TRN 2001-2002
Math Secondary Profiles Analysis

Notes for the reader:

Throughout the analysis, as I make comments, I will refer to myself as the "analyst" and to the writer, or writers of the profile(s) to which I am referring, as the researcher(s). I also notice, as I write, and revise, that I often use the adjective "rich" quite often in reference to various mathematics lessons. So that this term is not just some vague sort of irrelevancy, I would like to briefly offer the reader some description by other vague terms of what I mean when I use the term. A "rich" lesson in mathematics addresses a particular topic from several different perspectives, and engages the learners in thinking about the nature of the particular process as it fits into a wider mathematical context, as opposed to merely reinforcing a particular algorithm to compute an answer to some specific sort of problem. So, a rich lesson, for me, might be one in which the learning is motivated by some real world problem, for which a variety of perspectives, perhaps algebraic, geometric, and numerical, are presented in thinking about a solution process. A lesson is richest, if the preceding statements hold, and the learners are fully engaged in developing their own mental structures for the context of the processes they are learning.

Procedure:

There are 6 secondary math profiles this year, written by three researchers. Unfortunately, the CLES and MTEBI data was not available to one of the profile writers. Also, one MnMTOI post-observation instrument was missing. In addition, it might be noted that the criterion stating "One observation will focus on a lesson to develop student understanding of important content and the other will focus on student inquiry." seems to be not generally followed in the math profiles this year. In fact, three of the twelve observed classes were review days, and just two classes, taught by the same teacher, were unarguably "inquiry based". One additional class could be construed as representing an inquiry based activity, but from the description it was not clear to the analyst whether it was or not. This issue will be revisited in the remarks following the description of the profiles.

Contexts:

Teachers and Schools: Given the relatively small number of profiles, it makes sense to me to list briefly the context in which these six teachers taught:

Two were teaching grades 7-8; one was a 2nd year 7-12 licensed teacher, the other an elementary/math emphasis 1st year teacher. One school was suburban with ~900 students, the other small town with ~350 students.

Two others were 2nd and 3rd year teachers at a private college prep school teaching a variety of college prep math, and for both, geometry classes were observed. The setting was urban, with little or no diversity.

One was teaching math and social studies courses, the course observed was a class of "high risk" 10th and 11th graders, he is a 2nd year teacher, after being a small business owner/operator for a number of years before returning to obtain a licensure. The school is a rural school.

The last was a 3rd year teacher at a high school teaching integrated 9th grade math, and calculus. The school is in a small town with ~800 students.

Classes Observed: All classes observed had between 16 and 26 students. Here is a brief description of the sets of two lessons of each teacher:

One lesson, perhaps implying an element of inquiry, was "putting the finishing touches on models of fractals". The other was on triangles. (Geometry)

One was a review day, the other on "angles of dissecting lines". (Geometry)

One was on solving linear equations, the other a review. (7th grade math)

Both lessons on subsequent days were student lead inquiry into modeling and solving a marketing problem by using matrices, and developing a means for multiplying matrices together. (10th grade integrated "high risk" class)

One was review, the other a lesson on perfect squares. (7th grade math)

The two days were lessons on two different integration topics. (Calculus)

Knowing Math Content:

· **Important Content:**

Four of the profiles supported the content as being important, the other two fail to address the issue directly in the section, but it seems from the description of the classes in the context that the content was the usual content of a geometry class. It is the opinion of the analyst that in each case, the mathematics content was important.

However, there were deficiencies indicated in content having less to do with the content itself than with the approach to the content. In five of the six profiles, there is evidence that the mathematics is being taught as a collection of rote procedures rather than from a process standpoint. That is, one teacher focuses on the importance of "basic skills" rather than problem solving. A calculus teacher teaches integration topics as a means of calculating without reference to the insight these calculations can give into the meaning of integration. A 7th grade teacher teaches recognition of

perfect squares with little physical context. This is in contrast to one profiled teacher, Mr. Cord, who engaged his class with a problem regarding marketing of brands of tennis shoes, and they developed the algorithm for matrix multiplication in the process of solving the problem. In the other two cases, both teachers bemoan the necessity of following a fast paced "college prep" curriculum, and being unable to engage in many "constructivist activities" as a result.

The sources of data which play into this assessment are mainly observations by the researchers, or from the interviews. The MTEBI results are referred to as well by one researcher in two of the profiles, saying "the teacher feels competent with the material", in regards to "important content".

- **Accurate Content**

In four of the six profiles, the accuracy of the content is affirmed.

In one case, (Ms Jones) the researcher references an outright mistake on a "warm up" problem the teacher brought in for the beginning of the hour which went unrecognized. In another case, (Jen C) the researcher gave an example of a fairly subtle mistake in a calculus class, which, in combination with the manner in which topics were being presented (rote procedure rather than process oriented) lead the researcher to claim the teacher had an insufficient content background to be teaching calculus, despite affirming other aspects of that teacher's style.

This is observational data only.

- **Appropriate Content:**

Two profiles do not mention this, but it is implicit in other discussions that the content was appropriate to those courses in the college prep environment described. One profile mentions content as appropriate, being based on NSF curriculum. Two mention content selected from a text as appropriate, but shallow in its treatment. (rote rather than process oriented.)

- **Math for All**

There is some variety in this category. The two prep school teachers' (DR, AF) profiles indicate, from MTII interview data, that they <u>want</u> to make math relevant to all, but feel pressured to maintain a brisk schedule focused on a well established college prep math curriculum. One of them even mentions he "doesn't entirely buy into it (math for all) at this school". There is little reported diversity in this school, ethnic or otherwise.

The other four teachers each in their own manner were portrayed as attempting to engage a variety of students. One (Jen C) talked about an awareness of different learning styles, and addressed it in the class by having some concrete objects on hand to illustrate what might otherwise be just an abstraction. (MTII, MTOI post-obs)

Another also mentioned different learning styles, and as students worked, would pay special attention to certain students based on her knowledge of those students. (MTII) The material she was teaching, in one lesson at least, was practically oriented math- calculating discounts on jeans, for instance, and to have actual concrete settings for the mathematics is a step in the right direction. A third teacher is reported as using many 'real world' context problems as well.

The last teacher, Mr. Cord, is teaching a class consisting of the "at risk" 10th and 11th graders, including all of the school's LD and EBD students. His lesson, on matrix multiplication, was an inquiry lesson based on an application all the students could identify with, and was highly successful in the view of the researcher.

In summary, three of the six teachers acknowledged that making math more relevant was important, but blamed the curriculum they were mandated to work with for generally not spending much time on richer activities with a supporting context, which might engage a wider variety of students. Of the remaining three, one was teaching an elective calculus course, and made efforts to approach the subject from algebraic and geometric perspectives. One "adjusted the pace and number of problems students are expected to do" to accommodate all students, and tried to "say, and write the main points". It is not clear to the analyst whether this means the expectations were lowered for all students, or just those who the teacher felt needed lower expectations. In the final case, the teacher is doing an exemplary job engaging traditionally difficult students.

The data cited was from observations, pre/post obs instruments, and interviews.

- **Understanding the Nature of Mathematics**:

There are two basic styles indicated by the profiles, with respect to understanding the nature of mathematics, as this is expressed in the classroom. One, an investigative/problem solving approach, was demonstrated by 2 teachers, Mr. Cord, and Jen C. The other, a basic skills type approach, was demonstrated by Jen C., Ms. Jones, and Ms. Blue

Both the prep school teachers "appear to understand the nature of mathematics", (MnMTOI's) the only evidence given is that one addresses student questions from a variety of viewpoints, and the other brings up the idea of patterns to his students again and again, because to him "math is patterns", but there "isn't time to engage in constructivist activities." (MTII) It is unclear to the analyst how these two teachers fit into the above dichotomy.

The exemplary teacher in this area, is described by the researcher as developing problem solving abilities, basic skills, and correct use of mathematical language, but that the latter aspects flow from the first. A direct quote from the interview: "we develop some skills, but I want them to develop them through problem solving".

Data used were observations, interviews, and two profiles reference CLES data.

- **Curricular Decisions:**

One teacher referenced the MN Frameworks as the prime motivator for curricular decisions. All of the teachers made their curricular decisions based upon the textbooks they were given. Some of the reasons given for the reliance upon the text were fellow math faculty, administration, and time constraints. In the case of traditional curricula, 3 indicated discomfort with not being able to teach from a more flexible standpoint, and engaged only minimally in activities not supported by the text.

The calculus teacher was chosen to teach the course because of her familiarity with the text, having used it as a college student. This text was chosen by the school, maybe because it is a rather non-traditional, multiple perspective text, which fits with the integrated curriculum they have adopted for lower courses.

This data is mainly from interviews, although observation data also played a role.

Knowing Pedagogy:

- **Kinds of Activities:**

All of the teachers explicitly or implicitly indicate that an activity is anything that engages the students in mathematical thoughts. One teacher mentions reading the text, as an example of an (best used only occasionally in his opinion) activity. Four mention lectures. Four mention class discussions. One mentions problem solving. Three mention and/or utilize in observed classes collaborative work. Four indicate use of physical manipulatives. It is not clear that more of them did not engage in the activities mentioned- the reporting of this information was spotty. Finally, all the profiles indicate teachers who assigned homework, gave quizzes, and exams. One teacher, Mr Cord,

All reportedly use some level of collaborative activity in their classroom, the extent varying from seldom, in the case of one of the prep school teachers, Dr., because "the curriculum moves too fast for group work", and because of classroom management issues, to quite a lot of the time, in the case of Mr. Cord. The nature of the collaborative activity is unclear in some cases. In Mr. Cord's case, it was based upon solving a real world problem and in the process, developing some definitions and tools. In Jen C's case, the collaboration was informal as students mixed during the

hour to consult with each other on solving some problems. In Dr's case, it seemed to be limited to paired students working to solve problems.

This data is observation and interview based.

- **Appropriate Activities:**

The activities were reported as generally appropriate to the instructional goals, with various misgivings as to the appropriateness of the goals. The prep school teachers' only goals appear to be readying the students for AP exams, and they teach towards this narrow objective. Thus, the one activity which I mentioned might be construed as being inquiry based, on fractals, "was a stretch in this environment", according to the teacher.

The activity engaged in (a wide variety of "math warm up" questions on which the class spent nearly half of the two periods) by Ms Jones was reported as addressing standards, but only topics standards, without much mathematical process undergirding the particular topic.

Only in one case were the actual instructional goals and activities very evidently in line with developing students' broader mathematical abilities, as well as basic skills and use of mathematical terminology. (Mr Cord)

The data used is coming from the observation instruments, observations, and interviews.

- **Kinds of Thinking/Discourse:**

One teacher 8th grade teacher, Ms. Jones, was firmly ensconced in her role as teller, though she would question the class to see if they knew the correct answer before she told them. The researcher observed that students appeared to have recognized that if they did not know the answer to a question she posed, there was no need to think very hard, as it would be forthcoming soon.

Three of the other teachers (AF, Ms Blue, Jen C) are described as engaging in what I will call "engaged" lectures- one intentionally would commit errors, and the students knew to watch for those mistakes. The other two, while covering material, would have the students supply the next steps in the process. Another teacher possibly fit this description, utilizing what the researcher calls "open-ended questioning" in the lectures, although it is later stated that the result was "marginal discourse", due to his desire to maintain control of the direction.

Mr. Cord, in the observed classes, posed a problem, and then facilitated their explorations, in groups of three, and ended up helping them refine some of the terminology which evolved. The researcher mentions students referring to "up and down rows" in a matrix, and the teacher points to a column, at which point the

students begin referring to the matrices' "columns". The students also developed the algorithm for multiplying matrices, over the course of this two day problem, and used it to solve the motivating problem of marketing various tennis shoes. The final activity was him helping "the entire class at the end of the period to summarize what they had done". These are the only observations of this teacher, so it is unknown what other sorts of discourse occurred in his class.

In two cases, Dr, and Ms Jones, the profiles indicate that a fear of classroom management issues on the part of the teacher appears to be limiting the amount of collaborative interaction engaged in.

Most of the information in this sub-section was taken from the observations, CLES scores were mentioned by one researcher.

- **Teacher's Role in Discourse:**

There was a continuum of behavior here. At one end of the spectrum Mr. Cord was pure facilitator for student development, and, after concepts were developed by students, would provide appropriate terminology to the concepts students developed. He also displayed a willingness to let the answers to questions remain a mystery, and students would continue to think about them overnight. At the other end of the spectrum, Ms Jones tended to provide information to the students.

Typical of the remainder seemed to be indicating how one solves a certain type of problem, then engaging the students in attempting to solve other problems of the same sort, and supporting them in their efforts. Typical also was teachers attempting to foster some collaborative effort in these efforts. Further, these teachers asked questions of the students to foster their thinking about the topics. Ms Jones also engaged in questioning the class, but the researcher doubts the helpfulness of her questions, as mentioned in the previous section.

This data seems to be mostly based on observations, but some interview as well.

- **Assessments:**

All of the teachers some sort of informal assessment to determine how well students were following on a daily basis, through walking around the room observing students as they worked, in several cases, and through questioning in several. One teacher said he likes his assessment to be largely informal through discussion so that students are not threatened by it, and can learn the material and perform well in the formal setting later on.

They also all utilized formal in the form of quizzes, exams and homework, to see how well students were doing, to assign grades, and to prepare them for the further examinations they would encounter, in the case of the college prep courses. One used

very frequent formal assessment (2-3 quizzes per week, “so one bad day wouldn’t hurt them” (MTII)). This comes from observation and interview data.

- **Student learning**

  Two profiles indicate the teachers were generally happy with exam scores, and the researcher asserts that learning seemed to be taking place. (Dr, AF)

  In three cases, the evidence of student learning is that they displayed the ability to solve the particular problems. (Jen C, Mr Cord, Ms Blue) Two of these also mention observing that students were mastering the ideas from the discussion taking place in the classroom. (Jen C, Mr Cord)

  One profile, Ms Jones, affirms that some student learning took place, because students could obtain a correct answer, but the researcher observed they could not explain (and explaining was one of the stated instructional goals from the pre-obs form) the concept behind what they were doing, just the procedure by which an answer is arrived at. (MnMTOI)

  The data for this piece was obtained mostly by the observations, some in interviews. One researcher, (me) put the MTEBI data in this section, “lacking a better idea where to report it”.

- **External Resources:**

  All indicate use of graphics calculators.

  All but one indicate the class’s use of computer facilities.

  Two teachers mentioned talking to mentors as an additional resource. (Mr Cord, Ms Jones)

  Two indicate they incorporate common “real world” ideas which intersect with math in their courses, one often, the other on occasion. (Ms Blue, Jen C)

  Four mention physical manipulatives. (AF, Mr Cord, Ms Jones, Jen C)

  Three indicate getting material for lessons from the web (DR, AF, Mr Cord). Mr Cord also mentions NCTM P&S, MN Frameworks, and NCTM journals)

  This data comes from observations and interviews.

Knowing Students

- **Appropriate to Students:**

One teacher, Ms. Jones, adjusted to the students by altering the pacing and amount of material covered.

One mentioned engaging her 7th grade students by choosing fun activities, specially nearer the end of the year (Ms Jones).

All profiles mention the teacher established friendly or positive relationships with the class which helped the learning environment.

Two indicate a respectful environment(Ms Jones, Mr Cord).

Two indicate knowing the students (Mr Cord, AF)

Jen C is depicted as using humor to establish a positive environment.

Data cited by researchers here were CLES scores, observations, and interviews.

- **Students' roles in discourse:**

In one case, the students more or less lead the way in investigating a solution to a problem in groups. (Mr. Cord.)

In all cases, by observation or by indication on interview, students were expected to work together to get results, either in formal groups or informally as they saw fit.

In all cases students were expected to contribute to class discussions, although, in one case,(Ms Jones) it was by answering questions posed by the teacher followed by insufficient wait time. The extent to which this occurred for various teachers was not entirely clear from the profiles.

Three teachers also mention asking questions when they do not understand as part of the students' role. (Jen C, Ms Blue, Ms Jones)

One teacher also mentions coming prepared with paper, pencils, etc.

Only one says their role is "to learn", this may be an oversight on the part of the other teachers.

The data profilers used comes from observations, mainly, and also from the interviews and CLES data, for one researcher.

- **Management of Social Atmosphere:**

In every instance, the profiles indicated that the teachers fostered an environment which was positive for the students through means of respect, humor, personal contact, and friendliness.

In two of the classes observed, there were classroom management issues- one with geometry students not staying on task when working in groups, (DR) the other with semi-unruly 7th graders not settling down at the start of the hour, or staying on task until the end of the hour (Ms Blue). I might mention that the latter was not excessive, and the researcher (me) has not observed a 7th grade class for some time, this may be the accepted norm. In fact, it strikes me that the teacher had about as much difficulty getting the kids to all get busy as we do getting the faculty busy after a lunch break at a TRN meeting.

The data for this was mostly observation based, along with some interview data.

Establishing an Environment:

None of the researchers had anything noteworthy to report in this area.

Developing as a Teacher:

· **Pie Charts**:

I will present the average response from the 6 teachers for the main factors they mentioned, as I interpreted them(as an open-ended survey, the responses were not uniform, which makes interpretation more difficult, and the categories suggested by the individual researchers may have influenced which answers were mentioned rather heavily), in describing influences on their development as a teacher:

The teacher's education:	30%
Classroom experiences:	28%
Life Experiences:	12%
Students:	12%
Colleagues/mentors:	7%
Professional Dev.:	5%
Curriculum:	4%

· **Self Reflection on Teaching:**

All researchers report some level of self reflection on teaching for the teachers.

Three indicate doing formative assessment- that is, they kept track of how well various lessons went for future reference in determining pacing, (Ms Jones) and quality of activities and instructional method . (Ms Blue, Mr Cord.) (MTII)

One mentions she wishes there were another instructor of calculus at the school to discuss lesson plans with, as she find that helpful in other classes. (MTII)

Four, Dr, AF, Mr. Cord, and Ms Blue, are depicted as being very aware of curricular issues.

This data comes from the interviews.

- **Professional Development:**

Three report subscribing to a national journal for math teachers. (AF, DR, Mr Cord)

Two report attending conferences related to mathematics teaching. (Mr. Cord, AF)

Two report attending(or intending to attend) in-services related to curriculum. (Mr. Cord, Ms. Blue)

Two are or have already engaged in masters programs. (AF, Dr)

One more is planning on this. (Ms Jones)

This data was obtained in the interviews.

- **Resources, Support Communities, and Learning Communities:**

Two report having ample support from department chairs and principals, as long as the development supports the college prep curriculum. (AF, Dr)

Two teachers report having a mentors who have helped them in their development. (Ms Jones, Mr Cord)

The other two mention mainly other math teachers in the school as a support network in their teaching roles. (Jen C, Ms Blue)

This data is from the interviews.

Researchers' Notes & Analyst's Musings:

- **Disagreements with the Reviewer:**

First of all, I wish to offer many thanks to Kay Wohlhuter for reviewing my analysis. It needed substantial revision in its organization and I am indebted to her for her many good suggestions. By and large I agreed with her comments on my original draft, and made changes to incorporate her suggestions. There are just a few points on which we differed which I did not change, and I feel I should include a brief discussion of my reasons for leaving as they were.

The reviewer questioned my inclusion of homework, quizzes and exams in the "kinds of activities" section. In my opinion, these are certainly activities which engage the

students engage in mathematical thinking, which is, broadly, how various teachers approached the idea of activities. In fact, to think of these as assessment tools and not as activities misses the more valuable aspect of them, to my way of thinking. Many people, myself included, are not motivated to work until the pressure is on. For those people, and certainly for me, some of the richest learning came about as a result of finishing homework assignments, and studying for and taking exams. An exam, well crafted, does not merely measure what a student knows. Rather, it can set up a situation in which students are motivated to think deeply about how to solve a problem suggested by the exam, and grow considerably in that process.

Further, the teachers may not in fact mention these as activities, but this analysis, I believe, should not be just about what the teachers reported about their activities, but also what we observe.

- **Sources of Data:**

The MTEBI data was virtually unused by the profile writers. One researcher refers to it under "Important Content", because the teachers indicated they felt competent. The other researcher with access to this data places it as an aside under "Student Learning".

The CLES data was not used in the same headings by the researchers who had this data.

The bulk, far and wide, of the claims made by the researchers was based upon observation (including pre/post observation forms) and interview data. The degree to which claims were supported varied somewhat- one researcher for instance, said "So and so *appeared* to have a good understanding of the nature of mathematics." Others tried not to make statements like this without offering some concrete evidence supporting it.

- **Student Inquiry:**

As mentioned, 50% of the observations were "lectures" of one sort or another, 25% were "review days", and 25%, or less were unarguably "student inquiry" activities.

Two items stand out- one, the amount of reviewing being done initially struck me as rather high. On further thought, this does not worry me. In mathematics, it is often easy to lose sight of the forest due to the number of trees. Review days <u>can</u> be a chance for the class to collectively step back, catch its breath, and look again at topics which when introduced, the focus was more on implementation of a procedure than wider context. Once students have some familiarity with the computational side of the math, a review day could be very appropriate in helping the students develop a broader context for the new material. It did not seem evident, however, that this was the sort of review engaged in by teachers in the study this year- one "fielded students' questions", which will generally be pretty focused on procedure. Another had a

bingo game with a ton of various short computational problems. In any case, I would say that we should not wish for less reviewing so much as perhaps for reviewing the wider ideas once students have achieved some computational competency with the topics. I have no idea what the extent of this sort of activity is.

Second, and more to the point of the study, very little of what we observed this year was "a lesson focused on student inquiry", or at least far less than half, which is what the guidelines ask for. Perhaps this item is in need of re-interpretation. I am assuming this guideline came about in the context of a science classroom, in which students often do laboratory activities. The nature of mathematics is not quite the same as the nature of science- many of the experiments one might do, do not require investigation of physical objects, but can take place in the head, and on paper. It is more a function, in my mind, of how engaged the students are, which determines whether a lesson is focused on "student inquiry" or not. I would qualify one of the lectures I observed as being thus, based on the level of active participation by students in determining the direction of the discourse. However, I don't think our current consensus on the issue would consider that lesson an "inquiry" lesson.

- This may be my own issue, but I was unclear, as I wrote my profiles, of the distinction between important, accurate, and appropriate content, and there were several items I mentioned could be thought of as playing a role in any of these. Do we need 3 such similar sub-sections? Clarification of what these items mean would aid in writing profiles.

  Be that as may, a quick summary is this. The content is, by and large, superficially important, accurate, and appropriate, but the way in which it is being taught, at least in some of the observed classes, which are just a snapshot, weakens somewhat the statement we could make in these regards, since in several observed classes, the content was mainly rote procedures.

- It does seem clear, that the teachers in this years' profiles are relying strongly on the texts they have to inform curricular decisions. The most direct effect we can have in that case, if we want teachers to teach in a certain manner, is to provide them with appropriate supporting materials, most importantly the texts. However, this is not the end of the issue, see the following comment.

- The researcher observing the calculus class was me, and I commented at length in the profile, on my assertion that the teacher was teaching beyond her level. The basis for this claim was that the way in which she was teaching the topics I observed was algorithmic in nature, without thought for the ideas behind the algorithms. This is in contrast with her intentionality in culturing a good relationship with the students and fostering very good, albeit computationally geared, discourse in the class.

  The bizarre thing that happened in this class, was an assignment sheet was handed out, and the assignment was a list of very standard problems, 1-19, the only difference between them being the actual function and the axis around which it was

rotated. This is in contrast to the approach of the textbook she says they use, which has many questions designed to push the students to think in a broader context.

To briefly summarize my argument, I believe teachers who teach more advanced topics, such as calculus, should be required to participate in further math content training. One encounters the ideas of calculus as a freshman, and perhaps, in a very abstract setting, as a senior, in a real analysis course, but these courses are generally not going to be targeted at developing the students' understanding of the topics they might teach in a high school calculus course. Through my career as a rather successful mathematics student, I have never mastered the ideas behind a topic to a degree I would consider sufficient to turn around and teach that material, in one exposure, or even two. We should not expect our math ed students to be able to do this either.

Final Version 6/27/03 Luther Qson, The College of St. Scholastica