

# Creating a Community of Practice Around Geoscience Education Research: NAGT-GER

Laura A. Lukes,<sup>1</sup> Nicole D. LaDue,<sup>2</sup> Kim A. Cheek,<sup>3</sup> Katherine Ryker,<sup>4</sup> Kristen St. John<sup>5</sup>

**Key words:** community of practice, geoscience education research, community

## PREFACE

The *Journal of Geoscience Education* (JGE) has been a valued scholarly dissemination outlet for geoscience education researchers and practitioners for over three decades. This community of scholars has grown in the last decade, as both the number of graduate programs in geoscience education research has increased (see for example, Libarkin, 2014), and as more classically-trained geoscientists expand the scope of their scholarship to share literature-grounded and evidence-based teaching materials and methods with their peers (St. John et al., 2013). This growth is to be celebrated, as it attests to the value that the geoscience community places on ever-improving our teaching and understanding student learning.

The National Association of Geoscience Teachers (NAGT; <http://nagt.org/index.html>) is arguably the lead professional organization that supports this community growth - through its publication of JGE and *In the Trenches*; through professional development programs, including the upcoming Earth Educators Rendezvous (July 13–17 2015, [http://serc.carleton.edu/earth\\_rendezvous/2015/index.html](http://serc.carleton.edu/earth_rendezvous/2015/index.html)); through scholarship and award programs; and though the recent establishment of Divisions around shared professional interests. I wanted to call your attention to the newly created NAGT Geoscience Education Research (NAGT-GER) Division as readers, reviewers, and authors publishing in JGE. NAGT-GER is the result of the recent expansion of geoscience education research; it is also a potential catalyst for individual advancement, collaborations, and disciplinary evolution by giving organizational structure to the research and scholarship in geoscience education and serving as this field's community of practice.

## WHAT IS A COMMUNITY OF PRACTICE?

A community of practice is defined as a “group of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis” (Wenger et al., 2002, 2). Three components distinguish a community of

practice from simply a group of people that have an interest or profession in common: (a) engagement in relationship building activities/sharing that occurs over time, (b) a co-constructed common body of knowledge (Lave and Wenger, 1991, 98; Wenger, 1998), and (c) “practices”, which are ways of doing and approaching things that are shared to some significant extent among members (Smith, 2003). A community of practice, therefore emerges as people intentionally come together to actively invest in the sharing and negotiating process to co-create knowledge (Wenger, 1998). Furthermore, a community of practice will “develop some way to carry the accumulated knowledge of the community... in the form of tools, vocabulary, norms, etc.” (Smith, 2003, 1). Professional organizations may be considered communities of practice if they meet these criteria.

## WHY IS A FORMAL COMMUNITY OF PRACTICE NEEDED?

Communities of practice are beneficial at the individual level in that they create a network of expertise that can help an individual expand their skill set, enhance their reputation, develop a stronger professional identity, increase their enjoyment of their work, and overcome challenges they may experience (Wenger et al., 2002). A community of practice can also facilitate the growth of a discipline, such as geoscience education research (GER, the geoscience branch of discipline-based education research; DBER, National Research Council [NRC,] 2012). It does this through the establishment of “agreed” upon good practices and norms within that discipline, creating a forum for benchmarking which leads to confidence in an individual researcher's approaches to problems, and a shared sense of belonging (Wenger et al., 2002). Consensus may be formalized through the co-construction of products like an organizational position statement, in which community members agree upon a set of precise language to convey the collective viewpoint on an issue. With respect to geoscience education, formal organizations like the National Association of Geoscience Teachers (NAGT) can be leveraged to provide a functional structure for such a community of practice. Organizations do not inherently create communities of practice, but can provide opportunities of time or resources for a community to work, remove barriers, encourage participation, and value the communities' efforts at a national level (Wenger et al., 2002). Following the Two Year College (2YC; <https://www.nagt.org/nagt/divisions/2yc/index.html>) and Teacher Education (TED; <https://www.nagt.org/nagt/divisions/ted/index.html>) divisions of NAGT that have developed community college and teacher education communities of practice, the geoscience education

<sup>1</sup>George Mason University, 4400 University Drive; MS4D6, Fairfax, Virginia 22030, [llukes@gmu.edu](mailto:llukes@gmu.edu)

<sup>2</sup>Northern Illinois University, 315 Davis Hall, Dekalb, Illinois 60115, [nladue@niu.edu](mailto:nladue@niu.edu)

<sup>3</sup>University of North Florida, 1 UNF Drive, Jacksonville, Florida 32224, [k.cheek@unf.edu](mailto:k.cheek@unf.edu)

<sup>4</sup>Eastern Michigan University, 301W Mark Jefferson, Ypsilanti, Michigan 48197, [kryker@emich.edu](mailto:kryker@emich.edu)

<sup>5</sup>James Madison University, Harrisonburg, Virginia 22840, [stjohnke@jmu.edu](mailto:stjohnke@jmu.edu)

research division (GER) has emerged as a rallying structure for the community of GER practice.

## WHY IS GER DIVISION NEEDED?

Communities of practice bring people together around shared values and a common endeavor. Events, such as the Summit on the Future of Undergraduate Geoscience Education (2014), illustrate the recent broad efforts made by geoscience educators to bring together those who identify with or have an interest in geoscience education as a unified community to create a common vision (in the case of the Summit, for undergraduate geoscience education). Similarly, the academic journal for the geoscience education community, the *Journal of Geoscience Education*, has featured articles addressing the concerns and perceptions of the geoscience education community and its subgroups (e.g., Feig, 2013). It is through these broader efforts to create a community around geoscience education that it becomes apparent that there is need to further distinguish communities of practice around subgroups of geoscience education members such as geoscience education researchers. For example, even the publishing arm of NAGT has recently identified the need to further differentiate and support different audiences in geoscience education, targeting a decidedly scholarly and research (GER) audience with *JGE* and a teaching practice audience with *In the Trenches* (Libarkin, et al., 2009; Libarkin and St. John, 2011; St. John and Libarkin, 2012).

Within *JGE* itself, there is also a distinction between types of GER as illustrated by the article categories: (1) research and (2) curriculum and instruction (Libarkin et al., 2009; St. John and Libarkin, 2012).<sup>6</sup> The “research” category includes articles on fundamental geocognition and geoscience education theory and GER projects that involve data collection to answer specific research questions or test a hypothesis. The “curriculum and instruction” category, on the other hand, includes articles centered on the scholarship of teaching and learning in geoscience (SoTL), namely innovations in pedagogy and curriculum. SoTL, in general, involves practitioners conducting self-reflective (meta-level) inquiry on how student learning occurs in practice in the context of the author’s own teaching experience (Boyer, 1990; Hutchings et al., 2011). While this may be a subtle distinction to make, the different types of GER are important to note, as they come with different practices and the labels we as a community apply have implications for how publications are valued for promotion and tenure at different institutions.

People engaged in all forms of GER are welcomed and supported in the NAGT-GER community, as well as traditional geoscience researchers interested in learning more about or expanding their scholarship to include geoscience SoTL, GER, or GER-related collaborations. Similarly, geoscience education researchers can be found in a variety of career paths, some affiliated with traditional institutions of education (K-12, community college, university, etc.) and others outside of formal learning environments (non-profits, museums, science centers, outdoor field

schools, etc.). Anyone interested in GER is encouraged to join NAGT-GER and see their scholarship to the publication stage (St. John et al., 2013).

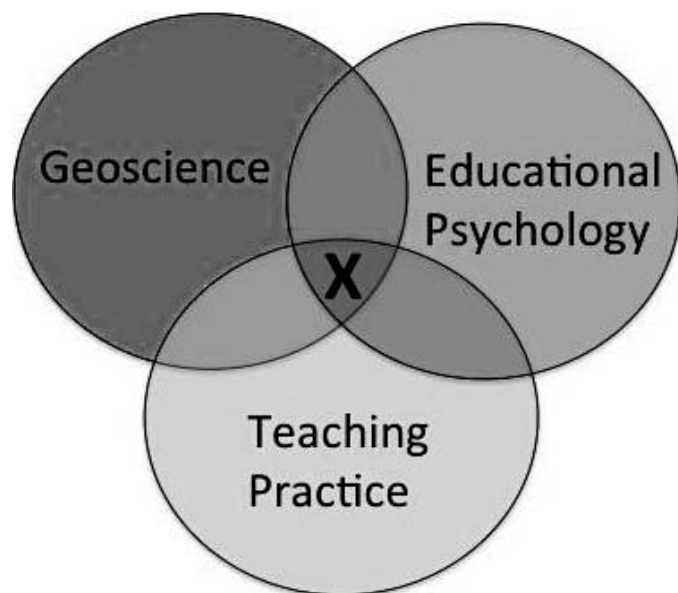
## WHAT IS UNIQUE ABOUT GER?

Feig’s article on geoscience educators, “The Allochthon of Misfit Toys” (2013; recipient of the JGE Outstanding Paper Award), struck a chord within the geoscience education community. His work brought attention to the isolation, confusion, and general anxiety within the geoscience education community even though he only interviewed a handful of geoscience education practitioners (five, three of whom were identified as geoscience education researchers), which limits the conclusions that can be drawn. He emphasized the need to parse out the unique qualities and subgroups within the broader geoscience education community—“whatever that means, and whoever we are” (Feig, 2013, 316). His study indirectly, therefore, identified the need to define and situate GER both within and outside of the broader geoscience education community—to formalize a community of practice around GER.

Feig (2013) gave voice to the isolation geoscience educators, especially those engaged in GER, can feel in their discipline and practice, particularly in institutions of higher education. Such feelings of isolation are not unique to geoscience educators and have been documented in the literature for faculty of all disciplines since the 1980s and 1990s (for a synthesis of this early work see Savage et al., 2000). Departments or programs with fragmented communication patterns, tight resources, and methods of evaluation and reward (promotion and tenure) that undermine faculty interaction have all been linked to faculty feelings of isolation (Massey et al., 1994). A detrimental sense of isolation is especially prevalent among faculty groups that face additional structural or social isolation barriers, such as early career/faculty new to a college or university (Savage, et al., 2000), and adjunct/contingent faculty (Dolan, 2009).

Geoscience education researchers face additional sources of physical and social isolation due to perceptions about the “fit” of their expertise, research, and role within a geoscience department as expressed by one participant in Feig’s study (2013). Adding to the confusion is the nature of geoscience education research itself. A geoscience education researcher’s expertise, as a discipline-based education researcher, is located at the nexus of geoscience, educational psychology, and educational practice, as well as their corresponding subdisciplines. Figure 1, similar in structure to the affective domain model presented by van der Hoeven Kraft et al. (2011), illustrates this general relationship of the overlapping discipline expertise of geoscience education researchers. A geoscience education researcher’s training and knowledge, and thus perceived expertise, may migrate outside of this ‘intertidal zone’ (marked by an X in the figure) into more traditional discipline categories over their career (broader circles in the figure), adding to the confusion and sometimes negative perceptions of where geoscience education research as a discipline “belongs.” Those individuals who identify as geoscience education researchers, or DBER researchers of the geoscience variety, therefore, face the additional challenge of establishing their research as a new and equally valid field of study (Feig, 2013; Libarkin et al., 2009). They can be socially viewed by faculty within their

<sup>6</sup> In addition to the Research and Curriculum and Instruction article categories, *JGE* published Commentaries and will start publishing Literature Reviews in Spring 2015. See p. 86 of this issue for updated descriptions on these article categories.



**FIGURE 1:** Situating geoscience education research in disciplinary expertise. The circles represent areas of disciplinary expertise. The “X” illustrates the overlap in disciplinary expertise required to effectively conduct geoscience education research.

department or within the geoscience community as not belonging in the department or discipline topically (Feig, 2013), or face misconceptions about their role (e.g., GER being synonymous with program, curriculum, or course evaluation). Despite these unique barriers within a department, geoscience educators are uniquely well positioned to facilitate departmental level transformation—as a study across 20 colleges and universities found, happily functioning departments correlated with those departments identified as supporting effective teaching (Massey et al, 1994).

Geoscience education researchers are frequently challenged to partner with geoscientists sometimes unfamiliar

with the general types of geoscience education research conceptualized in Figure 1, and the variety of forms collaborations can take: interdisciplinary, multidisciplinary, or transdisciplinary (summarized in Table 1). This can lead to misconceptions and miscommunications about what geoscientist-geoscience education researcher collaborations look like in practice (Incorporated Research Institutions for Seismology [IRIS], 2014). These collaborations often take interdisciplinary forms, in which GER and geoscience researchers aim to share expert knowledge to inform the practice of each other (TREC Center, Hadorn et al., 2008; Wickson et al, 2006; National Academies, 2005). For example, a geoscience education program evaluator working with a glaciologist to provide feedback on whether or not their broader impact/educational outreach efforts have had an impact on the climate literacy of participating students (e.g., InTeGrate Project <http://serc.carleton.edu/integrate/index.html>). The geoscientist can provide expertise around the content students should be learning and how that learning can be expressed. The GERer can provide insights into the role teaching practice and/or geocognition could be playing. Collaborations between GER and educational psychology or education practice, on the other hand, often take multidisciplinary or transdisciplinary approaches to research. For example, a multidisciplinary partnership involves experts in two or more disciplines working together at some point, but who are answering separate questions and producing separate results (TREC Center; Hadorn et al., 2008; Wickson et al, 2006). For example, in the GARNET project, an educational psychologist and statistician worked with the team to examine the affective domain in introductory geology courses (Gilbert et al., 2012), but used the Motivated Strategies of Learning Questionnaire (MSLQ) data to assess the theoretical fit of the instrument being used in the study (Hilbert et al., 2013). There was collaboration and sharing of expertise, but separate research questions. A transdisciplinary approach to collaboration involves experts from different disciplines working together and synthesizing their approaches to answer the same research question (TREC Center; Hadorn et al., 2008; Wickson et al., 2006;

**TABLE 1:** A comparison of types of research collaborations across disciplines based on TREC (no date) with examples from geoscience education.

Type of Collaboration	Interdisciplinary	Multidisciplinary	Transdisciplinary
Description	“Researchers interact with the goal of transferring knowledge from one discipline to another. Allows researchers to inform each other’s work and compare individual findings” (TREC)	“Researchers from a variety of disciplines work together at some point during a project, but have separate questions, separate conclusions, and disseminate in different journals” (TREC)	“Collaboration in which exchanging information, altering discipline-specific approaches, sharing resources and integrating disciplines achieves a common scientific goal (Rosenfield, 1992).”
Example in geoscience	As part of the InTeGrate project, a geoscience education program evaluator works with geoscientists, and other discipline specialists, developing curriculum (e.g., glaciologists) to provide feedback on whether or not their curriculum efforts incorporate research-based practices and have an impact on the learning of participating students (e.g., climate literacy).	In the GARNET project, an education psychologist and statistician worked with the GER team to examine the affective domain in introductory geology courses (Gilbert et al., 2012), but used the Motivated Strategies of Learning Questionnaire (MSLQ) data to assess the theoretical fit of the instrument being used in the study (Hilbert et al., 2013). There was collaboration and sharing of expertise, but separate research questions within each discipline.	In Van der Hoeven et al. (2011), an educational psychologist worked in concert with GER experts to co-construct a model of the affective domain in geoscience.



Rosenfield, 1992). For example, in van der Hoeven *et al.*'s (2011) construction of a model of the affective domain in geoscience, an educational psychologist worked in concert with GER experts to co-develop the model. A community of practice has the potential to help GER practitioners to overcome collaborative challenges by producing community artifacts (e.g., documents, websites, etc.) that outline or model effective collaborations involving GER.

Publications, like *JGE* and *In the Trenches*, are vital to co-constructing a shared body of knowledge, but publications alone do not provide the kind of sustained sense of community that comes from meaningful interactions. These interactions are needed to create a community of practice and to mitigate feelings of isolation experienced by those within the field. Events like the Summit on the Future of Undergraduate Education are important to building the broader geoscience education community through face-to-face networking, but, by their nature, are not specific to GER practices and are only attended by a limited number of geoscience education researchers. A formalized community specific to GER is needed to “connect local pockets of expertise and isolated professionals, [identify and rectify shared challenges in practice], analyze knowledge-related sources...and bring everyone up to the highest standard, coordinate unconnected activities and initiatives” (Wenger *et al.*, 2002, 5).

## WHAT IS THE DIVISION'S PURPOSE?

NAGT-GER was established specifically to create a community of practice around the unique needs of GER scholars who identify as geoscience education researchers. The division's mission is the “promotion of high quality, scholarly research in geoscience education that improves teaching and learning in K-12, higher education, and informal learning environments” (NAGT-GER division page, <http://nagt.org/nagt/divisions/geoed/index.html>). That mission is to be accomplished through:

- A. the exchange of ideas, research methodology, resources, and concerns related to geoscience education research;
- B. a network for those interested in engaging in scholarly research and/or implementing those research findings in their teaching;
- C. the development of relationships between the geoscience education research community and the broader educational research community;
- D. the recruitment or organization of research teams to address specific questions or respond to requests for proposals (RFP's);
- E. professional development events that increase the capacity of geoscience education researchers at various stages of their careers; and
- F. connecting geoscientists and geoscience education researchers to improve geoscience teaching and learning. (NAGT-GER division page, <http://nagt.org/nagt/divisions/geoed/index.html>)

It is important that our members have a shared sense of who we are as a community. It is equally important that those outside the division in the broader DBER community understand who we are and why we exist. For those reasons,

“We have chosen GER for our division name to be consistent with the original division charter and to better situate the division within the broader DBER community. We anticipate GER for Geoscience Education Research will be as recognizable a brand as PER (for Physics), CER (for Chemistry) and BER (for Biology)” (NAGT-GER, 2014; Mogk, [no date] SERC).

## WHO ARE OUR MEMBERS?

Although NAGT-GER has been in existence for less than one year, we currently have 207 members. The majority of our members have self-reported that they have earned a doctorate degree (51%). Our members are geographically diverse—as they are distributed fairly evenly across the NAGT geographic sections, with each of the sections averaging 10% of the membership (with sections ranging from having 5–18% of the membership—the Midwestern and Eastern sections respectively). Of the 61% of members that reported the year they earned their highest degree, 10% earned their degree in the 1980's or earlier, 17% in the 1990's, 16% in the 2000's, 16% in 2010 or later, suggesting that the community includes members at different career stages (student, early, mid-, late, retired). The fact that current members are at various points in their careers provides opportunity for mentoring around a range of common interests and concerns that will improve the scholarship of all the division's members.

## HOW WILL THE DIVISION BEGIN TO DEVELOP A SHARED IDENTITY?

As noted above, a key feature of a community of practice is that its members care about the same things (Lave and Wenger, 1991; Wenger, 2002). The division's executive committee has taken several steps to ascertain what is important to the members and respond to them. One of the first actions the executive committee took was to administer an online GER member survey. The goal of the survey was to identify the needs of the GER community to more effectively focus division efforts. Forty-three percent of the membership completed the survey (n=91).

When asked what they hoped to get from NAGT-GER, members (n=91) most strongly agreed with:

- opportunities to network with those in the GER community (58% strongly agree; 34% agree on 5-item Likert scale);
- news about funding opportunities (52% strongly agree; 39% agree);
- news about GER conducted at other institutions (36% strongly agree; 55% agree);
- strategies for developing a GER program (36% strongly agree; 38% agree);
- professional development on designing a GER project (36% strongly agree; 38% agree); and
- professional development on mixed methods (36% strongly agree; 34% agree) and quantitative methods (33% strongly agree; 38% agree).

In anticipation of the need for the community to interact through opportunities to network in person, the division facilitated two opportunities for the GER community to

exchange ideas by holding its first meeting at the 2015 Annual Meeting of the Geological Society of America and presenting at American Geophysical Union (Lukes, et al., 2014). Both of these meetings helped raise the division's profile within the larger geoscience research community and provided a way for those interested in GER to share their thoughts with division officers. .

We are also actively involved in the planning of special programming at the upcoming Earth Educator's Rendezvous, which will be held July 13–17, 2015 at the University of Boulder. The Rendezvous is focused on addressing the interrelated challenges faced by undergraduate Earth Education ([http://serc.carleton.edu/earth\\_rendezvous/2015/index.html](http://serc.carleton.edu/earth_rendezvous/2015/index.html)). There will be a program thread dedicated to geoscience education research. Additionally, there will be special professional development opportunities, including a workshop, to learn the latest in research methods and contribute to development of a guide to the norms and standards of the GER community.

When asked to rank activities in order of importance for the GER division, responding members (n=90) similarly identified the items above, but also identified aspects offered by a community of practice—establishing value of co-constructed knowledge and expertise, opportunities for meaningful interactions, and consensus of excellence in practice. Specifically, they ranked the following division activities as important:

- action to raise GER profile as a discipline;
- professional development on manuscript preparation;
- indexing of JGE
- stand alone, in-person GER meetings;
- recognizing excellence in GER

As the mission states, the division exists to promote high quality scholarship within the field and to encourage steps so that the work of geoscience education researchers is available to a wide audience, thus raising the public's perceived value of the community's work. Division officers composed a letter in support of the JGE Editorial Board's effort for the indexing of *JGE* in ERIC. Indexing benefits the GER community by gaining wider readership (higher research impact) beyond the geoscience education community and also is used for evaluating the merit of academic work for promotion and tenure at many institutions. To date, the contract between NAGT and ERIC to index *JGE* is in place, and a contract with EBSCO has just been signed. In addition, *JGE* is currently under review by Thomson-Reuters, for future indexing in the ISI Web of Science.

When asked what types of professional development they needed to grow as GERers (n=83), they focused on aspects of learning GER methods (research design, 59%; mixed method techniques, 59%; quantitative methods, 58%; qualitative methods, 51%), writing skills (preparing grant proposals, 65%; preparing manuscripts, 36%), and seeking mentorship from experienced GERers (61%). Interestingly, when asked if they would be willing to volunteer to lead such professional development events for the community, 31 individuals selected one or more of the options, but there were few volunteers available for each topic (22 for reviewing manuscripts; 11 to mentor; 7 for research design; 4 for mixed methods; 4 for grants; 3 for quantitative methods; 3 for qualitative methods). This suggests a need

for the community to expand its membership, or to intentionally collaborate with outside experts (e.g., grant writing workshops hosted by funding agencies) that can bring these needed knowledge resources to the community.

Regular, ongoing communication within the division is an essential part of developing a set of shared ideas and memories and a key component of successful communities of practice (Wenger, 2002). To facilitate sharing and communication across the community, members were asked about the format and frequency of desired communication from the division. Overwhelmingly, the community preferred an electronic newsletter format (94%) and listserv postings (43%). Blogs (23%), printed mailings/newsletter (22%), Facebook (13%), and Twitter (3%) were notably less popular. In terms of frequency, members preferred one (40%) to two/three (33%) times per month, or even weekly (20%), suggesting a desire to stay informed of the latest within the community. In response to this feedback, a listserv and an inaugural issue of NAGT-GER's electronic newsletter, GER Exchange, was produced and issued in December 2014. Each issue of the newsletter will provide information about research grant and GER-related professional development opportunities and serve as a place geoscientists and GERers can look for potential collaborators with expertise in different aspects of GER.

## HOW CAN SOMEONE JOIN OR GET INVOLVED IN NAGT-GER?

More information about the division and how to join can be found at <http://nagt.org/nagt/divisions/geoed/index.html>. Already a member? Join the conversation on our listserv (email [nagt-geoed@serc.carleton.edu](mailto:nagt-geoed@serc.carleton.edu)), contribute to the newsletter by emailing your submissions to [geoedresearch@gmail.com](mailto:geoedresearch@gmail.com), or volunteer to serve on a committee. We are currently seeking volunteers for the communication and long-range planning committees as described in our newsletter (newsletter can be found here: <http://nagt.org/nagt/divisions/geoed/index.html>).

NAGT-GER is an important entity that is actively working to create a true community of practice amongst geoscience education researchers. The effort will take time and there will undoubtedly be growing pains along the way. But we welcome all those interested in GER to join us in our community of GER practice.

## Acknowledgements

A special thanks to the GER members who completed the member survey and the editing staff at JGE for their time, effort, and feedback.

## REFERENCES

- Boyer, E. (1990). *Scholarship reconsidered: Priorities of the professoriate*. Princeton, NJ: Carnegie Foundation for the Advancement of Teaching.
- Dolan, V. (2009). Isolation of online adjunct faculty and its impact on performance. *International Review of Research in Open and Distance Learning*, 12, 2, 62–76.
- Dolan, V. (2011). The isolation of online adjunct faculty and its impact on their performance. *The International Review Of Research In Open And Distance Learning*, 12(2), 62–77. Retrieved from <http://www.irrodl.org/index.php/irrodl/article/view/793/1787>

- Feig, A. (2013). Allochthon of misfit toys. *Journal of Geoscience Education*, 61, 306–317.
- Gilbert, L., Stempien, J., McConnell, D., Budd, D., van der Hoeven Kraft, K., Bykerk-Kauffman, Jones, M., Knight, C., Matheney, R., Perkins, D., and Wirth, K. (2012). Not just “Rocks for Jocks”: Who are introductory geology students and why are they here? *Journal of Geoscience Education*, 60, 360–371.
- Hadorn, G.H., Grossenbacher-Mansuy, W., Joye, D., Pohl, C., Weissmann, U. and Zemp, E. (2008). The emergence of transdisciplinarity as a form of research. In *Handbook of Transdisciplinarity*, Hadorn, G.H., Grossenbacher-Mansuy, W., Joye, D., Pohl, C., Weissmann, U. and Zemp, E. (eds.). Springer: Zurich, Switzerland, 19–39.
- Hilpert, J., Stempien, J. ; Van Der Hoeven Kraft, K. J. ; Husman, J. (2013). Evidence for the Latent Factor Structure of the MSLQ: A New Conceptualization of an Established Questionnaire. *SAGE open*, 3, 4, p. 3 - 4/2158244013510305
- Hutchings, P., Huber, M., & Ciccone, A. (2011). *The Scholarship of Teaching and Learning Reconsidered*. San Francisco: Jossey-Bass.
- Incorporated Research Institutions for Seismology (IRIS). Engage Workshop Retrieved on 12 Decemeber 2014 from [http://www.iris.edu/hq/workshops/2015/01/engage\\_workshop](http://www.iris.edu/hq/workshops/2015/01/engage_workshop)
- Lave, J. and Wenger, E. (1991). *Situated Learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.
- Libarkin, J., (2014). Alphabetical List of Graduate Programs in Geocognition and Geoscience Education Research. Retrieved on 19 Decemeber 2014 from: <https://geocognitionresearchlaboratory.wordpress.com/graduate-study/>
- Libarkin, J., Elkins, J., St John, K. (2009). Editorial: The evolution of JGE: Responding to our community's needs. *Journal of Geoscience Education*, 57, 3, 165–167.
- Libarkin, J. and St. John, K. (2011). Editorial: Where have we been. . . *Journal of Geoscience Education*, 59, 4, 175.
- Lukes, L., LaDue, N., Cheek, K., Ryker, K. (2014). NAGT-GER: A Community of Practice to Support the Emerging Field of Geoscience Education Research. Abstract ED42B-07 presented at American Geophysical Union on 18 December 2014.
- Massy, W., Wilger, A., and Colbeck, C. 1994. Departmental cultures and teaching quality: Overcoming ‘Hollowed’ Collegiality. *Change*, June/July, p.10–20.
- Mogk, D. (2012?). Disciplined-based education research (DBER) Understanding and Improving Learning in Undergraduate Science and Engineering: Contributions and Opportunities for the Geosciences. Retrieved 4 December 2014 from <http://serc.carleton.edu/NAGTWorkshops/DBER.html>
- National Academies. (2005). *Facilitating interdisciplinary research*. Washington, DC: National Academies Press.
- National Research Council (NRC). (2012). *Discipline-based education research: Understanding and improving learning in undergraduate science and engineering*. Washington, DC: National Academies Press.
- Rosenfield, P. L. (1992). The potential of transdisciplinary research for sustaining and extending linkages between the health and social sciences. *Social Science and Medicine*, 35, 11, p.1343–1357.
- Savage, H., Karp, R., and Logue, R. (2004). Faculty mentorships at colleges and universities. *College Teaching* 52,1, p.21–24.
- Smith, M. K. (2003) ‘Communities of practice’, the encyclopedia of informal education, [www.infed.org/biblio/communities\\_of\\_practice.htm](http://www.infed.org/biblio/communities_of_practice.htm).
- St. John, K., Dickerson, D., and McNeal, K. (2013). Guide to aspiring authors. *Journal of Geoscience Education*, 61, 3, 253–255.
- St. John, K. and Libarkin, J. (2012). . . .where we are headed. *Journal of Geoscience Education*, 60, 1, 1–2.
- TREC Center. What is transdisciplinary research? Retrieved 12 Decemeber 2014 from <http://www.obesity-cancer.wustl.edu/en/About/What-Is-Transdisciplinary-Research>
- Van der Hoeven Kraft, K., Srogi, L., Husman, J. Semken, S., and Fuhrman, M. Engaging students to learn through the affective domain: a new framework for teaching in the geosciences. *Journal of Geoscience Education*, 59, 2, 71–84.
- Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge, UK: Cambridge University Press.
- Wenger, E., McDermott, R., and Snyder, W. (2002). *Cultivating communities of practice: guide to managing knowledge*. Boston, US: Harvard Business School Press.
- Wickson, F., Carew, A., and Russell, A. (2006). Transdisciplinary research: characteristics, quandaries, and quality. *Futures*, 38, 1046–1059.