

# **INTRODUCTION OF GRAPHICS CALCULATORS AND THE *TI-NAVIGATOR* IN A SENIOR ELEMENTARY CLASSROOM: EFFECTS ON STUDENT ATTITUDES AND TEACHING PRACTICE**

## **Case Study 12**

Teacher/Researcher – Catherine Bentivoglio  
Toronto, Canada



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## Case Study 12

<b>Teacher/Researcher</b>	Catherine Bentivoglio
<b>Location</b>	French-language elementary school in the greater Toronto, Canada area
<b>Course</b>	Elementary Math
<b>Grade</b>	7-8
<b>Student Profile</b>	7 Grade 7 students (4 boys and 3 girls) and 5 Grade 8 students (3 males and 2 females). Students were from a very mixed multicultural population.
<b>Technology</b>	TI-84+SE and TI-Navigator

*Introducing TI-Navigator led to more questions being asked which often led to discussions. Also, students often interpreted questions differently. This allowed for even more discussion because students were able to ask each other questions and explain themselves. Students also voiced their opinions more and questions were a lot more in depth. Students also began to argue which forced them to find supporting arguments to support what they were saying. In the end, this forced them to discuss more amongst themselves.*

**Setting:** Ms. Bentivoglio's grade 7-8 class of 12 is in a small (approximately 160 students) elementary school (JK-Grade 8) which is part of a French school board located in the greater Toronto area. All subjects are taught in French, but most students speak more than two languages and French was the first language of only 2 students.

Ms. Bentivoglio teaches all subjects to her students, with the exception of gym, which allows a good deal of flexibility in scheduling; her schedule is often modified, depending on the activities that she is planning to do. Therefore, as students enter her class in the morning, they see a daily menu of subjects and (often) activities on the board. She normally taught math every day after the first recess (10:30am-11:30am). Sometimes she mixed students into groups, sometimes they worked individually and sometimes she worked with the whole class. Sometimes students' desks were separated so that they really worked individually on their own "islands". Other times the class was set up in a "U" where students could see each other and also have someone on either side. The students often sat next to friends, even if they were in different grades. When students did group work, she frequently sent them to work in groups of 3-4 at a circular table. As well, sometimes she would give a group activity to the Grade 7 class while she worked on a more difficult concept with the Grade 8 class. She would then sit at the larger rectangular table with the students and we made use of the chalkboard. She often left work on the board so that students could later refer to it.

**Curriculum & Teaching:** The students' textbook, *Chenelière mathématiques 7<sup>e</sup>* (2005) and *Chenelière mathématiques 8<sup>e</sup>* (2006), contained the answers at the back of the book and students were expected to correct their homework themselves, but Ms. Bentivoglio frequently checked their work. She also chose supplementary work from different workbooks, for example *Connexions 7<sup>e</sup>* (2002), *Connexions 8<sup>e</sup>* (2002), *Maths Ontario 7<sup>e</sup>* (2001) and *Maths Ontario 8<sup>e</sup>* (2001). Her school follows the Ontario Ministry of Education's *Mathématiques* curriculum; it is available at: <http://www.edu.gov.on.ca/fre/curriculum/elementary/math.html>.

Ms. Bentivoglio's study had three phases:

- Phase 1 of the study (baseline with no technology) involved two units (17 lessons) from the curriculum. The first unit was number sense and numeration, and the specific expectations were *adding and subtracting integers* for Grade 7 and *multiplying and dividing whole numbers* for Grade 8. The second unit was geometry and spatial sense and the expectations were of *solving problems related to two dimensional shapes and solids*.
- Phase 2 (with Cabri, Jr.) involved one unit (16 lessons): geometry and spatial sense. For Grade 7, students *described the effects on coordinates of two dimensional shapes that had been translated and reflected*. For Grade 8, students *described the effects on coordinates of two dimensional shapes that had been rotated and dilated*.
- Phase 3 (with TI-Navigator) involved two units (11 lessons). The first unit was data management and probability. Expectations for Grade 7 and 8 were of *collecting and organizing data using charts* and *analysing the data*. The second unit was patterning and algebra. Expectations for Grade 7 and 8 were of *using a table of values* and *using a graph to solve problems about relationships*. The Grade 8 class also had to work with equations.

For Phase 1, students used algebra tiles for adding and subtracting integers, for the number sense and numeration unit. For the geometry and spatial sense unit, students used a compass, Mira and protractor while making circles, bisecting angles, creating parallel lines and finding the middle of a segment. Student also used connecting blocks, and three-dimensional shapes (solids and hollow shapes), constructed shapes from paper, cardboard and popsicle sticks; and built gingerbread houses.

For Phase 2, students used the graphics calculator *Cabri* program as well as grid paper while working on transformations. Students also used other things to show transformations (for example, rotating their body, translating a tissue box across a grid drawn on a desk). Ms. Bentivoglio also provided the *Geometer's Sketchpad* software to the Grade 8 students to install on their computers at home.

For Phase 3, the class used the graphics calculators at school, the *TI-Navigator* system and the LCD projector. On the graphics calculator, students used the *Celsheet* program to produce bar graphs and pie charts; the *List* table function, in which you put in your table of values and it produces points on a graph; and the *y=* function, in which you put in your algebraic equation and it produces the linear relationship. The *TI-Navigator* allowed her to send students questions using the *LearningCheck* program. She also was able to send them a question and the summary of the class' results, using the *QuickPoll* command. With the *capture screen* function, she was able to see, at that moment, what was displayed on the screen of each student's graphics calculator. The LCD projector projected onto a screen graphs and questions that she had compiled using PowerPoint. It also projected the results of student answers from *LearningCheck*, *QuickPoll* and the *capture screen* function.

Thus, there were many manipulation tools used during each phase. Students were always allowed to use manipulation tools during evaluations. In Phases 2 and 3, students were almost always using a manipulation tool. They used these tools to explore and also to prove others wrong. For example when two groups disagreed on a conclusion; they redid the transformation on their calculator to see who was right.

**Assessment Method:** For all three phases, sometimes Ms. Bentivoglio sent students to the chalkboard to see what they had learned. Homework from their textbook, or a worksheet was started in class and was to be finished at night. Students had to self-correct their homework and then show it to her. She also gave students individual written quizzes to test what they had learned and asked students individually to explain to me their group work (for example, the building of the monument). She also checked their journals to see their presentation summary, and to see how much they had learned during the presentations. A written test was always completed at the end of the unit.

Evaluations in the three phases were similar, except that there was less homework from the textbook in Phases 1 and 2, and much less homework in Phase 3. As well, throughout the three phases, students always had to write summaries in their journals and completed a test at the end of the unit. In Phases 1 and 2, students had to complete at least a quiz during the unit, while in Phase 3 she did not give students a quiz.

Ms. Bentivoglio also kept a diary of her reflections on the lessons, and surveyed the students.

**Results:** On the Phase 1 survey, students mentioned that they enjoyed math or found it to be easy because the teacher explained concepts well. On the Phase 2 and 3 surveys, students commented that they enjoyed using the technology and they believed that they were able to explain themselves better. This suggests that students had moved from expecting the teacher to explain, to seeing themselves as “explainers”; this could be because, as noted in the next section, I had changed my practice from a teacher-centered approach to a student-centered one. This also suggests that students found the graphics calculator and the *TI-Navigator* to be important manipulation tools for enjoyable learning.

Even though some students responded negatively in the survey, the majority of students were actively engaged in activities with the graphics calculator and all students were actively engaged with the *TI-Navigator*.

With the introduction of the graphics calculator, Ms. Bentivoglio reports her practice changed because all activities became exploratory and students almost always sat together. Students used the graphics calculator all of the time as a manipulation tool. Thus her teaching became more student-centered. She relied less on the

textbook and gained inspiration for my lessons by browsing the *TI-Teacher Exchange* web site.

With the introduction of the *TI-Navigator*, she reports her practice again changed because the projection screen became the focal point in the classroom as we were all seated in front of it. Students sat at round tables together and were almost always connected through their graphics calculators. She relied a lot less on the textbook, gave little homework and concentrated on discussions. Lessons were exploratory and students discussed and analyzed the lessons in their groups, and as a class as a whole.

At the beginning of Phase 2, students answered my questions without thinking. If they were wrong, they would just throw another answer at the teacher. However, Ms. Bentivoglio observed that as the class progressed more into the unit, with the use of the graphics calculator, students began giving more in depth answers with proof of what they were stating. In their presentations, they began orally to explain what they were showing, but she had to encourage them to add to their explanations on the chalkboard. When they summarized in their journals, they were often quite vague even though the solutions and explanations were still on the chalkboard.

With the use of the *TI-Navigator*, in Phase 3, students' answers were projected for all to see, and this led to more questions being asked which often led to discussions. Also, students often interpreted questions differently. This allowed for even more discussion because students were able to ask each other questions and explain themselves. Students also voiced their opinions more and questions were a lot more in depth. Students also began to argue which forced them to find supporting arguments to support what they were saying. In the end, this forced them to discuss more amongst themselves.

## REFERENCE

Bentivoglio, Catherine (2007), Introduction of Graphics Calculators and the TI-Navigator in a Senior Elementary Classroom: Effects on Student Attitudes and Teaching Practice. Toronto, Canada: York University.