Teachers' Capacity of Instruction for Developing Higher – Order Thinking Skills for Upper Secondary Students – A Case Study in Teaching Mathematics in Vietnam

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Abstract: *In the social model, in order to live and work in a complex and competitive environment of the 21st century, students must be well-equipped with such important skills and qualifications, of which creativity, critical thinking, communication and collaboration skills are very necessary for learners in the future. In this paper, the researcher aims to focus on teachers' competency of instruction for developing higher-order thinking skills (creativity, critical thinking skills) through teaching and learning Mathematics in Vietnam.*

Keywords: *higher-order thinking; teachers' capacity; critical thinking; problem-solved skills; creativity.*

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1. Literature review

In 1956, Bloom's taxonomy was introduced with six levels of thinking such as remembering, comprehending, applying, analyzing, evaluating, and creating (Ennis, 1987). Three first levels are lower-order thinking skills (LOTs) and the others are high-order thinking skills (HOTs). The lowest levels of thinking require basic recognition or recall while the highest levels of thinking require critical and creative thinking. Therefore, many teachers have become familiar with Bloom's taxonomy and applied it during their preparation courses. However, in recent years, when learners can easily get information from the Internet, teachers realize that developing higher-order thinking is very important for their students to learn.

There are some definitions of higher-order thinking, but according to Thomas and Thorne (2009), "Higher order thinking is thinking on a level that is higher than memorizing facts or telling something back to someone exactly the way it was told to you. When a person memorizes and gives back the information without having to think about it, we call that rote memory. That's because it is much like a robot; it does what it's programmed to do, but it doesn't think for itself".

"Higher-order thinking takes thinking to a whole new level. Students using it are understanding higher levels rather than just memorizing math facts. They would have to understand the facts, infer them, and connect them to other concepts" (Cox, 2017).

Higher order thinking, or "HOT" for short, takes thinking to higher levels than restating the facts. HOT requires that we do something with the facts (Williams, 2003). We must understand them, infer from them, connect them to other facts and concepts, categorize them, manipulate them, put them together in new or novel ways, and apply them as we seek new solutions to new problems.

From the abovementioned perspectives, we agree that higher-order thinking is thinking that students must understand the facts, analyze, evaluate, and give solutions for the facts.

2. Critical thinking, higher-order thinking and problem-solving skills

There are many ways to explain the relationship between critical thinking, higher order thinking and problem-solving skills. According to King, Ludwika and Faranak (1998) some researchers and scholars use the terms "critical thinking" and "higher order thinking" interchangeably, while others define "critical thinking" as a form of higher order thinking. Some use the terms "critical thinking" and "problem solving" interchangeably; yet

for others believe thinking is a form of problem solving. Still others define “critical thinking” as part of the process of evaluating the evidence collected in problem solving or the results produced by creative thinking.

Higher order thinking includes critical, reflective, meta-cognitive, and creative thinking (King, Ludwika & Faranak, 1998; Snyder & Snyder, 2008). These skills are activated when students of any age encounter unfamiliar problems, uncertainties, questions, or dilemmas. Successful application of these skills result in explanations, decisions, performances, and products that are valid in the context of available knowledge and experience, and promote continued growth in higher order thinking, as well as other intellectual skills.

Higher order thinking skills are grounded in lower order skills such as discriminations, simple application and analysis, and cognition strategies and linked toprior knowledge of subject matter content. Higher – order thinking occurs when a student takes new information orinformation stored in new context to achieve an answer (King, Ludwika, & Faranak, 1998).

3. Teachers’ capacity of developing higher-order thinking skills in the classroom

In the book of “Higher-order thinking skills to develop 21st century learner”, (Conklin, 2012a) introduced 8 core strategies for higher-order thinking skills including *questioning strategies, problem- solving strategies, decision – making strategies, idea-generating strategies, thinking organization, creative strategies*. Depending on the higher-order thinking definition and some core strategies for higher-order thinking, the authordetermined some requirements that each teacher need to ensure higher –order thinking skills in class as follows:

- *Master knowledge*, teachers need to in-depth understand the content (mathematical knowledge) if they want to give critical thinking questions for their students, teachers should make sure students understand the critical features that define a particular concept and distinguish it from other concepts. Also, teachers can help their students to recognize the key concepts. In any subject area, students should be alerted when a key concept is being introduced. Students may need help and practice in highlighting key concepts. Further, students should be guided to identify which type(s) of concept each one is - concrete, abstract, verbal, nonverbal or process (Thomas & Thorne, 2009). Moreover, teachers help students understand concepts by naming the main features of the concept; naming some additional features of the concept; naming some false features of the concept; giving the best examples or prototypes of the concept; giving some

non-examples or non-prototypes; and identifying other similar or connected concepts.

Teachers should lead students through the process of connecting one concept to another, and putting concepts into a hierarchy from small to large. Compare the new to the already known. Students should be asked to stop and compare and connect new information to things they already know.

- *Using question more usefully*, teachers can do a lot to encourage higher order thinking, even when they are answering students' questions. According to (Baron, & Sternberg, 1986), answers to students' questions can be categorized into seven levels, from low to high, in terms of encouraging higher levels of thinking. While teachers would not want to answer every question on level seven, they would not want to answer every question on levels one and two, either. Conklin (Conklin, 2012a), believes Bloom's taxonomy has been used in classroom for more than 50 years as hierarchy of question that progresses from less to more complex. It can provide a framework for introducing a variety of question to all students.

Another way to promote students' higher-order thinking skills is using Socratic Method. By using this method, students can get the value and recognize good questions while also improving up on thoughtful method of thinking. There are some kinds of Socratic Questions:

Table 1: Socratic Questions

Questions that clarify	. What is an example of...? . Can you explain...? . How would you say this in your words? . What is the right way to define this?
Questions that probe assumption	. Why do you think this way about...? . What are your assumptions? . What do you believe to be true? . What else could we believe about this?
Questions that probe reason and evidence	. What make you believe this? . How do we know this true? . What would make you change your mind? . What else do we need to know?
Questions about perspectives and viewpoints	. Whose viewpoint is this? . What is another view about? How many more perspectives could they be about?
Questions that look consequences	. How does this affect...? . Why this is important?

	. What effect can this have on...?
	. If this is true, then what else might be true?
Questions about the question	. What does the question mean?
	. Is this the good question?
	. Why was this question asked?
	. What does this have to do with our lives?

(Conklin, 2012a)

- *Have a positive attitude and a high sense of responsibility* for their teaching activities. In order to encourage higher order thinking, teachers must be mind ful of their students and make them feel free to ask questions without any negative reactions from their peers or their teachers. Encourage students to ask questions, and if for some reasons, teachers cannot get to their question during class time, and then show them how they can answer it themselves, or have them save the question until the following day. According to (Conklin, 2012a), the most important key to higher-order thinking skills is getting students to ask question. It is up to each teacher to train to be inquirers. Teachers train by using modelling inquiry for students and can pose those types of question for students for students. They can set up scenarios of exploration at the beginning of a lesson or place something in front of students and let them touch, observe, and listen. When teachers hear a good question, they need to point out, write on the board and make a big deal about it.

- *Problem solving abilities*, in the book of Higher-order thinking skills, *Wendy Conklin* believed that teachers who used a problem-based approach in the classroom not only helped students grasp particular concepts but they also paved the way for future learning. There are many reasons for using problem-based learning with students. First, when solving problem, students must use information they find through research to synthesize viable solution. Moreover, their minds are capable of thinking through complex situations, which promotes higher-level thinking skills. Problems need to be worked through systematically and logically in order to come to a satisfactory conclusion. Second, when solving problems, students are forced into thinking both critically and creatively as they seek to find solution to problem. (Conklin, 2012a)

To promote problem-based learning in the classroom, teachers must restructure their course around problem-based learning (Conklin, 2012b). Teacher must use real – life problems in explanation, and examples to help students understand the knowledge. In some cases, if the knowledge is more

difficult, teachers must use the Vygotsky's theory about zone – proximal development to create learning situations. Otherwise, teachers should link students' errors to misconceptions. Because students can all learn from their mistakes, teachers should make an effort to isolate the misconception and correct it, and then teach students to do this by themselves.

Hence, teacher's competencies in higher-order thinking instruction may include the components as presented in the following tables:

Table2. Competence elements of teacher's instruction on higher– order thinking

Competence elements of teacher's instruction on higher– order thinking	Description
Capacity in Master knowledge	Help students recognize the key concepts, formulas, and theorems.
	Help students recognize the features that define a particular concept, formulas, and theorems.
	Help students name the main features of the concept, and theorems;
	Help students name some additional features of the concept, and theorems;
	Help students name some false features of the concept; Help students give the best examples or prototypes of the concept;
	Help students identify other similar or connected concepts, formulas, and theorems;
Capacity in using questions more usefully	Give questions that clarify
	Give questions that probe assumption
	Give questions that probe reason and evidence
	Give questions about perspectives and viewpoints
	Give questions that look consequences
	Give questions about the question
Capacity in problem solving	Restructure their course around problem-based learning
	Use real – life problems in explanation, and examples to help students understand the knowledge
	Use the Vygotsky's theory about zone – proximal development to make the learning situations
	Link students' errors to misconceptions

4. A survey on teachers' capacity of instruction for developing higher-order thinking skills for secondary students in Viet Nam

The researcher has conducted a survey on teachers' capacity of instruction for developing higher – order thinking skills for secondary students in 3 provinces of Vietnam (Thai Nguyen, Quang Ninh, and Bac Giang). There are 60 secondary school teachers in this survey. In this study, the researcher would like to explore the following issues:

1. Teachers' perception about developing higher-order thinking skills for secondary students in Math;
2. Teachers' difficulties when implementing instruction higher-order thinking for secondary students;
3. Teachers' capacity of instruction for developing higher-order thinking skills for secondary students.

During the survey, the researcher used the following methods:

- Reviewing the teachers' answers by using questionnaires;
- Attending Maths classes to observe the expression of teachers and students in teaching and learning activities;
- Discussing with teachers and students;

The research results are shown as follows:

Table 3: Necessity to implement instruction for developing higher – order thinking skills for secondary students

Element	Level of necessity			
	Very necessary	Necessary	Not very necessary	Not necessary
Necessity to implement instruction for developing higher-order thinking skills for secondary students	31.7	56.7	11.6	0

The above table shows that 88.4% of the surveyed teachers are in awe of the necessity to implement instruction for developing higher – order thinking skills for secondary students through teaching and learning activities in Maths. When the researcher asked the surveyed teachers, “Why do you think it is necessary to implement instruction for developing higher- order thinking skills for secondary students”? Many of them said that they felt

more interested in teaching Maths for students who usually gave interesting and difficult questions.

Table 4: Level of regularity to implement instruction for developing higher – order thinking skills for secondary students

Element	Level of regular			
	Very regular	Regular	Not regular	Never
Level of regularity to implement instruction for developing higher – order thinking skills for secondary students	18.3	43.3	23.3	15.1

Although 88.4% of the surveyed teachers are aware of the necessity to implement instruction for developing higher-order thinking skills for secondary students, but there are only 18.3 % of them, who regularly implement instruction for developing higher -order thinking skills for secondary students. In addition, 15.1% of the surveyed teachers never implement instruction for developing higher-order thinking skills for secondary students. They said that it was difficult for them to instruct higher-order thinking skills for students because they did not in-depth understand the methods of developing higher-order thinking skills.

To assess component of Maths teachers' instruction abilities to develop higher -order thinking for students in secondary school, the researcher designed a survey toolkit based on Likert's 4-levels scale, which encoded attainment of competence component corresponding from lowest (=1) to highest (=4). The content below aggregates average score that teachers self-assess the extent of the component of instruction competency for developing higher-order thinking for students in secondary school in teaching and learning mathematics.

Table 5: Teachers' capacity in Master knowledge

Competence elements of teacher's instruction on higher– order thinking	Description	Average score
Capacity in Master knowledge	Help students recognize the key concepts/theorems/formulas	3.6
	Help students recognize the features	3.8

	that define a particular concept or determine theorems/formulas	
	Help students name the main features of the concept/theorems/formulas;	3.8
	Help students name some additional features of the concept;	3.7
	Help students name some false features of the concept;	3.7
	Help students identify other similar or connected concepts/theorems/formulas	3.7
	Help students give the best examples or prototypes of the concept/theorems/formulas;	3.8

The figures in this table show that secondary school mathematics teachers in Vietnam are master of knowledge. Through observation in Maths classes, the researcher found that mathematics teachers could understand more clearly about the mathematics concepts, theorems and formulas. It was not difficult for them to name the main features of the concepts, theorems, and formulas; help students identify other similar or connected concepts, theorems, and formulas; and help students give the best examples or prototypes of the concepts.

Table 6. Teachers' capacity in using questions more usefully

Competence elements of teacher's instruction on higher- order thinking	Description	Average score
Capacity in using questions more usefully	Give questions that clarify	2.9
	Give questions that probe assumption	3.0
	Give questions that probe reason and evidence	2.8
	Give questions about perspectives and viewpoints	2.9
	Give questions that look consequences	2.7
	Give questions about the question	2.8

The survey results showed that teachers' capacity in using questions were not proportional with their knowledge of Maths. Although they could in-depth understand the knowledge of Maths, they did not usually give any questions for their students that probe reason and evidence (average score of 2.8). Through observation in classroom, the researcher recognized that during teaching, teachers more frequently asked their students repeated concepts, formulas, and theorems; they often asked students distinguished concepts, gave examples, explained concepts and theorems; sometimes they wanted their students to apply concepts, formulas, and theorems in new situations. In addition, they rarely asked questions that students must give their perspectives and viewpoints or look for consequences of concepts, formulas, or theorems. The researcher discussed with surveyed teachers, they said that they did not really understand how to develop higher - order thinking for students by using useful questions.

Table 7: Teachers' capacity in problem solving

Competence elements of teacher's instruction on higher-order thinking	Description	Average score
Capacity in problem solving	Restructure their course around problem-based learning	2.5
	Use real-life problems in explanation, and examples to help students understand the knowledge	2.4
	Use the Vygotsky's theory about zone-proximal development to create the learning situations	2.0
	Link students' errors to misconceptions	2.2

Similar to capacity in using useful questions, problem-solving capacity of Maths teacher werenot good. Looking into the surveyed teacher's lesson plans, the researcher found that many of them could not restructure the knowledge in textbooks. Teachers faced many difficulties when using real-life problems in making lesson plans, explanation, and examples to help students understand the knowledge. Some teachers said that they had to spend much time to make lesson plan when they used real – life problems, and they did not have the habit of using real – life problems in making lesson plans. Through observation in classroom, the researcher found that the surveyed teachers could give many mathematical examples, but they

rarely used real –life examples to help students understand the concepts, theorems, and formulas. Some of them did not know about the Vygotsky's theory, so they could not use this theory in their work.

5. Conclusion

It can be said that, now, higher-order thinking skills are very important for students, for they can find a lot of information via Google. Students are not as receivers of information, but as users of information. There are many ways to enhance higher-order and creative thinking skills for students, however, similar to any other skills, higher-order thinking skills require training, practice and patience. Learning environment that students have been required not only to remember information, but also they may resist with assessment questions that are not taken verbatim from the book, students may be required solving real-life problem to learn mathematics. However, whether this instruction for developing higher-order thinking succeeds or not, it depends very much on teacher. Our study results once confirm the necessity to pay attention and focus on training and retraining of instruction for higher-order thinking skills for secondary school teachers.

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