Budapest Semesters in Mathematics Education: Study abroad program for pre-service teachers

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To teach effectively a teacher must develop a feeling for his subject; he cannot make his students sense its vitality if he does not sense it himself. ... How he makes his point may be as important as the point he makes; he must personally feel it to be important; he must develop his personality.

—George Pólya

AGENDA

- BSM: History, approach, impact, etc.
- *Hungarian approach* to learning and teaching.
- Budapest Semesters in Mathematics Education (BSME):
  - What is it? Why now?

BSME

BSM: Brief History

Budapest Semesters in Mathematics (BSM):

- Acclaimed study abroad program in Budapest, Hungary, designed for American and Canadian undergraduates.
- One of the most prestigious programs for mathematics students with a rich 30-year history and tradition.
- Enrolls more than 150 students each year, with many of them eventually pursuing graduate studies in mathematics.[1]

[1] According to an alumni survey, 60% of former BSM participants earn at least a master's degree, and 35% of them earn a Ph.D.

BSM: Approach

Foundations and features of BSM:

- **Goal:** To provide undergraduates with an opportunity to experience the mathematical and general culture of Hungary.
- Classes are taught in English by eminent Hungarian professors, who closely monitor each individual student's progress.
- In keeping with Hungarian tradition, considerable time is devoted to *problem solving* and encouraging *student creativity*. (**Note:** More on this later.)

BSM: Approach

- Students normally take three to four mathematics courses (and one or two intercultural courses) each semester.
- Over 30 mathematics courses are offered, including:
  - *Combinatorics* concentrates on combinatorial structures and algorithms, a stronghold of Hungarian mathematics.
  - *Conjecture and Proof* introduces students to the excitement of mathematical discovery.
  - Other courses include *Algebraic Topology*, *Mathematical Logic*, *Non-Euclidean Geometries*, and *Theory of Computing*.
- BSM courses are designed so that the credits will be transferable to American and Canadian colleges and universities.

BSME

BSM: Impact

BSM students consider the program to be a *transformative experience* in their undergraduate education:

- "This was exactly what I wanted out of study abroad—fantastic mathematics, a great community of students, and an incredible place to live."
- "It's unlike any other program you will EVER encounter. The courses are intense enough to satisfy the next Fermat, yet it's such a close knit and enthusiastic environment that you can't help but be pulled into the complex and fascinating world of mathematics."
- "Perhaps what I consider one of the most valuable aspects of the program would be the process of learning mathematics from a different cultural perspective. "

BSME

BSM: Key to success

Why students find BSM to be so transformative:

- Experiencing rigorous mathematics where students are pushed to figure things out on their own. (**Note:** More on this later.)
- Learning from faculty who carry out the spirit and tradition of Hungarian instruction in their teaching.
- Living in Budapest, a beautiful European metropolis on the banks of the Danube River.
- Forming a community of scholars—a common bond that lasts beyond their experience in Budapest.

BSME

Hungarian Approach

Hungary has a long tradition of excellence in mathematics education.

- Home to many eminent mathematicians, including Paul Erdős, John von Neumann, and George Pólya.
- In fact, Hungary has been cited as producing the "largest per capita number of mathematicians [and physicists] during the first half of the 20th century" (Vogeli, 1997).
- **Key:** Pedagogy that is known for creative problem solving and rigorous mathematical discussion.

HUNGARIAN APPROACH

From a participation perspective, the Hungarians have it both ways. Not only do they provide advanced mathematical experience to a large percentage of the cohort, and thereby increase dramatically the sum of mathematical knowledge in the culture, but they also do it without sacrificing the talents of their most capable students. As a model for both providing opportunity and creating a pool of talent, Hungary's bears scrutiny.

—Edward Kifer
Professor Emeritus of Education
University of Kentucky

Hungarian Approach

Key features of the *Hungarian approach* to learning and teaching:

- Strong and explicit emphasis is placed on problem solving, mathematical creativity, and communication.
- Learn concepts by working on problems with complexity and structure that promote perseverance and deep reflection.
- These problems emphasize procedural fluency, conceptual understanding, logical thinking, and connections between topics.

Note: The approach was originally developed for gifted students, but has been successfully implemented in more general school settings.

HUNGARIAN APPROACH

Implementing the Hungarian approach:

- For each lesson, a teacher selects problems that embody the mathematical goals of the lesson and provide students with opportunities to struggle productively towards understanding.
- The teacher carefully sequence the problems to provide focus and coherence to the lesson.
- The teacher sees the problems she poses as vehicles for fostering students' reasoning skills, problem solving, and proof writing (in addition to learning "the content").
- An overarching goal of every lesson is for students to learn what it means to engage in mathematics and to feel the excitement of mathematical discovery.

HUNGARIAN APPROACH

Another hallmark of the Hungarian approach is the *classwide discussion of approaches* to problems:

- After working on problems individually or in small groups, volunteers come to the front of class to share their solutions.
- Because of the non-trivial nature of these problems, students learn to communicate their thinking with clarity and precision.
- When a student gets stuck, others chime in to offer support and suggestions in a friendly manner.
- The teacher creates a welcoming environment that is conducive to the sharing of students' mathematical experiences.

Hungarian Approach

The teacher's role is that of a motivator and facilitator:

- The teacher provides encouragement and support as students engage with the task at hand.
- The teacher offers guidance when a student is stuck and probes when clarification is needed.
- After the student investigation, the teacher highlights important ideas embedded in a concrete problem, and summarizes and generalizes their findings.
- The teacher's summary makes sense and is meaningful, because students have had the experience of grappling with these ideas *before* coming together to formalize them as a class.

Sample Task: Wolves & Sheep

(5th grade class in Budapest)

Lesson goal: To understand how to find points equidistant from various points in the plane.[2]

The teacher began the class by posing the following scenario:

> *There are wolves and sheep. A sheep is eaten by any wolf that is closest to it, but if there are multiple wolves that are the same distance from a sheep, they do not eat the sheep (for fear of a fight between wolves).*

After acting out the problem in class, students gathered in small groups. The teacher gave each group poker chips to symbolize wolves and coins to symbolize sheep.

[2] Students are *not* told about this goal at the beginning of the lesson.

Sample Task: Wolves & Sheep

(5th grade class in Budapest)

The teacher posed several questions for investigation:

- Where are the sheep safe if three wolves stand at the vertices of a triangle? Try several triangles.
- Where are the sheep safe if four wolves stand at the vertices of a rectangle? What about a parallelogram? Trapezoid?
- What if there are two lines of wolves? Where are the sheep safe?
- What if one wolf stands facing a line of wolves?
- Find an arrangement of infinitely many wolves in which there is no safe place for sheep. (There are several correct answers.)

Sample Task: Wolves & Sheep

(5th grade class in Budapest)

After the student investigation:

- The teacher brought the class together for a discussion after students had time to conduct experiments, look for patterns, make conjectures, and uncover underlying structures.
- It was only at this time—*after* these student explorations—that the teacher introduced the definition and properties of perpendicular bisector.
- In summarizing the work that students had just done, the teacher shed light on important concepts and developed generalizations from their experiments.

BSME: Overview

Budapest Semesters in Mathematics Education (BSME):

- Semester-long program in Budapest, Hungary, designed for undergraduates interested in teaching secondary mathematics.
- Conceived by the founders of BSM.
- BSME is intended for students who are not only passionate about mathematics, but also the *teaching* of mathematics.
- **Main goal of BSME:** To study the Hungarian approach to learning and teaching of mathematics.

BSME

BSME: Approach

To accomplish this goal, participants will play *dual roles* as students and as teachers in the Hungarian approach:

- Participants will immerse themselves in the problem-solving experience, so they begin to understand and appreciate this approach to learning and teaching.
- Participants will observe Hungarian mathematics classrooms and will have the opportunity to plan and teach their own lessons to Hungarian students (in English).
- Participants will connect their learning experiences to their future classrooms, i.e., they will begin to think about how to bring the Hungarian approach to US secondary schools.

BSME

Participant Profile

We welcome students who are:

- Currently pursuing secondary mathematics teaching license at their home institutions,
- Planning to pursue other paths to mathematics licensure such as a master's program or alternative certification programs, or
- Simply curious about learning and teaching of mathematics, particularly the student-centered approach.

Note: We expect BSME students who are mathematically strong. Regardless, the mathematical content of our courses will have a "low threshold, high ceiling" nature.

BSME Community

The BSME community is another strength of BSME:

- Participants will enjoy a *shared experience* with other passionate future teachers, forming a rich support network and professional community that will extend beyond their time in Budapest.
- Through our work with the BSM program, we have seen the long-lasting impact that such a community can have.
- We are excited to invite the BSME participants into that larger community of scholars.

BSME

BSME Instructors

BSME courses are taught by Hungarian teacher scholars (in English). A few words about our instructors:

- BSME instructors actively teach grades 7–12 in Budapest and are experienced in teaching both mathematics and mathematics education courses at the college level.
- Following their own mathematical upbringing, they will bring a creative spirit to the program and challenge our participants to take part in creating, rather than just learning, the material.
- Many BSME instructors also have experience teaching at BSM.

BSME Courses

- In 2015–2016, BSME will offer four to five courses in secondary mathematics education. (**Note:** More on this later.)
- Some of these courses have been field-tested with BSM students over the past few years, with great success.
- Class sizes will be small, and will be taught in English.
- BSME participants may choose to take one mathematics course from the BSM catalogue.
- We also offer non-mathematics courses that participants may choose to take—e.g., Hungarian language, art, and culture.
- Courses are designed so that credits will be transferrable to American colleges and universities.

BSME

PRACTICUM

COURSE DESCRIPTION

- Participants will observe a wide range of Hungarian mathematics classrooms, and will also have the opportunity to plan and teach their own lessons to Hungarian students (in English).
- Participants will engage in pre- or post-lesson discussions with teachers and students.
- At the end of each day is a reflection session where participants share observations and connect their experiences to the theories learned in other BSME courses.

Discovery Learning: The Pósa Method

Course description

- Introduces the pedagogy developed by mathematician and educator Lajos Pósa, based on students...
  - working on tasks that build on each other,
  - deriving mathematical concepts on their own, and
  - having the experience of *thinking like mathematicians*.
- Participants will play the role of students and solve problems from Pósa's "mathematics camps."
- Participants will reflect on this learning experience, and will discuss the principles of Pósa's method and ways of applying them to their own teaching.

WHY BSME? WHY NOW?

"THIS IS THE MOMENT."

Key: BSME prepares future teachers to address important national needs in mathematics education.

BSME

WHY BSME? WHY NOW?

MET II REPORT

Recently published Mathematical Education of Teachers II (MET II) report by CBMS makes the following recommendation:

> *All courses and professional development experiences for mathematics teachers should develop the habits of mind of a mathematical thinker and problem-solver, such as reasoning and explaining, modeling, seeing structure, and generalizing.*

WHY BSME? WHY NOW?

MET II REPORT

The MET II report further recommends that high school teachers should know mathematics in the following ways:

- *As mathematicians.* They should have experienced a sustained immersion in mathematics that includes performing experiments and grappling with problems, building abstractions as a result of reflection on the experiments, and developing theories that bring coherence to the abstractions.
- *As teachers.* They should be expert in uses of mathematics that are specific to the profession, e.g., finding simple ways to make mathematics tractable for beginners; the craft of task design, the ability to see underlying themes and connections in school mathematics, and the mining of student ideas.

WHY BSME? WHY NOW?

CUPM CURRICULUM GUIDE

MAA's CUPM makes the following remarks and recommendation for the preparation of high school teachers:[3]

- Future teachers need to see the interplay between problem solving, general theory, and analytic reasoning to ensure that they embed it in all their teaching.
- Written and oral communication should be an integral part of all mathematics and education courses.
- Field experiences should occur early and be structured so that undergraduates have the opportunity to reflect on the practice of teaching and mathematical content.

[3] From CUPM Curriculum Guide 2015 (Draft).

WHY BSME? WHY NOW?

COMMON CORE

Key: BSME's philosophy and approach are also aligned with what future teachers will see in their classrooms.

The Common Core State Standards describe various *mathematical practices* that are fostered through the Hungarian approach:

- MP1 Make sense of problems and persevere in solving them.
- MP3 Construct viable arguments, critique reasoning of others.
- MP6 Attend to precision.
- MP7 Look for and make use of structure.
- MP8 Look for and express regularity in repeated reasoning.

Other paths to teaching

- Increasing number of undergraduates take other paths to teaching, e.g., master's degree or "alternative certification" for those who did not attend a teacher preparation program.
- As of 2010, 48 states and the District of Columbia have some alternate route to teacher certification.[4]
- **Key:** BSME gives undergraduates with an opportunity to gain knowledge and experience in teaching without having to commit to an entire program or major in secondary education.

[4] From www.teaching-certification.com.

QUESTIONS FOR THE AUDIENCE

- What would you want your students to get out of a program/experience like BSME?
- What barriers (if any) do you see facing these future teachers to participate in BSME? How can we support them in overcoming those barriers?
- How can we sustain the impact of BSME on our participants as they enter and progress through the teaching profession?

THANK YOU!

- Please visit

bsmeducation.com

for more information about BSME.

- Or email me

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with questions/comments.

- Take a poster & brochure on your way out.

BSME