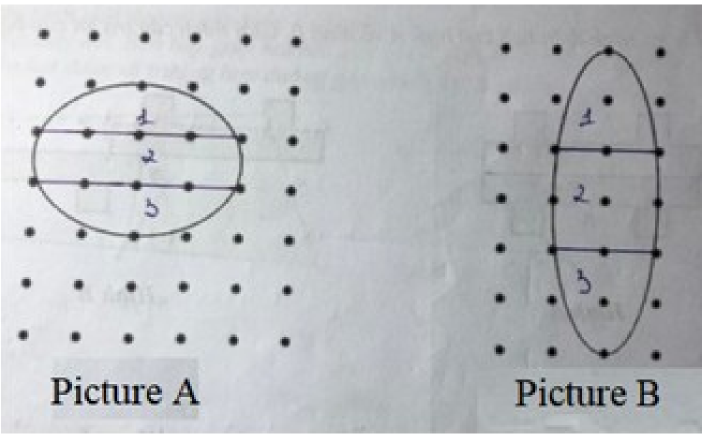
formulas to calculate the area of oval shapes to calculate the area of the given shapes to compare their areas.

- *Exploratory step (perception and metacognition)*: Similar to when solving the previous problem, students think about dividing the given shapes into corresponding components and comparing their areas in turn. They also thought about finding a general formula for calculating the area of ovals. They used the internet to search for a suitable formula for the area of these shapes and accepted the formula, but did not find out why it was obtained.
- *Step of implementation:* At first, students have divided picture A and picture B into three parts and commented that the area of each part is approximately the same. So you conclude that picture A and picture B have the same area:

Figure 2 – Compare the area of picture A and picture B of students



Source: Authors' collection

Then the students apply the formula to calculate the area of the ellipse found from online references. They have calculated the area of figure A and figure B using this formula and concluded that figure A and figure B have the same area. The following image shows how students argue when using the formula to calculate the area of an ellipse:

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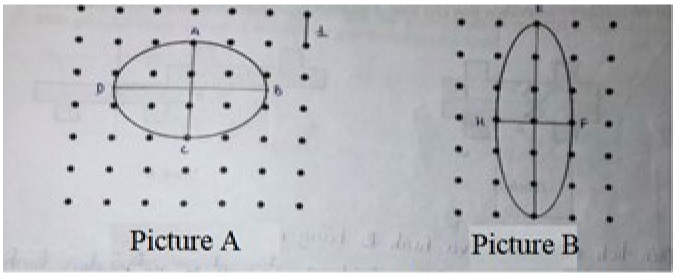
Figure 3 – Compare the area of figure A and figure B of students



- Areas of shapes A and shapes B are the same

-Because :

Suppose, the side of a small square is 1 cm

+In shape A: Let AC be the minor axis and BD the major axis of shape A

We have: $S_A = \pi . \frac{AC}{2} . \frac{BD}{2} = 3.^{\pi}$ (cm^2)

+In shape B: Let EG be the major axis and HF the minor axis of shape B

We have: $S_B = \pi . \frac{EG}{2} . \frac{HF}{2} = 3.^{\pi}$ (cm^2)

$\Rightarrow$Conclude: $S_A = S_B = 3.\pi$

Source: Authors' collection

- *Step of confirmation*: Students in group 1 completely believe in the problem solving plan that they have given themselves because they have found a formula for calculating the area of oval shapes (in mathematics in the near future. you will be known as the ellipse).

***Third problem**:* Rebuilding the fence with the given fence is a two-way bend is a problem that is not familiar to students, so at first they have difficulty in solving the problem posed:

- *Step of reading the problem:* Students read the problem silently and do not take time to recognize the requirements that the problem poses (perception).
- *Step to understand the problem*: Students quickly grasp the requirements of the problem, which is to change the fence from a crooked road to a straight line.
- *Planning step:* At first, students are confused about what knowledge to use to meet the requirements of the given situation. They realized that it is necessary to change the requirement of the problem about estimating the area of two shapes after the fence has been built. However, the knowledge and experience of dealing with previous problems does not support students to succeed if they divide the given garden plots into smaller parts and

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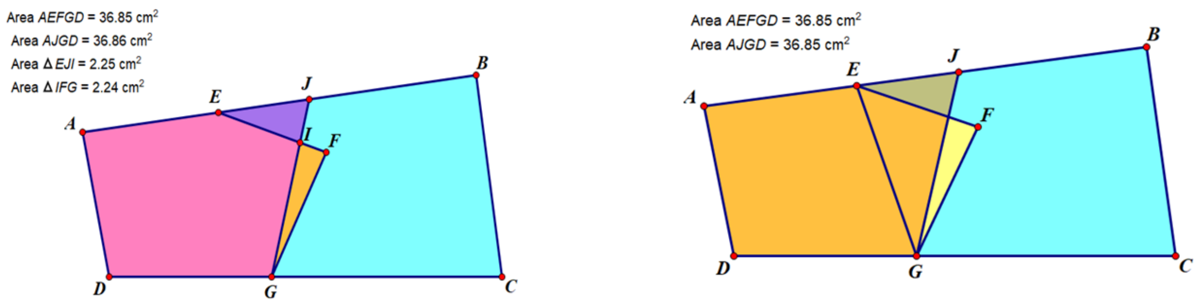
estimate their area as when solving the problem. problems encountered in previous situations. Students must use the command to drag points and calculate the area in GSP dynamic geometry software to predict and check the results obtained. Based on the results obtained from the GSP software, the students predicted the results, thereby proposing a solution to the problem posed in the original situation.

- *Exploratory step (perception and metacognition):* At first, students thought of finding a line passing through G that intersects AB at point J and intersects EF at I so that the area of triangle EJI is equal to the area of the triangle EJI. of the triangle IFG, then the line GI can be the desired line. However, that is only a theoretical inference, and in practice, how to draw a line that satisfies that requirement, they are still confused. Then they used GSP software to predict the location of the J point to find. Then they take a moving point J on DC, connect G and J then move the position of point J to predict the position of the line to find.

Figure 4 – Estimate the area by dragging the point



Source: Authors' collection

The students noticed that when J moves from left to right, the area of quadrilateral AJGD increases gradually, to a certain position, the area of this quadrilateral will be approximately equal to the area of the first garden. Students also realize that the position of point J has a special feature that the line FJ is almost parallel to the line EG. From there, they hypothesized that the point J to find is the intersection of the line passing through F parallel to EG and the line AB.

- *Implementation step:* Students have drawn a line through the point passing through F parallel to EG and intersecting line AB at J. At that time, they try to prove that the areas of two polygons AEFGB and AJGD are equal.

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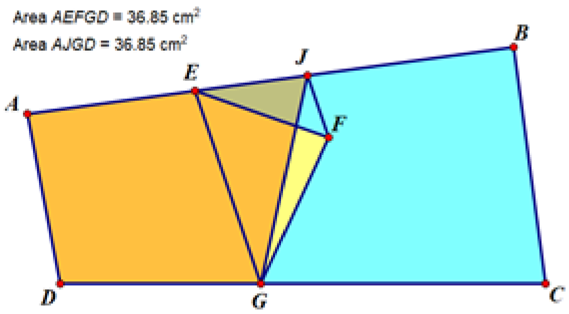
Figure 5 – Divide two garden plots by a straight line



Source: Authors' collection

Students assume that the areas of triangles EFG and EJG have the same area because they have the same base and the same height. Therefore, the areas of the two polygons AEFGB and AEVD are equal because they both contain the quadrilateral AEGD. Therefore, placing a new fence along the GJ line will satisfy the requirements of the original problem.

- *Confirmation step:* Students realize that building a new fence in the direction of the straight line EJ will help solve the problem posed at the beginning. Although facing certain difficulties in orienting the solution, with the teacher's support in guiding the children to use some tools in GSP software, they have helped them step by step to orient the method resolution project.

- After succeeding in rebuilding the fence with the given fence as a two-way bend, the students began to rebuild the fence with the given fence as a three-way bend. This is a similar but more complex problem than the one you just solved. Students think that they can use the knowledge and experiences they have learned from the above problem solving in this similar problem solving:

- *Step of reading the problem*: Students read the problem silently and do not take time to recognize the requirements that the problem poses (perception).

- *Step to understand the problem*: Students quickly grasp the requirements of the problem, which is to change the fence from a three-way bend to a straight line.

- *Planning step*: Although realizing the similarity in statements and requirements posed in this problem compared with the above problem, at first, students were also confused in finding a way to change the fence from the folding road. three-segment into a straight line. They had difficulty deciding which two-section bend road to change from the three-segment road to the two-section bend in order to apply the solution to the problem they found earlier. To overcome that difficulty, at first, the students used GSP software to predict the line to be found by dragging the point and using the command to calculate the area of the polygon. Then

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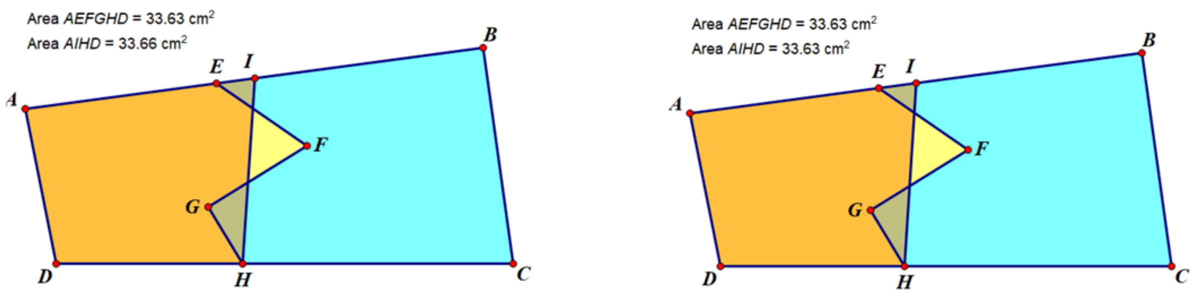
they thought about changing from a three-segment bend to a two-segment bend, using the parallel line method to convert the two-segment bend into a straight line and using the area command in the software to calculate the area. GSP dynamic learning to predict and test the results obtained.

- *Exploratory step (perception and metacognition):* Students use GSP software to predict the line to be drawn, they use the area command to calculate the area of the first garden and the second garden. Then they draw a line segment with a fixed point H and the other point I moving on the line AB, calculate the area of quadrilateral AIHD and compare it with the area of the first garden.

Figure 6 – Estimate the area by dragging the point



Source: Authors' collection

The use of drag command in GSP software has helped students predict the position of the line to find, but students still cannot figure out how to determine point I because it does not suggest a special factor. to help them come up with an idea where this point is located. Therefore, students try to apply the method of straightening the two-segment bend from the previous problem to this problem. They created a new two-segment road EKH and checked the area of the obtained garden:

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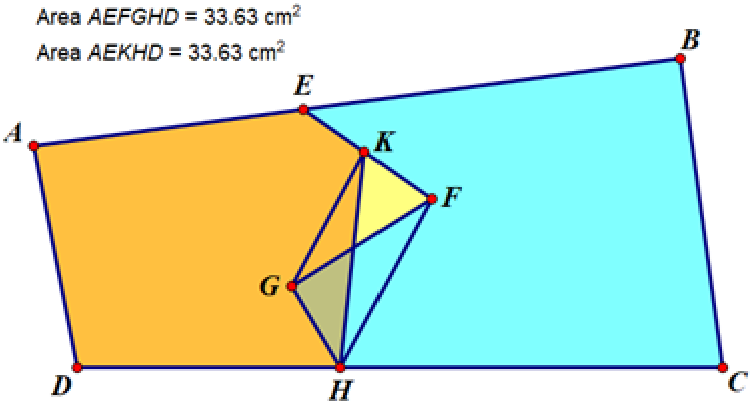
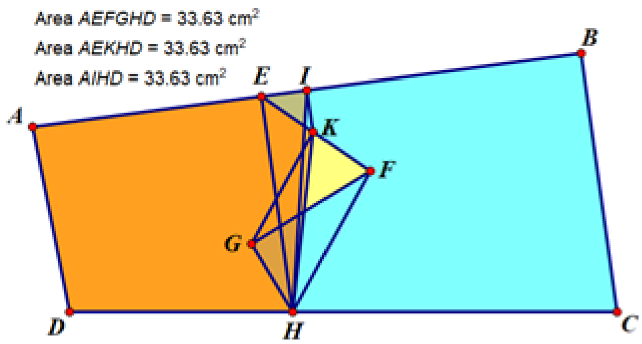
Figure 7 – Estimate the area by dragging the point



Source: Authors' collection

At this time, students feel more confident with the idea of straightening the original bend when they see that the obtained garden area is equal to the original area. After that, they continued to stretch the two bends of EKH into a straight line by the same method and obtained a garden with an area equal to the original area and satisfied the requirements of the problem of moving from the fence. is a line that bends three segments into a straight line:

Figure 8 – Estimating the area with a straight line



Source: Authors' collection

- *Implementation step:* Students draw a line through G parallel to HF that intersects EF at K. They show that the area of triangle HFG is equal to the area of triangle HKF. Next, the students used the option of converting from a two-segment road to a straight line by connecting two points E and H, building a line through K parallel to EH and cutting AB at I. At that time, students built a fence along the way. The straight line HI will meet the requirements of the problem because the area of triangle EKH is equal to the area of triangle EIH.

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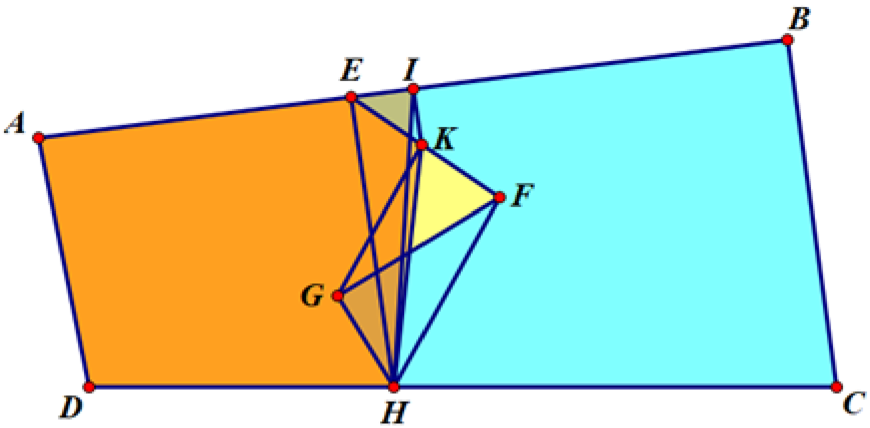
Figure 9 – Rebuild the bank into a straight line



Source: Authors' collection

- *Confirmation step: Students find that building a new fence in the direction of the straight line HI will help solve the problem posed at the beginning. Although facing certain difficulties in orienting the solution, but with efforts in using some tools of GSP software and applying knowledge gained from previous situations, help them step by step orient the problem solving plan.*

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