

SOME FEATURES OF CRITICAL THINKING OF HIGH SCHOOL STUDENTS, A CASE STUDY IN VIETNAM

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ABSTRACT

People often think that only students of high learning competence may have high –order- thinking (HOT) especially critical thinking. In this article the authors describe a survey conducted in some high schools in Vietnam to emphasize that all students including the slow ones can have critical thinking in learning mathematics with different levels. One of the most important task of maths teachers is to help each student develop his or her own critical thinking by using flexible teaching and learning strategies and methods.

Keywords: *thinking; critical thinking; specific student groups.*

1.

Understanding about critical thinking:

Many teachers notion that they can teach high order thinking ,especially critical thinking for only bright students. However such psychologists as T. M. Amabile (1983), H. Jellen and K.K. Urban (1986), H. Gardner (1993), D. Perkins (1995), EP Torrance (1995), T. Armstrong (2000), . showed that normal individuals may have intellectual potential, potential for critical thinking at different levels. To clarify this statement, in this paper, we focus on researching to identify some characteristics of critical thinking high school student groups.

The authors such as K. B. Bayern, M. Scriven, R. Paul, L. Elder, T. A. Angelo, gave some notions of critical thinking:

"Critical thinking means making reasoned judgments" (K. B. Beyer) [4].

"Most formal definitions characterize critical thinking as the intentional application of rational, higher order thinking skills, such as analysis, synthesis, problem recognition and problem solving, inference, and evaluation" (T. A. Angelo) [3]

"Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action" (M. Scriven and R. Paul) [13].

"Critical thinking is that mode of thinking- about any subject, content or problem – in which the thinker improves the quality of his or her thinking by skillfully taking charge of the structures inherit in thinking and imposing intellectual standards upon them" (R. Paul and L. Elder) [10]

Our concept: Critical thinking is the kind of thinking which based on evidence, experience and confidence, thinker considers, evaluates and contacts all aspects of information sources with active skepticism to solve problems, predict the ability to develop and expand the problem.

According to Matthew Lipan [8], critical thinking has some basic characteristics:

- The outcomes of critical thinking are judgments
 - Critical thinking relies on criteria
 - Critical thinking is self-correcting
 - Critical thinking is sensitive to context
- Raymond S. Nickerson (1987) characterized a good critical thinker in terms of knowledge, abilities, attitudes, and habitual ways of behaving. Here are some of the characteristics of such a thinker:
- Uses evidence skillfully and impartially
 - Organizes thoughts and articulates them concisely and coherently
 - Distinguishes between logically valid and invalid inferences
 - Suspends judgment in the absence of sufficient evidence to support a decision
 - Understands the difference between reasoning and rationalizing
 - Attempts to anticipate the probable consequences of alternative actions
 - Understands the idea of degrees of belief
 - Sees similarities and analogies that are not superficially apparent
 - Can learn independently and has an abiding interest in doing so
 - Applies problem-solving techniques in domains other than those in which learned

-Habitually questions one's own views and attempts to understand both the assumptions that are critical to those views and the implications of the views

-Is sensitive to the difference between the validity of a belief and the intensity with which it is held

-Is aware of the fact that one's understanding is always limited, often much more so than would be apparent to one with a non-inquiring attitude

-Recognizes the fallibility of one's own opinions, the probability of bias in those opinions, and the danger of weighting evidence according to personal preferences [12]

In the book "Critical Thinking" Beyer elaborately explains what he sees as essential aspects of critical thinking. These are:

- Dispositions: Critical thinkers are skeptical, open-minded, value fair-mindedness, respect evidence and reasoning, respect clarity and precision, look at different points of view, and will change positions when reason leads them to do so.
- Criteria: To think critically, must apply criteria. Need to have conditions that must be met for something to be judged as believable. Although the argument can be made that each subject area has different criteria, some standards apply to all subjects. "... an assertion must... be based on relevant, accurate facts; based on credible sources; precise; unbiased; free from logical fallacies; logically consistent; and strongly reasoned" (p. 12).
- Argument: Is a statement or proposition with supporting evidence. Critical thinking involves identifying, evaluating, and constructing arguments.
- Reasoning: The ability to infer a conclusion from one or multiple premises. To do so requires examining logical relationships among statements or data.
- Point of View: The way one views the world, which shapes one's construction of meaning. In a search of understanding, critical thinkers view phenomena from many different points of view.
- Procedures for Applying Criteria: Other types of thinking use a general procedure. Critical thinking makes use of many procedures. These procedures include asking questions, making judgments, and identifying assumptions. [4]

According to R. Paul and L. Elder, habitual utilization of the intellectual traits produce a well-cultivated critical thinker who is able to:

- Raise vital questions and problems, formulating them clearly and precisely
- Gather and assess relevant information, using abstract ideas to interpret it effectively
- Come to well-reasoned conclusions and solutions, testing them against relevant criteria and standards;
- Think open-mindedly within alternative systems of thought, recognizing and assessing, as need be, their assumptions, implications, and practical consequences; and
- Communicate effectively with others in figuring out solutions to complex problems [10]

Thus, although it is slightly different in expression, but can see the authors emphasize the characteristics of Critical thinking as follows.

-Organizes thoughts and articulates them concisely and coherently

-Uses evidence skillfully and impartially

-Distinguishes between logically valid and invalid inferences

-Sees similarities and analogies that are not superficially apparent

- Critical thinking means making reasoned judgments

-Listens to the views of others; regularly asks the views of others and attempt to understand the assumptions and their implications

-Ability to debate and recognize mistakes in the opinion of myself and of others.

-Sensitives to context, capable of self-correcting and application of problem-solving techniques appropriate to the new situation or other fields.

In the table below we summarize the expression of critical thinking of high school students in learning maths:

Ability to re- create, to organize information and to describe the problems	<p>1. Having ability to compare, sort, categorize information gathered from the problem to be solved. Having ability to find out the nature of the problem, similarities and differences in the similarities . Having ability to restructure the non-standard problems in a way that standard techniques can be used to solve them. Having ability to reorganize the information, data and talk about them concisely and clearly.</p> <p>2. Having ability to ask questions in order to find information, search for directions to solve the problem</p>
Ability to link, to evaluate and to process information in order to solve the problem	<p>3. Having ability: to connect the knowledge and experiences; to approach and consider the problem from many different perspectives; to find the logical relationship between data. Having ability to use logical reasoning and thinking skills to make plans to solve the problem. Having ability to evaluate the reasonableness in posing and solving the problem.</p> <p>4. Being ready to consider and consult different opinions with active skepticism and ready to participate in debate to find out ideas and most reasonable way to solve the problem.</p> <p>5. Having ability to argue to make judgments and decisions. Having ability to predict and conclude from one or some details. Having ability to find the unusual approach to complex problem.</p> <p>6. Having ability to self evaluate to find his/her own shortcomings and mistakes in posing and solving the problem and being able to repair , correct the mistakes or shortcomings.</p>
Ability to reflect issues	<p>7. Having ability to set and solve complex problems. Being capable of doing abstraction, generalization.</p>

2.

Some features of critical thinking of specific student groups (group of excellent and good students ,group of average students and group of below average students) in learning maths.

We have conducted a survey on critical thinking of students at 10 high schools located in 5 provinces of Vietnam (Hanoi, Thanh Hoa, Ha Nam, Bac Giang, Lai Chau) . The survey involved 360 students including 72 below average students, 180 average students, 108 excellent students and good students (35 students of Nguyen Hue high school for gifted student, 32 students of Tran Hung Dao high school, 38 students of Ngo Quyen high school, 36 students of Lam Son high school for gifted student, 39 students of Ngoc Lac high school, 34 students of Ha Van Mao high school, 36 students of Binh Luc B high school, 38

students of Nguyen Huu Tien high school, 42 students of Yen Dung high school, 30 students of Le Quy Don high school for gifted students)

In this study, we wanted to find out the following:

- The expression of critical thinking of high school students in learning maths
- Critical thinking features of specific student groups (excellent and good; average; below average) in learning maths

During the survey we used the following methods:

- We reviewed the students' answer to the questions and problems of the spatial geometry programs in grades 11
- We attended maths classes to observe the expression of teachers and pupils

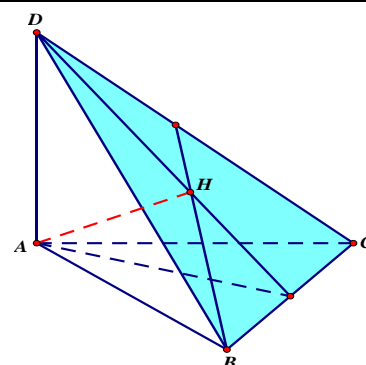
(regarding awareness, attitudes, behavior) in teaching and learning activities.

- We viewed student's notebooks and talked to the students

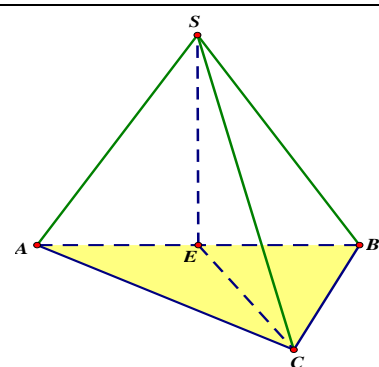
Through our research we found that all three groups of students having signals/ expression

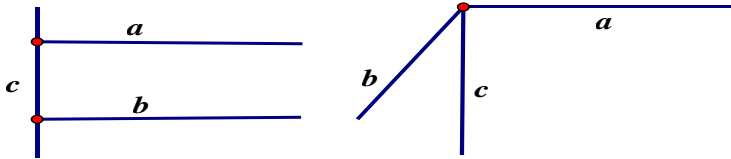
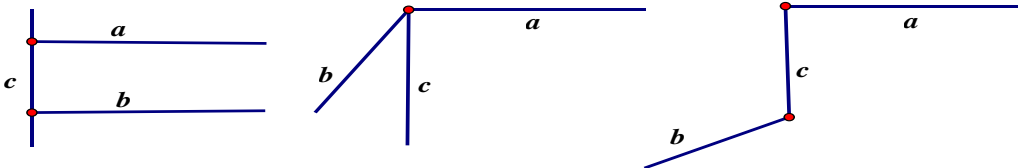
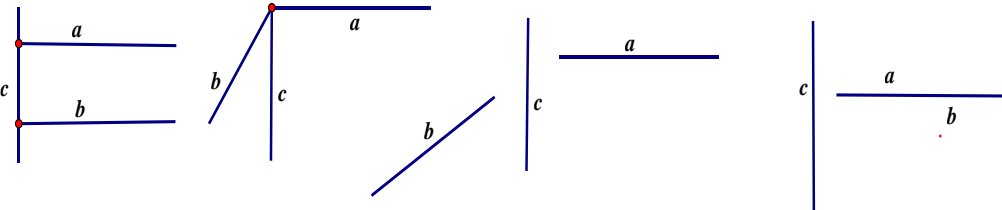
of critical thinking. However, the expression of critical thinking of different groups had differences. The following table describes the details of differences:

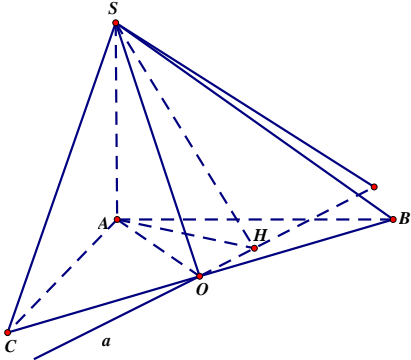
	Below average students	Average students	Excellent students and good students
Ability to re create, organize information and describe the problem	For the basics, standards problems, below average students began with the ability to sort and classify the information gathered from the problem, such as when solving a problem they can classify what information belongs to the assumption, what information belongs to conclusions. However, students usually prone misperception, confused by the sign outside so not to see clearly the nature of the problem when they solve non-standard problems	For the basics, standards problems, below average students have the ability to sort and classify the information gathered from the problem. Students known dismissed outward signs to find out nature of the problem. However, when they solve non-standard problems, organizing and rearranging information is fragmented, lacks coherence, recognizing problems is the lack of inclusiveness.	Having the ability to compare, sort, categorize the information gathered from the problem to be solved. Looking out the similarities and parallels are not visible at the surface and found differences in the similarities, is not be misled by the superficial signs. Having the ability to reorganize the information, data and speech them mounted, concise. However, they have not paid attention to the description of the problem in new ways, not interested in the relationship between problem with practical and other problems.
	<p>Example 1: Teacher posed the question: Write in a clear and detailed the assumptions and conclusions of the following problems: "Given tetrahedron ABCD with three pairwise perpendicular edges AB, AC, AD. Prove that the perpendicular foot drawn from vertex A to plane (BCD) is the orthocenter of triangle BCD."</p> <p>Here are the answers of the students:</p> <p>a. The answers of the below average students: 15/72 below average students (20.8% of students in the group of the below average students) have the answer as follows: "Assumptions: Given tetrahedron ABCD with three pairwise perpendicular edges AB, AC, AD. Conclusions: the perpendicular foot drawn from vertex A to plane (BCD) is the orthocenter of triangle BCD"</p> <p>57/72 below average students (79.2% of students in the group of the below average students) have the answer as follows: "Assumptions: Given tetrahedron ABCD with three pairwise perpendicular edges AB, AC, AD. Let H be the perpendicular foot drawn from vertex A to plane (BCD). Conclusions: H is the orthocenter of triangle BCD"</p> <p>b. The answers of the average students: 18/180 average students (10.0% of students in the group of the average students) have the answer as follows: "Assumptions: Given tetrahedron ABCD with three pairwise perpendicular edges AB, AC, AD. Let H be the perpendicular foot drawn from vertex A to plane (BCD). Conclusions: H is the orthocenter of triangle BCD"</p> <p>162/180 average students (90.0% of students in the group of the average students) have the answer as follows: "Assumptions: Given tetrahedron ABCD with three pairwise perpendicular edges AB, AC, AD; $SH \perp (BCD)$. Conclusions: H is the orthocenter of triangle BCD"</p> <p>c. The answers of the excellent and good students:</p>		

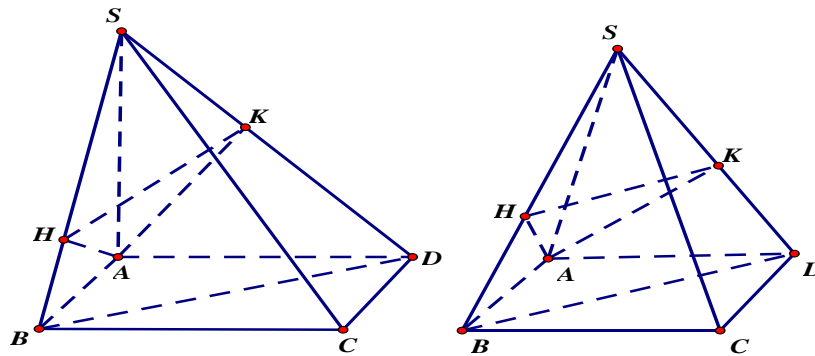


	<p>108/108 excellent and good students (100% of students in the group of the excellent and good students) have the answer as follows: “Assumptions: Given tetrahedron ABCD with three pairwise perpendicular edges AB, AC, AD; $SH \perp (BCD)$ and $H \in (BCD)$. Conclusions: $BH \perp CD$, $CH \perp BD$”</p>		
	<p>When solving complex problems, students often do not know where to start so do not know to ask questions in order to find information, search for directions to solve the problem.</p>	<p>Students know questioning search for information to solve the task at hand, but do not know to build a system of strategic questions seeking information, seeking direction to solve the problem</p>	<p>-Students know how to build the system of strategic questions to search for information, seeking direction to solve the problem</p>
	<p>Example 2: Teacher posed the question: Given a triangular pyramid S.ABC with $SA = SB = SC = a$, $AB = a\sqrt{3}$, $\angle BSC = 60^\circ$, $\angle CSA = 90^\circ$. State the steps to take to find the angle between line SC and plane (ABC). Here are the answers of the students:</p> <p>a. The answers of the below average students: 72/72 below average students (100% of students in the group of the below average students) do not have the answer.</p> <p>b. The answers of the average students: 128/180 average students (71.1% of students in the group of the average students) have the answer as follows: “Step 1: Determine the projection of line SC onto plane (ABC). Step 2: Compute the angle between line SC and its projections onto plane (ABC).”</p> <p>52/180 average students (29.9% of students in the group of the average students) have the answer as follows: “Step 1: Determine S’C - the projections of line SC onto plane (ABC). Step 2: Compute the angle between line SC and line S’C.”</p> <p>c. The answers of the excellent and good students: 27/108 excellent and good students (25.0% of students in the group of the excellent and good students) have the answer as follows: “Step 1: Determine point H - the projections of point S onto plane (ABC). Step 2: Compute the angle between line SC and line SH.”</p> <p>81/108 excellent and good students (75.0% of students in the group of the excellent and good students) have the answer as follows: “Step 1: Consider the characteristics of triangle ABC. Step 2: Determine point H - the projections of point S onto plane (ABC). Step 3: Compute the angle between line SC and line SH.”</p>		
<p>Ability to link, evaluate, process information in order to solve the problem</p>	<p>-Having ability to contact the knowledge, the experience. However the speculation issue was not thoroughly.</p>	<p>- Having ability to contact the knowledge, the experience. Capable of considering the issue of the common circumstances, the common case. However still have not seen the case of</p>	<p>- Having ability to contact the knowledge and the experience; considering the issue in a comprehensive way, the attention to degenerate cases and the special cases.</p>



	degenerate, the special case	
<p>Example 3: Teacher posed the question: “Let c be line perpendicular to both two line a and b. Determine relative positions of two lines a and b. Let's draw figure to illustrate”. Here are the answers of the students:</p> <p>a. The answers of the below average students: 72/72 below average students (100% of students in the group of the below average students) have the answer as follows: “Two possible situations an occur: a and b are parallel; a and b are intersect”. Here are their illustrations:</p>  <p>b. The answers of the average students: 72/72 average students (100% of students in the group of the average students) have the answer as follows: “Three possible situations an occur: a and b are parallel; a and b are intersect; a and b are diagonal”. Here are their illustrations:</p>  <p>c. The answers of the excellent and good students: 26/108 excellent and good students (24.0% of students in the group of the excellent and good students) have the answer as follows: “Three possible situations an occur: a and b are parallel; a and b are intersect; a and b are diagonal”. 82/108 excellent and good students (76.0% of students in the group of the excellent and good students) have the answer as follows: “Four possible situations an occur: a and b are parallel; a and b are intersect; a and b are diagonal; a and b are overlap”. Here are their illustrations:</p> 		
<p>- Always ready to consider, consult the opinions of the other, however they normally do not join the debate that just listen.</p>	<p>-Always ready to consider, consult the opinions of others. Joining the debate but just stops at the level of giving to their opinions that no explanation, unknown-defend own opinions.</p>	<p>-Always ready to consider, consult the different opinion, willing to participate in this debate to find out ideas and solving problems. However positive skepticism not yet present in the students. Students usually only stop in finding out the way to solve problems, not interested in finding out more ways to solve, not interested in finding out how to solve the problem in an optimal and most reasonable way.</p>

<p>- Having the ability to make predictions, but no accurate basis for the predictions</p>	<p>- Having the ability to make predictions, but no accurate basis for the predictions</p>	<p>- Having the ability to argue to bring out the judgements and decisions; having the ability to test and prove the judgment.</p>
<p>Example 4: Teacher posed the problem: “Given a triangular pyramid S.ABC whose base is an isosceles right triangle with the hypotenuse $BC = a$, edge $SA = a$ and $SA \perp (ABC)$. Let O be midpoint of segment BC and (P) be plane contains the line SO. Determine the position of plane (P) such as the dihedral angle between two planes (P) and (ABC) is a maximum”. Here are the answers of the students:</p> <p>a. The answers of the below average students: 72/72 below average students (100% of students in the group of the below average students) do not have the answer.</p> <p>b. The answers of the average students: 128/180 average students (71.1% of students in the group of the average students) have the answer as follows: “Step 1: Determine the projection of line SC onto plane (ABC). Step 2: Compute the angle between line SC and its projections onto plane (ABC).” 52/180 average students (29.9% of students in the group of the average students) have the answer as follows: “Step 1: Determine S’C - the projections of line SC onto plane (ABC). Step 2: Compute the angle between line SC and line S’C.”</p> <p>c. The answers of the excellent and good students: 27/108 excellent and good students (25.0% of students in the group of the excellent and good students) have the answer as follows: “Step 1: Determine point H - the projections of point S onto plane (ABC). Step 2: Compute the angle between line SC and line SH.” 81/108 excellent and good students (75.0% of students in the group of the excellent and good students) have the answer as follows: “Step 1: Consider the characteristics of triangle ABC. Step 2: Determine point H - the projections of point S onto plane (ABC). Step 3: Compute the angle between line SC and line SH.”</p> 		
<p>- Students are not capable of self-review and self-assessment to identify the shortcomings and mistakes in the way of solving the problem. Students perform this activity under the guidance of the teacher</p>	<p>- Self-review and self-assessment to identify the shortcomings and mistakes in the way of solving the problem are limited. Students perform this activity under the teacher's suggestion</p>	<p>- Students are capable of self-review and self-assessment to identify the shortcomings and mistakes in the way of solving the problem. However, HS has not done well the fix the mistake, not to do well the addition of the shortcomings, especially in the stage of argument.</p>
<p>Example 5: Teacher posed the problem: “Given a pyramid S.ABCD. Let H and K be the projections of point A in line SB and SD, respectively.</p> <p>a/ Let ABCD be rectangle and $SA \perp (ABCD)$. Prove that: $AH \perp (SBC), AK \perp (SDC), SC \perp HK$.</p> <p>b/ Let ABCD be a rhomb and $SB = SD$. Prove that: $SC \perp HK$”.</p>		



Here are the answers of the students:

a. The answers of the below average students:

With question a/, at first, the HS has difficulty. When GV pose the question: "To prove $AH \perp (SBC)$ we need prove anything?" then there are 51/72 below average students (70,8% of students in the group of the below average students) have to answer: "To prove $AH \perp (SBC)$ we need to show that: "AH perpendicular 2 intersecting lines in plane(SBC) which is SB and BC". After the discussion, 32/72 below average students (44% of students in the group of the below average students) has given right solutions.

With question b/, 32/72 below average students (44% of students in the group) recognized that can not use the same solution as the solution of question a/ to solve questions b/, however the they do not think the solution to questions b/.

b. The answers of the average students:

With question a/, at first, the HS has difficulty. When GV pose the question: "To prove $AH \perp (SBC)$ we need prove anything?" then there are 180/180 average students (100% of students in the group) have to answer: "To prove $AH \perp (SBC)$ we need to show that: "AH perpendicular 2 intersecting lines in plane(SBC) which is SB and BC". After the discussion, 159/180 average students (88,3% of students in the group) has given solutions. but 21/179 average students (11,7% of students in the group) HS also confused in solution.

With question b/, 169/180 below average students (93,8% of students in the group) recognized that can not use the same solution as the solution of question a/ to solve questions b/, however the they do not think the solution to questions b/.

c. The answers of the excellent and good students:

108/108 excellent and good students (100% of students in the group) had right solutions for question a/ and recognized that can not use the same solution as the solution of question a/ to solve questions b/. However, only 52/108 excellent and good students (48,2% of students in the group) know to adjust illustration by drawing HK parallel to BD, and give correct solutions to question b/.

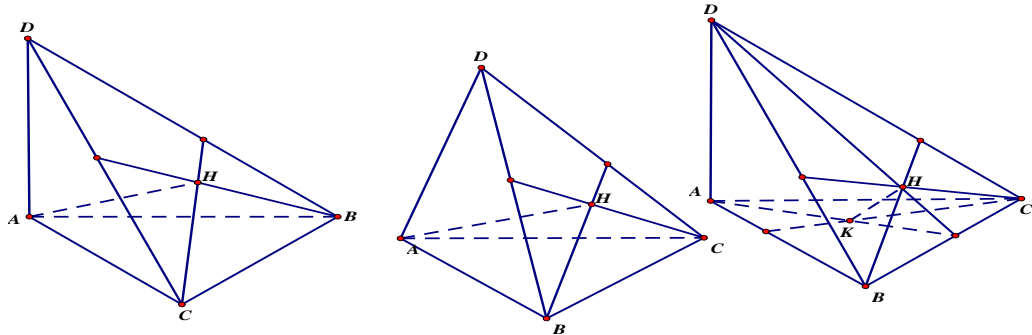
Ability to reflect issues	- Students do not have ability to issue abstraction, generalizing the problem.	- Students do not have ability to to issue abstraction, generalizing the problem.	- Students have ability to issue abstraction, generalizing the problem, however this ability is often only at the level of generalized external manifestation of the problem, the ability to generalize the inner nature of the problem is still limited.
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Example 6: After students, complete problems: "Given tetrahedron ABCD with three pairwise perpendicular edges AB, AC, AD. Prove that the perpendicular foot drawn from vertex A to plane (BCD) is the orthocenter of triangle BCD", teacher pose the question:

a/ Generalize the results in the case of a tetrahedron ABCD has opposite edges perpendicular to

each other.

b/ Generalize the results in the case of a tetrahedron ABCD has $DA \perp (ABC)$.



Here are the answers of the students:

a. All of below average students and average students do not have the answer.

b. 20/108 excellent and good students (18,5 % of students in the group) do not have the answer.

79/108 excellent and good students (73,1% of students in the group) have the answer as follows:

“Given a tetrahedron ABCD has opposite edges perpendicular to each other. We can show that the perpendicular foot drawn from vertex to its opposite plane is the orthocenter of this opposite plane”. They do not have the answers to questions b /.

9/108 excellent and good students (8,4% of students in the group) have the answer as follows:

“Given a tetrahedron ABCD has opposite edges perpendicular to each other. We can show that the perpendicular foot drawn from vertex to its opposite plane is the orthocenter of this opposite plane” and “Given a tetrahedron ABCD with $DA \perp (ABC)$. Let K, H be the orthocenter of triangles ABC and DAC. We can show that point H is projection of point K onto plane (DBC)

Conclusion

Not only excellent and good students have critical thinking in learning mathematics but all students including the average or even below average students can have and can be developed their critical thinking. Of course qualities of critical thinking of different groups of students are different. The development of critical thinking for all groups of student in the same class requires maths teacher to identify the characteristic of the critical thinking of each group of students. Since then teachers should have appropriate pedagogical interventions that aim at developing qualities of critical thinking of each students.

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