Angeliki Mali, Vilma Mesa

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INSTRUCTOR CREATION OF LECTURE NOTES WITH DIGITAL TEXTBOOKS

SCHOOL OF EDUCATION
UNIVERSITY OF MICHIGAN

NSF

American Institute of Mathematics

Est. 1888 UNIVERSITY of PUGET SOUND

SFA

University of Colorado

THE PROBLEM

Free, open source, dynamic textbooks for university mathematics courses are becoming available for students and instructors.

Little is known about their uses in classrooms.

Exploratory study with two digital open source textbooks, Rob Beezer's *First Course in Linear Algebra* , and Tom Judson's *Abstract Algebra: Theory and Applications*.

Today:

- How do instructors use digital textbooks in creating lecture notes?

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OUTLINE

- Design
- Theoretical and analytical underpinnings
- How do instructors use digital textbooks in creating lecture notes?

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DESIGN

- Eleven teachers and their students:

Version	Textbook	Course	Instructor	# of Students
HTML	Beezer	Linear Algebra	T1	29
			T4	12
			T8	22 (1st term), 29 (2nd term)
			T9	23
			T11	26
			T12	29
	Judson	Abstract Algebra	T3	12
			T5	27 (1st term), 22(2nd term)
PDF/Hardcopy	Judson	Abstract Algebra	T7	19
	Beezer	Linear Algebra	T10	14
Hardcopy	Strang	Abstract Algebra	T2	37

- Ten institutions, seven states:

  Large research, mid-size regional, and small state, universities in California, Colorado, Michigan, Mississippi, New York ,Texas, and Wisconsin.

- Ongoing data collection (data analytics and logs) and one week site visits (interviews, observations, focus groups, documents)

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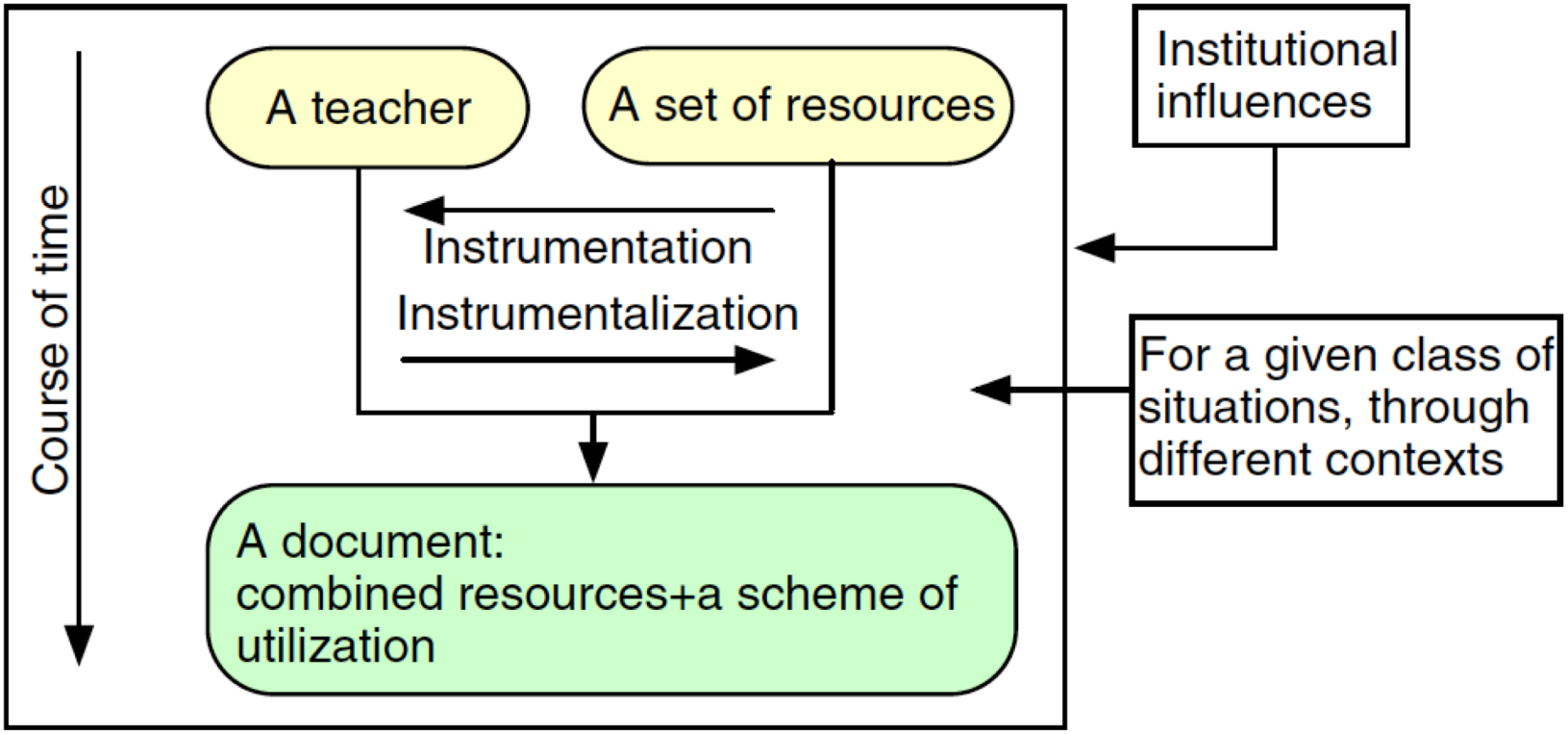
THEORETICAL AND ANALYTICAL UNDERPINNINGS: DOCUMENTATIONAL APPROACH, I

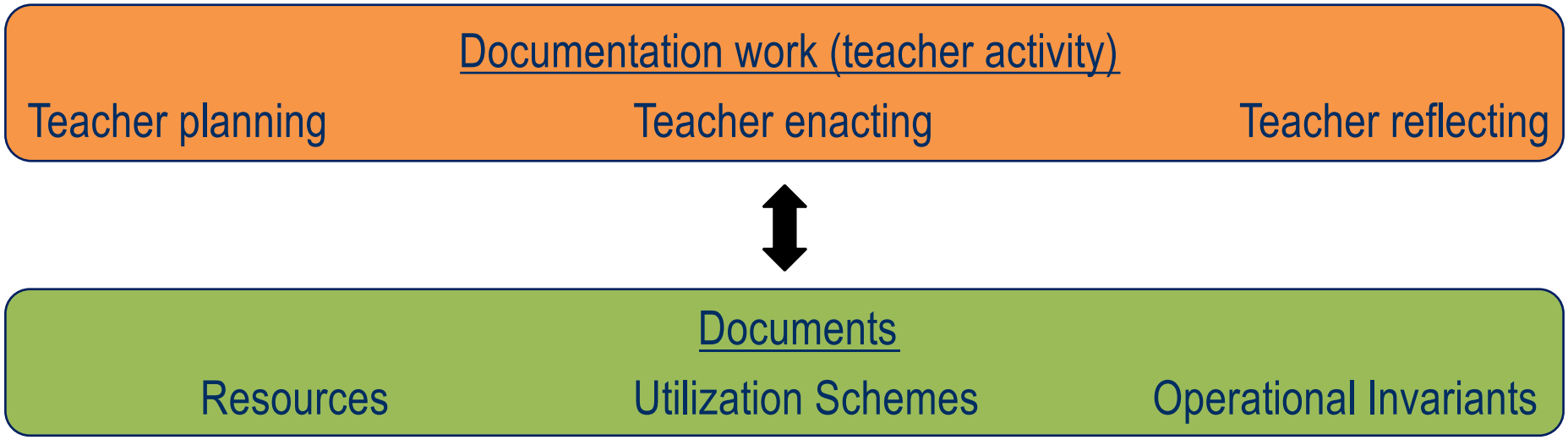


Instrumentalization: the teacher/user shapes the set of resources by using them

Instrumentation: the affordances and constraints of the set of resources influences the teacher/user

Figure 1: Schematic representation of the documentational approach (adapted from Gueudet & Trouche, 2009)

THEORETICAL AND ANALYTICAL UNDERPINNINGS: DOCUMENTATIONAL APPROACH, II



(adapted from Gueudet & Trouche, 2009)

HOW DO INSTRUCTORS USE DIGITAL TEXTBOOKS IN CREATING LECTURE NOTES?

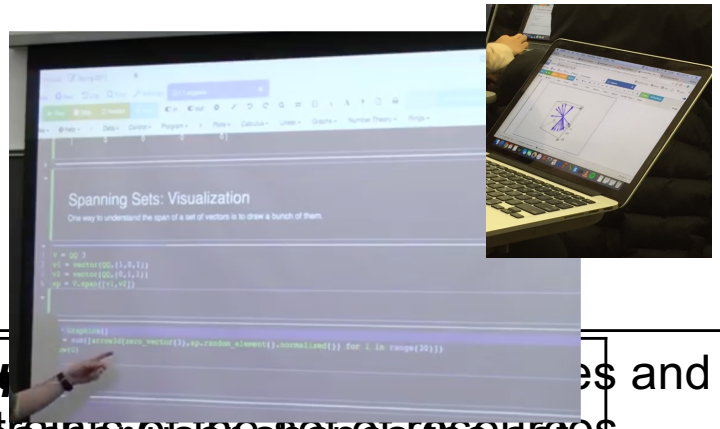


Figure 9: Lecture notes embedded in Sage worksheet and shared with a student work.

Instr ***tr*** ...es and constrains/uses shapes the set influences the teacher/user.

An instructor ⟷ A set of resources

"The geometric interpretation in $\mathbb{R}^3$ with more than two vectors linearly dependent better reveals the concept of linear dependence [than the technical definition of linear combinations being zero.]"

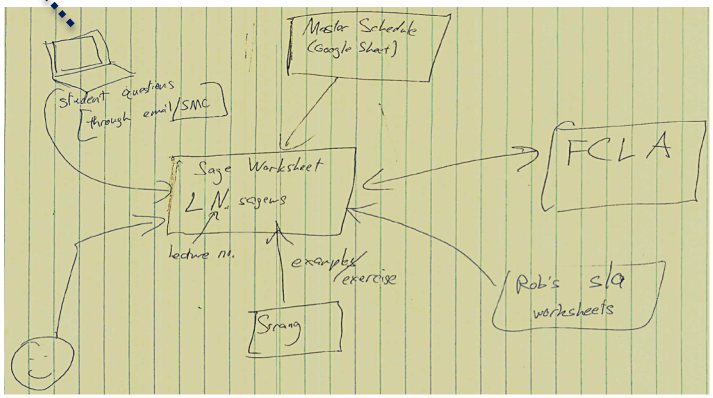


Figure 8: Instructor set of resources.

7 The schematic representation of the processes of *instrumentation* and *instrumentalization* is adapted from Gueudet and Trouche (2009).

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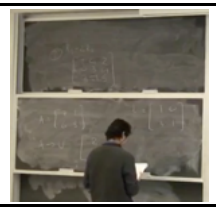
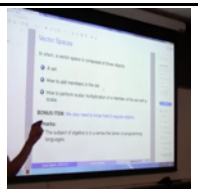
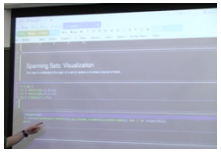
HOW DO INSTRUCTORS USE DIGITAL TEXTBOOKS IN CREATING LECTURE NOTES?

Less to More Dynamic

Media of Lecture Notes		Connection to the Textbook
Handwritten notes in paper (from points of reference to full notes)		References to the textbook
Online videos using the textbook		• Whole parts of the textbook • Practice problems from the textbook in accompanying problem sheets
Beamer/Power Point presentations		Hyperlinks to the textbook
Sage worksheets		• Hyperlinks to the textbook • Capabilities for the production of graphs and calculations of the textbook

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HOW DO INSTRUCTORS USE DIGITAL TEXTBOOKS IN CREATING LECTURE NOTES?

- **Additional resources:** other textbooks, past lecture notes, grad school notes, software, online resources, student questions, community
- **Schemes of utilization**

  Additional resources: Some instructors included different proofs/examples than those of the course textbook

  - *Operational invariants*: Instructors used proofs they considered “elegant”. Instructors expected students learned techniques from proofs.

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HOW DO INSTRUCTORS USE DIGITAL TEXTBOOKS IN CREATING LECTURE NOTES?

- **Schemes of utilization (continued)**

  Digital textbooks:

  All instructors created their lecture notes maintaining the notation and definitions presented in the textbooks

  - *Operational invariants*: Instructors expected that students used the textbook as reference. Instructors were participants in the research study of those textbooks.

  Little to no use of some dynamic features of the textbooks (e.g., computing cells).

  - *Operational invariant:* Instructors used the dynamic features of the textbooks depending on their knowledge of and familiarity with those features.

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UNDERGRADUATE TEXTBOOKS IN MATHEMATICS WITH OPEN SOFTWARE AND TEXTBOOKS

THANK YOU!

Collaborators:

Tom Judson	Stephen F Austin State U
Rob Beezer	University of Puget Sound
David Farmer	American Institute of Mathematics
Vilma Mesa	University of Michigan
Kent Morrison	American Institute of Mathematics
Susan Lynds	University of Colorado at Boulder

utmost.aimath.org

mathbook.pugetsound.edu

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