DEVELOPING PROSPECTIVE MATHEMATICS TEACHERS' PROFESSIONAL COMPETENCIES FROM A SITUATED PERSPECTIVE

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Abstract: This study investigates prospective mathematics teachers (PMTs)' competencies for teaching mathematics from a situated perspective. We used the teacher competence model drawn from Blömeke, Gustafsson, & Shavelson (2015) as a main theoretical framework. This model aims at resolving the common dichotomy between cognitive and situated perspectives in the study of teachers and their work. In this model, teacher competence is seen as a continuum starting from cognitive and affect-motivation aspects moving to situation-specific skills that lead to performance in the classrooms. In this study, we have also developed a framework for evaluating teachers' noticing competence based on lesson analysis after observing videos. Each video clip described a classroom situation related to the interpretation of the derivative in an economic context. More specifically, we used a qualitative analysis to bring out the characteristics of Vietnamese PMTs' professional competencies for teaching the derivative in real-world contexts. Finally, implications for the professional learning of Vietnamese mathematics teachers are also discussed.

Keywords: Prospective mathematics teacher, professional competence, situated perspective.

1. INTRODUCTION

In the last two decades, research in mathematics education has significantly expanded our understanding of the nature and type of knowledge that impacts on teachers' performance. There have been several studies conducted in an attempt to identify what kinds of knowledge teachers need to teach mathematics effectively (Shulman, 1987; Ball, Thames, & Phelps, 2008). From the work of Shulman (1987), many researchers have tried to develop and clarify the nature of the different types of knowledge that teachers need to teach mathematics effectively. Ball and her colleagues made an important contribution by developing a model of mathematical knowledge for teaching (the MKT model) for assessing and developing the domains of teachers' knowledge for teaching.

Recent studies on teachers' competencies have focused more on practical orientations and the concept of competency based on situated approaches (Blömeke, Gustafsson & Shavelson, 2015; Kaiser et al. 2017). At this point, the cognitive aspect (types of teachers' knowledge for teaching) is considered as a theoretical framework for analyzing classroom

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situations. Furthermore, applying the cognitive aspect to specific classroom situations requires situation- specific skills such as perception, interpretation and decision making. Recently, researchers have given remarkable results on the role of teacher noticing and situation-specific skills (Yang, 2019; Kaiser, König & Blömeke, 2017; Santagata, 2011, 2014, 2016). However, very few studies have focused on the links between cognitive and situated approaches in a specific teaching situation.

In this study, we proposed a lesson analysis framework for connecting the cognitive and situated approach to the evaluation of mathematics teachers' professional competences. The lesson framework allows to assess PMT's noticing competence while working on video-based lessons. The video-based lessons are videos-clips designed for teaching the derivative and its application in economics. Twenty Vietnamese PMTs participated in a video-based assessment of their professional noticing. Qualitative analysis of the results has helped us draw meaningful conclusions about the developing Vietnamese PMTs' professional competence

2. THEORETICAL BASIS

2.1 Teacher competency model and Lesson analysis framework for evaluating teachers' noticing compentencies

To enrich the model of cognitive-driven competency, some researchers (Blömeke, Gustafsson, and Shavelson, 2015; Kaiser et al.2017) have added to the model the basic elements of a noticing approachto achieve a more balanced model combining the cognitive orientation and the situational orientation (Figure1). The elements of teacher noticing are introduced under the name of Situation-specific skills, expressed through three components forming a PID model: Perception, Interpretation and Decision making (Figure 1).

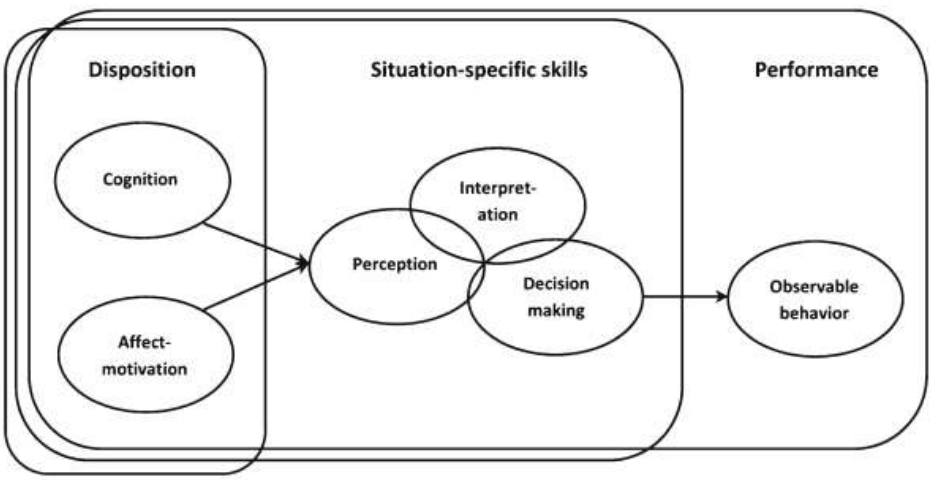


Figure 1. *Modelling competence as a continuum (Blömeke, Gustafsson, and Shavelson, 2015)*

Perception: Perceiving particular events in an instructional setting which corresponds to attending to particular events in an instructional setting.

Interpretation: Interpreting the perceived activities in an instructional setting which corresponds to making sense of events in an instructional setting.

Decision-making: either as anticipating a response to students' activities or as proposing alternative instructional strategies, which corresponds although less straightforwardly than the first two facets to acting.

Table 2. *MPLA Framework for evaluating teachers' noticing competencies*

	Items	Type of capacity	Group capacity
1	What are the main learning goals of the lesson?	SCK_P	S_PID
2	What topics in other subjects do the lesson content relate to?	HCK_P	
3	Do you have any comments on the accuracy of the mathematical content in the lesson?	CCK_I	
4	What mathematics knowledges that the students have learned and will be learning do these goals relate to (which grade)?	KCC_P	P_PID
5	Do you have any comments on the teaching method of the teacher in the lesson? Point out the activities or techniques the teacher illustrates for your answers.	KCT_ID	
6	Please comment about how to state the problem of the teacher? Specific illustration.	KCT_ID	
7	Please comment about how to resolve the problem of the teacher? Specific illustration.	KCT_ID	
8	Which instructional decisions assisted students in making progress towards the goals, which did not?	KCT_ID	
9	What did the students encounter difficulties?	KCS_ID	
10	Did the students make progress towards the learning goals?	KCS_ID	
11	What alternative strategies could the teacher use and how would these assist students in making progress toward the learning goal?	KCT_ID	

From the Lesson Analysis Framework of Santagata (2016), we proposed a lesson analysis framework consisting of 11 open-ended questions to assess teachers' competence through analyzing teaching videos (Figure 2). The PID competence facets were assessed with respect to subject-related classroom demands (S_PID) and pedagogy-related classroom demands (P_PID). The questionnaire was divided into two competency groups: 3 questions in the S_PID group (Subject Instruction: Perception, Interpretation, and Decision) and 8 questions in the P_PID group (Pedagogy: Perception, Interpretation, andDecision). They also include six types of knowledge of theMKT model: Common content knowledge (CCK), Specialized content knowledge (SCK), Horizon content knowledge (HCK), Knowledge of content and teaching (KCT), Knowledge of content and students (KCS), Knowledge of content and curriculum (KCC) (Ball, Thames, & Phelps, 2008, Lien & Minh, 2018).

2.2. Participants

Participants of the study are 20PMTs studying at Quang Binh University, Vietnam (a four year program, school year 2019-2020). These PMTs had studied derivative of functions in the first three semesters of their undergraduate program, and they had subsequently completed other courses related to mathematical analysis. They had also studied the subjects related to the teaching mathematics.

2.3. Instruments and Data collection

The research instrument was four video-vignettes for teaching the derivative in real-world contexts in high school (5-6 min each) and a questionnaire, respectively. Important scenes from the lessons are used in the video-vignettes such as the introduction of a mathematical task followed by students' activities. To help participants more completely understand the videotaped teaching, background information of the class and lessons prior to the lesson that was videotaped were provided. In order to be close to real classroom teaching, each video could only be watched once: rewinding or pausing was not possible before the items had to be answered. After watching the videos, the test takers were prompted to answer several items covering the facets of the MPLA framework: perception, interpretation, and decision-making.

The beginning problem

A shop selling Doan Hung pomelo for 50,000 VND per kilo. At this price, the shop can only sell about 40 kilos. This shop intends to reduce the selling price. It is estimated that if the shop reduces the price of each kilo by 5,000 VND, the quantity of pomelos sold will increase by 50 kilos. Determine the selling price so that store have the most profit knows that the price for imported pomelo is 30,000 VND per kilo.

1. What are the main learning goals of the lesson?
2. What topics in other subjects does the lesson content relate to?
3. What mathematics knowledges that the students have learned and will be learning do these goals relate to (which grade)?

Figure 3. *Example of low-inference S_PID items and P_PID item referring to percepting a classroom situation*

In order to evaluate different levels of expertise in noticing, low-inference and high-inference items are used. In Fig. 3, some low-inference items assessing the competence facet of perception are displayed.The test design implied that the items on S_PID and P_PID referred to the same classroom situations. However, the items assessing perception skill and the items evaluating interpretation and decision-making skills were grouped together.

The data were analyzed qualitatively and quantitatively. The coding for low-inference items assessing the competence facet of perceptionwas developed from four-point rating scales of TEDS-FU and TEDS-Instruct studies (Kaiser et al., 2015).In the following table, we illustrated the coding of the task 1). Other tasks involving low-inference items assessing the competence facet of perception (task 2, 4) were coded by using the similar technique.

Table 1. *Illustration of the coding of the task 1)*

Codes	Description	Criteria
3	Fully correct	Given three main learning goals of the lesson: Familiarize yourself with the concept of derivative; knowing the meaning of derivatives in reality; developing problem solving ability for students;
2	Rather correct	Given two of three ideas above
1	Rather not correct	Given one of three ideas above
0	Not correct at all	Not having given any response or giving an incorrect response to the task

Table 2. *Illustration of the coding of the task 11)*

Codes	Description	Criteria
3	Making accurate decisions from mathematical interpretations	Giving at least two alternative instructional activities and having provided correct explanations.
2	Capable of interpreting mathematical ideas	Giving an alternative instructional activityand having provided correct explanations.
1	The commentary was merely descriptive	Giving an alternative instructional activity, but not having provided explanations or giving an incorrect explanation.
0	Not correct at all	Not having given any response or giving an incorrect response to the task.

Table 2 shows theillustrated coding of the task 11). Participants' responses for other high-inference items (task 3, 5, 6, 7, 8, 9, 10, 11) assessing the competence facet of interpretation and decision-making were coded by using the similar technique.

3. RESULTS AND DISCUSSION

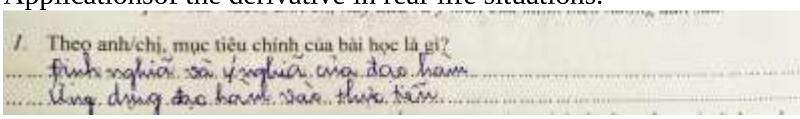
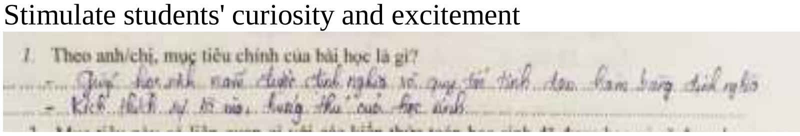
3.1. Results

In this section, we present preliminary results recorded when applying our a lesson analysis framework to the analysis of a teaching session involving the topic of derivative. The results of PMTs' noticing competence are presented in two groups: perception skill and interpretation and decision-making skills.

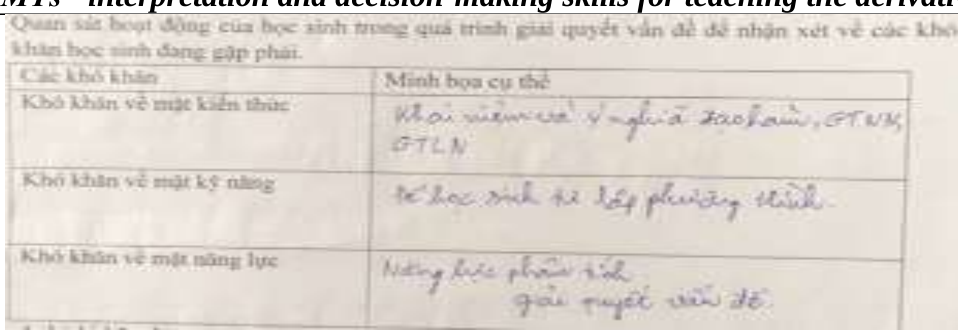
PMTs' perception skill for teaching the derivative

As seen in Table 3, for the task 1, no PMTs had a fully correct answer (code 3). The number of PMTs that were able to give two exact ideas is equal to the number of PMTs that were able to give one correct idea (50%).

Table 3. *Codes regarding the PMTs' written explanations for the task 1)*

Codes	Illustrative example	Frequency	%
3		0	0
2	Concepts and meanings of derivatives; Applicationsof the derivative in real-life situations.  1. Theo anh/chị, mục tiêu chính của bài học là gì? Định nghĩa và ý nghĩa của đạo hàm Ứng dụng đạo hàm vào thực tiễn	10	50
1	Help students understand thedefinition of the derivative and the derivation rule; Stimulate students' curiosity and excitement  1. Theo anh/chị, mục tiêu chính của bài học là gì?	10	50
0		0	0

PMTs' interpretation and decision-making skills for teaching the derivative


Quan sát hoạt động của học sinh trong quá trình giải quyết vấn đề để nhận xét về các khó khăn học sinh đang gặp phải.

Các khó khăn	Minh họa cụ thể
Khó khăn về mặt kiến thức	Khái niệm và ý nghĩa đạo hàm, GTNN, GTLN
Khó khăn về mặt kỹ năng	
Khó khăn về mặt năng lực	Năng lực phân tích giải quyết vấn đề

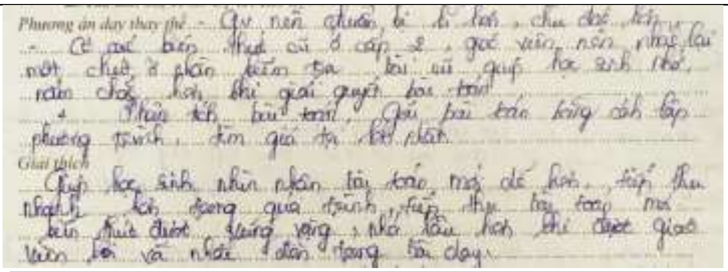
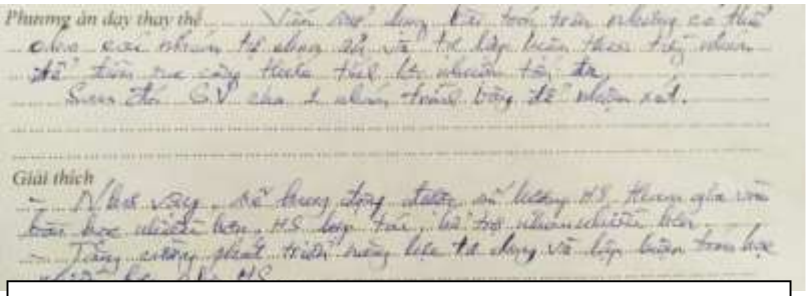
Observe students' activities during problem solving to comment on students' difficulties.	
Difficulty	Illustration
Difficulty in knowledge	Theconcept and differentmeanings of thederivative, min, max.
Difficulty in skills	students create equations themselves
Difficulty in competence	Abilities to analyse and solveproblem

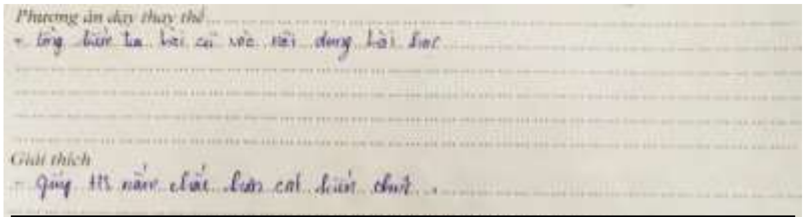
Figure 4. *Illustration of a teacher's answer for task 10*

Concerning the PMTs' interpretation and decision-making skills, for the task 10), an illustration of a teacher's answerwas showed as figure 4.

Table 4 summarizes thefindings for the task 11) related to the KCT. PMTs' ability to propose alternative strategies was measured by the number of teachingalternatives they proposed.About30% of PMTs were able to give an alternative instructional activity without acorrect explanation (code 1). There were fiveoutof twenty PMTs still did not give any response to this task or offered incorrect explanations. The number of PMTs thatwere able to give more than one alternative instructional activity and correct explanation (code 3) is very small (10%).

Table 4. *Codes regarding the PMTs' written explanations for the task 11)*

Codes	Illustrative example	Frequency	%
3	 Alternative instructional activities:The*teachershouldprepare more carefully and recall old knowledge.* Interpretation:*Help students recognize new problems easierand master more knowledge.*	2	10
2	 Alternative instructional activities:*still using thegiven problem but let students establish equations themselves, then let one studentgroup present their results.* Interpretation:*mobilizestudents to participate in the lesson; develop mathematical thinking and reasoningcapacity for students.*	7	35

1	 Alternative instructional activities:*Teachershould recall prior knowledge while implementing the lesson.* Interpretation:*promote students' understanding of the lesson.*	6	30
0	Not having given any response or giving an incorrect response to the task.	5	25

3.2. Discussion

Our above results mean that many PMTs have a basic perception skill and general understanding of the SCK for teaching the derivative. But their understanding is not deep enough to give an accurate answer.Concerning the PMTs' interpretation and decision-making skills, for the task 10), related to the KCS, PMTs have not been fully aware of the difficulties that students are facing (Figure 4). It can be stated that, PMTs' KCS was not at an adequate level. Therefore, they also have difficulty to make decisions about students' common mistakes and interpret them. The responses of PMTs for the task 11 (Table 4) have also showed PMTs' interpretation and decision-making skills related KCT was not at an adequate level. It can be stated that most of the PMTs haven't adequate interpretation and decision-making skills of teaching economic applications of the derivative. In general, for the items related to S_PID, most of PMTs gave correct answers. Nevertheless, for the items related to P_PID, it has been difficult for many PMTs to provide answers.

4. CONCLUSIONS

In this study, we proposed a framework for evaluatingPMTs' noticing competence linking the cognitive and situated approaches. We then used this framework to assess Vietnamese PMTs' professional competence in the context of teaching the derivative in real-world contexts in high schoolthrough analyzing teaching videos. By analysing PMTs' responses, we first concluded that Vietnamese PMTs' professional competence is still limited, especially regarding the decision-making skills. Nevertheless, many PMTs have been able to perceive the different types of knowledge necessary for teaching, their ability to perceive and interpret students' difficulties, teachers'teaching techniques. In fact, although Vietnamese PMTs take courses on mathematics education throughout their undergraduate education, these courses traditionally focus on rules, techniques and procedural knowledge for teaching mathematics (Minh & Lien, 2018). The aspects of MKT (Ball, Thames, Phelps, 2008) or the situation-specific skills of PMTs seem to be less analysed in these courses. Therefore, we suggest that the content and duration of these courses on mathematics education should be reviewed and modified.

Although the present study is one of the few studies thus far to explore PMTs' professional competencies from situated approaches, the limitations of the study still exist.We will continue to expand our research to clarify the effectiveness of the video approach to develop PMTs'professional competencies in Vietnamese teacher training institutions.

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