

# Mathematics CAI in the Classroom

*Judy M. Barnes*

The purpose of this study was to evaluate computer-assisted instruction (CAI) materials developed to teach concepts of polynomials to Grade 12 students. These materials were designed (under contract from Alberta Education) by staff of the Apple Innovation Support Center (AISC)<sup>1</sup>, at the University of Alberta, to meet the objectives of the Mathematics 30 curriculum (advanced diploma Grade 12 course) in use in Alberta. The polynomials unit from the CAI materials (about 10 percent of the 125-hour mathematics course) was studied.

Two high schools in a county in central Alberta (Gauss High School and Hilbert High School) were identified as having Macintosh computer laboratories (containing at least 25 Macintosh computers) with networks,<sup>2</sup> and were invited to participate in the study. The study involved observing the students and their mathematics teachers using the CAI materials for one-and-a-half weeks, and discussions with these participants.

## Students at Gauss High School

Four of the 30 students from the class in Gauss High School were interviewed by the researcher. These students were selected by the researcher because they had asked questions of the researcher and shown a willingness to discuss the CAI materials while using them. The four students interviewed were Barb, Jan, Martin and Donald.

<sup>1</sup>AISC is housed in the Faculty of Education, University of Alberta. AISC is directed by Dr. M. Petruk, professor with the Department of Adult, Career & Technology Education and executive director of Apple Canada Education Foundation.

<sup>2</sup>A local-area network, or network, is used to connect machines to a file server that contains information used by those connected to the network.

Barb had taken Mathematics 20 (the Grade 11 advanced diploma course) about one year before entering Mathematics 30, and indicated she sometimes found it difficult to remember the mathematics from the previous year. She was frustrated because the teacher usually reviewed the material from previous years, but the computer materials did not necessarily review material where she needed it. She stated that she was a good mathematics student although it was no longer her strongest school subject. She had never used a computer-teaching program before. However, she said she was comfortable with computers, and using the CAI materials did not affect her feelings toward computers.

Jan had taken Mathematics 33 (the Grade 12 general diploma course) in the previous semester. She stated that mathematics "is my worst subject. I don't catch on to it easy. I have to be taught it over and over again and have lots of practice." Research observations indicated she had difficulty using the computer, which seemed to be partly due to a weak mathematics background. However, she stated in her interview that she was comfortable using a computer, and thus using the CAI materials did not affect her feelings toward computers.

Martin had completed Mathematics 20 the previous year. Mathematics was a subject with which he felt comfortable. He was also comfortable with computers, although initially not with the Macintosh because he had not used one before. His initial reaction to the computer experience seemed one of frustration as he had difficulty accessing the CAI materials on the network. However, after using the Macintosh computer, he stated he was comfortable with it. Martin said that the use of the CAI materials did not affect his feelings toward computers in general but made him feel more positive about using Macintosh computers.

Donald had taken Mathematics 30 before and was repeating the course this term in the hope of improving his grade. Mathematics was one of the subjects Donald once felt comfortable with, but his marks had been "going downhill" since Grade 10. Donald was comfortable using computers and stated that "all a computer really is, is just a tool. It depends on what's in it, the program." He stated that the use of the CAI materials did not affect his feelings toward computers.

## Reaction to the Materials

All students were asked whether or not they enjoyed using the CAI materials. Barb responded, "Not really," adding that she found the material "hard to understand. I had to go home at night and reread everything in that little book<sup>3</sup> and take notes myself." She implied that she would have preferred the teacher's lessons and the teacher's notes.

When asked if the CAI materials affected her feelings toward mathematics, Barb responded "Yes. I was getting frustrated." She added, "I just need somebody to show me step-by-step. . . . I just can't relate to a computer teaching me." When asked if she thought a computer was a good way to teach and learn Mathematics 30, she answered "No." In her opinion, changes to the computer-assisted materials should include the provision of step-by-step movement through the concepts, with an explanation of each step as the material is presented.

Would Barb recommend the use of the CAI materials to friends who wanted to complete Mathematics 30? She said that if her friends really wanted to use the CAI materials, then she would recommend it, but not if they were struggling with mathematics. Barb indicated that she struggled with the CAI materials. This occurred despite the fact she is a strong mathematics student. She suggested that she may have struggled because she had not taken mathematics for one-and-a-half years and may have forgotten a great deal. Barb thought she needed to review notes from her previous mathematics course and the CAI materials did not provide enough review for her, especially in factoring and expanding polynomials. She felt the CAI materials "jumped right into the mathematics material," and she was left saying, "Wow! Where am I?"

---

<sup>3</sup>By "little book," she refers to the print materials provided to students containing most of the same information as the CAI materials.

Jan reacted differently from Barb to the CAI materials. She thought they were a good way to teach and learn Mathematics 30, as long as help was available from the mathematics teachers or other students. She would recommend them to friends wanting to complete Mathematics 30 only if they were good at mathematics. She said, "It can be fun if you are good at math." On the first day, she found the CAI materials difficult, although "kind of neat." The graphs were enjoyable, but after a while she "got kind of sick" of the CAI materials. She thought they were "good" because she "could get help," but there was a lot to work through, so she had to take notes. She also thought that help from other students was not always sufficient because students don't always know the answers; teacher help was deemed necessary. She would have preferred regular classroom instruction over the computer CAI materials because she finds mathematics difficult and needs someone to help her learn mathematics. She explained: "The computer can't sit there and try to explain it to you in different terminology. It just has this one explanation. That's why a teacher can help."

Martin thought that using the computer was a "good way to review [material] and [to receive] help but . . . it's not a substitute for a teacher." He did not feel that the computer was a better way to teach and learn Mathematics 30 than the regular classroom. However, he would recommend the use of these CAI materials to friends wanting to complete Mathematics 30, for home study, for continuing education, or for review. Martin did not enjoy using the CAI materials. He said he "felt tempted to just whiz through it and then you have to work harder to try to understand." He said he "didn't really enjoy mathematics that much this week." He said he usually enjoys mathematics more than he did while using the CAI materials. He missed the one-to-one relationships developed in a classroom and also had some difficulty visualizing the concepts. When asked if the CAI materials could be used instead of a class in Mathematics 30, he replied, "It would need a better textbook to go with it." Rereading one explanation over and over again was not what was needed when one didn't understand. Alternative explanations, or the same ones reworded, were needed.

Donald thought the CAI materials were "okay," except for some programming errors that he mentioned several times. He said he "never really did like mathematics but [the CAI materials were] a change of pace instead of sitting there and listening to a teacher. . . . It was a refreshing change." He

thought the computer was a good way to teach and learn Mathematics 30 "as long as there was a teacher there who knew how to use the computer and who could help you out in trouble spots."

Because Donald had taken Mathematics 30 previously, he was asked to compare the regular classroom experience with the computer experience. He thought the CAI materials were easier for him because he'd taken Mathematics 30 before, and he knew basically what [he] was supposed to do. He wasn't sure it would have been easier if he had used Mathematics 30 CAI materials after only taking Mathematics 20 (the Grade 11 advanced diploma course). He would recommend the use of the CAI materials to friends for "extra help." He also said, "You could use it instead of a teacher as long as there was a teacher who knew what was supposed to be going on and could help you out with questions. . . . I'd like it." He also thought that it could be used alone if a user's manual or reference guide were provided to "tell you what you are supposed to be doing."

It appears that this group of students did not enjoy the CAI materials much and thought that a teacher's assistance was essential for them to use them effectively. The need for a more individualized program of study and better resource materials was also indicated in students' comments. Despite these needed changes, the students recommended the use of the materials to others, provided teacher assistance was available and they were motivated and capable mathematics students.

Mr. Brown thought that using the CAI materials to teach his classes was a good and positive experience. However, he thought the CAI materials could not be used to the exclusion of classroom teaching. He said, "It's a nice supplement." From his discussions with students, he felt students "didn't seem that keen on it. They actually prefer, by their voice count, traditional spoon-feeding to having to read it off the screen. . . . They didn't like having to do the work on their own. They said they had to rush through it too fast." Despite students' reactions, Mr. Brown would use the unit again with his class but in a modified form. He feels he would "pull pieces" of the CAI materials together with his teaching and use them "for a couple of periods or half-periods." Mr. Brown also commented about his students:

I would say, in this group, maybe one student in five is a self-motivated and disciplined student who is probably at least as well off and maybe better

off to do it on the computer. He can take it in his own time frame. He can take it by himself and he can work through things at his own speed. It does cater to a person that has those kind of motivations and abilities but for the student that doesn't really accept the responsibility, doesn't want the challenges or basically needs the verbal feedback to any questions he has, the computer doesn't offer it.

The students and teacher were asked what they liked the most about using the mathematics CAI materials. Jan said she found it fun sometimes and liked doing the graphing. Barb also found it fun and "different from the classroom work." Martin and Donald did not answer this question. Mr. Brown "liked it" and thought the CAI unit was

a good attempt to take the polynomials unit in Math 30 and put it into a sequenced, self-directed learning [package] available to students. I think it's a good opening but it definitely needs some work yet. . . . For those kids who . . . work through the program, for whatever reason, on their own . . . it's a nice option available to them. . . . I don't know how useful it's going to be in a regular classroom [but for] a school where you have totally individualized instruction time it may be more suitable.

The four students interviewed thought they had learned enough from the researcher's introductory demonstration to use the CAI materials. However, Martin had some trouble using the network on subsequent days and suggested that some notes be provided, possibly in the form of a guide, that students could follow to accomplish the start-up procedure. Mr. Brown, however, did not make much use of the user's guide provided because "so much of what's in the guide is actually available on the computer so you don't really need it." However, because the students seemed to need a guide, and the teacher did make some use of the guide, the researcher developed a version of the user's guide to use with future students. This was used at Hilbert High School.

The concerns and problems with the CAI materials that were reported to the researcher by Mr. Brown and his students were addressed and/or corrected by the researcher in the two weeks between use of the CAI materials by Gauss High School students and their use in Hilbert High School.

## Students at Hilbert High School

The class at Hilbert High School had completed two units of mathematics guided by the teacher

before beginning use of the CAI materials so they were eager for a change in routine. From this class, four students were interviewed: Carol, Paul, Mark and Cindy.

Carol was the only student who had not used a computer before this experience, and she said she was not initially comfortable using the computer. However, after using the CAI materials she became comfortable using it and her feelings toward computers were positively affected. The other students were all comfortable with computers before using the CAI materials and observed no effect on their feelings toward computers as a result of using these materials.

Carol was a good student in mathematics, but she found the CAI materials difficult to understand and "get through." She had completed Mathematics 30 the previous semester, but, as a result of trauma, had lost much of her memory of previous mathematics courses. She was enrolled in Mathematics 31 (the introductory calculus course), and through this course and a second try at Mathematics 30, she was recovering much of what she had lost.

Paul said he was comfortable using computers and used them as much as he could. Mathematics was not, however, a subject he felt comfortable with. Paul had taken Mathematics 33 (the general diploma Grade 12 course) before entering Mathematics 30.

Mark was comfortable using computers as his family had computers at home. Using CAI materials did not affect his feelings toward computers. Mathematics was a subject with which Mark felt comfortable, but he indicated he was not a strong mathematics student. He had taken Mathematics 33 last semester for extra credits, and it had helped his progress in Mathematics 30.

Cindy, the fourth student in Hilbert High School, entered Mathematics 30 after completing Mathematics 20 (the advanced diploma Grade 11 course) in the previous year. She said that she was a strong student in mathematics and other subjects. She also said that she enjoyed using computers, so using the CAI materials had no effect on her feelings toward computers. She had never used a computer-teaching program before but liked learning mathematics this way.

## Reactions to the Materials

Carol enjoyed using the CAI materials and thought "it was fun, I could understand it." This resulted in a more positive reaction to mathematics which she

says is "usually boring." She thought that the computer was a good way to teach and learn Mathematics 30 "as long as a teacher [was] there to help in understanding." Carol thought that using only the computer to complete Mathematics 30 might also get boring. Doing both, that is, using a computer and being in a regular classroom, might be the best arrangement. She recommended using CAI materials to friends. She said, "It's so different. It gives you a new perspective and a new way of thinking about doing it."

Paul thought the CAI materials were "all right." He said, "The computer way [of teaching and learning Mathematics 30] is pretty good. With computers, it's pretty well self-explanatory." He preferred using the CAI materials to the regular classroom instruction because he could "go back and review" material which would be less possible in a classroom. Because of this preference, Paul would recommend using CAI materials to other students.

Mark thought the CAI materials were "pretty good." He felt he paid attention when using the computer but was often distracted by other students in a regular classroom. The CAI materials made "it a bit more fun to come to the math class." He thought the computer was a good way to teach and learn Mathematics 30, and he would like to do another unit by CAI materials rather than in a regular classroom. He thought he would probably do better with the CAI materials because he would pay attention.

Cindy liked using the CAI materials to learn mathematics. She liked working at her "own speed." She said, "I like to have a teacher around to help but I liked doing most of it on my own." She liked having help when she needed it because she "might have gotten frustrated" if she had to do it all at home. She said that the method of computer presentation "might be a better way for students who like to work on their own, but for students who need constant teacher supervision they might not like it." She also said, "I think it would be neat to possibly do the whole course [this way]." She would recommend the CAI materials to friends wanting to complete Mathematics 30, especially if they were taking it by correspondence.

The reaction of students in Hilbert High School was positive toward the CAI materials. All four students would recommend the use of the computer to friends, and all would like to do more Mathematics 30 using the CAI materials. Despite differences in students' mathematics background and perceptions of computers, these students were positive about the experience.

Mr. Carson thought that using the CAI materials to teach his classes was a good and positive experience. However, he thought the CAI materials could be used to the exclusion of classroom teaching. He thought that a "percentage of the time" in Mathematics 30 could be used for computer presentation of information. He said he "could be uncomfortable with an entire five-month block to do the entire course [by computer]." He added:

The computer was as good a way to teach and learn Mathematics 30, if not a better way, given a fairly structured topic. I think some interaction, doing some sections in the classroom time, would help and then maybe doing more [by computer]. I base that on some of the questions I am getting. These students have gone through sections of the program and obviously have missed a primary or secondary point and yet are still working on questions and doing reasonably well. In class we could catch this. . . . I think trying to get the best of both worlds should be the focus. . . . For some instances, for some individuals, [using the computer] would be better [than regular classroom instruction] but not for all. For kids who like to work at their own pace and are sufficiently literate [this would be better]. . . . This is always a concern with any materials of this kind. The reading ability determines the success.

Mr. Carson said he would use the CAI unit again in whatever form seemed to fit his course because he thought that his students reacted positively to it. Some students did express concerns and were frustrated using the CAI materials, but they were among those identified by Mr. Carson as being frustrated in his regular classes.

In reaction to a question of what he liked about the CAI materials, Mark stated the materials "broke the monotony of sitting in class and writing notes [copied] off the blackboard. It made it more exciting to go to math class. We were doing something nobody else was doing. It was fun." Carol thought it was different. She was not used to using a computer but found it enjoyable. She liked some of the graphics. Cindy liked working at her own pace and doing mathematics individually but also emphasized the need for the teacher's help when she "got stuck." She wouldn't want to use the CAI materials without teacher assistance. Paul thought mathematics was easier to do on the computer using the CAI materials and liked the fact that it was "up to me to get the information and make sure I learn."

According to Mr. Carson:

[I] liked the students' ability to move at their own pace and to be forced, for the bottom third [of the students when grouped by ability], into doing and following sequentially through a thought to get through a particular idea or topic as opposed to just going through exercises without being concerned about what they were learning or supposed to be doing. Even though it seemed that there was a fair bit of teacher input as far as individual questions [were concerned], students did have the opportunity to have their questions answered directly by the program—whether moving backward or forward or having to sit there and think for a few minutes to answer their question. That is the strength of CAI in general.

Students were asked what they disliked about the CAI materials. Paul couldn't think of anything. He thought the CAI materials were "really good" and he enjoyed the experience. He would be willing to do another unit by computer if asked to do so.

Cindy disliked the fact that the CAI materials "gave a lot of information that you didn't really absorb. . . . I found that I was just beginning to get the hang of it and we went on to a new topic or more examples. I could have used more practice." She also would complete another unit by computer if asked to do so because she "liked this unit."

Mark disliked the fact that the computer was slow but felt he may have been comparing the speed of the CAI materials on this network (with 25 users) to that of a computer at home (which he alone used). However, despite the slowness of the CAI materials, he would recommend them to friends doing Mathematics 30 and would definitely be willing to do another unit of the CAI materials.

Carol also criticized the CAI materials for being a "little too slow. . . . The computer takes so long for your reaction, for your answers to be in. You just sit around waiting and then it goes on." However, she would be willing to do another unit by computer. She also would recommend the CAI materials to others in Mathematics 30 because she says, "Students in class would benefit from it." She based this on the fact that "students in the other class didn't know some of the stuff and it was surprising I knew all this stuff. They asked me questions and I knew the answers. It's a good way to learn."

Mr. Carson said, "I don't have any major dislikes. The program works quite well. Nothing really stands out. There are a few errors, rough edges, I guess,

but nothing serious.” However, he made recommendations for using the CAI materials:

. . . For individual students, it would depend a lot on the student. Some would make out better than others and get more out of it. I would certainly think that if I have the opportunity to do a portion of the course on computer that I would use it.

He would recommend the CAI unit to a student who could not be scheduled into the course as opposed to recommending Alberta Education’s correspondence materials. He thought it was better than correspondence materials “without question!”:

Any student that was working individually for any reason, [for example, if] they were sick for a month or were trying to fit in a course that wasn’t available to them, this would be far superior to correspondence lessons.

He felt that, if available, it would be appropriate to use this unit with students who had been away from school, even if the class wasn’t doing this unit on the computer: “Given the chance, I would make sure that all students in the course were comfortable with the program so that they could use it” and had the necessary skills to use the CAI materials independently. He would then use it for students who needed the extra material:

It would be useful for remedial, as well as first-time, exposure. Its [the CAI unit’s] major strength in comparison to other things that are available is that it’s matched to the curriculum very well. There are other things out there, but by the time you

figure out where they fit in and try and convince the kids this is the same topic that they are talking about, only discussed from a different vantage point, the point is lost. This will be very useful.

After using the unit during the research project, Mr. Carson went on to acquire another unit of the CAI materials and used it with his class because he wanted to experiment further. He continues to use the CAI materials used in the research and the other CAI units with his classes.

## Conclusions

Three main points are apparent from these discussions with students and teachers.

1. Students are not comfortable using the CAI materials without the assistance of a teacher. They need a teacher to help them understand the mathematics.
2. The students interviewed see the use of the CAI materials as valuable for enhancing their learning of mathematics and motivation to learn mathematics. They even used the word *fun* when describing some of their activities using the CAI materials.
3. The teachers view the CAI materials as useful for students unable to attend mathematics class, for students who need mathematics review, and for classes of students to learn concepts in mathematics. However, the teachers do not feel that the CAI materials can be used alone but that teacher intervention in the process enhances the learning of mathematics.