

Connecting Modern Algebra with Secondary Math Content

Violeta Vasilevska
Utah Valley University

Keywords: modern algebra, in-service teachers, connections with secondary curricula.

The 2010 report of the Conference Board of the Mathematical Sciences states that among four-year institutions with secondary pre-service teaching certification programs, 89% of the math departments require students to take abstract/modern algebra (Blair, Kirkman, & Maxwell, 2013). In addition, this requirement is advocated by many mathematical societies. However, there is a continued interest in and need for research on how knowledge of mathematical content is employed in teaching practice, as well as how secondary teachers view the relevance of their post-secondary courses in teaching (Zazkis & Leikin, 2010). In May 2019, the presenter attended *Connecting Advanced and Secondary Mathematics* conference, that brought together researchers, mathematicians, and teacher educators to explore these connections and develop plans for further research and/or professional development on these topics (Murray et al., 2017).

In fall 2019, the presenter taught a modern algebra class (covering topics of ring and field theory) for the Graduate Certificate in Mathematics for secondary level math in-service teachers. They implemented ideas from the conference by making intentional connections between the material taught and the secondary math curriculum. The presenter was interested in researching how these intentional teaching interjections changed the in-service teacher's opinion about the relevance of the advanced material covered with respect to the secondary math content the in-service teacher taught as well as the connections they see between the two curricula.

The students in the class (10 in-service teachers) were given pre- and post-surveys, that contained quantitative opinion questions about the relevance and connections between the advanced and secondary content in the curricula. The feedback obtained confirmed the advanced algebra material could be meaningful to teachers by connecting the material with the secondary mathematics and could also support teachers to re-conceptualize, re-structure, and re-understand their knowledge of secondary mathematics (Wasserman, 2016). The pre- and post-survey results showed the students' opinions changed significantly about the relevance and connections of the advanced algebra to secondary math content and about recognizing connections in their own classes.

In addition, students were asked to provide reflective feedback on the exam and the class projects about advanced topics they learned in the class that were the most useful/meaningful for them as well as sharing their opinions and suggestions on these topics. Almost all the advanced topics chosen by students as their favorites/most meaningful/useful, were the ones that were the most applicable in their high school classroom settings. In their comments, students expressed confidence that the advanced class material and connections made in class helped them understand the majority of topics that were covered in the course. As a result, they were now familiar to them on a deeper level. The in-service teachers expressed confidence in better understanding and being able to explain many seemingly true statements (taken for granted) they had been using in their own classes and making their students see relevance in mathematics.

Moreover, the presenter will discuss the questions of the pre- and post-survey results, which show a small increase in change of the students' opinions and brainstorm further (follow up) research questions.

References

- Blair, R., Kirkman, E. E., & Maxwell, J. W. (2013). *Statistical abstract of undergraduate programs in the mathematical sciences in the United States: Fall 2010 CBMS survey*. American Mathematical Society. <https://www.ams.org/profession/data/cbms-survey/cbms2010-Report.pdf>
- Wasserman, N. (1994). Abstract algebra for algebra teaching: Influencing school mathematics instruction. *Canadian Journal of Science Mathematics and Technology Education*, 16(1), 28-47. <https://doi.org/10.1080/14926156.2015.1093200>
- Zazkis, R. & Leikin, R. (2010). Advanced mathematical knowledge in teaching practice: Perception of secondary mathematics teachers. *Mathematical Thinking and Learning*, 12(4), 263-281. <https://doi.org/10.1080/10986061003786349>

Connecting Modern Algebra with Secondary Math Content

Dr. Violeta Vasilevska (College of Science – Department of Mathematics)
violeta.vasilevska@uvu.edu

Motivation / Literature Review

- Every five years, the Conference Board of the Mathematical Sciences(CBMS) executes a national survey of undergraduate mathematical and statistical sciences in two- and four-year colleges and universities.
- The 2010 report states that among four-year institutions with secondary pre-service teaching certification programs, 89% of mathematics departments require students to take abstract/modern algebra (Blair, Kirkman, & Maxwell, 2013).
 - ❖ Blair, R., Kirkman, E. E., & Maxwell, J. W. (2013). *Statistical abstract of undergraduate programs in the mathematical sciences in the United States: Fall 2010 CBMS survey*. American Mathematical Society.
- The Mathematics Association of America along with other professional mathematics societies also advocate for advanced courses such as these to be taken by future secondary mathematics teachers.
- Despite this requirement and advocacy, there continues to be a need for research on how knowledge of mathematical content is employed in teaching practice, as well as how secondary teachers view the relevance of their post-secondary courses to teaching (Zazkis & Leikin, 2010).
 - ❖ Zazkis, R., & Leikin, R. (2010). *Advanced mathematical knowledge in teaching practice: Perceptions of secondary mathematics teachers*. Mathematical Thinking and Learning, 12(4), 263–281.

Connecting Advanced and Secondary Mathematics (CASM) Conference (<http://casmconference.org/>)

Held in Minneapolis, MN, May 20-22, 2019
NSF Funded (53 participants)

- “The conference will bring together researchers, mathematicians, and teacher educators interested in exploring connections between advanced and secondary mathematics. The CASM Conference has three main objectives:
 - I. To develop plans for research and/or professional development to expand current knowledge on connections between advanced and school mathematics, so that attendees can take concrete steps to move projects forward.
 - II. To provide a space for mathematicians, mathematics educators, and other stakeholders to discuss their work and develop a common vision for future directions.
 - III. To share current research on mathematical connections between advanced and secondary mathematics, focusing specifically on abstract algebra.”
- ❖ Murray, Eileen; Baldinger, Erin; Wasserman, Nicholas; Broderick, Shawn; White, Diana. *Connecting Advanced and Secondary Mathematics*. Issues in the Undergraduate Mathematics Preparation of School Teachers, v1 Aug 2017 (<https://files.eric.ed.gov/fulltext/EJ1151024.pdf>)

CASM Conference

- Five theme groups formed
 - ❖ Curriculum
 - ❖ Educator Knowledge
 - ❖ Item Development
 - ❖ **Professional Development for Teachers** (I was part of this group)
 - ❖ Project Design

Implementation

- Fall 2019:
 - ❖ Class: Modern Algebra (Ring and Field Theory)
 - ❖ Program: Graduate Certificate in Mathematics
 - ❖ 10 Students: Secondary-level math in-service teachers
- Proof-based class - hence very demanding and hard for students
To address:
 - ❖ Why taking this class?
 - ❖ How to make the class relevant for students?
 - ❖ What is the connection to the material they teach at the high schools?

Research Project

- Collecting data from the in-service teachers (pre- and post-surveys) about the material/topics covered;
 - ❖ **What is the relevance of this material with respect to the secondary math content they teach?**
 - ❖ How to better equip them in teaching secondary math topics?
 - ❖ Which topics will prepare math education students better for understanding secondary mathematics?
 - ❖ What are in-service teachers' opinions and suggestions on the topics?

Survey Questions IRB Protocol #s 349; 350	Pre Survey	Post Survey
# of surveys	10	10
The <i>Abstract Algebra</i> material is relevant to secondary math content.	2.6	3.9
The <i>Abstract Algebra</i> provide <u>connections</u> to secondary math content.	2.5	4.3
The <i>Abstract Algebra</i> material equips the pre-service teachers to better teach secondary math content.	2.9	3.4
I have used <i>Abstract Algebra</i> material/concepts when teaching my secondary math classes.	2.3	3.9
I believe that <i>Abstract Algebra</i> material/concepts should be taught to pre-service teachers.	3.1	3.6

5 – strongly agree 4- agree 3 – neither agree nor disagree
2 – disagree 1 – strongly disagree

Student Feedback – Reflections

- I. Exam question – reflection:
Describe your favorite part (or topic) of *Modern Algebra* class this semester. Explain why that part (or topic) was your favorite.
- II. Project question – Reflections on the course material
 - ☐ address the topics covered;
 - ☐ which topic(s)/concept(s) was/were most meaningful and useful for you;
 - ☐ which topic(s)/concept(s) was/were the most exciting and new to you;
 - ☐ which connections you see with this material and the high school curriculum;
 - ☐ what would you change or leave the same in terms of the course content; etc.
- Almost all the topics chosen by students as their favorites/most meaningful/useful, were the ones that
 - ✓ were most applicable in their high school classroom settings
 - ✓ provided connections to the secondary math content
 - ✓ were familiar to the students
- In their comments, teachers expressed confidence that the class material and connections made helped:
 - ✓ them understand the majority of topics that were covered in the course and were familiar to them on a deeper level;
 - ✓ them to understand and explain many seemingly true statements (taken for granted) they use in their classes;
 - ✓ them communicate mathematics to their students by connecting concepts;
 - ✓ their students see relevance in mathematics.

Conclusion

- The feedback above confirms that the *Abstract Algebra* material
 - ❖ can be meaningful to teachers by connecting it with the secondary mathematics;
 - ❖ can support teachers to re-conceptualize, re-structure, and re-understand their knowledge of secondary mathematics.

(Wasserman, N. (2016). Abstract algebra for algebra teaching: Influencing school mathematics instruction. *Canadian Journal of Science Mathematics and Technology Education*, 16(1), 28-47).
- The pre- and post-survey results show that students' opinions changed significantly about
 - ✓ the relevance of the *Abstract Algebra* to the secondary math content;
 - ✓ connections of the *Abstract Algebra* to the secondary math content;
 - ✓ recognizing these connections in their own classes.
- Why the small increase in change of the opinion of the students about the last question on the survey? Few conjectures:
 - ✓ the proof-based classes are difficult, demanding, and time consuming;
 - ✓ most of the in-service teachers have taken the needed prerequisite (*Abstract Algebra* course (Graph Theory)) long time ago;
 - ✓ lacking of good proof writing skills.
- **Further research questions:**
 - ❖ What connections of *Abstract Algebra* can impact teacher instructions?
 - ❖ How can Variation Theory be implemented in *Abstract Algebra* classes with goal to impact teacher instructions?