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Monitoring Student Cues: Tracking Student Behaviour in Order to Improve Instruction in Higher Education *

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ABSTRACT

In this paper, we focus on monitoring, a particular aspect of reflection related to teaching. We define monitoring as a feedback mechanism which entails attending to and evaluating a multitude of cues in the environment in order to evaluate progress towards a goal. We direct our attention to monitoring because it is a way in which a teacher is able to gain understanding of how effective his/her teaching actions are. Thus, knowing what cues to evaluate (and being able to do so) is a critical skill in reflection. Further, we focus exclusively in this paper on the concurrent monitoring of cues related to students since we believe that attention to student cues while teaching provides teachers with a window into their students' learning experiences. We call this particular type of reflection, reflection-in-action. As well as depicting multiple examples of monitoring drawn from our research, we explore the contribution of this work to the literature in higher education and to faculty development activities, particularly, to the growing literature on teacher thinking.

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RÉSUMÉ

Cet article est principalement consacré au «monitorage», c'est-à-dire à un aspect particulier de la réflexion portant sur l'enseignement. Nous entendons par monitorage un mécanisme de rétroaction qui consiste à observer et à évaluer une multitude de signaux dans un environnement donné afin de mesurer les progrès accomplis par rapport à un objectif. Nous nous intéressons au monitorage, car ce moyen permet au professeur de mesurer l'efficacité de ses interventions. Pour mener à bien cette réflexion, il est donc essentiel de pouvoir déterminer quels signaux il faut évaluer (et d'être en mesure de les évaluer). Cet article porte en outre exclusivement sur le monitorage simultané des signaux émis par les étudiants, car nous pensons que l'observation de ces signaux fournit au professeur un aperçu des apprentissages que font les étudiants. Nous appelons "réflexion sur le vif" ce type de réflexion. En plus d'offrir de nombreux exemples de monitorage tirés de nos recherches, nous étudions sous tous ses aspects la contribution qu'elles apportent aux études consacrées à l'enseignement supérieur et au perfectionnement des professeurs et particulièrement aux études de plus en plus nombreuses qui portent sur la pensée des professeurs.

INTRODUCTION

> Successful practice [in teaching] . . . is simply more complicated than standard measures of learning might suggest, and the self-monitoring [the personal supervision of one's own practice] that supports it involves critical distinctions at almost every turn in the road, distinctions that allow a teacher to separate the significant from the trivial. In this instant, what is important here? What am I trying to do with this student? What is the aim of this interaction? How do I justify it? (Kilbourn, 1991, p. 727)

Since we are not born with this ability to monitor and make split second decisions while teaching, we must learn it. For instance, Chi, Glaser and Farr (1988) note that experts in general have developed stronger self-monitoring skills than novices and are faster. These qualities of experts are also noted by Ericsson and Smith (1991). In looking more

specifically at teaching, Sternberg and Horvath (1995) describe experts as different from novices in having developed automated skills that enable them amongst other things to "effectively . . . monitor . . . their approach to problems" (p. 353).

Kilbourn (1991) raises two questions about monitoring that we try to answer in this paper:

> What guidance could we give teachers learning to monitor their own practice? What kinds of issues would it be reasonable for a teacher to be aware of in the self-monitoring of teaching acts? (p. 727)

PERSPECTIVES ON REFLECTION: A MECHANISM FOR LEARNING ABOUT AND IMPROVING TEACHING

Although reflection was a term used by Dewey (e.g., 1910), the recent interest in reflection was stimulated by Schon (1983) who focused attention on the value of reflection in helping professionals learn about and improve their practices. Our own interest is similar to Schon's, but focuses particularly on learning about and improving teaching.

In this paper we focus specifically on reflection-in-action (Schon, 1983, 1987): reflection on teaching while teaching. We distinguish this concurrent or synchronous reflection from reflection-on-action (Schon 1983, 1987) that occurs asynchronously at some point after class, and thus is disconnected from the teaching actions to which it is related. Reflection may also occur asynchronously when considering future actions (reflection-for-action) in light of past experience (McAlpine, Frew & Lucas, 1991); this is distinct from planning, although related, since planning need not draw on previous experience.

Further, we direct our attention to what we call the practical sphere of reflection. Reflection can be understood to operate in different spheres. We use the term 'sphere' since the word does not suggest levels that must be achieved or transcended in a particular order. Based on the literature (e.g., Carr & Kemmis, 1986; van Manen, 1977), we envisage three spheres. Reflection in the practical sphere focuses on improving actions in a particular course or class. Reflection in the strategic sphere involves an attention to generalized knowledge or approaches to teaching that are

applicable across contexts. Reflection in the epistemic sphere represents a cognitive awareness of one's reflective processes, as well as how they may impede reflection and enactment of plans. We focus on the practical sphere since we agree with Neufeld and Grimmett (1994) that teacher growth can result from reflection on:

> the ordinary day-to-day experience of instructing students in classrooms . . . (which) . . . elevates the activity of instruction from the level of mundane drudgery to one that has the potential to educate practitioners, thereby changing and improving their practice. (p. 210)

Lastly, although our background is in higher education, we also draw on the public school literature to some extent in our work since there is more discussion of reflection there, and we believe the issues in both settings are similar, particularly with respect to teaching being a developmental process. The relevance of this literature is illustrated by stage theories of teaching development both in public (e.g., Berliner, 1988) and higher education (e.g., Ramsden, 1992). These theories are premised on the idea that as individuals teach they have the opportunity to learn more about teaching and learning; that is, their knowledge about teaching develops from experience, from evaluating their own teaching and trying to improve it.

Our definition of reflection

Reflection is a mechanism for turning experience into knowledge. Similarly to Centra (1993), we see reflection as a process of formative evaluation in which one collects and evaluates feedback to revise and improve instruction. Our particular interest is documenting how it operates as a metacognitive process for formatively evaluating teaching. A number of years ago, we saw parallels between reflection and metacognition (e.g., Flavell, 1979; Nelson & Narens, 1990), in the sense that one can envisage reflection as a process of thinking about teaching and learning in which one monitors external cues related to the impact of teaching, evaluates them, and on the basis of the evaluation makes subsequent decisions to maintain or change one's actions.

As we presently envisage it, the process of reflection incorporates six components: goals, action, monitoring, decision making, knowledge,

and corridor of tolerance. *Goals* represent the teacher's expectations or intentions regarding what is to be accomplished in terms of instruction and what actions should be taken to achieve them. They are the component around which the process of reflection takes place. *Action* constitutes the actual enactment of teaching, what others see, hear, experience. *Monitoring* of one's teaching actions involves knowing what cues to attend to and how to make an appropriate evaluation of them. *Decision making* is the mechanism which enables *knowledge* to be used to adjust or modify teaching actions based on the evaluation of cues. Lastly, when monitoring, there appears to be a *corridor of tolerance* representing the extent to which a cue is found to be acceptable or not. If a cue is evaluated as acceptable, within the corridor, then modifications to teaching actions will likely not occur. However, if a cue is evaluated as unacceptable, outside the corridor, then the professor draws upon his/her knowledge and makes a decision about what, if any, action to take. The ongoing processes of monitoring and decision making are central to how reflection functions, and are essential for building and accessing knowledge. We believe increasing knowledge in this manner is a necessary but not sufficient condition to increase one's ability to reflect effectively and develop as a teacher.

As noted earlier, our focus is reflection concurrent with class instruction, reflection-in-action. We emphasize this use of reflection for the following reasons. First, the evidence we have from our research suggests that concurrent reflection may be an automated process which deserves to be made explicit in order to be better understood and used by experienced professors as well as those new to teaching. Second, concurrent reflection represents an opportunity to take full advantage of teachable moments: to be immediately responsive to student interest and need. To modify teaching plans immediately in response to events that arise during class can make the teaching more directly relevant to particular students which may thus enhance student learning. All of this suggests that reflection-in-action may be indicative of good or best practice, and an important strategy in developing teaching expertise.

As mentioned previously, we are highlighting a particular component of reflection, the process of monitoring. We direct our attention to it since it is a way in which a teacher is able to gain understanding of how effective his/her teaching actions are, whether the cues are monitored

independently of each other or concurrently. Knowing what cues to evaluate and being able to do so is a critical skill in reflection.

Within this narrowed perspective, the concurrent monitoring of cues, we focus particularly on student cues, the stimuli from students that teachers can attend to. We do this for three reasons. First, we believe that attention to student cues while teaching provides teachers with a window into their students' learning experiences, the raison d'etre of any teaching activity. Second, we have evidence that experienced professors direct a great deal of attention to student cues. Third, it is likely that inexperienced teachers are unaware of the role this skill could play in their teaching. As Kilbourn (1991) noted, the difficulty in the moment of teaching is to know what is trivial and what is important. Making explicit information about the concurrent monitoring of student cues may provide new teachers with insight into how to begin understanding what is important in improving their teaching. Thus, after describing the study that developed our understanding of the monitoring of student cues, we depict multiple examples of such monitoring drawn from the data, as well as descriptions of the extent to which monitoring of student cues plays a role during teaching. We finish with an exploration of the contribution of this work to the literature in higher education, particularly to the growing literature on teacher thinking and faculty development.

OUR STUDY DOCUMENTING THE PROCESS OF REFLECTION

Method

The empirically based model of reflection we have constructed is the result of an analysis of professors' descriptions of their reflections on teaching. (For more detail, see McAlpine, Weston, Beauchamp, Beauchamp and Wiseman, in press). Six professors recognized for their teaching excellence participated in the study: three at McGill University in Montreal, and three at Queen's University in Kingston. Three were in Faculties of Education and had earned pedagogical degrees, and three were in Faculties of Science and had no pedagogical degrees. There were two women and four men. All were experienced professors who had taught in universities a minimum of ten years; all were at least 45 years of age.

For this research, the professors were all teaching an undergraduate introductory level math course they had taught before. All courses included students from Faculties of Education and other faculties where students might be assumed to have minimal knowledge of math. All the professors noted that helping students overcome their fear of math was an objective for them.

The classes ranged in size. Three (two in Science and one in Education) were given in tiered lecture halls (with 90-100 students) and three were more seminar-like in regular size classrooms (with 20-30 students). The professors with the large classes recognized the difficulty of this teaching/learning context and each had strategies for coping. The professor of one of the large classes had labs where he could meet with the students on a more informal basis. Another worked at having "a community, a living room" in which he had conversations with the class and lamented that the time had passed when the class was small enough that everyone could meet at his home. The third approached such a difficulty in a different way. For instance, in preparation for teaching a new undergraduate course which would include a large number of engineering students, he took an undergraduate course in their field so that he could better understand the students' background and concerns.

For each professor, 1/3 of a 39-hour course was videotaped. Interviews were conducted after each videotaped class, first retrospective recall without the videotapes, and then stimulated recall using the videotapes. These retrospective and stimulated recall interviews were transcribed, verified by the professors, and then coded and analyzed. Specifically, we began by reviewing the transcripts looking for examples of monitoring and decision making.

We identified episodes, reflective moments, as the unit of analysis. An episode was composed of an evaluation of a cue, possibly a decision to change, and a rationale drawing on the professor's knowledge for the evaluation (and any decision to change). Episodes were analyzed using a multi-tiered coding scheme. Codes were derived from the theoretical constructs underlying the research (e.g., monitoring and decision making) and also emerged from the episodes. An important example of the latter is codes relating to types of student cues monitored, which emerged wholly from the data. Since these are of particular interest to this paper, we describe them here.

The transcripts revealed four categories of student cues being monitored by the professors. *Student verbal* (SV) cues represent oral comments or questions by a student or students (e.g., "his question gave me an opening"). *Student nonverbal* (SNV) cues include student facial expression or movement (e.g., "they were fidgety"). *Student written* (SW) cues refer to student written work (e.g., "their assignments were good"). *Student state* (SS) cues refer to student cues that were subjective interpretations or assessments of the state of the learners (e.g., "they jumped right into that" or "they're astounded that I know them"). (Other cues, which were monitored less frequently than student cues, are not dealt with here.)

In the case of each professor, we documented multiple episodes such as the one below in which each of them monitored cues concurrently in order to assess the relation of their actual actions to their plan(s), and depending on their evaluation of the cue(s) maintained their activity or made a decision to change their actions.

> Math Educator (ME) 3: *I am still not getting the answer that I want* [monitoring SV — student verbal cue], *so I am letting it [discussion] go on* [first decision]. *I wanted them to say 'discipline'* [SV not present] . . . *so I had to tell them [another decision] because it wasn't coming out* [still monitoring SV].

In this example, a Faculty of Education professor is monitoring student verbal cues in order to track the goal of student learning. The absence of the verbal cue she is looking for leads her first to decide to extend the activity. When she still doesn't hear what she is monitoring for, she decides to switch her approach from elicitation and provide the answer.

The codes emerging from the analysis of these episodes expanded and refined our understanding of how the professors reflected. When we had finished the coding we held a symposium with the six in order to present the codes and the resulting model to them. Their overall reaction verified the accuracy of both. They felt that the processes represented in the model and the coding scheme depicted what they did while teaching, although none had previously attempted to articulate it. By the end of the symposium, they were using the language of the model to discuss how they went about evaluating their teaching.

Results: The model

The model (see Figure 1) that emerged from the analysis is premised on the notion that goals drive the development of teaching plans and teaching actions. Learning goals, such as student participation, focus on aspects of learning, tracking the characteristics of the learners and the nature of their experiences in the class and course. Teaching goals focus on aspects of teaching, factors more directly under the teacher's control, such as method or content. As plans and actions related to the goals are being implemented, the teacher monitors a variety of cues to track progress towards teaching and learning goals. Cues are evaluated as positive, neutral, mixed and negative in relation to the extent to which the professor feels they show the effective implementation of the plan(s). When cues fall within the corridor of tolerance, decisions to modify instruction are less likely to occur than when cues are evaluated as being outside the corridor. In the example above, the professor did not hear the student verbal cue she was wanting. Initially, she evaluated this neutrally, waiting for it to emerge. However, ultimately the cue fell outside the corridor of tolerance, was evaluated in a negative fashion, and she decided not to elicit the response but to provide it.

Results: Student cues

This is a summary of the quantitative analysis that emerged from the data relating to the monitoring of concurrent student cues. The following excerpt provides a striking example of the extent to which professors were aware of and monitored student cues.

Interviewer: How will you know if it's going well?

Mathematician (M)1: The experience that I have at just looking at the students and seeing whether they have *blank faces* (SNV) or they have *looks of comprehension:* (SNV) that's at the first level, and the second level is *how they do on assignments* (SW) and also whether they come to see me and *what kinds of questions they ask* (SV).

This Faculty of Science professor, similarly to the other professors, was constantly monitoring student cues during instruction. In this excerpt, he gives examples of student nonverbal (SNV), student written (SW)

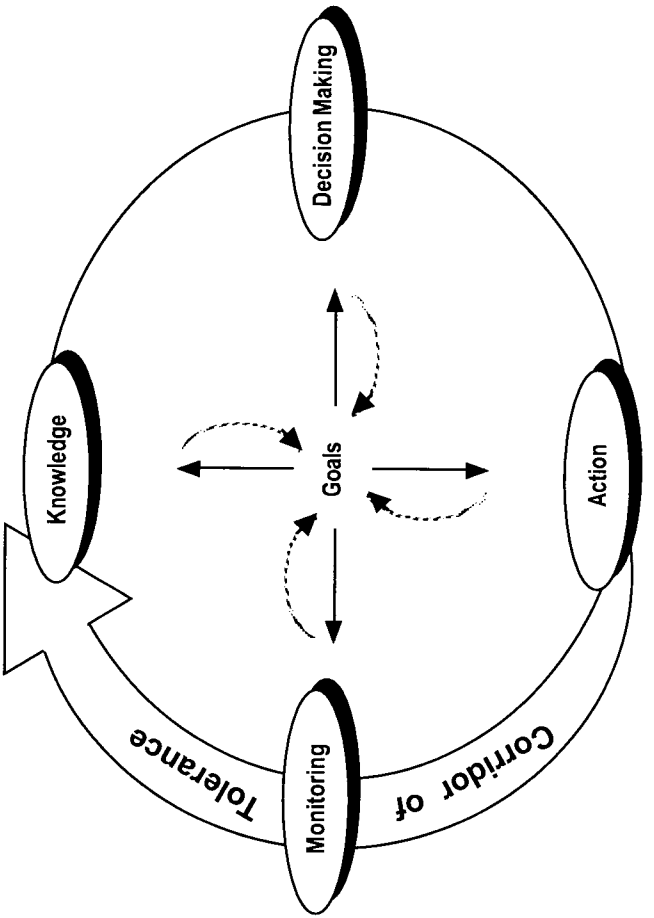

Figure 1
Model of Reflection

and student verbal (SV) cues that he uses to track the impact of his teaching actions.

In looking at the distribution of all cues in relation to student cues that were monitored in concurrent episodes, we found that student cues represented 80% of all cues monitored. This, in itself, points to the saliency of student cues for these professors. The four categories of student cues monitored concurrently with teaching were 4% student written, 7% student non-verbal, 44% student verbal, and 45% student state. Monitoring of student cues included attention to individuals, groups, and the class as a whole.

As well, it should be noted that these cues were not always monitored separately. We found that professors monitored more than one cue in 38% of all concurrent episodes (this could include monitoring cues other than student cues). In considering the occurrence of multiple student cues during episodes of concurrent monitoring, 6% of episodes included student written cues, 9% non-verbal, 60% verbal cues, and 62% student state. The most common pattern of multiple monitoring of cues was a combination of two student cues, student state and student verbal, which represented 42% of episodes with multiple cues. For instance, one professor in discussing student response to an assignment noted "they are still asking me the same questions (SV). They are still agonizing (SS)." She was monitoring both student verbal and student state cues.

It was not just the presence of cues which was monitored, e.g., asking a question in class. Also monitored was the potential presence and absence of cues, e.g., offering to ask a question by raising a hand, not offering by not raising a hand. This is evident in the previous example of the math educator where the absence of a student verbal cue led the professor to decide to let the discussion go on: "I am still not getting the answer that I want [monitoring — lack of SV] , so I am letting it [discussion] go on." Monitoring for cues (even if they are not present) indicates the constant ongoing nature of the process. It also shows that these professors have developed through their experience a repertoire of cues which represent an extensive knowledge base related to learners.

Evidence for the experiential origin of this knowledge was that we found no differences in how these professors reflected on their teaching, even though the three from Faculties of Education had training in pedagogy whereas the ones from Faculties of Science had no educational

training. Further evidence for our supposition about the experiential nature of this knowledge is that all six professors had a highly developed ability to attend to student cues which must have been developed through personal experience since in teacher education programs attention to student cues is not explicitly taught. Lastly, in the symposium the professors reported their belief that they had largely learned about teaching by teaching, through personal experience.

We believe the significance of student cues to these professors results from their recognition of the relation between the learning process that students are engaged in and the accomplishment of the professor's own teaching and learning goals. In other words, professors perceive the goal of their students as making meaning of instruction and as a result learning. Since the professors cannot directly access student cognition, they rely on the next best thing, external cues from individual students, groups of students and the class as a whole, to assess the extent to which their instruction is meaningful in facilitating or enhancing learning. If the professors perceive their actions as meaningful to the students, they continue. If not, they make decisions to modify their plans and actions if they can.

Aside from noting the striking prevalence of student cues in the majority of concurrent episodes, there are other questions we are asking ourselves about this behaviour. Are these professors consistently monitoring multiple cues concurrently so that they have more than one basis on which to assess their progress towards their goal(s)? Or, in a reflective episode, do they only seek corroborative evidence by triangulating cues when they evaluate a cue as negative or mixed. (You will recall that cues can be evaluated in four ways: positive, negative, neutral or mixed.) Further consultation with the professors as well as further analysis will be necessary to explore these questions.

CHARACTERISTICS OF STUDENT CUES

In the description that follows, each of the types of student cues is fully defined and then examples of concurrent monitoring are presented and analyzed to show how these professors monitored student cues and made decisions to maintain or change their actions as a result of monitoring. For each example, the verbatim words of the professors that

exemplify the category of student cue, as well as how it is evaluated, are highlighted in bold. (Other categories may be present, but are not highlighted.) In the descriptions of each example, the cue is related to the nature of the evaluation, the decision to change (if any) as well as the goal which was guiding the reflection. The categories are presented from least frequent to most frequent.

Student written cues

Written cues represented the smallest percentage of all student cues monitored in concurrent episodes. They include formal written work, assignments designed by the instructor to track student learning, such as a mid-term or a lab report. Written cues also include informal work done by students to facilitate their learning both in and out of class, such as an e.mail message or notes taken in class. Lastly, student course evaluations provide information after the course. We believe that there were few written cues in the concurrent episodes since most contact with student written work occurs outside of class, and thus was not captured in the analysis of episodes of concurrent reflection.

Example 1:

Interviewer: So how was his [assignment] better [than another students']?

Math educator [ME] 1: Well I think it had more texture to it- more elements to it than I thought it might and . . . ***his handout was well-presented*** and [he had] a ***moderately good range of sources*** and different types of things and he attempted to exemplify . . .

ME1 tracks the learning of an individual student by monitoring and evaluating positively the presence of a number of criteria in the student's assignment, in particular, a handout presented in class. He evaluates the cues positively (e.g., "well presented", "moderately good range of sources") and no change in his instruction is planned.

Example 2:

Mathematician [M] 1: The challenge is to bring it across so that they should be able to understand it and I can just perceive that. It's hard to describe- you know I can also see that some people are just ***writing notes feverishly*** . . . in the hope that if

they don't understand here they'll understand it at home. ***I don't think that was the case here.***

M1 describes how in tracking student learning he evaluates the students' written response to an episode in class as positive. He does this by distinguishing the kind of written behaviour ("writing notes feverishly") that indicates a lack of understanding to what he perceived in the class, which was positive ("I don't think that was the case here").

Example 3:

Interviewer: There were a number of students . . . busy ***taking notes while you're talking.***

M3: . . . that's ***good process*** and ***in fact in the best of all worlds they come to class with a heavily annotated poem sheet*** and a few do — at least in past years I've seen the copy of the poem that was given out the week before they've been to class — there's writing all over it — and I should probably say something about that . . .

M3, teaching a class exploring the similarities between ways of analyzing math and poetry, responds to a comment about student notetaking while he was teaching; he evaluates the activity positively ("good process") and discusses the positive impact on learning of notetaking outside of class as well ("in the best of all worlds . . ."). The note taking in class leads to no immediate decision to change since it is seen as a positive sign. However, he decides to modify his instruction in the next class by adding an explanation or a reminder about the value of making notes.

In these three examples of student written cues, we see professors monitoring generalized note taking and student's prepared notes. In all cases, the cues are evaluated positively leading to no immediate change; in example 2, a possible negative evaluation is contrasted with a positive evaluation. As well, we see differences here in terms of goals. Like other student cues, writing can be linked to the teaching goal of method as in example 2, where the professor links how he is teaching to the way in which students respond. In examples 1 and 3, the cues are related to learning goals of student understanding, through an evaluation of a student written assignment, and the use of note taking as a learning strategy.

Student non-verbal cues

This code, the next smallest percentage of all student cues in concurrent episodes, incorporates a concrete physical description of student facial expression (e.g., quizzical look, blank look), as well as movement of parts of the body (e.g., head nodding, leaning forward, looking at the text, applause).

Example 1:

Interviewer: What did you see?

M1: Well, ***looks of understanding — gentle nods of their heads*** indicating such, and with experience it's very easy to perceive, especially contrasting that with a situation where you see students whose ***faces are so bland*** that I realize right away . . . without anything being said that I have to go over the same topic in a different manner.

M1 tracks the impact of teaching on student learning by contrasting non-verbal cues of the group of students positively ("looks of understanding — gentle nods of their heads") and negatively ("faces are so bland"). Bland faces (not evident in this case) would have led to a decision to elaborate on the topic.

Example 2:

ME3: . . . that is when they are really learning to do something.

Interviewer: Why do you say that?

ME3: Wow! Because of the concentration. You could feel the static there at that moment because they're all — look at the ***body language***. Everyone is ***bent over,*** the few people you can see there. They are all ***hunched over*** — they're all ***looking at the screen*** . . . they've got the instructions — now let's get onto the screen, let's see if we can do this.

ME3 tracks student learning by evaluating group body language positively ("bent over", "all hunched over — . . . all looking at the screen"), the implication being that this indicates engagement in the task.

Example 3:

M3: . . . and I did get to the end point . . . though I was a bit rushed at the end- I noticed that [at] . . . twenty five, . . .

> twenty to ten the ***class was getting restless*** . . .this is a common phenomenon with evening classes, . . . unless you're doing something that's terrifically exciting at that point you'll lose their attention. And in fact you might as well stop and so I did that last example more quickly than I might have — in fact there were 2 examples I could have done . . . one of them was more interesting and would have been more fun to do but it would have taken longer and I made a decision at that point to just work with the even numbers.

M3 is tracking the impact of his teaching and evaluates the student attention as not being sufficient to deal with what he had planned ("class was getting restless"). As a result, he changes his instruction by presenting only one example, the shorter but less interesting one, to speed up the lesson.

In these three examples, we see generalized cues from the class being assessed: positively in the first two cases and negatively in one (this latter leading to change). Examples 1 and 3 are related to the teaching goal of method. In example 1, the professor tracks the impact of his teaching by contrasting what he saw, a perceived positive student cue, with what he would have considered a negative one. In example 3, the professor tracking his teaching goal, interprets a cue negatively and changes his plan. Example 2 is linked to the learning goal of student participation, assessing the extent to which students are engaged in some activity.

Student verbal cues

These cues were the second most frequent of all student cues monitored concurrently. They include both comments and questions about class content and student work and assignments, both during and outside of class. They can be solicited by the teacher or initiated by the student. Cues initiated by students can be directed at the professor or be overheard by the professor, e.g., while students carry out a group activity. As with all cues, absence as well as presence of the cues is monitored, and cues can refer to group, class and individuals.

Example 1:

> ME3: . . . I don't know how to give this assignment. I have done it now for a couple of years and I never yet explained this

assignment in a way that doesn't freak people out. And I don't know what I am doing wrong. . . . I have to rephrase my instructions or give them a better example. Most of the students find it very difficult to do this. . . I know that. But they shouldn't be agonizing about it.

Interviewer: It sounds like you have been needing to change it for a while?

ME3: Well, last year I thought I had phrased it a bit better, and this year. But I guess I didn't . . . Because they are ***still asking me the same questions.*** They are still agonizing. They're going to be in my office in a hour asking more questions.

Interviewer: But you are not clear on how you would change that?

ME3: No, I just need to think about it again because something is going wrong.

ME3 monitors unsolicited student comments and questions after describing an assignment. She evaluates these negatively in relation to her presentation ("still asking me the same questions"). This is not the first time she has had this experience. As a result of student questions in previous years, she has already adjusted the assignment. She realizes she still needs to make more changes, but doesn't know exactly how to resolve the problem. This ability to recognize a problem with instruction but not yet to have found a solution occurred from time to time for all professors.

Example 2:

M2: . . . you think somebody asked a question here.

Interviewer: Yeah because you had said you wanted to talk about counter examples . . .

M2: Yeah, it was a response to something somebody said. . . . ***his question gave me an opening.*** I mean that's where it's good to have planned all kinds of things you want to say . . . [because] people do ask you questions and if you have things [you] wanted to say then they give you openings to say them anyway and maybe they'd hear even better.

M2 monitors students' questions during a lecture and evaluates a student question neutrally ("his question gave me an opening") since it

creates an occasion for her to teach something she wanted to at a time when she believes students will more easily 'hear' it.

Example 3:

> ME1: . . .[this student] is an outlier in many ways in that class and I think she's . . . probably very bright. But she's from another culture. . .. I've also noticed on many things she's misinterpreting what I'm saying and so . . . we've talked privately . . . you know I sort of approached her with this perspective in terms of . . . how was she feeling about it and she said well this stuff is all new to me so I took it as an indication that . . . she wants to continue with this . . . but it's going to take her a little while to tune in . . . I want to try to help her as much as I can and so ***she gave a very different answer.*** It wasn't sort of a wrong answer but she wasn't doing quite the same thing as the other people. Interviewer: And you came back to her.
>
> ME1: And I did consciously come back to her afterwards. And I came back to her at the end of class and she asked me a very interesting question.

ME1 begins the episode by providing some background on the situation. He has been monitoring a particular student's verbal cues for some time to track her learning. In this episode, he evaluates her answer negatively ("a very different answer"). He believes he understands that coming from a different culture is why she may be giving the answers she is. He has already modified his behaviour by meeting with her several times to clarify the difficulties, and during this class he "consciously comes back to her"; he modified his teaching in order to try to help her "as much as [he] can".

Example 4:

> ME2: . . .and that hasn't changed. I haven't been able to in any way cause myself to feel any salvation that it wasn't that bad after all because ***I haven't heard any other opinions.*** I haven't had students walk up to me and say that was ***really a crappy lecture.*** You know, are you going to get better or are you going to get worse? But on the other hand, I haven't heard anyone come up and say, you know ***I enjoyed the things you said.*** . .

ME2 monitors student verbalizations in order to understand the impact of his teaching. The student cues are evaluated in a mixed fashion. He compares an absence of cues ("I haven't heard any other opinions") with a possible positive cue ("enjoyed the things you said"). He also contrasts this with the absence of a negative opinion ("really a crappy lecture"). If he had had positive verbalizations from the students, he would have felt more positive about the lesson than he did.

In these four examples of student verbal cues, we see attention to both cues from the class and cues from individual students. In the case of the individual cues, example 2 was linked to the teaching goal of content and provided the professor the opportunity to teach something she had wanted to teach. Example 3, was linked to the learning goal of student understanding and concerned how to enhance the learning of this particular student who was 'different'. The use of cues from the whole class is also interesting. Example 4 highlights the importance professors place on the absence of cues, the lack of positive verbal comments from the students about his teaching of the class, as much as on the presence of cues. Example 1 is representative of other occurrences for all these professors, situations where they know they need to make a change in their teaching but cannot define what would be appropriate.

Student state cues

These cues were the most frequent of all concurrent student cues. They are subjective or abstract interpretations or assessments about the state of the learners, in which the cue and evaluation are often the same word. For example, "inertia" in example 2 below is both a cue and a negative evaluation. Student state cues are distinct from verbal, non-verbal, and written cues in that concrete descriptive evidence for the evaluation (e.g., question, comment, action, expression) is not provided by the professor.

Example 1:

M1: .. The challenge is to bring it across so that they should be able to understand it and I ***can just perceive that [they did]***. It's hard to describe . . .

M1 tracks student learning and evaluates positively his sense that he has been successful in getting across the point he wanted to ("can just perceive

that they did"), so he feels no need to change anything. He acknowledges that how he perceives this is "hard to describe".

Example 2:

> M2: . . . and I had a presentation- actually it's quite a nice presentation- about approval voting that I was thinking would go here. The thing is that ***if it were light*** and things were easily understood it would be an interesting thing to throw in but by this time I was having the ***sense of the inertia and the density of the room*** and getting things across and I would be presenting them with something they'd have to struggle with, rather than just an interesting further thing to think about . . .

M2 tracks student learning and evaluates negatively the atmosphere, the "sense of the inertia and the density of the room". This is contrasted with what she would perceive as positive ("if it were light") and as a result decides not to make a presentation that she had planned because it would be a "struggle" for the students.

Example 3:

> ME2: . . . I felt good about the labs because they had gone well, they had taken to the things pretty well and they ***seemed to be getting at the ideas that I wanted them to*** get at with the various things I'd sort of structured for them at the stations. So the lab was a good complement to a bad lecture, if there can be such a thing.

ME2 tracks student learning and perceives that the students have learned what he had intended for the lab ("seemed to be at getting the ideas that I wanted them to"). He is satisfied and feels no need to make changes.

Example 4:

> ME3: . . .It is funny. I thought they would ***click into this a bit faster than they did.*** I am just giving extra instruction here.

ME3 tracks student learning and perceives that the students are not learning as quickly or easily as she had expected ("click into this a bit faster than they did"), a negative evaluation. Due to the absence of cues indicating "clicking" or understanding, she adds instruction in response.

All these examples relating to student state cues are of the class as a whole. Examples 1 and 3 link positive evaluations of student state cues to the teaching that has occurred, and result in no change. Example 2 links

the impact of students' lack of attention (the goal of student participation) at the end of class to the professors' decisions to change. On the other hand, example 4 shows a lack of student understanding leading to change.

HOW THE PROFESSORS USED STUDENT CUES

Based on the reflection we documented in the professors, we have provided concrete, narrative descriptions of the nature of the monitoring of student cues and, in some cases, subsequent decisions to change actions. In order to provide a sense of the overall impact of student cues on professor thinking and actions, we now provide a cumulative description. We first summarize what we learned about the professors' evaluation of cues, and second, their decision making related to these assessments. Third, we discuss the role of goals, and lastly the knowledge they drew upon.

Evaluation of cues

The pattern that emerged with respect to the evaluation of student cues was similar to how cues in general were evaluated. Student cues were categorized as 20% negative, 14% mixed, 28% positive, and 38% neutral. The high percentage of positive and neutral cues suggests that these professors monitored continually regardless of whether they perceived potentially negative outcomes to their teaching. Additional evidence for their continual monitoring is the fact, already noted, that for all student cues, professors attended to a lack or absence of a cue as well as the presence of a cue. These findings indicate that professors have a well developed knowledge base which helps them recognize when the absence of a cue may be as meaningful as the presence of a cue. We also learned that particular cues are not consistently evaluated in the same way. Cues are perceived as embedded in the surrounding environment and this environment influences the evaluation. This interpretation is consistent with the notion of situated cognition (Brown, Duguid & Collins, 1989). For instance, Lampert and Clark (1990) note the extent to which the development and use of knowledge about teaching is contextual. They state "all knowledge is a joint construction of mind and the situation in which the mind finds itself" (p. 22).

The variable evaluation of silence is a helpful illustration of this idea. For instance, in instances not included in this paper, M3 evaluated silence negatively as regards his teaching in an episode in which he asked a question of the students that was followed by silence; he realized he had made too great a demand on the students. In another episode, this same professor evaluated silence positively during a class, as an air of expectation amongst the students. Similarly, while lecturing, ME3 evaluated a lack of student questions (their silence) negatively as a sign students were turned off. However, on an occasion when they were working in groups and there was silence, she interpreted it as a sign that the students were concentrating and learning. From this we conclude that the monitoring and evaluation of cues is a complex metacognitive activity, particularly when it is carried out concurrent to teaching.

Changes resulting from monitoring cues

The data on changes in teaching resulting from concurrent monitoring were different from the overall data representing both concurrent and retrospective monitoring. Forty-seven percent of all concurrent episodes with student cues led to a decision to make a change. This contrasts with only 32% of all episodes in the data set leading to change and offers further evidence for the saliency of student cues in making adjustments during the act of teaching.

Although 27% of the negative evaluations and 14% of the mixed evaluations led to a decision to change, changes to teaching were also made when cues were evaluated positively (15%) and neutrally (47%). We conclude from this that professors made adjustments to their teaching even when satisfied with their instruction. Several sources of evidence support this conclusion. First, in looking at the kinds of changes that were made, the majority were micro-level: making minor adjustments to content such as adding an explanation, or adjusting the order in which activities were done. Further, there is some evidence that more than one of these professors came to class prepared with a loose set of items which they could draw on as student interest and need became apparent. Note the description of the professor's thinking in example 2 under Student Verbal Cues. Two other professors also used student questions and comments in similar ways. One, a mathematician, used them to

guide the discussion and elaboration of text. He preferred using student questions to guide the discussion, although he noted that he sometimes maintained his own direction despite a student verbalization because of a point he wanted to make. The other, a math educator, used student comments and questions interactively with her own comments, as a scaffold on which to build toward the math agenda/plan she had in her head.

In episodes in which changes were made, changes in method represented 57% and content 47% (this equals more than 100% because more than one type of change could be made in an episode). The emphasis on these aspects of instruction rather than learning outcomes or evaluation (which were infrequently changed and then mostly outside of class) could suggest that the professors were satisfied with their overall intentions and were focussed on making progress towards well established learning outcomes for the learners; this is consistent with the professors' comments that classes were progressing as hoped. As well, method and content are much easier to adjust during a class. And, if one views reactivity to students as valuable in furthering learning, then decisions to adjust content and method make sense, since these aspects of instruction can be adjusted while still maintaining one's overall learning objectives and evaluation of student learning. The moment by moment monitoring evident in these professors enabled them to do this: to be attentive to student learning and student interest and adjust their actions concurrent with their teaching.

The finding that nearly one half of the episodes of concurrent reflection involving student cues resulted in change leads us to ask several questions. Does it show professors who are particularly attentive and responsive to student cues and are prepared to make adjustments they believe respond to student need or interest? Or, perhaps the professor's plan is to be largely driven by student interest and questions. Alternately, does it mean that the class didn't go as intended in the plan . . . or that it was a bad plan? We favour the former two explanations for understanding the thinking (and action) of the professors, based on the evidence presented and the fact that the professors in the symposium believed these explanations were the most appropriate.

Goals underlying monitoring of cues

What emerges in an analysis of how these professors monitored student cues is the underlying concern with goals related to learning. One would expect teachers to track teaching goals, monitoring the immediate impact of their actions relating to method and content. These are goals over which they have direct control, and so can make adjustments that they feel will improve their actual instruction. However, these professors also gave considerable attention to tracking goals in a sphere where they have much less influence, learning. In other words, they were tracking something which they wanted to influence, student learning, but this was controlled by the motivations and the cognition of the individuals who were the target of their actions. In terms of learning goals, these professors mostly tracked learning goals related to student understanding and participation. We perceive participation as a necessary but not sufficient condition for learning, and understanding as the desired outcome.

That these professors attended to learning goals concurrent to teaching goals may indicate their experience as teachers, as well as best practice (since they had been chosen for their exemplary teaching). As the literature on expertise notes, such individuals have superior memory performance (e.g., Ericcson & Smith, 1991), and can hold and process more information in short-term memory (e.g., Sternberg & Horvath, 1995). Thus, in tracking the impact of their actions, they are able to concurrently hold two kinds of goals in memory.

Knowledge used in monitoring cues and making decisions to change

As mentioned earlier, all of the professors drew on extensive knowledge in monitoring and making decisions to change as evident in the rationales they provided. The domains of knowledge most frequently referred to in the literature were evident, including Shulman's (1987) content, pedagogical, and pedagogical content domains. These professors drew on pedagogical knowledge (broad general principles and strategies of classroom management and organization that transcend subject matter) in 27% of concurrent episodes when monitoring and making decisions concurrently. Pedagogical content knowledge (the ways particular subject areas are formulated to make them comprehensible to learners) was

drawn on in 14% of episodes, and content knowledge (knowledge of the subject matter per se) was evidenced in 8% of episodes.

The results of our study give particular substance to the domain, knowledge of the learner, that is rarely described in the literature. This domain was the second most frequently drawn on domain of knowledge by the professors during concurrent reflection-in-action (18%). Shulman (1987) described this domain as including knowledge of the "conceptions and preconceptions that students of different ages and backgrounds bring to most frequently taught topics" (p.8). We interpret this definition as focussing on groups of students, and based on the cues these professors attended to, we concur with this definition. However, based on the data we analyzed, we would expand the definition to include specific attention to the individual experiences of students' learning during instruction and also through contact outside of class, such as was reported in example 3 of Student Verbal Cues. In the data, we found many episodes in which the professors demonstrated the extent to which monitoring and decision making were based on familiarity with individual students, which came from direct personal contact, overhearing conversations among students, and from assignments. There appears to be some corroboration in the literature for this expanded definition of knowledge of learners. A recent study (Rahilly, 1997) surveyed a large number of professors about the knowledge they drew on in teaching, using as the basis for the analysis a critical teaching incident. One aspect of the professors' knowledge he documented was what he termed current knowledge of learners; it appears comparable to what we observed about how professors use their familiarity with individuals to build knowledge of learners. We believe this broadened definition highlights the principle of attending to students, both as groups and as individuals.

CONCLUSION

Our interest in reflection is as a metacognitive process used by professors to learn about and to improve their teaching. In this paper, we have focused on a particular aspect of reflection-in-action: how professors, while instructing, monitored and evaluated student cues in order to assess the impact of their teaching actions. We noted at the beginning of the paper three reasons why attention to reflection-in-action, specifically

concurrent monitoring of cues, was valuable. We return to these now: concurrent monitoring represents an opportunity to take full advantage of teachable moments; concurrent monitoring may be an automated process which deserves to be made explicit; and it may be indicative of good or best practice and an important strategy in developing teaching expertise.

Taking advantage of teachable moments

We believe that a lack of monitoring (and reflection) concurrent with teaching results in losing opportunities to learn about teaching since some important moments may be lost. As Kilbourn (1991) notes:

> a teacher's ability to retain data worth considering at a later time, in a more quiet moment, is limited. The details of the heart of teaching may come and go in an instant. (p. 734)

Concurrent monitoring (and reflection-in-action) are critical skills if we are to track the multitude of minute details that impact student learning and thus, if we wish, have the potential to be immediately responsive to student needs and desires. In contrast, retrospective reflection-on-action, which can be a powerful mechanism for making substantive more global changes to teaching, does not permit such immediate response. It may also tend to be influenced by personally salient affective responses we have had to a class.

Although these professors entered class with a plan (which they articulated to us prior to teaching), they were willing and able to respond flexibly to student feedback. We suggest that the two aspects of knowledge of learners that we defined earlier are related to two aspects of instruction: the intended curriculum and the lived curriculum. Attention to the conceptions and preconceptions that students in general bring to the learning of the subject matter was used prior to actual instruction in order to create plans. Attention to the particular students in a class (their needs, their present difficulties, their affect) was incorporated while actually teaching in order to modify instruction. Thus, an explicit understanding of and ability to use reflection-in-action would provide teachers an opportunity to take full advantage of teachable moments, events that arise during class when teaching plans may be modified to respond to particular student interest.

Making explicit an automated process

In higher education, the potential value of monitoring student cues during teaching has been noted by Angelo and Cross (1993):

> As they are teaching, faculty monitor and react to student questions, comments, body language, and facial expressions . . . teachers depend heavily on their impressions of student learning and make important judgments based on them . . . (p. 7)

They describe the process of monitoring as an almost automatic, subconscious and implicit process. This may be the case in experienced teachers who have had the opportunity to develop automated routines (e.g., Chi, Glaser, & Farr, 1988; Scardamalia & Bereiter, 1986; Sternberg & Horvath, 1995) , and, in fact, statements by the professors in our study would tend to bear this out. Nevertheless, the professors had a positive response to having the process they had been using made explicit. Further, they found that they could use the language associated with the process of reflection to describe their teaching, and model the processes they engaged in.

Thus, by having made explicit this automated process of monitoring, we believe it becomes possible to teach individuals, whether experienced or inexperienced as teachers, how to reflect-in-action, how to monitor concurrent to teaching. Furthermore, we believe that learning how to monitor and evaluate cues, to pay attention to aspects of teaching that can influence learning, may facilitate professors' improvement of their teaching. Lastly, by making explicit and then sharing the role and extent of this process with others, we can contribute to Shulman's (1993) notion of teaching as community property. He suggests that at this time, teaching is largely a solitary and isolating activity, one in which we develop independent personal knowledge about teaching. If we share a language for discussing teaching, then we can move it from private to community property, and it can become part of our disciplinary discourse.

An indication of good practice

We focus now on the third point: whether or not the use of concurrent monitoring represents best or good practice. The professors in the study reported here were chosen because they were deemed exemplary teachers. Thus, the automated use of monitoring (and reflection) we have

documented may represent best practice, the development through sufficient practice and feedback of automated routines that are efficient and effective (Ericsson & Smith, 1991). One of the difficulties that individuals face as they develop as teachers is finding ways of integrating careful pro-active planning (designing instruction that can approximate learning goals for a group of students) with a responsive or reactive stance during teaching which allows one to adapt instruction in an ongoing fashion to meet the actual rather than expected learning needs of students. Thus, when reviewing stage theories of teaching development in the public education literature (e.g., Berliner, 1988), one often finds reference to the inflexibility of new teachers to modify instruction whereas in later stages, there is considerable ability to do this. We believe that this shift from inflexibility to flexibility would be equally the case for university professors. We saw these very experienced professors constantly adjusting their actions and their plans; they were being reactive to student feedback. This could be defined as flexibility, particularly since we have evidence that at least three of these professors intentionally used student cues in firming up their class agenda while instructing.

Contribution to the field

Overall, we see our enhanced understanding of reflection-in-action, and in particular, the process of concurrent monitoring of student cues, as making two contributions to the field. First, it describes a mechanism whereby teachers draw on experience to develop and use domains of knowledge pertinent to teaching, in particular, knowledge of learners. Our research supports Shulman's (1987) suggestion that knowledge of learners and their characteristics is particularly relevant to teaching , at least to these professors in higher education. Further, the results have expanded our understanding of this domain beyond Shulman's original description of general principles and attention to groups of students of different ages and backgrounds in relation to particular subject matter. We now include knowledge of particular students' ongoing experience (understanding and affect) of learning during instruction.

The second contribution is that we have documented a reflective process used concurrent with teaching which we believe enables teachers to be flexible and responsive to their learners, that is, more student-centered.

Our understanding of this process, the concurrent monitoring of student cues, while still not fully developed provides a useful vehicle for articulating how teachers are able to be flexible

We believe this enhanced understanding of monitoring and more in-depth representation of knowledge of learners can help us to answer two important questions raised at the beginning of this paper. These questions are particularly important for those involved in faculty development work, those interested in helping others learn about and improve their practice:

> What guidance could we give teachers learning to monitor their own practice? What kinds of issues would it be reasonable for a teacher to be aware of in the self-monitoring of teaching acts? (Kilbourn, 1991, p. 727).

We believe that explicitly learning about monitoring concurrent with teaching as well as about the existence of a domain of knowledge about the learner may provide a very tangible way for beginning instructors to become more effective teachers. First, monitoring student cues is a very concrete strategy to apply, and the process can initially focus on just a few students with only a few cues, rather than the class as a whole with multiple cues. Second, professors can be intentional in examining their experiences with students in order to define the knowledge of learners they are developing. Third, the process represents a way of being attentive to students which doesn't require instructors to make a change in their preferred teaching style (e.g., as in changing from a lecture to a group discussion method), so does not involve a large risk factor in terms of their public persona. Thus, the enhancement of teaching can be incremental, beginning with attention to a few cues with a few students and increasing in use as ability to monitor and knowledge of learners develops. We provide the following example of such an approach.

We introduced the model of reflection and the notion of monitoring student cues to teaching assistants in a graduate course on teaching and learning in higher education. They found the idea of monitoring student cues a powerful tool for thinking about their own teaching. Once introduced to the idea, they used the concept and the language to describe their own microteaching episodes. In summarizing their learning, they commented on the following: an appreciation of the importance of flexibility

in teaching, and an increasing self-awareness of what they were doing when teaching,

As well as providing new teachers with a concrete mechanism to formatively evaluate their teaching in an informal ongoing manner, this knowledge about reflection-in-action could also be useful for more experienced teachers. Although it is likely many experienced professors may be carrying out this process tacitly, if they become aware of and can use this process in an explicit fashion, we believe it could enhance whatever formal and informal classroom assessment techniques they are using.

Readers may well ask what real impact does this reflective monitoring have on student learning? This is an important question and one we have been grappling with for some time. After all, reflection is not an end in itself, but a mechanism for improving teaching and hence maximizing learning. We are just beginning to investigate the relationship between reflective teaching in class and student learning. In the meantime, we take heart from Kilbourn's (1991) statement:

> The moment-by-moment moves that a teacher makes are, over time, critical to what teaching is about and have long term consequences for learners. Yet, with any single pedagogical act . . . It would be difficult to say that there were demonstrable, long lasting "effects". But, because of a belief that teaching has some kind of significant effect, single pedagogical moves merit attention and are an appropriate focus for self-monitoring . . . . (p. 725)

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