HOW DO MENTORS DECIDE: INTERVENING IN PRACTICE TEACHERS’ TEACHING OF MATHEMATICS OR NOT
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In this paper, we mainly investigate, through the teaching Critical Incident of Practice (CIP), the ways mentors intervene in the mathematics teaching of practice teachers, and the principles and underlying values for their interventions, based on case studies of a group of 8 mentor-practice teachers and their students in secondary schools from the first-year data of a 3-year longitudinal study. The preliminary results show that the principles and ways of mentors’ interventions were varied, and they developed frameworks of decision-making in mentoring closely related to the specific modes of intervention that they chose. We expect that both mentors and practice teachers are learning-to-see in mentoring, and developing their professional powers through the co-learning cycle of teaching and mentoring.

INTRODUCTION
Student teachers of secondary mathematics in Taiwan study both mathematical and educational courses in the university, followed by a paid placement of teaching practice at a junior or senior high school as practice teachers. Some experienced school teachers are assigned to be their mentor teachers. This new internship of addressing in-school teaching practice and mentoring plays an important role in Taiwanese teacher preparation programmes. It was reported that a novice mathematics mentor switched his role in the one-year mentoring process from ‘mentor’ to ‘co-mentor’ and then to ‘inner-mentor’ (Huang & Chin, 2003). Mentor teachers thus may play different roles to foster the professional development of practice teachers in different periods, for example model, coach, supervisor, helper, guide, supporter, facilitator, observer, evaluator, critical friend, etc. (Furlong & Maynard, 1995; Jaworski & Watson, 1994; Tomlinson, 1995). They may offer practice teachers every opportunity to learn, including designing material, planning lesson, grading, observing mentors or other teachers’ teaching, teaching in the mentors’ classes, to improve their “mathematical power” and “pedagogical power” (Cooney, 1994). Thus the pedagogy of teachers should be at the heart of promoting the professional growth of teachers (Clarke & Hollingsworth, 2002). What most mentors usually do is to organise and offer practice teachers opportunities to teach in a few pre-selected topics, and to discuss the collected CIPs with them later. We are then interested in understanding the ways and principles of mentors’ decisions on intervening in such CIPs.

Shulman (1986) distinguished teachers’ professional knowledge into three major categories: subject matter content knowledge (MK), pedagogical content knowledge (PCK), and curricular knowledge. Wilson, Cooney & Stinson (2005) suggested that teachers’ perspectives on good teaching includes requiring prerequisite knowledge,
promoting mathematical understanding, engaging and motivating students, and organising effective classroom. Bishop & Whitfield (1972) also suggested that good or effective teachers are those who are aware of the variables they can control, aware of the likely effects of manipulating these variables in different ways, and able to manipulate them so that they can achieve what they regards as effective learning. As novices in the profession, the practice teachers might be unable to understand fully what and how students think, to represent accurately what subject content they know, to manage the classroom situations effectively, as Ponte, Oliveira & Varandas (2002) observed that “it is not enough for pre-service mathematics teachers to have knowledge of mathematics, educational theories, and mathematics education” (p. 96). As can be foreseen that the majority of practice teachers are deficient in the professional knowledge required and they are not yet good or effective enough in teaching, so school mentors are mainly responsible for this. Nilssen (2003) also agreed that mentors should endeavour to develop student teachers’ understandings of child-centred approaches to teaching and pupil learning in the subject.

In general, school mentors possess two different identities. On the one hand, they are mentors of teaching for the practice teachers; on the other hand, they still are teachers for the students. Although they offer the practice teachers opportunities to teach in their classrooms, but at the same time, they must consider the learning of his or her students. When watching practice teachers’ teaching, due to lack of professional knowledge and experiences, mentors might get the feeling that the students are confused about or ignorant of what the teaching is going on, or classroom situations are not under teacher’s control, so that they must deal with the situations at the critical moment. Bishop (1976) considered CIs as the teaching events where the pupil(s) indicated that “they don’t understand something, by making an error in their work or in their discussion with the teacher, or by not being able to answer a teacher’s question, or by asking a question themselves” (p. 42). Lerman (1994) described CIs as “ones that can provide insight into classroom learning and the role of the teacher, ones that in fact challenge our opinions and beliefs and our notions of what learning and teaching mathematics are about” (p. 53), and “critical incidents are those that offer a kind of shock or surprise to the observer or participant” (p. 55). Skott (2001) further addressed that CIP possesses the feathers of offering potential challenges, requiring decision making, and revealing conflicts. In the light of this, CIPs can be conceived from both teaching and mentoring aspects, because the incidents invoke the conflicts and challenges of mentors’ beliefs and values, as well as thinking about their roles or identities from both a teacher and a mentor’s stand for making the best on-the-spot decisions on the teaching-mentoring process.

It is likely that when teachers become more experienced in their teaching, then a kind of decision schema or criteria develops (Bishop, 1976). The teacher’s value structure also monitors and mediates the on-going teaching situation, connecting choices with criteria for evaluating them, and then they carry out the decisions in a consistent manner (Bishop, 2001). Gudmundsdóttir’s (1990) research indicated that teachers’
PCK has been reorganized to take into considering students, classrooms and curriculum revolving around their personal values, in other words, the values decided what teaching methods are important for students’ learning the teachers believe. Decision-making is therefore an activity at the heart of the teaching process (Bishop, 1976). We then consider mentors as decision makers in mentoring, paralleled to the view of teachers as decision makers in teaching, in this case, a decision-making system of mathematics teaching both informs and is informed by a decision-making system of mentoring (as Figure 1). When mentoring CIPs occur and mentors encounter the conflicts and challenges of their beliefs and values, whether the factors underlying these incidents occur are due to lack of practice teachers’ professional knowledge or capacity of managing classrooms, the value judgments must be activated (Goldthwait, 1996) and decide how they should do at the moment. One general technique a mentor might use is to “intervene-in-action” of practice teachers when such CIPs appear. Our interest is to describe the values underlying decision-making for mentoring.

![Figure 1](image_url)

**Figure 1:** A decision-making system for mathematics teachers’ teaching and mentoring

**RESEARCH METHODS**

The case study method, including classroom observations, pre and post-lesson interviews, and mentor-tutor conferences, was used as the major approach of inquiry to investigate the values of mathematics mentors. The systematic induction process and the constant comparisons method based on the grounded theory (Strauss & Corbin, 1998) were used to processing data and confirming evidence characterized the method of our study. Eight mentors (M_i, i=1~8) and their practice teachers (A_i, i=1~8) and students (S) were participated in the 2005 academic year as the first of this 3-year longitudinal case studies on the development of mentors’ “educative power” (Jaworski, 2001). M_i are all mathematics teachers with at least 4 years of teaching experiences, but most of them might have insufficient experiences in mentoring A_i. We as both the researchers and tutors visited every A_i twice during the academic year, one in the first semester and the other in the second semester, observed A_i’s classroom teaching with M_i and interviewed M_i in the later mentor-tutor conferences. The classroom observations were focused on collecting CIPs of teaching and how M_i would react when the CIPs occurred, and what ways A_i interact with M_i and S. The post-lesson interviews helped us clarify and consolidate our observations, and we could explore
the principles and underlying values of the M_i’ decision-making. And all classroom observations and post-lesson interviews were tape recorded and later transcribed.

**RESEARCH RESULTS AND DISCUSSIONS**

According to the data collected through classroom observations and interviews in mentor-tutor conferences, we distinguish initially the manners of mentors’ on-the-spot teaching interventions into three major categories: *active intervention*, *passive intervention*, and *no intervention*. Two subcategories *direct intervention* and *indirect intervention* are also salient within *active intervention* category. It is not possible for us to report all CIPs of the 8 cases, but an outline of our categories for the interventions is given in Table 1. We will describe in detail the transcripts and interpretations of two major CIPs and mentor interviews related to the *active* and *passive interventions*.

<table>
<thead>
<tr>
<th>Category (underlying principle of intervention)</th>
<th>Active intervention</th>
<th>Passive intervention</th>
<th>No intervention</th>
</tr>
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<tbody>
<tr>
<td>Case</td>
<td>Direct</td>
<td>Indirect</td>
<td></td>
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<tr>
<td>M_3,M_5</td>
<td>M_3</td>
<td>M_4</td>
<td>M_1,M_2,M_3,M_4,M_5,M_6</td>
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<td>Concerning teacher self-esteem</td>
<td>Caring about students</td>
<td>Concerning teacher self-esteem</td>
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<tr>
<td>Supporting teacher authority</td>
<td>Supporting teacher authority</td>
<td>Considering professional identity</td>
<td>Supporting teacher authority</td>
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<tr>
<td>Caring about students</td>
<td>Caring about students</td>
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**Table 1: Categories of mentor teachers’ on-the-spot interventions observed**

**CIP_1**

After introducing the concept of ‘the equation of circle’, A_3 asked students to do the exercise: ‘Find out the shortest and longest distance between point P(-3,5) and circle: x^2+y^2-2x-4y-4=0, and the coordinates of these points’. A series of teacher-student dialogues were then developed as follows:

A_3: Given an equation of circle and a coordinate of point, what is the shortest and longest distance between point P(-3,5) and circle: x^2+y^2-2x-4y-4=0, and the coordinates of these points? (A_3 drew a circle on the blackboard)

A_3: Where can we find the nearest point? (A_3 drew the point P outside the circle)

S_1: (The first student’s response) Teacher, why the point P is outside the circle?

A_3: It must be outside the circle according to the meaning of the question.

S_2: Teacher, if the point P is inside the circle, how would it be?

A_3: We can’t do it if the point P is inside the circle.

S_3: Why not?

A_3: Maybe we can do it, but… (A_3 was thinking)

M_3: We can do it either the point P is outside or inside the circle, but just the answers will be different.

A_3: Right, we can do it regardless where point P is. (A_3 continued the lesson)

In CIP_1, we found that A_3 was too urgent in solving the problem through the action of “drawing the point P outside the circle”. He didn’t consider that students might trouble in seeing the exact position. Consequently, one student came up with “why the point P is outside the circle?” and the other was then asking “if the point P is inside the circle, how would it be?” We think that he was lack of understanding students’ mathematical experiences
while learning the topic. His MK was also questionable of saying “we can’t do it if the point P is inside the circle” and “maybe we can do it, but...”. When A₃ was thinking the students’ questionings, M₃ stated directly that “we can do it either the point P is outside or inside the circle, but just the answers will be different”. M₃ considered the content A₃ taught might let the students confuse or misunderstand, even influence their future learning, so he had to clarify it immediately. We viewed CIP₁ as a teaching CIP, because it resulted in challenging A₃’s teaching and leading M₃’s active intervention.

In the post-lesson interview, we asked M₃ what problems there were in the CIP₁? He said that “A₃’ trouble was that he sometimes thinks students all understand the contents; so, he drew point P outside the circle directly today. And his MK was more or less problematic; it might then have embarrassed the students”. When we asked the principles of his sudden intervention, he indicated that “if practice teachers let students confuse due to their faults or misleading, and then might further influence the learning of students, I will intervene in their teaching immediately”. In the interview, he described his underlying belief for this intervention as “the most important thing what teachers must consider in teaching is the learning of students”. We asked why he had to intervene in A₃’ teaching actively and immediately, and whether it would attack A₃ self-esteem, teaching authority and the students’ feelings about him. He mentioned that “when students having the reflection and question, if I didn’t deal with and clarified it at the moment, maybe they would forget it after some days and the misunderstanding would still remain in the mind of students” and “the students’ feelings about him were not so bad, I was just addressing problem and I didn’t intend to take the lead”. In this case, when mentors think that the MK of practice teachers was problematic and it could let the students confuse, then they may actively intervene in the teaching directly; and the most important focus for them is on student’s learning.

CIP₂

A₆ was lecturing the topic of ‘the formulary solution of the system of linear equations’. She illustrated the operation of determinantal expansion in ‘Cramer’s rule’. When she introduced ‘normal vector’ and ‘vector product’ with determinantal expansion and suddenly got a feeling that the content of teaching was out of her control. A series of mentor-practice teacher dialogues were then developed as follows:

A₆: Mentor, do I speak far away from the topic? I connect it with the meaning of geometry. (A₆ was looking at M₆)

M₆: You can’t go back to the beginning now. (The whole class was laughing) You can ask them, and then you would perhaps understand their problem through their facial expressions.

A₆: I need help (from M₆).

M₆: Let me take it over. (The whole class was laughing and clapping again)

M₆: (To the whole class) A₆ is lack of teaching experience that you all understand, isn’t it? (M₆ took over the teaching and finished the lesson)

In CIP₂, we found that A₆’s MK was alright, but she was just unable to adopt a more accessible way of introducing the concept. We though that A₆ and M₆ were aware of the condition by “Do I speak far away from the topic? I connect it with the meaning of geometry” and “You can’t go back to the beginning now”. Although M₆ was aware of some students’
confusions, but he didn’t intend to intervene in A_6’s teaching in the beginning; he intervened until A_6 asking for help. M_6 conceived that A_6’s problem was about PCK and teaching experience rather MK, so that he was just observing how A_6 would do with the situation till A_6 conveying the signal for help, so he was forced to intervene in A_6’s teaching. We considered CIP_6 as a teaching CIP, because it just challenged A_6’s teaching and led M_6 to passive intervention.

In mentor-tutor conference, M_6 confessed that he would not have taken A_6’s teaching if she did not ask for immediate help by saying that “no, I just observe how she deals with the condition; I play the role of an observer”. We asked if A_6 encountered difficulties in teaching but didn’t ask for help, then whether he would help her or not? He answered that “I would certainly not intervene in her teaching, since my roles are observer and mentor, not a teacher, at the moment, and I have no reason to intervene instantly when time is sufficient for me to lead the students to re-visit the concept later”. We then asked M_6 “if you consider the students’ learning at that moment”. He then indicated that “she is just a bit lack of PCK and teaching experiences, her MK is alright” and “she just uses a more complicated method to illustrate the subject, if she is unaware of using a simpler method then I will correct it next lesson”. But M_6 took the lead to lecture the content finally, he said to us “in such situation, the teaching process couldn’t be gone on well, so I was forced to intervene in her teaching at that critical moment”. Therefore, if mentors think that the MK of practice teachers is unproblematic and is just lack of general teaching experiences, they are not necessarily intervening in teaching on the spot, and may just talk to practice teachers in after lesson or correct later by themselves. Sometimes the mentors are forced to intervene in the teaching of practice teachers due to their expectations and invitations (for help).

From the above two exemplary CIPs, we find the teaching CIPs of practice teachers appear when their professional knowledge is not properly used or their teaching decisions are moving toward an inappropriate direction. Mentors view these CIPs as mentoring CIPs and using them as the opportunities to guide mentees’ professional development. We find also that the decision-making system in teaching for practice teachers will arouse the mentor’s system of decision-making in mentoring. Therefore, mentors may adopt a variety of ways and strategies based on their value priorities to intervene in practice teachers’ teaching.

**RESEARCH CONCLUSIONS AND IMPLICATIONS**

**Understanding the varied principles for and ways of teaching intervention**

The principles and ways of mentors’ interventions in teaching are varied depending on the values upheld. We find that what the mentors indicate most frequently is about the shortage of practice teachers’ professional knowledge, teaching experiences and management capabilities; and what they concern most is the learning of students. But there were mentors who did not intervene in the CIPs where practice teachers were teaching, even if the occasions that they had professed were appeared eventually. We also find that some mentors’ mentoring strategies were changing in the format of intervention at different tutoring periods in terms of their own reflection-on-mentoring.
So, we think that the affective dimension should also be viewed as the principles influencing mentor teachers’ teaching interventions. At the same time, our previous proposal of ‘distinguishing the manners of on-the-spot intervention into active intervention including direct and indirect intervention, passive intervention and no intervention’ is perhaps oversimplified and needs to be further examined.

**Developing the framework of decision-making for mentoring**

When mentors decide whether they intervene in the teaching of practice teachers or not, as if they make decisions about mentoring, their underlying values and beliefs about mentoring are likely to be revealed at that moment. Mentors enact their value structures about mentoring through the relevant knowledge, beliefs and experiences, the structures monitor and mediate the on-going teaching-mentoring situations. When the teaching CIPs appear, they make choices in terms of certain intervention criteria for evaluating them, and then they carry out the resulting decisions in mentoring; and the criteria and choices may reorganize mentor’s value structure, it will reveal other priority in the next intervention (see Figure 2). We could further explore whether there were other values and principles about mentors’ teaching interventions except those we have discovered.

![Figure 2: A framework for decision-making on intervention in mentoring](image)

**Learning-to-see through teaching CIPs**

The meaning of mentors’ teaching interventions is not only for correcting the practices teachers’ faults and caring the students learning; the major purpose for the interventions is for education which means to foster the practice teachers’ mathematical and pedagogical powers through teaching interventions while mentoring. At the same time, we can view CIPs of teaching interventions as the catalysts to advance mentors’ educative power. But most of the mentors we studied were still beginners in mentoring, so, ‘how to discover and effectively use these CIPs of mentoring?’ is a question worthy to be re-examined. We expect that practice teachers learn to develop their mathematical and pedagogical powers, and meanwhile mentors learn to develop their educative power through their own CIPs; that is, mentors and practice teachers can both learn-to-see in mentoring together (Furlong & Maynard, 1995), and empower their own professional growth through the co-learning cycle of teaching and mentoring (Huang & Chin, 2003).

**References**


