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Micro-credentialing Urban Math and Science Teachers’ Action Research to Improve Student Learning

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8th Annual STEM Forum & Expo, hosted by NSTA
July 24-26, 2019; San Francisco, CA

This project is funded by a grant from the National Science Foundation (awards 1540840 and 1557397) to the University of Wisconsin Milwaukee. The content in this paper does not necessarily reflect the views of the NSF.

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Context

- The CCSSM and NGSS standards frameworks represent significant shifts in what students are expected to learn and recast demands on teachers' content knowledge, pedagogical content knowledge, and knowledge for teaching (Goertz, Floden & O'Day, 1995; Sykes & Plastrik, 1993; and Ball, Thames, & Phelps, 2008).

- General public believes "anyone can teach if they know a particular subject and that it is not really necessary to first learn about curriculum, classroom management and instruction" (Strauss, 2017).

- Legislation allows teachers to be hired with no formal training (e.g., Arizona, Louisiana, and Wisconsin) and the use of industry-sponsored, 'teacher-proof' curriculum (Wertz, 2017; Gunter, Hall & Apple, 2017).

- This context is particularly problematic in large, high poverty, urban school districts where accountability frameworks require documented gains in student learning and teacher professional development is limited and inconsistent (Avalos, 2011; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007).

Research Framework

Research Question: How might action research and micro-credentialing in the knowledge domains for teaching document development of a teacher's professional practice?

Three theoretical lenses:

- Teacher learning as a situated, distributed, and social activity (Borko, 2004; Lave & Wenger, 1991; Lieberman & Miller, 2008) that stimulates an ever-evolving professional practice (Bales & Saffold, 2011; Dall'Alba & Sandburg 2006, Bell & Gilbert, 1996) .
- Action research, as a professional learning action strategy, enhances teachers' knowledge, improves educational practice, and contributes to the knowledge base (Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010).
- A system of micro-credentials motivates participation (Gibson, Ostashewski, Flintoff, Grant & Knight, 2013), allows participants to make individualized decisions about what to learn, provides opportunities to customize content specific to their needs and local work (Kinshuk, Graf and Yang, 2010), and makes professional knowledge visible to the public.

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Model Design and Participants

Professional Development Model: Action research-based micro-credentials to develop expertise in the knowledge domains for teaching (Ball, Thames, & Phelps, 2008; Windschitl, Thompson, Braaten, & Stroupe, 2012).

- **Common Structure of Micro-credentials:**
  - An opening activity orients teachers to the construct and links to a specific mathematics or science task.
  - Discussion of teachers' pedagogical experience with the topic.
  - Reading of selected research-based texts.
  - Development of a research question
  - Design and implementation of action research project.
  - Collection and analysis of student artifacts.
  - Response(s) to research question.
  - Reflections on teacher and student learning and next steps.

Participants: 24 high school mathematics and science teachers with master's degrees primarily in Curriculum and Instruction.

CONCEPT MAPPERS EXHIBIT GREATER CONTENT APPREHENSION

Andrew P. Goetsch, JD in collaboration with UW-Milwaukee, the Noyce Foundation, Milwaukee Public Schools, and the National Science Foundation

PRODUCED IN THE COURSE OF THE MILWAUKEE MASTER TEACHER PARTNERSHIP (MMTP)

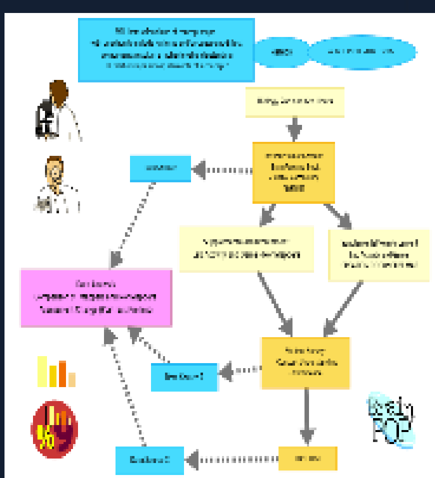
Conceptual Context

Problem: Without connecting a discrete topic to the "bigger picture," students will often fail to reach higher level understanding of content and will achieve reduced development of metacognitive skills.

"According to the National Research Council, experts differ from novices in that experts notice features and patterns of information… organized in ways that reflect deep understanding… (Bransford, Brown, and Cocking 2000). More important, experts have efficiently coded and organized this information into well-connected schemas that help experts interpret new information and notice features and meaningful patterns… (Pellegrino, Chudowsky, and Glaser 2001). ***As students gain mastery of concept maps, they develop an understanding of relationships among elements of a concept, ultimately making incremental gains*** in moving from novice to expert-level learners. Furthermore… students enhance a metacognitive approach to learning by negotiating their ideas… As the learner physically draws the connection between two subtopics, he/she reinforces that same connection mentally."

[illegible]
[illegible]
[illegible]

Question: Will students obtain a greater understanding of genetics, reproduction, and mutation by recognizing patterns, or cause-and-effect relationships, through concept mapping?



METHODOLOGY

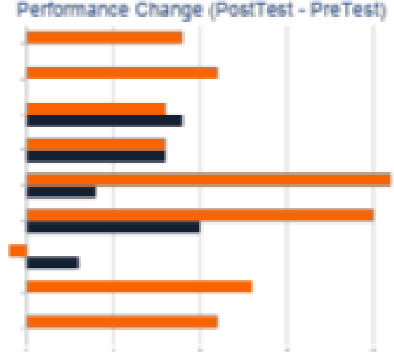
High School biology students were asked to use the BrainPop® internet based platform in the study of Genetics, Heredity, and Genetic Mutations units. The students:

1. Received introductory content materials and literacy building in the units
2. Pretest on the introductory materials.
3. Received advanced activities (laboratory and higher demand supplemental activities are provided, to include the BrainPop® Make-A-Map concept mapping activity)
4. PostTest was administered, along with a survey question as to the student opinion on the usefulness of the concept mapping task.
5. Data is analyzed to determine PreTest to PostTest performance change in the segregated pools of those students who made the maps (Mappers) and those who did not (Non-Mappers).

DATA

Student Population: 16 students completed both the Genetic Mutations Pre-Test and Post-Test, and Survey. All of these students are included in the data analysis.

Performance Change (PostTest - PreTest)



Survey Results - "Making concept maps is…"?

NON-MAPPERS
very helpful 14%
a little helpful 57%
not helpful 0%
don't know/care 29%

MAPPERS
very helpful 78%
a little helpful 22%
not helpful 0%
don't know/care 0%

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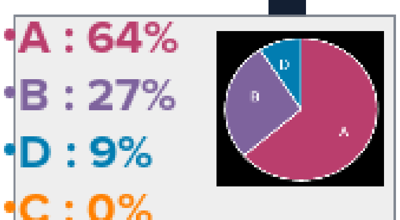


Survey – "Making concept maps is …"
A. very helpful
B. a little helpful
C. not helpful
D. don't know/care

ALL RESPONDENTS

DATA ANALYSIS

Descriptive Analysis (Post-Pretest)

	NonMappers	Mappers
Mean	4.86	11.50
SD	4.18	6.97
SEM	1.58	2.46
N	7	8

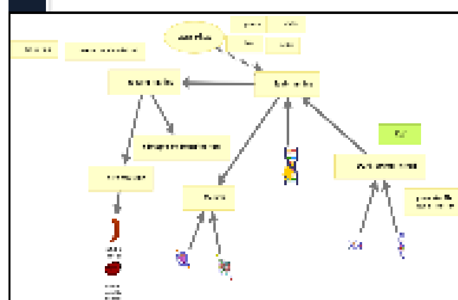
Unpaired *t* test results

P value and statistical significance:
The two-tailed P value equals 0.0470
By conventional criteria, this difference is considered to be statistically significant.

Confidence interval:
The mean of score change Non Mappers minus score change Mappers equals -6.64
95% confidence interval of this difference: From -13.18 to -0.10

Intermediate values used in calculations:
$t = 2.1941$
$df = 13$
standard error of difference = 3.028

A PROFICIENT STUDENT CONCEPT MAP



CONCLUSIONS

Mappers exhibited a statistically significant improvement in Pre to Post test assessment scores, when compared to NonMappers. This can be a measure of greater content apprehension. Notably, the increase was evident regardless of the quality of the concept maps that were attempted or produced. It is possible that the metacognitive act of engaging in any concept mapping activity resulted in greater content apprehension.

Survey results indicated that all Mappers found the activity helpful, and most "very helpful." In contrast, NonMappers mostly reported the activity only "a little helpful." The latter is remarkable as those subjects did no concept mapping in this unit. The NonMapper responses may be an attempt to appease the surveyor/instructor, or may be a reference to the prior concept map process instruction and practice in earlier units. Regardless, the activity was viewed positively by nearly all respondents.

FURTHER RESEARCH

The study could be replicated with other students, distinct content units, or alternate concept mapping software or techniques. Additional research questions include:
- Can a different metacognitive activity produce a similar result?
- Is there a correlation to the quality of the concept map produced by a student and her change in assessment performance?
- Will students produce concept maps and enhance content apprehension without the aid of computer software?
- Can concept mapping enhance disciplinary literacy, particularly writing?

ACKNOWLEDGEMENTS

"BrainPOP" is a registered trademark of FWD Media Inc. d/b/a BrainPOP. "Make-A-Map" is a registered trademark of BrainPOP IP LLC. Images in this presentation taken from BrainPop platform for non-commercial, educational use.

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Using the Modeling Cycle with 9th Grade Biology Students to Explain Population Cycles

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Research Question

How does the modeling cycle affect student ability to create a model that is logical and can be defended based on research of lemming populations?

Lesson Description

Groups of 3-4 students created and revised a concept map/model of the various organisms and environmental conditions that interact with a lemming population to understand why lemming populations cycle dramatically every 4 years.

NGSS Standards Address with DCI and Cross Cutting Concepts

LS2: Ecosystems: Interactions, Energy, and Dynamics

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

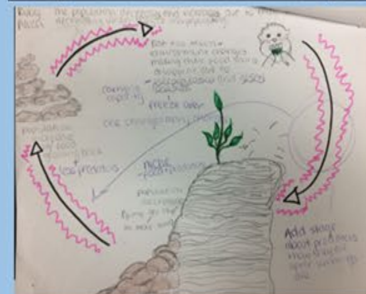
HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

Methodology

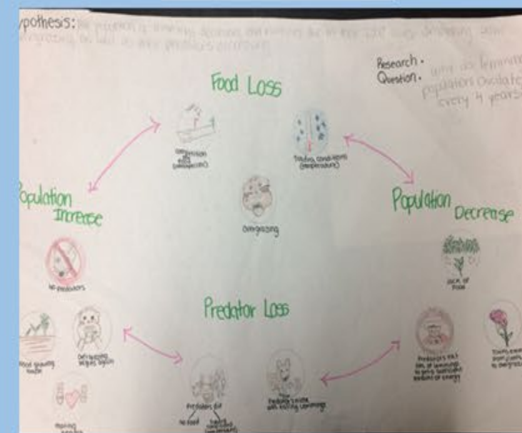
- One heterogeneous group of 9th grade Biology students partook in the lesson.
- The lesson took place over six 90 minute periods.
  - **Day 1**: Students **created preliminary models** and hypotheses about the Norwegian Lemming population cycle.
  - **Day 2**: Students **peer evaluated** each others models after they explored the ideas of 1. Habitat/Niche/Limiting Factors 2. The organization of life on planet earth. 3. Energy flow through an ecosystem
  - **Day 3**: Students **revised models** and explored ideas of Population interactions and Nutrient cycling
  - **Day 4**: Student **read and discussed various scholarly articles** about lemming population cycles.
  - **Day 5**: Students **created a final draft** of their models.
  - **Day 6**: Students will finalize their final drafts of their models and answer various assessment questions about their models.

Sample of Student Work

Rough Draft Revised Example



Sample Final Drafts



The Percentage (%) of Each Score Students Earned on Each Sub-Criteria

	Creating the Model			Evaluating and Using The Model			
Scores	Formulate and explain a testable hypothesis using correct scientific reasoning.	Design a logical model	Always uses correct scientific terminology	Defends the model using at least three valid reasons	Explains the limitations of the model.	Can use the model to make logical predictions	Percentage of Each Overall Grade
% Advance	11	5	17	17	20	26	27
% Proficient	69	67	67	60	43	37	57
% Basic	14	28	3	11	20	23	8
% Minimal	6	0	13	11	17	13	8

Results & Analysis

Student models were varied and on average provided logical reasoning of lemming population cycles based on research. Examining written responses that evaluated the use of the model, over 68% of students provided on average proficient or advance responses. Student surveys suggest a vast majority of the class thought that the modeling activity was enjoyable and allowed them to apply their knowledge about ecosystems and population cycles as they dug deeper into the content.

Work Cited

Models and Modeling: An Introduction. (2015). *Ambitious Science Teaching*. Retrieved from http://ambitiousscienceteaching.org/wp-content/uploads/2014/09/Models-and-Modeling-An-Introduction1.pdf

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Data Generation and Analysis

Data Generation

Survey responses, video observation of teachers teaching, year-end focus groups, and a document analysis of their action research projects.

Analysis of Data

- Identified essential features related to project goals and theoretical underpinnings.
- First cycle coding was deductive and structural (Saldana, 2016).
- Microanalysis of the language within each artifact.
- Second cycle coding noted any interrelationships and patterns among analyzed segments (Wolcott, 1994).

Three Themes Emerged then Resituated in Data

- How teachers understand the knowledge domains for teaching.
- How they make sense of and take up new learning in their professional practice.
- Tighter sequence of claims, evidence, and reasoning in action research projects.

Three Findings + New Instrument

F #1. Teachers built a personalized learning path into the knowledge domains for teaching.

Three Findings + New Instrument

F #2. The Importance of teacher voice in their learning

Self-selection of badges and the individualized nature of action research projects was essential in personalizing what each teacher wanted or needed to learn.

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Three Findings + New Instrument

F. #3. Micro-credentialed action research is a mechanism to develop teachers' practice.

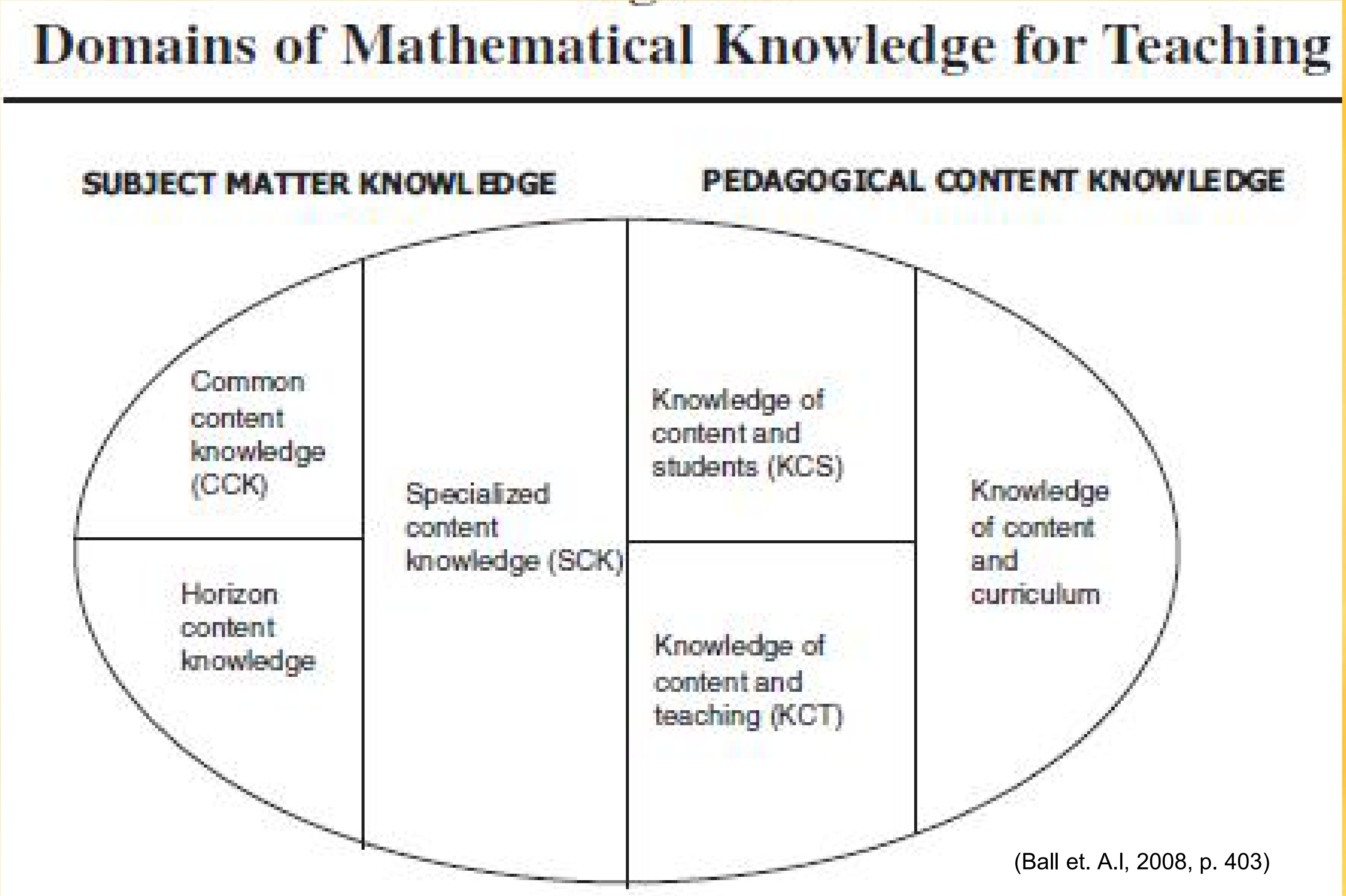
Teachers honed their research questions and skills each time they took up a new micro-credential, which afforded a more focused look at teaching and learning in their classroom. Specifically, teachers

1. Recognized that classroom teaching and learning was a valid platform from which to base their inquiry and offered a legitimate source of data.

2. Built a shared conception of well-grounded action research.

3. Moved beyond overly broad and inappropriate causal constructions in their research design.

A New Instrument: CLADE
Chronicles of Learning And Development Episodes



(Ball et. A.l, 2008, p. 403)

A New Instrument: CLADE
Chronicles of Learning And Development Episodes

Teachers used the CLADE to mark/chart/plan their learning.

They did this by:

1. Identifying each badge completed and three key concepts learned.

2. Providing an example of student learning that depicted explicit connections between teacher learning and classroom practice.

3. Linking the knowledge domain of each badge completed – what they learned – to the theoretical constructs of each domain, which provided a three-dimensional view of their efforts (i.e., how many domains and how many in each).

4. Reflecting on totality of their learning over the year, offer evidence of growth/changes in their classroom practice, generate goals and badges for following year.

Significance

2019 STEM for ALL Video

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