Teaching Linear Algebra

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Short description of the Discussion Group: aims and underlying ideas

Research on students' conceptual difficulties with linear algebra first made an appearance in the 90's and early 2000's (e.g. Carlson, 1997; Dorier & Sierpinska, 2001). Over the past decade, research on linear algebra has concentrated on the nature of these difficulties and students' thought processes (e.g. Stewart &Thomas, 2009; Wawro, Zandieh, Sweeney, Larson, & Rasmussen, 2011). The aim of the discussion group is to initiate a multinational research project on how to foster conceptual understanding of Linear Algebra concepts. Key questions and issues to be discussed are listed below:

a. *How can applications of Linear Algebra be used as motivation for studying the topic?*
b. *What are the advantages of proving results in Linear Algebra in different ways?*
c. *In what ways can a linear algebra course be adapted to meet the needs of students from other disciplines, such as engineering, physics, and computer science?*
d. *How can challenging problems be used in teaching Linear Algebra?*
e. *In what way should technology be used in teaching Linear Algebra?*
f. *What is the role of visualization in learning Linear Algebra?*
g. *In what order (picture, symbols, definitions and theorems) should we teach Linear Algebra concepts?*
h. *How can we educate the students to appreciate the importance of deep understanding of the Linear Algebra concepts?*

Planned structure:

Tuesday, 16.30-18.00: Planned timeline	Topic	Material / Working format / presenter
16:30-17:10	Introductions	Members of the leadership team will give a brief (2-3 minute) overview of their research, and present the initial set of research questions for discussion. Attendees will introduce themselves and their interests/expertise as well.
17:10-17:35	Breakout Groups: Examining artifacts from projects & research	Attendees will have the opportunity to bring a task, activity, framework, or interesting piece of data for discussion in breakout groups. Members of the leadership team will provide materials for at least 3-4 groups building on themes and resources from their own work which will provide the basis for these breakout

		groups.
17:35-18:00	Reconvene for whole group discussion	Each group will share new insights gleaned from their discussion in their breakout group; feedback on research questions will be collected.

Friday, 16.30-18.00: Planned timeline	Topic	Material / Working format / presenter
16:30-16:45	Summary of priorities and themes	The leadership team will present a summary of tallies regarding the highest priority questions, as well as a summary of themes from the previous day's discussions.
16:45-17:15	Breakout groups: revisiting research priorities	Attendees will break into interest groups focused on a similar set of topics/issues identified as high priority following the previous day's discussion. Each group will be charged with laying out a research agenda relative to what is already known in their topic area (with regard to research and resources on the teaching and learning of linear algebra).
17:15-18:00	Discussion of research agendas; future research.	Each group will share their agenda along with a summary of their discussion. These agendas will be used to form the basis of a publication synthesizing the issues, perspectives, and future agenda for linear algebra education research at the international level. Possibilities for international collaborative efforts will be identified and discussed.

References:

Carlson, D. (1997). Teaching linear algebra: Must the fog always roll in? In D. Carlson, C. R. Johnson, D. C. Lay, A. D. Porter, A. Watkins & W. Watkins (Eds.), *Resources for Teaching Linear Algebra, MAA Notes* (Vol. 42, pp. 39-51). Washington: Mathematical Association of America.

Dorier, J. L., & Sierpinska, A. (2001). Research into the teaching and learning of linear algebra. In D. Holton, M. Artigue, U. Krichgraber, J. Hillel, M. Niss & A. Schoenfeld (Eds.), *The Teaching and Learning of Mathematics at University Level: An ICMI Study* (pp. 255-273). Dordrecht, Netherlands: Kluwer Academic Publishers.

Stewart, S., Thomas, M.O.J. (2009). A framework for mathematical thinking: the case of linear algebra. *International Journal of Mathematical Education in Science and Technology*, *40*(7), 951-961.

Wawro, M., Zandieh, M., Sweeney, G., Larson, C., & Rasmussen, C. (2011). *Using the emergent model heuristic to describe the evolution of student reasoning regarding span and linear independence*. Paper presented at the 14th Conference on Research in Undergraduate Mathematics Education, Portland, OR.