Describing the dynamic nature of mathematics as a cultural product

M Sencer Corlu

Introduction

The purpose of this ethnographic study is to describe the formal *mathematical enculturation* (Bishop, 1988) of middle school students at an international school. Specifically, I shall examine the ongoing creation of a mathematical culture within the classroom and show how class members define, maintain, and share the unique mathematical culture of the classroom, understood in terms of ideas, norms, and values.

The Middle Years Programme (MYP) of the International Baccalaureate (IB), a five-year program for students aged between 11 and 16, is used by a large number of international schools (IB, 2010). Although this program is flexible in the sense that the course of study is determined by the school, all versions of the MYP foster a common understanding of the fundamental IB concepts: holistic learning (integration of mathematics into other disciplines); intercultural awareness (how cultural forces help foster developments in mathematics); and communication (how to effectively use the language of mathematics) (IB, 2000; 2002a; 2002b; 2005; 2007).

These fundamental concepts ensure that the MYP mathematics program is congruent with the notion that mathematics is embedded in a cultural context that gives it its purpose and meaning (Wiest, 2002). Mathematics education in the MYP is a reflection of the culture of those using it and can thus be utilised to understand other people with whom we share the planet (Barta, 2001). Thus, mathematics education in the MYP may provide opportunities to create healthy connections among people of different cultures.

An ethnography of the mathematics culture of an international middle school class

A total of 29 students – 17 in grade 6 (G6) and 12 in grade 7 (G7) – participated in the study. The students, who attended an international IB school in a major city in Turkey, held non-Turkish passports (although some had Turkish parents). They had come to their host country from different parts of the world. They were of high socio-economic status and were economically privileged and culturally aware. The language of instruction at this school was English.

Because the transience of international school student tenure at a particular school, due to the high mobility of their parents, made the culture of the classroom highly volatile, the expectation of change was an integral part of

ISJApr2013pages.indd 72 28/03/2013 16:02

the cultural setting. Thus, the interpretivist paradigm (Glesne, 1998), which portrays an ever-changing reality, influenced the methods utilised in the study.

As the investigator and the students' mathematics teacher, I was the main qualitative data collector for this one-year-long ethnographical study. Data collection occurred during my second year at this school and was designed to be a 'dialectic and responsive process' (Lincoln & Guba, 1985, p. 44). The process employed multiple trustworthiness strategies (Gonzalez y Gonzalez, 2004) to overcome the difficulties emerging from studying my own class (Glesne, 1998). For example, in addition to typical data collection methods, such as observations, interviews, classroom documents, and audio-visual materials (Creswell, 1998), I collected unobtrusive data, including students' comments posted to the study's social media environment, students' personal mathematics diaries, and several other teachers' observations (Webb, Campbell, Schwartz, & Sechrest, 2000).

I analysed data in three stages: description; analysis; and interpretation of the culture-sharing group. The findings also included a section on my own mathematical enculturation in order to provide the readers with a sense of why the research was designed, implemented, and analysed the way it was (Kirby & McKenna, 1989). To achieve this goal, I kept a reflective journal in which to note down my experiences.

The mathematical enculturator

Over the course of my own middle school years, my mathematical enculturation turned me into a rote learner, through a process of repeatedly practicing algorithms to achieve mastery. I did not remember any of my mathematics teachers utilising any teaching material other than textbooks and chalk. Things did not change much at university. As a mathematics major, I was now expected to memorise the proofs of theorems. Interaction remained minimal and lecturing was essential.

In an effort to address the shortcomings of my own mathematical enculturation, when I started teaching at a national school it was with the motivation of showing the beauty and practical side of mathematics to my students. In one of my algebra classes, for instance, I was particularly excited about teaching how trigonometry was used by people in the past to solve real-life problems in astronomy. However, one of my students complained that that material would not be covered in the high-stakes tests completed by public school students at that age.

Bored with teaching mathematics in a highly structured curriculum with students lacking motivation other than to get good test results, I finally decided to become a mathematics teacher at an international school. I wanted to teach mathematics for a meaningful purpose, and not just 'teach to the test'.

The first week

His hand raised and with hesitation in his voice, Oliver (British; G6) said, "But this is the very first week. We can't do maths!" While the G6 students were

ISJApr2013pages.indd 73 28/03/2013 16:02

quietly trying to figure out their new life in middle school, I was introducing a mathematical icebreaker. In the activity, I asked students to find a method to represent the common and different interests of the members of their group, using a single sheet of paper. I used this opportunity, which emerged during a conversation with Sofia (Italian; G6), to introduce John Venn (1834–1923), a British mathematician who invented the Venn diagram, a notation used in set theory.

> Sofia: "I think I know what you are trying to teach."
>
> Teacher: "What is it?"
>
> S: "It is Venn diagrams, isn't it?"
>
> T: "So, you know about John Venn?"
>
> S: "Not really, but look! We drew a map of our countries; and this is [pointing the intersection of two Venn sets] United Nations for our common points."

Students in G7 were less shy about complaining about mathematics during the first week of school. However, it was not long before Nur (Malaysian; G7) stepped in to motivate the class: "Come on, guys. Remember, he continued teaching until the last bell [sounded] last year."

I wrote in my journal after the end of the activities:

> I learnt a great deal about my new students today: Three students in G6 and two students in G7 are new to the school; one speaks little English; others are native speakers [of English], but this is going to be their first experience of being abroad.

The first term

I organised a meeting with my G6 students' teacher from the previous year to gain some insights about their readiness for middle school mathematics. The teacher gave me some information about the Primary Years Programme (PYP) which helped me perceive the continuities from PYP to MYP. However, I realised that not all students in G6 were proficient in some basic mathematics skills that they would need to be successful in G6. I changed the order of a number of units in my plan for the year, and decided to extend the time devoted to some topics. My students in G7 were going to learn many new topics, like integers and equations.

I was satisfied with their performance during the first term; they knew what I wanted them to do and I knew what they could do. The adaptation of newcomers to the class culture was going smoothly. One student who knew little English (Albanian; G7) and who was having difficulties had changed the climate of the class, in that several students, as well as the school's English as a Second

ISJApr2013pages.indd 74 28/03/2013 16:02

Language (ESL) teacher, were trying to help this student. Meanwhile, I was trying to find some mathematics activities in this student's own language on the internet.

In November, I announced that I needed volunteers to help me publish a mathematics gazette. Among the ten students that volunteered, only two came from western countries. All but three were G7 students. Unfortunately, we could publish only two issues, as it was not easy to find a meeting time that suited us all. I regretted that I had voted in favour of limiting recess time to five minutes at the teachers' assembly, since we could otherwise have met at recess.

The second term

'Spy Game' was the name of a two-month long activity in number theory, combinatorics, and graph theory, which I designed around a cryptology theme. After a careful planning period of 15 days on my part, the game commenced with training sessions for both classes in March. The Spy Game included different activities for G6 and G7, which were implemented during a set period each week.

Some students had obviously heard of cryptology. During the training sessions, Chloé (Swiss; G6) wanted to share her ideas about the Enigma machine, which she had learned about from a TV documentary, while Jack (Irish; G7) asked whether barcodes would count as an example of cryptology. After the G7 class learnt how cryptology had affected people's lives throughout history, Madison (American; G7) expressed her anxiety about using her father's credit cards for internet shopping.

However, Daniil and Maxim, two G6 students from Russia, were, less interested:

> Teacher: "Did you not find cryptology interesting, Daniil?"
>
> Daniil: "Yes, it is interesting. Is this going to be on the test?"
>
> T: "What do you think; is code-breaking worth putting on the test?"
>
> D: "It looks hard; please don't put it in."
>
> Maxim: "They don't teach these in Russia. We never learnt these things before."
>
> T: "Did you know that there were Russian cryptologists who were trying to break the codes of the Americans?"
>
> M: "Really? I don't know. Will you talk about them? I'd like to learn about Russian cryp-tolo-gists [having some difficulty in his pronunciation]."

Later, Mary (a newcomer, American; G7) surprised me with her independent discovery of the method used by a famous Arabic cryptologist, Al-Kindi (c.

ISJApr2013pages.indd 75 28/03/2013 16:02

801–873). Mary had guessed that the most frequently appearing letter in the encrypted text, G, could be substituted by E, the most frequently used letter in English. Mary's method did not work for the particular text given to her group (the names of four famous mathematicians), but it did provide me with the opportunity to jump ahead and talk about 'frequency analysis', which Al-Kindi invented to read the texts encrypted with Caesar's letter transition method.

> Teacher: "How did you know the most frequent letter was 'E' in English?"
>
> Mary: "From the internet. I read that kind of stuff, but it did not work."
>
> T: "Why do you think it did not work?"
>
> M: "Because none of these mathematicians are American [looking annoyed]."
>
> T: "Do you think your method would work with any four English names or words?"
>
> M: "It should; you have to do some guessing, too."

I chose four random words from the dictionary, encrypted them using the Caesar's transition method, and asked Mary to apply her method on these words. The rest of the class was curious about where this challenge was going.

> T: "Why do you think your method did not work this time?"
>
> Ananya (Indian; G7) was at the back listening and then raised her hand. She said: "I think you need more words, Mary. With four words, it is impossible."

At the end of this part of the Spy Game, the students were surprised to discover that Blaise Pascal was represented by their French deputy principal, Aryabhata was their Indian IT teacher, and Isaac Newton was their guidance counsellor from England. Finally, Ulugh Beg was their Turkish language teacher.

During the class discussions, I asked: "what would happen if Newton was born in India and Aryabhata in England?" Nathan (French; G6) had an interesting point: "Newton could not have found gravity in India, because I don't think there are apple trees in India." Some students pointed out that, given the vast advantages Newton had in England, such as a much stronger intellectual community in the field of mathematics, Aryabhata could have discovered greater things than Newton had he been in England.

However, someone said, "Aryabhata and Ulugh Beg were the only clever people in their countries." When I criticised this viewpoint, asking, "Why do you think we all know about Newton but no one knows about Ulugh Beg, and only Ananya knows Aryabhata?", Sofia (Italian; G6) commented: "I think it is because of TV or because all books are written in English. I think English

ISJApr2013pages.indd 76 28/03/2013 16:02

people are more sensible towards their culture, because I did not know Fibonacci before you told us about the golden ratio. I never saw his name in Italian books before."

All the students in G7, but only the western students in G6, knew of at least one mathematician from their culture, and none of the G6 students from other parts of the world could name a mathematician from their countries. I believed the G7 students had better knowledge in this regard because of the project they had completed the year before, when they had presented the life and works of a mathematician who was born in their home country. I realised that the majority of the discussions in G6 were dominated by the western students, while other students were silent and would not join the discussion unless I directed a question to them.

Some other interesting patterns appeared in the Triangle Game, in which G6 students had to place numbers from 1 to 8 in circles located on the sides of a triangle. The goal was to obtain the sum 13 on each side. Neither I nor the other teachers helping me noticed a negative atmosphere during our observation of the game until Emil, (a newcomer, Norwegian; G6) brought to our attention that the number 13 had made him 'feel sick' during the game because of its 'evil powers'. Six other students in G6 agreed that they were not comfortable with working with 13. In other words, although, the majority of the participants disagreed, much of the G6 class seemed to agree with the idea that some numbers have special powers.

Jennifer (American; G6) explained: "I believe that numbers have special powers; in a way they affect people. For example, if a person sees his lucky number in a math problem, they will do better, because it is in their brain."

She continued speaking in an excited, rapid tone: "Some numbers are scary. I fear that something is going to happen on the 6th June. It is the Devil's birthday. I am not going to leave my room on that day and I also have 13 in my life, so bad things happened to me. I fell down the stairs and broke my leg last year, and it was the 13th of the month, and many other bad things happened to me on the 13th."

Harry (English; G6) further commented: "I think if you search for a certain number you will find it, everywhere. Let me pick, say, hmm, let's say 134 is my unlucky number. Ok? Is there going to be something bad in 30 minutes? Because it is now four past one. Or, does it mean anything if you open your emails and find 134 emails in your inbox."

When I extended this conversation to my G7 class, Jack (American; G7) had a totally different perception of the number 13. He said that 13 was a lucky number for Americans, because "on the flag there are 13 stripes and 13 colonies" and about the 6th June, he said, "I will feel so confident that I will insult the devil on that day."

Students in G7 tended to agree that the powers of numbers are limited to individual perception and that this is psychological in nature, or as Filip (Polish;

ISJApr2013pages.indd 77 28/03/2013 16:02

G7) said: "we just notice it because we say that number is lucky or unlucky." We all also learnt that there are other numbers with special meanings in different cultures, as Ananya (Indian; G7) explained that the number six has a very spiritual, positive meaning in Indian culture.

The last week

At the end of the game, many students expressed their appreciation and said that they had never participated in such activities in their home countries. When I asked Madison (American; G7) what was special about the Spy Game, her answer was "the Spy Game was a multicultural game and we learnt that there were mathematicians in all cultures." Grace (British; G7) said that she had previously participated in classroom activities like the Spy Game in her former school in Botswana, but that they had not been as well planned as this one. Emil's (Norwegian; G6) mother wrote a letter of thanks to the school with regard to the Spy Game and for training her son as a multicultural person and expressed her appreciation to us for decreasing the anxiety caused by leaving his home country.

The game ended with the presentation of gifts to participating students by the Headmaster. I was happy to be the teacher of this exceptional group of students and grateful for the support of the school administration, which had allowed me to teach in the way I believed would help the adults of tomorrow learn to coexist peacefully through their experiences learning mathematics.

Discussion and conclusion

The students, throughout the study, consistently referred back in their comments to their homes or the cultures in which they were initially enculturated, comparing them to the mathematics culture of their current class. They also expressed their appreciation of the Spy Game for helping them change the way they thought about the people doing mathematics, moving them away from the ethnocentric assumption that mathematics is largely a product of the intellectual work of Europeans (Sleeter, 1997). It is evident from the present study that mathematics is a cultural product, in keeping with Bishop's theory of mathematical enculturation (1988) and D'Ambrosio's ethnomathematics (2001). The study shows that mathematics is a dynamic form of knowledge, created by and in different cultures.

This study did not aim to model the international school at a macro level, for instance by performing an analysis of its curriculum or administrative setting. There have been many such studies conducted in the past that have been very valuable to researchers. Nor are the results generalisable to other school settings. However, I wanted to convey to curious minds the insights that can be gleaned in the more intimate setting of a mathematics classroom in an international school in the hope that this ethnographical study the reader has developed a better understanding of what can go on in international school mathematics classrooms.

ISJApr2013pages.indd 78 28/03/2013 16:02

References

Barta, J. (2001): By way of introduction: Mathematics and culture, in *Teaching Children Mathematics, 7(6), pp305-311.*

Bishop, A. J. (1988): *Mathematical Enculturation: A Cultural Perspective on Mathematics Education*. Dordrecht: Kluwer.

Corlu, M. S. (2005): Creating an international culture, in *International School* magazine*, 8 (1), pp29-30.*

Creswell, J. W. (1998): *Qualitative Inquiry and Research Design: Choosing Among Five Traditions*. Thousand Oaks: Sage.

D'Ambrosio, U. (2001): What is ethnomathematics and how can it help children in schools?, in *Teaching Children Mathematics, 7 (6), pp308-310.*

Glesne, C. (1998): *Becoming Qualitative Researchers: An introduction*. New York: Longman.

Gonzalez y Gonzalez, E. M. (2004): *Perceptions of Selected Senior Administrators of Higher Education Institutions in Mexico Regarding Needed Administrative Competencies* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses (UMI No. 3157028).

International Baccalaureate. (2000): *Middle Years Programme Mathematics*. Geneva: Author.

International Baccalaureate. (2002a): *A Basis for Practice: The Middle Years Programme*. Geneva: Author.

International Baccalaureate. (2002b): *School's Guide to the Middle Years Programme*. Geneva: Author.

International Baccalaureate. (2005): *Program Standards and Practices*. Cardiff: Author.

International Baccalaureate. (2007): *Middle Years Programme: Mathematics Guide*. Cardiff: Author.

International Baccalaureate. (2010): *Middle Years Programme Mathematics*: *Preparing Students for University in the 21st Century.* Geneva: Author.

Kirby, S. &K. McKenna (1989): Experience, Research, Social Change: Methods from the Margins. Toronto: Gramond Press.

Lincoln, Y. S. & Guba, E. G. (1985): *Naturalistic Inquiry.* Newbury Park: Sage.

Merryfield, M. M. (2000): Why aren't teachers being prepared to teach for diversity, equity, and global interconnectedness? A study of lived experiences in the making of multicultural and global educators, in *Teaching and Teacher Education, 16 (4), pp429–443.*

Murphy, E. (2003): Monolingual international schools and the young non-English-speaking child, in *Journal of Research in International Education, 2 (1), pp25-45.*

Sleeter, C. E. (1996): Multicultural education as a social movement, in *Theory Into Practice, 35*, *pp239-247.*

Sleeter, C. E. (1997): Mathematics, multicultural education, and professional development, in *Journal for Research in Mathematics Education, 28 (6), pp680–698.*

Walker, G. (2012): Tea and oysters: Metaphors for a global education, in *International Schools Journal, 31 (2), pp8-17.*

Webb, E. J., Campbell, D. T., Schwartz, R. D. & Sechrest, L. (2000): *Unobtrusive Measures.* Thousand Oaks: Sage.

Wiest, R. L. (2002): Multicultural mathematics instruction: Approaches and resources, in *Teaching Children Mathematics, 9 (1), pp49-55.*

Dr M Sencer Corlu is an assistant professor at the Graduate School of Education of Bilkent University in Ankara, Turkey. He facilitates teacher education courses at Bilkent, which qualify prospective teachers for Level 1 IB teacher awards. He has taught mathematics in international schools in Morocco, Switzerland, and Turkey.

ISJApr2013pages.indd 79 28/03/2013 16:02

Copyright of International Schools Journal is the property of European Council of International Schools & the Council of International Schools and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.