

Board 111: Gateways-ND: Building the Institutional Infrastructure towards Viable Postsecondary STEM Education Reform

Dr. Jill Marie Daigh Motschenbacher, North Dakota State University

Motschenbacher focuses on educational program development and support, instructional improvement projects, assessment program implementation, science, technology, engineering, and math (STEM) educational reform, and university-wide administrative initiatives at North Dakota State University. Motschenbacher works to provide opportunities for faculty, instructional staff, and graduate students to advance individual and discipline-focused scholarship in the area of teaching and learning, with an aim of creating pathways that lead to student success, professional development, and institutional transformation.

Motschenbacher received a Ph.D. (2012) in Crop, Soil and Environmental Sciences, with a focus in Soil Physics, from the University of Arkansas. She also received an M.Ed. (2007) in the Administration of Higher Education and a B.S. (2006) in Agribusiness from Middle Tennessee State University. Prior to working at NDSU, Motschenbacher completed a research and extension education postdoc in the Department of Agricultural and Biosystems Engineering at Iowa State University and two USAID agricultural development projects in rice mechanization and post-harvest maize production in Wang'uru, Kenya and Iganga, Uganda. She also served for four years in the U.S. Navy aboard the USS Sacramento (AOE-1) as an Interior Communications Electrician.

Dr. Melissa Vosen Callens,

Melissa Vosen Callens is currently an assistant professor of practice in instructional design and communication at North Dakota State University, Fargo. Her areas of research and teaching interest include Popular Culture and Online Education. Her writing can be found in *The Ultimate Walking Dead* and *Philosophy, English Journal, Communication Teacher, Hollywood Heroines: The Most Influential Women in Film History*, and *A Sense of Community: Essays on the Television Series and Its Fandom*, among other publications.

Dr. James Nyachwaya Nyachwaya, North Dakota State University

James Nyachwaya is an Associate professor in the departments of Chemistry and Biochemistry and School of Education at North Dakota State University.

Emily A Berg, North Dakota State University

Emily Berg is the Director of Institutional Research and Analysis at North Dakota State University.

Dr. Jared Ladbury, Minnesota State University Moorhead

Prof. Paul Kelter, North Dakota State University

Paul Kelter's 39-year career has focused on the integration and transfer of knowledge among students and teachers at all educational levels. He was the inaugural director of the Science Outreach Office at the University of Wisconsin – Oshkosh in the late 1980's through early 1990's. Many of the programs he instituted via external funding are still part of that office. He was the co-PI on the successful, long-term Operation Chemistry literacy program for all levels of teachers, and parlayed that national program into grant-funded summer and year-round workshops in Wisconsin, Nebraska, and North Carolina over a 15-year period. During his 7-year tenure at Northern Illinois University (NIU), Kelter worked extensively with middle school teachers in high-Latino population communities in the service of science education. He has been at the forefront of science literacy for postsecondary students via three major chemistry textbooks, aimed at the first-year chemistry audience, as well as a book on the international impact of chemistry and learning. Kelter has won two dozen campus, state, and national awards in education, including career-long designations at distinguished teacher at the Universities of Wisconsin-Oshkosh, Nebraska, and Illinois. He was Board of Trustees professor at Northern Illinois University, the highest professorship available at that university. He began present position as the inaugural director of the Office of Teaching and Learning at North Dakota State University in June 2014. His current interest is advocating for literacy in sustainable development among students and teachers.

Gateways-ND: Building the Institutional Infrastructure towards Viable Postsecondary STEM Education Reform

Gateways-ND is a five-year (2015-2020), National Science Foundation (NSF)-funded faculty and instructional staff development program that is designed to offer relevant, collaborative, and sustained support to science, technology, engineering, and math (STEM) postsecondary educators at North Dakota State University. The instruction of the program, which is based on current, evidence-based pedagogy and course design, teaches postsecondary instructors how to create and/or reinvent STEM courses to be more learner-focused and engaging. Gateways-ND aims to produce a critical mass of highly-engaged STEM faculty and instructional staff, across multiple disciplines, course levels, and career phases, to develop a sustainable model of pedagogical change within a postsecondary institution. The long-term aims of the program are to increase student learning, improve student outcomes in STEM disciplines, and create institutional change in postsecondary teaching and learning.

Producing a Critical Mass for Change.

Gateways-ND has been successfully running for four years. Each fall, about 30 faculty and instructional staff are selected to form a cohort. Cohort members participate in workshops and faculty learning communities together for two years. During this time, there are 10 full days of workshops, divided into two-day periods, and smaller, faculty learning communities that meet every three weeks during the academic year. Thus far, there have been over 140 participants in four cohorts.

Participants are selected from a wide variety of STEM fields, including traditional sciences, agricultural disciplines, and technical fields that are characteristic of land-grant universities. Altogether, more than half of the faculty participants are women, and roughly half of the participants are among traditionally underrepresented populations in higher education (i.e., in association with gender, age, race, and ethnicity) [1]. In addition to NSF-funded participants, there have also been 25 non-STEM academic participants in the program. These participants were financially supported through the Office of the Provost to extend active learning ideologies past STEM disciplines and to create disciplinary diversity within the cohorts.

Developing a Learner-Focused Infrastructure.

To create tangible change in the way students are instructed, several developments have occurred to create an educational foundation that promotes and allows change to occur. These developments include moving towards a more active learning-based curriculum and classroom design changes that allow more instructor mobility and student engagement throughout the space. Active learning, as opposed to the more traditional passive learning, strives to have students dynamically involved with the learning process. Active learning-based teaching techniques emphasize engaging students in reading, writing, discussion, and problem-solving to promote synthesis and deeper learning, as opposed to passively listening to a lecture. In active learning, instructors want students involved, and students want to be involved. Active learning is

thinking and exchanging ideas as deeply and often as possible. Evidence for the success of the active learning is well documented. Collectively, a number of educational learning studies demonstrate that engaged students learn better than those who are not actively involved [2], [3], [4], [5].

Building Administrative Support.

To sustain institutional change in pedagogical practices resulting from the Gateways-ND program over time, building administrative support is vital. To get this support, the upper administration must have evidence of a sustainable peer-to-peer educational development system and data-driven evidence that the new pedagogical approaches help students learn. In that, the Gateways-ND trained personnel must be able to train the incoming faculty and instructional staff in the best teaching practices after the grant has ended. As part of the program, cohort participants are trained on educational leadership within and outside of the university. Topics include changing the promotion and tenure framework, peer-to-peer discussion engagement, educational assessment, and educational grant proposal development.

In addition to a sustainable training model, there needs to be statistical evidence collected to demonstrate improved student performance. To evaluate teacher pedagogical change, observers from the grant team use the Classroom Observation Protocol for Undergraduate STEM (COPUS) instrument to note teacher classroom practices and student classroom activities with a particular view to active and engaged teaching and learning. Teachers are observed 1-2 times per semester during their two-year professional development period. Research questions posed by Gateways-ND are allowing us to investigate how faculty attitudes and beliefs influence the implementation of active teaching, learning strategies, and student-faculty interactions.

Prompting Participant Feedback.

Based on preliminary analyses of several quantitative and qualitative data points, including participant workshop feedback, course documents (i.e., syllabi and assessments), and COPUS results, participants appear enthusiastic about the program and have adopted many of the active learning techniques introduced throughout workshops and faculty learning communities. After each workshop, participants were asked to rate the quality of the workshop using a five-point Likert scale [6]. To better assess the learner-focused infrastructure developed by Gateways-ND, participants were also asked several open ended questions that address what they thought were: 1) The most helpful or valuable aspects of this workshop, and 2) Ways future workshops be improved to be more beneficial to their needs and interests.

Participant responses about Gateways-ND workshops demonstrate positive engagements from participants, such as more time for discussion and “worktime” to apply concepts were common responses. In response to the assessment feedback, the Gateways-ND Curriculum Committee adjusted future workshop programming to allow for more small- and large-group discussion and worktime. In general, Gateways-ND participants favored engaging in instructor-centered behaviors with passive student engagement prior to engaging in the Gateways-ND

workshops and FLCs. As participants progressed through the program, however, there has been a shift to more student-centered, active learning strategies.

Creating Change in STEM Teaching.

Teaching-related data has been collected using the COPUS instrument and student attitudinal data from separate surveys. Participant journals show the positive impact of the FLCs and other project collaborations have on active learning-based teaching, including assessment. Workshops examining learner analytics (i.e., using early student course performance to identify and intervene with students) resulted in suggested courses of action including early alert messaging, further integrating existing student support services, and framing interventions to increase student belonging. Classes are also becoming more active for students. Instructors are showing a 20% year-over-year reduction ($M = 67.61\%$, $S.D. = 23.8\%$ vs. $M = 56.32\%$, $S.D. = 21.6\%$ percent of coding intervals) in lecturing, as captured by the COPUS for the first cohort [$t(27) = -2.30$, $p = .03$] and a three-fold year-over-year increase ($M = 5.2\%$, $S.D. = 9.4\%$ vs. $M = 16.1\%$, $SD = 21.6\%$ percent of coding intervals) in the amount of time instructors use group work in the classroom [$t(27) = 2.52$, $p = .02$].

Discussion.

Gateways-ND will continue formally for one more year (through August 2020). At this time, roughly 175 instructional faculty and staff will have completed the two-year program, which will, in turn, would have directly impacted the educational experiences of more than 30,000 students during the five-year period. The ultimate goal of Gateways-ND is to maximize instructional effectiveness and student success in STEM disciplines.

References.

- [1] Office of Planning, Evaluation and Policy Development, “Advancing diversity and inclusion in higher education: Key data highlights focusing on race and ethnicity and promising practices,” *U.S. Department of Education, Office of the Under Secretary*. pp. 1-95, November 2016. [Online]. Available: <https://www2.ed.gov/rschstat/research/pubs/advancing-diversity-inclusion.pdf>. [Assessed February 4, 2019].
- [2] J. E. Froyd, “Evidence for the efficacy of student-active learning pedagogies,” *Project Kaleidoscope*, pp.1-16, August 27, 2007. [Online]. Available: <http://www.pkal.org/documents/BibliographyofSALPedagogies.cfm>. [Assessed March 19, 2018].
- [3] G. D. Kuh, “Unmasking the effects of student engagement on first-year college grades and persistence,” *The Journal of Higher Education*, vol. 79, pp. 540-563, 2008.
- [4] D.C. Haak, J. HilleRisLambers, E. Pitre, and S. Freeman, S., “Increased structure and active learning reduce the achievement gap in introductory biology,” *Science*, vol. 332, pp. 1213-1216, 2011.
- [5] S. Freeman, S. L. Eddy, M. McDonough, M. K. Smith, N. Okoroafor, H. Jordt, and M. P. Wenderoth, “Active learning increases student performance in science, engineering, and mathematics,” *Psychological and Cognitive Sciences*, vol. 111, pp. 8410-8415, 2014.
- [6] J. Robinson, “Likert scale,” In: A.C. Michalos (eds), *Encyclopedia of Quality of Life and Well-Being Research*, Springer, Dordrecht