LINE: Linear Algebra in New Environments – Focusing on Students' Learning

LINE supports the development and implementation of local change towards the integration of mathematical content, applications, and math learning theories.

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Draga Vidakovic, Georgia State University;
Sergio Loch, Grand View University;
William Martin, North Dakota State University;
Jeff Suzuki, Laurel Cooley, and Scott Dexter, Brooklyn College

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Overall goal of the project

- Create a professional learning community of STEM faculty dedicated to creating classroom experiences drawing from a diversity of application domains;
- Provide collaborative support, drawing on expertise in both content and pedagogy, for designing effective instructional practice (modules); which, together
- Ensure conceptual alignment between content and pedagogical goals through the use of theory of learning (APOS) and instructional models.

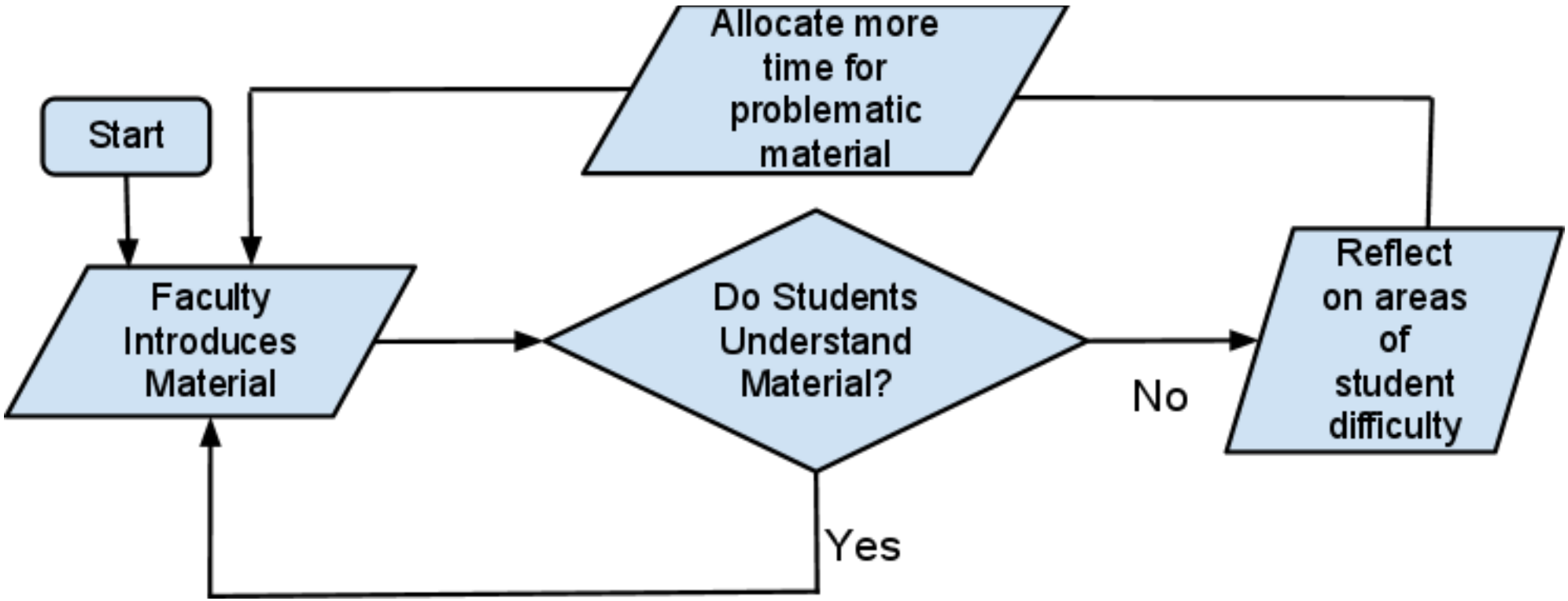
Participating institutions

- College A is a four-year liberal arts public college with enrollment of about 15,000 students;
- College B is a state land grant institution with enrollments of over 14,000;
- College C is a private liberal arts university in with enrollment of over 2,000 students, mostly undergraduates;
- College D is s public urban research university, with enrollment of over 30,000.

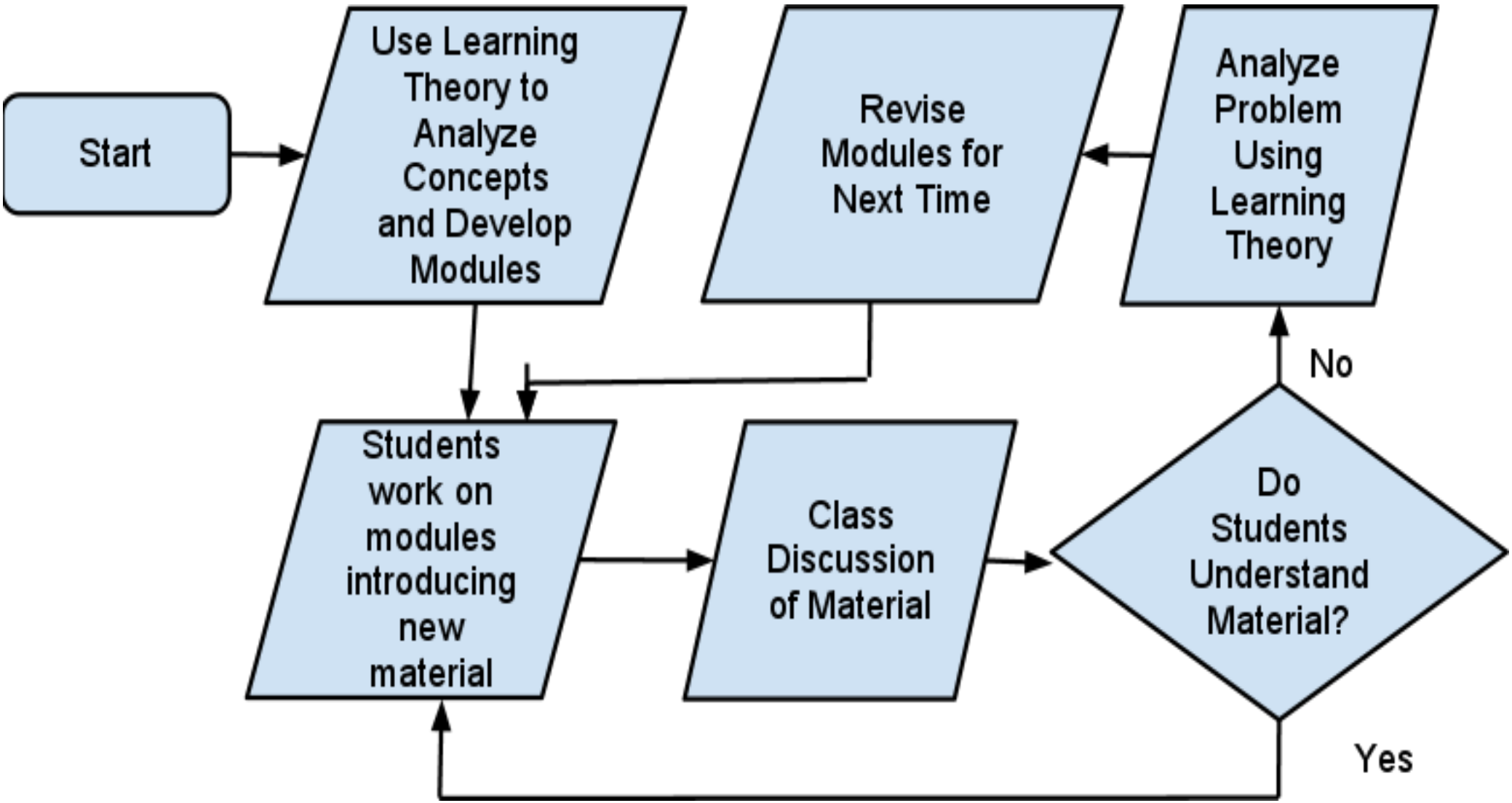
Professional Learning Communities

- Teaching is a very lonely profession: Can we form a community?
- Skype, Google docs, Dropbox (free!) for collaborative work.
- Sharing of resources.
- Multiple perspectives on topics.
- Multiple perspectives on students.
- Stories of successes (and failures!)
- Advice without commitments: collaborators won't be voting on your tenure case!

Old Environment



New Environment



Modules - illustrations

- Module 1 – Institution A
- Module 2 – Institution B
- Module 3 – Institution C
- Module 4 – Institution D

Assessment of students learning

- Written work on the modules;
- Video-recorded class discussions/journal entries/ observations;
- Concept maps;
- Student interviews;

Preliminary results of the impact on students

- Case of Module 1 (In class)
  - Most students/groups successfully completed the activity;
    - Debate about ‘least similar vectors’: opposite or perpendicular vector?
  - All students identified the most similar texts (with the same frequency vectors);
  - Misconception about using the dot product to calculate the angle of a vector vs. angle between two vectors;

Preliminary results of the impact on students (cont.)

- Case of Module 2 (outside of class, before)
  - Median score was 87, mean was 82;
    - All students answered correctly first two questions;
  - Usefulness of the proof in this particular module to the other upper math classes such as abstract algebra (individual student interview);
  - Most students find the whole-class discussion of the module gave them more feedback than any written comment/feedback the instructor can ever provide on their submitted work;

Preliminary results of the impact on students (cont.)

- Case of Module 3 (in class)
  - All students completed the GSP activity with transformations;
  - Only pre-engineering and physics students were able to relate linear transformations to the concept of isometry;

Preliminary results of the impact on students (cont.)

- Case of Module 4 (outside of class, before)
  - All students were able to identify correctly which sets represented space or a subspace;
    - Only one provided detailed verification of all axioms;
  - 12 out of 13 correctly identified which sets were not spaces or subspaces;
    - 10 of those 12 correctly identified which axioms failed

Impact on Instructors

Faculty reflections on the experience of instructional design and teaching in the LINE framework had some common themes:

- gaining insight into the mechanisms of conceptual development;
- the benefits of collaboration;
- the value of communicating mathematical ideas using applications; and
- the importance of visualization for some students.

Impact on Instructors (cont.)

I have gained some awareness when crafting mathematical questions to my students. I have always thought that going from simple to complex is a good approach. After these readings I consciously divide this evolution from simple to complex into several layers that require increasing levels of understanding.

Impact on Instructors (cont.)

"The readings were helpful in that they guided me to reflect on my teaching styles and how they could be used to help students understand things more deeply. The reading phase also showed me how serious and elaborate some of the learning theories are."

"I used to try to get students to understand the material the way that I understood it, when I should have been getting the students to understand the material in their own way"

Contacts for LINE project:

- Draga Vidakovic, dvidakovic@gsu.edu
- Sergio Loch, sloch@grandview.edu
- William Martin, William.Martin@ndsu.edu
- Laurel Cooley, laurel.cooley@gmail.com

Reflective Learning (Student Interviews)

- What did you realize about yourself as a learner of mathematics?

"*I need to concentrate more on the language and less on the operations."*

"I learned to not take theorems and definitions for granted. Of course I always new they were important, but now I feel I have a better respect for the rigors of mathematical building blocks."

"I think I learned that although the class relied heavily on linguistic syntax, that when one says these concepts out loud, they make more sense than just looking at in on page."