Deaf students and the language of mathematics: a teacher training proposal

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Deaf Students and the Language of Mathematics:

A Teacher Training Proposal

Master's Project

Submitted to the Faculty of the Master of Science Program in Secondary Education of
Students who are Deaf or Hard of Hearing

National Technical Institute for the Deaf
ROCHESTER INSTITUTE OF TECHNOLOGY

By

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In Partial Fulfillment of the Requirements for the Degree of Master of Science

Rochester, New York May 22, 2001

Approved: (Project Advisor)

(Program Director)
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Section 1: Project Summary

High-level mathematical reasoning is important in order to be able to compete in today’s world. The focus of this project is on the mathematics aspect of deaf student’s education and how the lessons learned there will help them compete. Specifically concentrating on the language of a textbook used in middle school mathematics. Mathematics instruction is turning toward more real world problems that develop students’ reasoning skills and problem solving abilities. With this new focus, word problems and critical thinking have become a more critical aspect of mathematics instruction. Students need to be able to read and comprehend the problems as well as know the mathematics skills involved in solving them. In order to make this type of instruction more accessible to deaf students, their teachers need to understand the language problems that come with this new focus.

The proposed project will create materials and workshops for mathematics teachers. The goal is to train them to recognize problematic structures in mathematics materials in general and particularly in the Connected Mathematics Program (CMP). Mathematics teachers in both mainstream education and in residential schools will be the primary participants of the workshops.

A workshop will be created along with supplemental materials to assist teachers in understanding the language problems the deaf student faces. These will help the teacher to understand the potential problems. The workshop will cover three major areas: structure, vocabulary and content. The workshop will have three sections and each section will focus on a different problem area. A section will include a description of the problem area, examples, tips for helping students and an application session. During the
application session teachers will be expected to find the possible problems in a given text and brainstorm what they could do to help students.

The three workshops will occur over a period of one year. All three workshops will be the same and will cover the three problem areas. The evaluation of each workshop will include surveys and interviews with all the participants. Data from this evaluation may be used to modify the workshops pending additional future funding.

Section 2: Project Description

Need:

Due to the increase in technology there is a greater need for deaf and hard-of-hearing students to be prepared for jobs that require high level mathematical reasoning. Though it is known that deaf and hard-of-hearing students do better on mathematics tests than reading tests, this only applies to computation tasks. In 1996 a survey of deaf educators was performed by the Gallaudet Research Institute (GRI) to determine if they were complying with the standards created by the National Council of Teachers of Mathematics (NCTM). It was found that there was less curricular focus on problem solving skills than procedures. These preliminary reports are showing that teachers in deaf education are not meeting the NCTM standards (Allen, 1998).

In order to follow procedures and accomplish problem solving, students must have access to the language of the mathematics textbook. New texts increase the probability of access by introducing new vocabulary and using it throughout a unit and by using straightforward sentence structures. However, even in new materials there are problematic areas for deaf students.
There are several categories of problems deaf students have with the language of mathematics. Lamb (1980), as cited in Kidd (1991), identified five vocabulary areas: multiple meanings, technical vocabulary, words with special emphasis, varied forms, and symbols and abbreviations. Kidd (1991) analyzed five randomly selected word problems and categorized the problems she saw as syntactic and semantics problems. Sentences in mathematics tend to have a high percentage of prepositions. Other syntactic problems include time phrases, and nominalization (verbs used as nouns). Semantic problems also include not understanding the meaning of the prepositions nor being able to infer meaning from a sentence. This project will focus on semantic and syntactic problems in one middle school mathematics textbook.

The goal of educators is to help our students become literate. What exactly being literate means is an issue that is highly debated in education today. It does not matter what subject is being taught, the overall goal is that students become literate in that area. For Vince Daniele (1993) quantitative literacy includes the ability to reason as well as specific knowledge and skills. However, it is pointed out that the definition of literacy will continue to change, namely due to technology. Technology is changing what and how things are taught in schools today. This is why the 3Rs should become the 4Rs to include reasoning. The NCTM standards were developed with some assumptions about what quantitative literacy should include. Content knowledge will involve real world experiences, manipulatives and appropriate materials. Students will be actively involved in their learning. This means that students will be talking to each other about the materials taught in class, writing about what they are learning and utilizing technology in
the classroom. However, these are only a guideline for what quantitative literacy is, specific skills and knowledge remain elusive (Daniele, 1993).

Hillegeist & Epstein (1989) refer to three types of categories the language of learning, the language of mathematics, and language of instruction. The language of learning and the language of mathematics are universal problems for teachers. Students create their own language of learning, and like the language of mathematics the teacher does not usually influence it. The teacher does, however, determine the language of instruction by the words she chooses when she teaches, and the textbook she uses. This aspect of instruction is what teachers of the deaf struggle with most. Most are dealing with students that are not competent in English. (Traxler, 2000)

**Significance:**

By understanding the problems that deaf students have with the language used in mathematics, teachers will be able to assist their students more effectively. The Connected Mathematics Program (CMP) was designed to meet the new standards developed by the National Council of Teachers of Mathematics (NCTM). By creating materials to go with CMP, teachers of the deaf in residential settings will be able to use the most current textbooks and help to keep these schools on the cutting edge of education. These materials will also help mainstream teachers who may already be using CMP, to understand the special needs of the deaf and hard of hearing students in their classes.

CMP has a unique organization that makes it ideal for deaf students. Unlike traditional mathematics textbooks, CMP does not model a procedure in the form of several problems and then ask the students to practice a page of similar yet slightly
altered problems. Instead, each unit is broken up into several “investigations” that
explore some aspect of the unit. The “investigation” is written in the form of a story
problem. A situation is presented and several problems are asked related to that situation.
The student must create the algorithm for solving the problems.

Project Design:

A preliminary language analysis was done on one “investigation” in the unit
“Accentuate the Negative” from the Connected Mathematics Program (CMP). The
analysis consisted of three sections: language, rhetoric, and content. The language
analysis identified problematic structures and vocabulary. The rhetorical analysis
pertained to the organization and genre of the unit. The content analysis investigated the
extent to which the materials were culturally appropriate for deaf people.

The language analysis revealed several problematic items for deaf students. In
the language category potential problems exist for both structure and vocabulary.
Structural problems were relative clauses and passive sentence structure. For example,
“A player’s score for a round of golf can be reported as the total number of strokes she is
above or below par for the entire course” is an example of relative clause. And “A golf
hole is assigned a value called par” would be an example of a passive sentence structure.

There were also two types of vocabulary problems, primary and secondary. Examples of
primary vocabulary are “greater than” and “less than” and examples of secondary
vocabulary are “corresponding” and “category”. The two most common rhetorical forms
in this text are dialogue and story. It was thought that deaf students would find this an
easier format to read. The text was found to be culturally appropriate for deaf students
and did not include information they would not know strictly based on their deafness.
Once the preliminary analysis was completed a series of questions for the pilot project with teachers was compiled. Four teachers were interviewed: a mainstream teacher, teacher in a school for the deaf, an itinerant teacher and a teacher in a self-contained program. The interview included 1) questions about the type of problems their students had, 2) additional problems the students were faced with, and 3) questions related to the type of format of the workshops and materials to be created.

With funding, more interviews will be conducted and the information from the teachers will be used to create teacher-training materials and workshops. The materials will be used to help teachers understand the specific language problems that face the deaf and hard-of-hearing students in each unit of CMP.

**Project Evaluation:**

Each teacher that attends the teacher-training program will be asked to fill out an evaluation. A follow-up interview will be performed to gain their feedback about the training program.

**Management Plan:**

Several things will take place. First more interviews will occur to collect more information about language problems observed by mathematics teachers. Time will be needed to then create the workshops and materials. Three workshops will be conducted. The evaluations from each of the workshops will be analyzed to determine if more workshops should be offered and how they can be modified to better serve teachers.

**Budget:**

The three workshops will be given in three locations, one in California, one in Chicago and one in New York over a period of one year. Expenses will include travel,
and accommodations for each. Additional expenses include money to create materials and a salary. Below is a table of the specific costs.

<table>
<thead>
<tr>
<th></th>
<th>Travel (airplane and car rental)</th>
<th>Accommodations (hotel and food)</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>$700</td>
<td>$400</td>
</tr>
<tr>
<td>Chicago</td>
<td>$500</td>
<td>$400</td>
</tr>
<tr>
<td>New York</td>
<td>$500</td>
<td>$400</td>
</tr>
<tr>
<td>Salary, includes creating materials and doing workshops</td>
<td>$12,000</td>
<td></td>
</tr>
<tr>
<td>Materials</td>
<td></td>
<td>$500</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>15,400</td>
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</tbody>
</table>

Section 3: Pilot Project, description and remarks

An interview was piloted with four mathematics teachers who have used the Connected Mathematics Program (CMP) with deaf students. The goal of the interview was to get feedback from the teachers about language problems they have encountered in CMP. Several problem areas were identified, and each teacher was asked if they have seen these areas or other problem areas when teaching deaf students. Another section allows the teacher to give input about the type of workshop and materials they would find useful.

Teachers

Four teachers participated in the pilot study. One teacher was found through personal communication. The other three teachers were found through the CMP list service. All four teachers have worked with CMP and deaf students. Each teacher has a different type of role in Deaf education. Three are teachers of the deaf and the fourth is a mainstream mathematics teacher. Of the three teachers of the deaf, one works as an itinerant teacher in a “push in” situation, one is at a school for the deaf and the last is a teacher in a self-contained classroom in a public school. Two of the teachers have been using CMP since it was first released in 1998. While the other two have worked with it
for only one year. Two teachers are in Massachusetts, one is in Oregon, and the last is in New York State.

<table>
<thead>
<tr>
<th></th>
<th>Type of Program</th>
<th>CMP Grade level</th>
<th>Number of years teaching deaf students</th>
<th>Number of years teaching CMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rebecca</td>
<td>School for the deaf</td>
<td>6th grade</td>
<td>10 years</td>
<td>1 year</td>
</tr>
<tr>
<td>Victor</td>
<td>Mainstream</td>
<td>7th grade</td>
<td>4 years (31 years total)</td>
<td>5 years</td>
</tr>
<tr>
<td>Sandra</td>
<td>Self-contained</td>
<td>7th &amp; 8th grade</td>
<td>6 years</td>
<td>1 year</td>
</tr>
<tr>
<td>Jessica</td>
<td>Itinerant</td>
<td>6-8th grade</td>
<td>20 years</td>
<td>5 years</td>
</tr>
</tbody>
</table>

Method

A set of questions was established for the interviews (see Appendix). The questions focused on the three areas (structure, vocabulary and content of CMP) and the problems and advantages of the program. In addition, teachers were questioned about the types of workshops, and manuals they would find helpful. Three of the teachers were contacted first through email, and then the interview was done over the phone. The fourth was contacted over the phone and was interviewed in person. Each interview was between 30 and 45 minutes. During the interview the teachers were encouraged to speak freely about the problems they saw include examples if they so desired.

Results

First, the teachers were asked if they saw their students having problems with sentence structure in the textbook, including relative clauses, passives or others. All three teachers of the deaf, Rebecca, Sandra and Jessica, had seen problems with the language of CMP. Victor, the mainstream teacher, did not notice language problems with the student he had. It is important to point out that the student was responsible and sought the teacher's help often but not for specific language-related problems that he could identify. The three teachers believed that the reading level of the students was below that
required for the textbook. It was difficult for the teachers to name specific structures that the students struggled with. One teacher stated that she tried to avoid reading the text completely. Another worked systematically through the text with the class as a whole instead of having students work independently.

The second area was vocabulary. Again the same three teachers found that their students had problems with the vocabulary used in the textbook. The teachers felt that the textbook did not have clear explanations and words were not used repeatedly throughout the units making it difficult for students to really learn the vocabulary. According to one teacher, the vocabulary used was not “standardized” and there were no common “signal phrases” that helped students to know what to do next. By this she meant that terms were not used repeatedly and that there were no terms that gave the student a hint as to what was expected. Some of the vocabulary that caused problems for students included nonmathematical words such as the technical word for the rails on a rollercoaster. Victor did not observe any problems with his student.

The third area focused on the content of the textbook. The responses varied related to this question. Victor again saw no problems for his student. Rebecca liked the book in a sense, pointing out that it exposed students to situations and problems, which they hadn’t encountered yet. She also brought up the problem of translating the text into American Sign Language (ASL). She saw an inherent difficulty in that additional examples are often needed when translating text from written English to ASL and the textbook did not have multiple examples for each task. Jessica agreed that often when the text is being interpreted, unless the interpreter is very skilled in mathematics, students often became lost.
There were other problems that the teachers talked about. Jessica found the page set up to be distracting for the students. An unrelated box was often placed in the middle of a question was. The flow of the question was disrupted by the box and this can be distracting. Rebecca found that her students did not venture to read the text independently because there were not examples for them to use to help them understand the text. Sandra thought that the "pace" of the text was too fast for her students. By this she meant she needed to supplement the text with basic skills work because her students had many gaps in their knowledge. This was the first place Victor was able to comment. He found that his student had some short term retention problems, though she was better at remember things from the beginning of the unit. Victor was not sure if this was related to her deafness or another problem.

Despite the above mentioned problems, the teachers did like CMP. The teachers liked the projects and the ACE problems. Though reading may be a challenge for many deaf students it is an important skill to have. Admittedly this curriculum requires more work for students who struggle with reading. Since the textbook has the story format it requires students to learn how to follow directions and interpret what is being asked. When it is used properly it can have many benefits. It also promotes problem solving skills.

All the teachers were excited about the workshops and manuals and had suggestions for additional formats that would be helpful. Each teacher was given a choice of two formats and was asked which one would they prefer. One format focused on general linguistic problem while the other focused on the linguistic problems within each unit of CMP. There was an interesting split, Victor and Jessica, who have been
working with CMP since it originated, wanted a format that focused specifically on the
linguistically problems of deaf students. These two teachers had also been teachers for
over 20 years. Rebecca and Sandra, who had only worked with CMP for one year and
had only been teaching for ten years or less, prefer to focus on each unit. Perhaps this is
due to their lack of experience and felt a more step by step workshop would be more
useful to them.

The teachers were given the same choice regarding manuals. When it was
something they could use in school only one teacher, Rebecca, wanted one that would
focus on the linguistic problems. The three other teachers wanted something that was
more focused on the unit. Initially the manuals had been meant to be materials teachers
would get from the workshop. All four teachers seem to interpret this, as something not
necessarily related to the workshop. This is related to the fact that during the interviews
the word “manual” was used instead of “materials”. However this spurred the feasibility
of additional components to the workshops including manuals that would be separate
from the workshop and online manuals.

Lastly the teachers were asked if there was another format or sources of
information that would be helpful to them. All the teachers agree that a website that had
examples of problems deaf students have run into and how other teachers have dealt with
these problems would be extremely useful and convenient to access after the workshop.
Also, creating a list serve or network of other teachers using CMP with deaf students
where teachers could talk or observe each other would be useful. An online or distance
learning type workshop would be beneficial to teachers especially because it is often hard
to get time off.
Conclusions

All of the teachers expressed a need and a desire for training and information about how they could use CMP more effectively with their deaf students. The teachers had many problems identifying specific problematic structures. While one teacher responded that the syntax of CMP was complicated, overall the teachers could not identify specific examples. This points to a need for mathematics teachers to have more training in identifying and understanding language problems.

A third category of vocabulary words was identified through the interviews. Nonmathematical and unfamiliar terms, such as the technical term for the rails on a rollercoaster, could distract the student from more relevant content. The teachers also felt that the definitions in the glossary used complicated language. This observation was not surprising since typically glossaries are not written with language learners in mind. Repeatedly the teachers pointed out that the text did not include enough examples. Their students struggled because the text was reading intensive. It is important that these teachers find a way to help their students learn to read the text. The goal of the workshop will be first to help the teachers to identify the problems and integrate language learning smoothly into their lessons.

Several of the problems that Rebecca and Sandra had experienced seem to be connected to the fact that they have had only one year of experience with CMP. For example, Rebecca felt that her students did not venture to read independently because there were not examples in the textbook to look at to help them understand what they were supposed to do. However, this is done purposely as the authors wanted students to create their own way of answering questions. Sandra felt she needed to supplement the
text but she was only using selected units. This is discouraged because the units build on each other. Though it may seem as though the units are missing information it is eventually covered. The CMP approach to learning is comprehensive. That is, all aspects of a concept are covered in a unit.

For the workshops, some wanted to focus on the general linguistic problems of deaf students, while others wanted to focus on specific problems within each unit of CMP. This seemed to be related to a teachers’ experience with CMP. For example the two teachers who had been working with CMP since it began wanted to focus on the general problems and apply what they had learned to the units. They were more comfortable with the information within the units and felt it was not necessary to be so specific. Three out of the four teachers expressed a desire for manuals, or supplemental guides, for the teaching of each unit. The teachers suggested that such materials could be online through a website. Other suggestions included having a workshop on the web and creating a network of teachers.

Despite the problems mentioned, the teachers liked the textbook and felt that it introduced students to new and interesting situations. At the same time CMP promotes the problem solving skill of the students. In today’s technological society problem solving skills are extremely important, especially for deaf students. This is why it is important that efforts be made to help teachers of deaf students adapt materials to their students without compromising the approach of the program.
References


Appendix

Interview Protocol

Thank you for taking time from your busy schedule to complete this interview. The purpose of this interview is to gather some information related to your work with a deaf student, whom you taught using the Connected Mathematics Program.

1. Name:
2. Type of program:
3. Location of school:
4. How many years have you been teaching CMP?
5. How many years have you been teaching deaf students?

6. The following are two types of possible structural problems a deaf student might have. Have you noticed these types of problems?
   a. Relative clauses such as “How far behind each of the other two teams is this team?”
   b. Passive such as “A golf hole is assigned a value called par.”
   c. Other?

7. The following are two types of vocabulary problems a deaf student might have. Have you noticed these types of problems?
   a. Technical vocabulary such as “negative number”
   b. Supporting vocabulary such as “corresponding” “category”
Appendix

c. Other?

8. Have you noticed a problem with the style of the text?

9. What other problems have you noticed?

10. What other benefits have you noticed?
Initially there will be one, five-hour workshop that will talk about each type of problem I have identified. The workshop covers the three major problem areas: structure, vocabulary and style. Each workshop will have three sections and each section will focus on a different problem area. A section will include a description of the problem area, examples, tips for helping students and an application session. During the application session teachers will be given a text and will be required to find the possible problems and what they would do to help students.

1. Workshops
   a. Would you want a workshop that include information each linguistic problem?
   b. Would you want a workshop that explored the problems in one unit of CMP?

2. Manuals that accompany the workshops
   a. Would you want a workshop that include information each linguistic problem?
   b. Would you want a workshop that explored the problems in one unit of CMP?

3. Other topics or formats?