

# Enhancing Professional Knowledge: A Case Study of an Elementary Teacher

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In this case study, I report on the teacher development that resulted when an elementary teacher explored multiple intelligences theory (MI theory) and used it as a guide to make decisions about her curriculum planning and classroom practice. Several data collection methods and sources were used — semi-structured interviews, participant observation, group action-research meetings, and journal writing. Through critical self-reflection, she became more adept at integrating many aspects of her professional knowledge — subject-matter knowledge, pedagogical-content knowledge, knowledge of her own strengths and weaknesses as a teacher, and knowledge of how students learn — thus enhancing her ability to teach science.

L'auteure rapporte une étude de cas portant sur le perfectionnement professionnel. Une enseignante du primaire a étudié la théorie des intelligences multiples et s'en est servie pour planifier ses cours et choisir ses méthodes pédagogiques. L'enseignante a réussi à mieux intégrer ses compétences professionnelles – connaissance de la matière, du contenu pédagogique, de ses forces et de ses faiblesses comme enseignante et du mode d'apprentissage des élèves –, ce qui lui a permis d'améliorer son aptitude à enseigner les sciences.

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This project was useful for “taking stock” of my students, for exploring their preconceived notions about something, for discovering what kinds of activities motivate them, and for assessing formally how much learning was taking place. It appears to have been extremely useful in assessing where I am with my teaching and what I might focus on next. (Celia, diary entry, May 12, 1999)

Celia, an elementary teacher, entered this comment in her diary after participating in a professional development initiative over a period of several months. It reflects her personal and professional growth as she explicitly examined many aspects of her professional knowledge and practice. As part of a collaborative group of four teachers (two elementary teachers, one intermediate science teacher, and one high-school science teacher) and me, a university researcher / facilitator and the author of this paper, Celia adopted action research as a strategy to

explore multiple intelligences theory (Gardner, 1983, 1999) for teaching elementary science in her grade-5 classroom. Through participation in this study, Celia responded to current calls for educational reform in science education and her own desire to offer all students a meaningful and engaging science curriculum.

Educational reformers see many targets for change in science education (American Association for the Advancement of Science, AAAS, 1989, 1993, 1998; Council of Ministers of Education, 1997). For example, AAAS (1998) suggests the need for change at several levels within teacher education, including changes in undergraduate teacher education, teacher recruitment, college and university teaching, and professional development for teachers. Furthermore, this call for change is consistent with a body of literature that points to a need to support and promote teacher development. Research has shown that many elementary teachers feel uncomfortable teaching science and lack confidence in their ability to teach it (Holroyd & Harlen, 1995, 1996). They often adopt coping strategies such as teaching as little science as possible, avoiding difficult topics, relying heavily on textbooks, using outside experts, or overemphasizing practical activity (Harlen & Holroyd, 1997; Lee, 1995).

Current reform initiatives will require "a substantive change in how science is taught; and equally substantive change is needed in professional development practices" (National Research Council, 1996, p. 56). Teachers will need support and encouragement to participate in a variety of professional-development opportunities to foster an understanding of science and science teaching and to learn to change their practices to make them consistent with new reform ideals.

In this article, I describe Celia's experiences as she translated the basic tenets of multiple intelligences theory (MI theory) into classroom practice to enhance her professional knowledge and practice. She adopted MI theory as an instructional organizer<sup>1</sup> (Bennett & Rolheiser, 2001) to explore her professional knowledge of science teaching and learning, and to develop a greater awareness and understanding of her goals, values, and personal strengths and weaknesses.

Several questions guided this research: (a) How did Celia interpret MI theory? (b) How did she translate MI theory into classroom practice? and (c) How did she enhance her professional knowledge in the context of science teaching and learning as a result of adopting an MI theory approach?<sup>2</sup>

## TEACHERS' PROFESSIONAL KNOWLEDGE

Education scholars have proposed several frameworks to describe teachers' professional knowledge base for teaching (Carter 1990; Clandinin & Connelly, 1996; Connelly & Clandinin, 1988; Elbaz, 1981, 1983; Grossman, 1995; Shulman, 1986, 1987). For example, Elbaz (1981) believes that teachers possess a broad range of knowledge, often tacit knowledge: knowledge of subject matter; of classroom organizational and instructional techniques; of the structuring of learning experiences and curriculum content; of students' needs, abilities, and interests; of the social framework of the school and its surrounding community; and of their own strengths and shortcomings as teachers. She states that teachers' knowledge is "dynamic" and "is held in active relation to practice and used to give shape to that practice" (p. 47).

MI theory helped Celia explore and enhance several aspects of her professional knowledge of science teaching. In discussing outcomes, I adopted the notion of pedagogical content knowledge (PCK) as an area of professional knowledge that Celia developed. PCK "identifies the distinctive bodies of knowledge for teaching. It represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (Shulman, 1987, p. 8). To consider Celia's professional growth, I used Elbaz's (1981) framework, which helped Celia understand herself as a teacher.

## MULTIPLE INTELLIGENCES THEORY

MI theory<sup>3</sup> represents a pluralistic view of intelligence that is premised on several key principles:

Each person possesses all . . . [eight] intelligences.

Most people can develop each intelligence to an adequate level of competency.

Intelligences usually work together in complex ways.

There are many ways to be intelligent within each category. (Armstrong, 1994, p. 11–12)

According to Gardner (1983), everyone possesses all the intelligences, but they are present to differing degrees, with some being better developed than others. Individuals "can get better at each of the intelligences, although some will improve in an intelligence area more readily than others, either because biology gave them a better brain for that intelligence or because their culture gave them a better teacher" (Checkley, 1997, p. 8).

Since the publication of Gardner's (1983) seminal book, *Frames of Mind: The Theory of Multiple Intelligences*, some educators have embraced his theory, interpreting it in a variety of ways. Educators first used Gardner's theory with young children, but more recently they have adopted it with special populations (Gardner, 1995b). It has been used at all grade levels across many disciplines to identify gifted students, to provide subjects with equal time and emphasis in the school curriculum, to explore teaching styles, to broaden assessment, to meet individual learning needs, to develop integrated curriculum, or to enhance student meta-cognition.

Despite the strong endorsement of MI theory by many in the educational community, scholars have criticized this theory for several reasons. Morgan (1996) claimed that Gardner did not discover new intelligences, but simply reframed what had been traditionally called cognitive styles. Sternberg (1983) questioned the validity of the theory, describing several weaknesses. He believed the evidence is overwhelming for the existence of an executive process within the brain that coordinates different types of intelligence. Gardner, according to Sternberg, does not allow for the existence of a central integrative function. In addition, Sternberg wondered whether Gardner's intelligences should simply be called talents, and he criticized the theory for its lack of a foundation or set of constructs to explain behaviours. Klein (1997) believed the theory is seriously flawed conceptually, empirically, and pedagogically; it presents a static view of student abilities; and it is too broad to be useful for curriculum planning. In responding to Klein's critique of the theory, Gardner (1998) offered substantive clarification on two major issues: domains versus intelligences and the nature of intelligence. In addressing more specific criticisms of Klein, Gardner discussed conceptual, empirical, and pedagogical issues.<sup>4</sup> In terms of pedagogy Gardner's response to Klein describes his belief about the two major implications of the MI theory — theory provides a way to individualize instruction by considering the uniqueness of individual learners and, to represent and teach students curriculum concepts and ideas. I have used Gardner's response to inform my case study of Celia.

To date, limited research has been conducted exploring the pedagogical value of MI theory in the context of science education. Fuller (2001) reported on a state-wide initiative in Massachusetts that explored teachers' perceptions of changes in student learning and changes in their teaching practices after implementing a program called PALMS, Partners Advancing the Learning of Math and Science. PALMS incorporated MI theory and other curricular frameworks and approaches. Teacher participants felt the program had a positive impact on classroom and school culture and

students enjoyment in learning. As well, the teacher participants felt that the program encouraged them to cater to individual learning needs.

Other studies have applied principles of MI theory to motivate students in learning. For example, Lane, Marquardt, Meyer, and Murray (1997) used MI theory to improve content relevance in seventh-grade math, language arts, and science classes in conjunction with teaching students goal-setting processes. From a broader perspective, in a comprehensive three-year investigation of schools using MI theory, Kornbacher and Fierros (2001) sought to identify and document effective implementation of MI theory in schools. Results indicated that MI theory had a prominent influence on improving test scores, discipline, parent participation, and learning for students with disabilities.

## METHOD

In this interpretive case study (Merriam, 1998; Stake, 2000), I have reported on the experiences of Celia as she enhanced her professional knowledge of science teaching and learning through the adoption of MI theory as an instructional organizer. The study is both intrinsic, gaining an understanding of a particular case (how Celia developed her professional knowledge and practice) and instrumental (Stake, 2000), providing insight into an issue (science teaching and learning) and refinement of a theory (multiple intelligences theory).

Although I determined the focus of the study — MI theory and science education — I did not impose a specific direction on the research. The research evolved, influenced by all group members. The collaborative research group provided a forum for Celia and other group members to explore ideas, to share ideas and resources, to provide each other with moral support, and to offer feedback about ongoing classroom activities. In addition, both Celia and I used the transcripts from audiotaped meetings as sources of data for interpretation and reflection. We kept journals, assisting us to explore ideas and make our developing understandings more explicit.

I used several data collection methods and sources in the study: semi-structured interviews; participant observation; audiotaped, group, action-research meetings; and journal writing. Celia participated in semi-structured interviews (Fontana & Frey, 2000) at the beginning and the end of the study and in informal interviews throughout the study. I visited Celia's school on six occasions (three- to four-hour sessions) within a four-month period, recording notes about the setting, the participants, and the

activities and interactions (Merriam, 1998). The research group met on twelve occasions over a six-month period; all meetings (ranging from 120 minutes to 150 minutes) were audiotaped.

In this study, data analysis coincided with data collection. In analyzing the data, I used grounded theory (Strauss & Corbin, 1998), beginning with open coding to identify concepts. I assigned labels to units of text from transcripts, field notes, journal entries, and interviews, forming the basis to identify concepts throughout the data set. Simultaneously, I engaged in constant comparison, identifying similar incidents and events to group into the same conceptual categories.

I next used axial coding, generating main categories and subcategories, to establish larger categories and make connections among larger categories and subcategories. After returning to the literature, I conceptualized the emerging categories into two general themes: pedagogical content knowledge (Shulman, 1986, 1987) and knowledge of the self (Elbaz, 1981). To assist with the management of the large amount of data collected, I used NUD\*IST (version 4.0), a qualitative computer software analysis program, to assist with coding and retrieving data. In addition, I used the program to generate visual maps of developing categories and their relationships.

When researchers engage in qualitative research, they often have to address issues of soundness or quality. In traditional, quantitative research, this is often referred to as validity and reliability. In qualitative research, scholars have presented a range of criteria to reflect its underlying philosophical assumptions. Many have argued for conceptualizing the notions of validity and reliability differently from traditional, quantitative research. For example, Richardson (2000) rejected the notion of triangulation, stating that this assumes there is a fixed point or object that can be triangulated. Rather, she argued that validity in postmodern text involves crystallization "that combines symmetry and substance with an infinite variety of shapes, substances, transmutations, multi-dimensionalities, and angles of approach" (p. 934). In other words, what one sees in qualitative interpretation depends upon how the inquirer holds and views the crystal — her lens. In reporting this case, I used this notion of crystallization to delve into the complexities of the case, while recognizing the partiality of my own understandings and interpretations.

To facilitate the process of crystallization, I adopted several strategies such as prolonged engagement at the research site, reciprocity, and fostering voice. There was considerable interaction between Celia and me over an extended period of time at group meetings, during classroom visits, and

through numerous telephone conversations. Because of a lack of time and other commitments, Celia was unable to co-author this paper. To ensure that I represented Celia's voice strongly in the writing of the case study, I asked her for feedback about my interpretations of events during and after the completion of the study. In addition, I kept a journal throughout the data collection process to reflect on what was happening and to constantly consider my role in the study. Through this introspection, I was better able to monitor how I was influencing unfolding events and to foster conditions to establish and maintain a collaborative relationship between Celia and me.

## FINDINGS

### *Understanding Celia*

Celia had very little formal training and experience in science and science education. "Of all the areas I teach in grade five, science has been the one that has been sadly neglected" (Interview, January 26, 1999). Furthermore, she was clearly ambivalent about joining the project. Although she did state that she had no preconceived notions (which in reality she did) about teaching and learning science, I believe this was her way of saying that she would try to remain open-minded and consider all ideas as they developed and emerged.

I'm clearly the participant with the least experience with teaching science. At first I thought I would not participate [in the project] because I wouldn't be able to contribute much. Right now I'm feeling differently. I feel I have no preconceived notions about the teaching or learning of science, so I feel very receptive to all input, and am looking forward to developing a philosophy around teaching science. (Celia, diary entry, January 21, 1999)

This was Celia's eighth year of teaching. She had previously taught grade levels from junior kindergarten to grade four; this was her first year teaching grade-five students. She had experience teaching in multi-grade settings and for several years had taught music at a music school. She had B.Mus. and B.Ed. degrees and at the time of the study was a part-time M.Ed. student. Her class consisted of 24 students, nine boys and fifteen girls, and Celia was responsible for teaching most areas of the curriculum. She described most of her class as being fairly strong academically, a "B" class on average, with two students labelled as learning disabled, another labelled as gifted, and another needing part-time support outside the regular classroom. The school Celia worked in had 550 students, ranging



from kindergarten to grade six, and many of the parents were from a middle-class background. The school had a staff of 30 and parental involvement was fairly high.

The initial meetings of the action-research group focused on reading and discussing a variety of literature about MI theory.<sup>5</sup> When the group felt it had become comfortable with understanding the nature of MI theory, it decided to examine the theory's efficacy as a pedagogical organizer for science instruction. The group's goal was to explore how other educators have interpreted and applied the theory in the context of their schools and classrooms, thus allowing group members to develop a broad range of ideas about how the theory might be applied to their classrooms.

### *Exploring MI Theory*

After considerable reading and discussion about MI theory and its use in practice, Celia began to formulate her thoughts about it. She believed it could help students become more cognizant of their weaknesses as well as their strengths (self-awareness), and provide an impetus for improving those weaker areas.

It [MI theory] should be a self-discovery thing and finding out what your weaknesses are and then tackling those. That is what appeals to me. If I discover I am weak in logical-mathematical and then I investigate the value of that and why I would need it. (planning session one, January 20, 1999)

In addition, Celia believed she could use the framework of MI theory to structure learning experiences for students that would allow them to become more responsible for their learning. "I really like the idea of it [MI theory] for students to get to know themselves and become more responsible for their learning" (Celia, Diary entry, February 10, 1999).

In applying the tenets of MI theory to science teaching and learning, Celia and other group members felt it was extremely important to emphasize the question, "How am I smart?" (Gardner, 1995a). In other words, instead of asking the traditional question, "How smart am I?" the focus should switch to promoting a broader conception of intelligence. Celia questioned the feasibility of trying to use all the intelligences in any one lesson. She believed all the intelligences should be targeted during teaching; however, the use of any one intelligence should be based on its ability to support the aims of a particular lesson. The use of a strategy or activity should be compatible with the nature of the learning task.

By the sixth meeting of the group, Celia decided to focus on energy, a



mandatory topic in a new Ontario science curriculum (Ministry of Education and Training, 1998). Her goal was to adopt MI theory as an instructional organizer to guide her planning as she developed and implemented a unit on energy.

*Using MI theory as a Catalyst in the Science Classroom*

Prior to introducing MI theory to her students explicitly and implementing the unit, Celia asked them to answer a series of open-ended questions on a science survey. By using this pre-unit survey, she explored students' current beliefs about science, their prior experiences in learning science, and their attitudes towards science. She used this knowledge to develop student learning experiences in conjunction with MI theory, thus capitalizing on students' prior knowledge, while introducing them to scientific concepts and principles. "I really, really believe in the value of ascertaining students' views and beliefs about science before beginning any activities, and must remember to do that!" (Celia, diary entry, January 25, 1999).

The results of the survey provided Celia with some very important insights about her students' understandings of, and attitudes towards, science. Very few students knew what science was and most had a limited understanding of what scientists do. In responding to the question, "What have you learned in science in previous grades?", few students felt they studied science and only three out of 24 students named some specific science topics from previous grades.

Celia next introduced her students to MI theory explicitly, affording them opportunities to learn about the nature of MI theory and to explore their own intelligences. This explicit exploration of the theory continued throughout the unit, providing students with a framework to reflect upon and assess how they were learning in science classes.

Celia developed the plan for the curriculum unit on energy with support and feedback from members of the collaborative research group. She included seven detailed lessons in her Energy unit that target each of the multiple intelligences, especially the bodily-kinesthetic, interpersonal, intrapersonal, verbal-linguistic, and logical-mathematical intelligences. Celia adopted a range of instructional strategies and activities, many of which she had not used before, such as direct instruction, mind mapping, visualization, inventing, learning centres, art posters, games, debates, and critical thinking. In one lesson, she asked students to invent a contraption to illustrate how to convert energy from potential to kinetic energy. Many

activities in each lesson became part of a student assessment portfolio. These activities were teacher-evaluated, teacher-evaluated and student self-evaluated, or peer-evaluated.

In a final journal entry at the end of the project, Celia summarized how she had used the theory in her science teaching and learning:

I used MI to develop a unit that would be engaging in its sheer variety of activities, trying to incorporate activities that would address all the intelligences, and thereby cater to different learning styles.

I used MI to cater to students with different strengths and weaknesses in that I provided choice of responses to some activities, and in some instances allowed the students to choose from a range of formats for presenting information that was limited only by their imagination and creativity.

After the students completed activities . . . we debriefed why they had chosen the formats they had; why certain formats may have been more successful than others; why certain formats may have been more appropriate in a particular situation than another situation . . . so the students were challenged to reflect regularly on what they were doing, and the type of responses they were choosing.

I used it to evaluate how I myself learn . . . so I felt challenged to look at myself again. (Celia, diary entry, May 10, 1999)

In planning the unit, Celia used MI theory as an instructional organizer to make decisions about how to structure learning experiences to cater to the needs of diverse students, while teaching to and through the intelligences. She used the theory to offer variety in teaching and learning activities and approaches, to offer students choice in how they were learning and being assessed, to foster student reflection about their learning, and to engage in self-reflection about her own learning.

## CONCLUSION

Teachers can develop their professional knowledge of science teaching through a variety of means (workshops, action-research groups, study groups, school-university partnerships) and for a variety of purposes (Loucks-Horsley, Hewson, Love, & Stiles, 1999). Often, participation in professional development opportunities requires teachers to explore their beliefs about subject matter, students, pedagogy, and themselves as teachers.

In this study, Celia not only explored her beliefs about science and science teaching, but became much more comfortable with integrating science content and pedagogy, and planning learning experiences that would meet

learners' diverse needs. Furthermore, she became more confident in her ability to teach science and more enthusiastic about teaching it.

### *Pedagogical Content Knowledge*

Teachers possess a broad range of knowledge that informs their decision-making about what they teach and how they should teach. In this study, Celia was successful in enhancing her pedagogical content knowledge (Shulman 1986, 1987). The following comments reflect how Celia experienced growth in this area:

I feel much more aware of the need both in myself to have variety, and for my students to have variety. . . . I have a wider repertoire of strategies upon which to draw when teaching a lesson in any curricular area of designing a unit. . . . However, this group of students felt they had done very little in the past that constituted science, and needed to become enthusiastic about science. The activities they found the most igniting were the ones in which they actually got to build, invent, or design something. (Celia, diary entry, May 10, 1999)

Celia became much more appreciative of her students' need for variety in assessing their learning. She learned to use MI theory as a means to create a student-centred learning environment that, according to Celia, fostered excitement about learning. Initially, when she announced to her class that their next science topic would be energy, the collective response was not enthusiastic.

Certainly at the beginning when I announced that the topic would be energy for this term, there was this dead silence and then a few groans. I tried to find out what they knew, and they knew nothing and they didn't want to know anything. (Celia, final interview, May 6, 1999)

As the unit progressed, this lethargy evolved into excitement about learning science. During my classroom visits, I shared in and observed this excitement. According to Celia, students showed extraordinarily high levels of engagement when doing activities and were very committed to their work: "One thing that is obvious is the increase in enthusiasm for science. The class is super-enthusiastic after lessons one and two. The Rube Goldberg contraptions were a big hit" (Celia, diary entry, March 11, 1999).

At the end of the unit, Celia asked students to respond to this statement in order to share their feelings about how MI theory facilitated their science learning: "I enjoyed the variety of activities." All students enjoyed the variety of activities used in the unit, with 11 of the 24 students responding with a strongly agree to the statement, while 13

students responded with agree.

Celia deliberately targeted teaching approaches and learning activities to cater to each of the multiple intelligences. By designing learning experiences that targeted each intelligence, she offered students other means (outside the traditional verbal-linguistic and logical-mathematical intelligences) to learn about energy. She described how one student benefited by using her strong intelligence (the visual-spatial intelligence) to complete an activity: "The student would not have possibly been able to read and write about energy, but with this kind of project [constructing Rube Goldberg inventions to demonstrate the difference between kinetic and potential energy] had been successful building something and explaining it. Even though the contraption was the simplest, she had been successful in meeting the criteria and handing it in on time and warranted a B" (Celia, diary entry, April 4, 1999).

### *Knowledge of the Self*

In addition to enhancing her PCK, Celia developed a more in-depth understanding of her own teaching style and a higher level of confidence in her ability to teach science, in other words, "knowledge of the self." Knowledge of the self, according to Elbaz (1981), represents knowledge that is highly "personal" and "helps teachers work towards personally meaningful goals in their teaching" (p. 47).

When asked at the end of the project about future plans, Celia's comments reflected a greater understanding of her own teaching abilities.

I will definitely devise more activities in which the students move around the room more [the bodily-kinesthetic intelligence] . . . and I will definitely use the musical-rhythmic intelligence more extensively. For this project, I only incorporated it as a way students could opt to present or communicate information. I'd like to use it to be more creative with my instructional practices by composing songs and creating chants. I am not sure why I haven't done more in this area. (Celia, final interview, May 6, 1999)

Ironically, the musical-rhythmic intelligence was one of Celia's strongest intelligences (she held an undergraduate degree in music, played several instruments, and had taught music privately for several years); yet, she had not capitalized on this strength to any significant degree in her teaching.

As mentioned previously, Celia entered this project questioning her ability to contribute to the group because her subject-matter knowledge in science was weak and her experience in teaching science was minimal. Another important area of growth for Celia was the development of more confidence in her ability to teach science.

Participating in this project has made me more confident about teaching science, although I certainly have miles to go! . . . I do feel comfortable enough to go beyond the curriculum here and there, and not just feel challenged simply covering the large amount of expectations that are stated categorically in our curriculum. I feel far more enthused about teaching science, and think this rubbed off [on my students]. It's much more fun to teach with a variety of instructional strategies. (Celia, diary entry, May 9, 1999)

The enhancement of Celia's pedagogical content knowledge and the development of her understanding of her strengths and weaknesses as a teacher (knowledge of the self) occurred in conjunction with opportunities to engage in reflection. MI theory provided a tool for engaging in reflection-on-action (Schön, 1983), conscious and deliberate forms of thinking, feeling, and talking after events or before events have occurred. Celia considered herself to be a reflective practitioner and this project reinforced this practice.

I think if you are a reflective kind of person . . . it's very meaningful to me to have that procedure in play. I have to sort of analyse what I'm doing and write it down and draw some conclusions, and what have you. I liked that aspect of it. (Celia, interview, April 6, 1999)

Celia's participation in the project encouraged her to consider the issue of teacher change and the challenges inherent in changing one's practice, especially if it necessitates the expenditure of large amounts of time and energy.

I learned a lot [from the project] and this provoked thought about change, how difficult it is to implement, how much easier it is to follow the simpler path, and how to reconcile taking the easier path with the knowledge that students learn well when engaged, undertaking varied tasks. (Celia, Diary entry, May, 1999)

### *Challenges Throughout the Project*

One challenge for Celia was becoming comfortable with the science content. Before designing and implementing the unit, she spent considerable time becoming familiar with the concept of energy.

Because I am unfamiliar with energy and the concepts to be taught, I am busy investigating materials/activities, and don't feel ready to introduce the added layer of MI yet . . . I'm learning about the topic of energy, teaching science in general, and MI from the ground up! (Celia, journal entry, February 1, 1999)

The ongoing support from group members at meetings, especially the intermediate and high-school teachers, provided a forum for Celia to clarify

her developing understanding about energy.

Another challenge for Celia centred around the issue of time. Planning, designing, and implementing a variety of MI teaching and learning activities to create learner-centred classrooms necessitates teachers expending high levels of energy and huge amounts of time. Many things compete for teachers' time inside and outside the school setting; thus, creating an MI-based science curriculum placed increased demands on Celia's time and energy.

The collaboration with Celia, a highly energetic, insightful, and motivated individual, was a very positive experience. Although few problems arose, I did find at one point that Celia had become very apprehensive about the project after being ill for a three-week period. "Celia has been very sick . . . . She called last night expressing her concern about getting behind and delaying the project. I assured her that she should not worry and that she could progress at her own pace" (Author, journal entry, February 27, 1999). Providing individual moral support was a critical, ongoing role I assumed throughout the project.

## DISCUSSION

This study contributes to a greater understanding of teacher development and how teachers can enhance their professional knowledge. MI theory provided a means for Celia to reflect on many aspects of her professional knowledge. She used MI theory as an instructional organizer to critically examine her teaching beliefs and classroom practices and to make pedagogical decisions about how to structure learning for students. She engaged in curriculum making and was an "integral part of the curriculum constructed and enacted" (Clandinin & Connelly, 1992, p. 363). If teachers are to engage in critical self-reflection and inquiry about their practice (as Celia did), they must be more than technicians who implement curricula developed by others; they must also assume the role of curriculum makers. In this way, they are more likely to enhance their professional knowledge and to gain a greater understanding of how to best meet the needs of their students.

Through participation in this project, Celia not only enhanced various aspects of her professional knowledge (pedagogical content knowledge and knowledge of the self), but she also became more adept at integrating all aspects of her professional knowledge. By exploring her teaching style, Celia broadened both her teaching repertoire and her approaches to assessment. She challenged herself to develop intelligences in areas that she had not focussed on in the past; hence, she included teaching and

learning strategies in her science classes that catered to a variety of student learning styles. In addition, she stated she would continue to expand her approaches to science teaching and learning by incorporating more of the bodily-kinesthetic and the musical intelligences into her curriculum.

As evidenced in this study, MI theory is much more than a theory of intelligence. It encourages educators to see student ability from a much broader perspective, and consequently, provides a lens for guiding teaching decision-making. Although this study provides little evidence to support or refute many criticisms of MI theory (as espoused by Klein, 1997; Morgan, 1996; and Sternberg, 1983), it does provide support for the pedagogical merit of MI theory. Furthermore, MI theory, when adopted as a pedagogical organizer, can provide educators with a starting point to consider their teaching styles and beliefs about learners and how to structure learning experiences for all learners. MI theory has the potential to foster positive teacher learning that can translate into improved student learning in science.

## FINAL REMARKS

In this article, I reported on how one teacher enhanced her understanding and practice of science teaching and learning. The study is important because it provides evidence about and describes how MI theory can be used as an instructional (pedagogical) organizer to enhance teacher development. It supports Gardner's claims (1998) that MI theory offers a way to "begin to think about individual differences in the classroom" (p. 101) as well as about how teachers can communicate content knowledge to students in multiple ways. Many instructional organizers exist (learning styles, research on gender, for example) and I would recommend MI theory be added to the repertoire of elementary teachers and other educators as a means to reflect on and inform their teaching of science. Just as Celia had an opportunity to participate in an ongoing teacher-development project, other educators need opportunities and encouragement to enhance their professional knowledge through participation in a range of innovative approaches to teacher development.

## NOTES

- 1 Bennett and Rolheiser (2001) refer to instructional organizers as specific bodies of knowledge that play a role in "assisting educators to make wise decisions about the design of learning environments" (p. 339). I have applied this notion to MI theory.



- 2 The experiences of other members of the collaborative research group are reported elsewhere (Goodnough, 2001a, 2001b, 2001c).
- 3 In his seminal book, *Frames of Mind: The Theory of Multiple Intelligences*, Howard Gardner (1983) posited the existence of seven intelligences: verbal-linguistic, logical-mathematical, visual-spatial, musical-rhythmic, bodily-kinesthetic, interpersonal, and intrapersonal. More recently, he added an eighth — the naturalistic intelligence (Checkley, 1997).
- 4 It is beyond the scope and space of this article to provide an in-depth discussion of the entire debate between Klein and Gardner, which is addressed in Gardner (1998) and Klein (1998).
- 5 Some of the texts and articles read and discussed by Celia within the action-research group included Armstrong (1994), Chapman (1993), Gardner (1983, 1993, 1995a, 1995b), Kagan and Kagan (1998), Klein (1997), and Lazear (1994).

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