Assimilating Computational and Mathematical thinking into Earth and Environmental Science (ACMES)

Michelle Zhu
zhumi@montclair.edu

Nicolle Panorkou
panorkoun@montclair.edu

Pankaj Lal
lalp@montclair.edu

Bharath Samanthula
samanthulab@montclair.edu

College of Science and Mathematics, Montclair State University, New Jersey

What is ACMES?
An Experiential Integration project which aims to nurture the next generation of innovators by advancing student learning in STEM+C through a seamless integration of earth and environmental science, mathematics, and computer science in Grades 5–7.

Background

Issues
- ACMES can help in
  - Human activity is the primary cause of environmental imbalance (NRC, 2000)
  - Although 71% of jobs in STEM are related to computing, only 8% of STEM graduates are computer science majors (US Bureau of Labor Statistics, 2012)
  - Students’ performance and their interest in mathematics decreases after 4th grade (Wells, Sanchez & Attridge, 2007)

Research Questions
1. What are the most effective activities and tools that assimilate computational and mathematical thinking into Earth and Environmental Science?
2. What forms of students’ reasoning can be seen as a result of students’ systemic engagement in the ACMES modules?
3. How can teachers use the ACMES instructional materials for instruction and formative assessment practices?
4. How can ACMES instructional materials be integrated and implemented into existing curricula?

Methodology
- Design-based research methodology (Brown, 1992; Cobb et al., 2003) focusing on continuous cycles of design, enactment, and redesign.
- Whole class design experiments
- Ongoing analysis (Cobb & Gravemeijer, 2008) as each experiment proceeds to plan for the next session.
- Retrospective analysis (Cobb et al., 2003) at the end of each experiment aiming to monitor how students’ reasoning progresses through the module and refine the module accordingly.

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Curriculum Design and Implementation
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Examples of Simulations and Tasks in the Water Cycle Module

1. Manipulate the sliders and identify the factors that influence evaporation. What factors affect evaporation? Check the ones that apply. Note that you need to click on Reset! and go before you start exploring each factor.
   - Lake temperature
   - Land temperature
   - Relative Humidity
   - Speed of evaporation

2. Change the relative humidity to 15%. Then change it to 75%. What do you observe?
   The higher the relative humidity, the (higher / lower) the rate of evaporation and the (higher / lower) the amount of water vapor.

3. Change the lake temperature to 15°F. Then change it to 75°F. What do you observe?
   The lower the lake temperature, the (higher / lower) the rate of evaporation and the (higher / lower) the amount of water vapor produced.

Selected References

Valerie Barr and Chris Stephenson (2011) “Bringing Computational Thinking to K-12: What is Involved and What is the Role of the Computer Science Education Community?” ACM Transactions, 3(2), pp. 48-54

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