

## Chapter V. Reflections on InTeGrate

from *InTeGrate: End of Project Evaluation Report*  
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This brief final chapter tries to provide some insights about why InTeGrate worked as well as it did. What was the secret sauce that made it possible for this project to accomplish so much? What might the designers and leaders of future large education reform projects wish to emulate?

These reflections are the holistic judgment of the author of this report, based on more than 9 years of observation and ongoing engagement with all aspects of InTeGrate effort. These thoughts were informed by a recorded, hour-long round table discussion with the Leadership Team<sup>1</sup> around the question of “Why did InTeGrate work?”, plus email feedback from several Advisory Board members. It’s not possible to gauge or compare the relative levels of impact of these various factors. They are offered as ideas for future project leaders to contemplate, and as hypotheses for future researchers to test.

*InTeGrate combined strategies and approaches that would work in any field of education, or indeed in any large, distributed organization, with strategies tailored for education about the Earth.*

An example of a strategy that would be applicable to any large organization is to establish multiple nodes with analogous structures, components, mission, information flow, and outputs, e.g. multiple curriculum development teams, multiple IP’s.<sup>2</sup> Example strategies that would be applicable to education in any discipline are those that tie instruction to important issues that students care about, and that engage students with authentic data. An example of an instructional strategy that is distinctive to--or at least characteristic of--Earth education would be virtual field trips.

The generalizable approaches in InTeGrate’s toolkit tend to be large-scale, and the Earth-specific approaches tended to be smaller scale, with the following exception:

*InTeGrate gained energy from the conviction that humanity is facing a profound environmental crisis, and that Earth education can be part of the solution.*

InTeGrate demanded a lot from its participants: time, creativity, courage to try something new. Among both the leadership and the rank and file, some found the energy to go the extra mile because of concern about climate change, the sixth extinction, depletion of natural resources, vulnerability to natural hazards, environmental justice, or some looming combination of these and similar threats. These same concerns attracted new people, both faculty and students, to InTeGrate’s offerings.

*InTeGrate’s two big reform ideas may have been mutually reinforcing.*

InTeGrate’s two big non-negotiable insistences were (1) to teach using student-centered, active-learning pedagogies, and (2) to teach about the Earth in the context of societal problems. Based on faculty interviews, Iverson & Wetzstein (in review) raise the possibility that there is a constructive interaction between these two interventions.<sup>3</sup> High-stakes authentic problems form the context and

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<sup>1</sup> Zoom call on February 15, 2019.

<sup>2</sup> This strategy is articulated in Kastens, K. A., & Manduca, C. A. (2017) Using systems thinking in the design, implementation and evaluation of complex educational interventions, with examples from the InTeGrate project. *Journal of Geoscience Education*, 65(3), 219-230.

<sup>3</sup> Iverson, E. R., & Wetzstein, L. (in press). Connecting learning about the earth to societal issues: Downstream effects on faculty teaching. In J. Ostrow (Ed.), *Teaching about Sustainability across Higher Education Coursework, New Directions for Teaching and Learning*, No. 161. San Francisco: Jossey-Bass.

motivation for students to enter into the deep engagement that active-learning pedagogies strive for. Conversely, active-learning pedagogies provide the tool kit that enables students to grapple with high-stakes problems in a meaningful way. Thus, A encourages B, and B encourages A, in a virtuous cycle, and the outcome is non-linearly more powerful than either intervention alone.

*InTeGrate went where the students are.*

Rather than improving education within geoscience departments and waiting for students to come, InTeGrate sent tendrils out into the farthest reaches of higher education. InTeGrate found faculty members who were already teaching some Earth-related content within agriculture, biology, chemistry, economics, education, materials science, physics, and urban studies, and brought them into the InTeGrate community. InTeGrate created curriculum materials and program models to support incorporation of Earth content into business, economics, engineering, Spanish, and literature courses. Collaboration with MSI's, 2YC's, and institutions with no geoscience department, brought quality Earth education to new audiences.

*InTeGrate placed great faith in the capacity and motivation of college faculty.*

Certain threads of educational reform have advocated for “teacher-proof” curricula: a course of study crafted by professional curriculum designers, and so well structured and so well supported that strong learning gains would happen regardless of the teachers’ actions. InTeGrate took almost the diametrically opposite stance.

For curriculum development, InTeGrate bet that heterogeneous teams of ordinary college faculty, with little to no formal education in curriculum or instruction design, could produce world-class instructional materials, if they had access to appropriate coaching and scaffolding. In large numbers, they rose to the challenge. In retrospect, the 2-3 week module was the appropriate quanta of materials development to ask from faculty members who had full time day jobs doing teaching and/or research.

For curriculum use, InTeGrate also trusted faculty to adapt the provided materials in ways that would be beneficial for the instructor’s unique context and audience. Rather than pushing for “fidelity of implementation,” InTeGrate actively supported adaptation by providing instructors’ stories, variants for some units, links to data sources that would provide geographically optimized data sets for analysis, and so on. It has been suggested, but cannot be proven, that InTeGrate’s high rate of curriculum uptake by non-developer faculty results in part from this adaptability.

*InTeGrate combined accountability with support and recognition.*

“Trust, but verify.” InTeGrate trusted that faculty and faculty teams could do great work—but set up accountability systems to help keep that great work on track and on schedule. Accountability systems included the checkpoints for materials developers, the quarterly reports of IP leaders, and the independent review of all materials for scientific accuracy. Although the accountability systems set a high bar, InTeGrate also provided extensive mentoring and support towards meeting the expected level of quality and productivity. And then when success was achieved, InTeGrate provided recognition in the form of letters to Deans, press releases, and opportunities to publish.

*InTeGrate created leaders.*

InTeGrate needed a lot of leaders, at all scales: from national leadership to local IP's. To get off the ground, InTeGrate mobilized a cadre of existing leaders from across the country who had developed capacity and working relationships from earlier NSF-funded Geo-Ed projects. InTeGrate also created new leaders. A myriad of micro- and mid-level leadership opportunities were built into the structure,

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such as materials developer, webinar presenter, Rendezvous session leader, workshop co-convenor, and IP leader. Individuals who showed promise in entry-level leadership opportunities were consciously sought out and recruited into more ambitious leadership positions.

*InTeGrate recruited world-class advisors, gave them substantial roles, and attended to their advice.*

Rather than structuring Advisory Board meetings mostly as opportunities to showcase InTeGrate's accomplishments, the Board was exposed to InTeGrate's knottiest problems and entrained in seeking solutions. They rose to the occasion; for example, when InTeGrate struggled to find leverage points for increasing diversity and inclusion, Board member Dr. Judith Ramaley personally provided mentoring and coaching for two candidate IP teams with strong diversity goals. The Board consistently encouraged the leadership team to think big and think long term. That nudging may have helped the team push back against being overwhelmed by the infinitude of details and decisions.

*InTeGrate was designed and implemented using systems thinking.*

Kastens & Manduca (2017)<sup>4</sup> described the process by which InTeGrate's leadership selected which components of the higher education system to target, drove interactions between program components, and set up parallel subsystems with extensive internal information flow and decision-making autonomy. These strategies made it possible for different parts of the system to both benefit from and contribute to one another.

An element not discussed in the earlier paper was the role of people as connecting links who straddled system components, conveying information and insights across boundaries. Ellen Iverson spanned between InTeGrate's Materials Development and Professional Development components. Anne Egger spanned MD, PD, plus the teacher-education community. David Blockstein spanned from InTeGrate outward to the environmental education and sustainability education communities. Felicia Davis spanned from InTeGrate outward to the HBCU community. InTeGrate found suitable bridge persons and then supported their efforts to perform this challenging role.

*InTeGrate prioritized improving teaching and learning over researching teaching and learning.*

When confronted by a fork in the road where one path offered the potential for more robust educational research findings and the other path offered the potential for greater improvement of teaching and learning about the Earth, InTeGrate prioritized improved teaching and learning. For example, the decision to have to have IP's design and implement their own evaluation plans resulted in an uneven data set that was not ideally suited for education research, as did the decision to proactively encourage faculty to adapt curriculum materials rather than strive for fidelity of implementation. The upside of these decisions is that the faculty had a greater sense of ownership of the materials and evaluation data. Arguably, the materials and evaluation systems were better suited for the particular instructional context, and thus more likely to be continued in use after the end of InTeGrate funding.

*InTeGrate consciously planned to leave lasting traces on the landscape of higher education*

InTeGrate leadership adopted the metaphor of a geological event that leaves enduring traces on the Earth even millions of years after the causal impetus has dissipated. Just as a mountain building orogenic event leaves behind metamorphic rocks and distinctive landforms that endure long after the causal compressional forces are gone, so too would InTeGrate leave behind profound changes in Earth education long after NSF grant DUE-1125331 was gone. This intent to leave lasting traces informed the structuring of the Rendezvous, the funding model for the revamped Travelling Workshops, the ramping up of the webinar program, and other large and small decisions.

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<sup>4</sup> *op.cit.*

InTeGrate's idea of leaving lasting traces pertained to people as well as structures. InTeGrate sought to change faculty worldview and priorities, trying to catalyze deeper reflection about what Earth education is for, and how it should therefore be carried out. Such changes have the potential to permeate all facets of the instructor's teaching practice, for life, and to spread from the so-influenced instructor to his or her colleagues, department, and institution. Among students, InTeGrate tried to ratchet up students' motivation to contribute to solving environmental grand challenges, in addition to teaching them to understand how Earth systems work. Changes in worldview, priorities, and motivations are difficult to document, especially on a nationwide scale, but can be felt by participants. In making this choice, InTeGrate tried to focus on what is important, rather than what is measurable.

*The success of individual components of InTeGrate depended on the backing of other components, and thus to some extent InTeGrate depended on scale.*

InTeGrate's design was such that an output from one component often served as the input to another component. For example, materials developers and IP leaders were able to point faculty users to web pages about pedagogical strategies, specific geoscientific habits of mind, program-building strategies, etc. Those resources existed only because other parts of the larger organization had already created them. The overhead of creating shared structures such as assessment infrastructure, publication template, and materials development rubric was spread across many development efforts. Such a mutually-supportive ecosystem was possible because of InTeGrate's large scale.

*InTeGrate tackled many things, all at once.*

Scanning down through the project chronology (Exhibit I-4) can give the impression of InTeGrate as a multi-ring circus, and living through it sometimes felt the same way, with way too much going on, all at the same time. Keeping track of the rapidly-growing, far-flung enterprise challenged the project leadership, the PI, the Advisory Board, and the evaluators. But in the deepest vision of what InTeGrate was trying to do, this complexity was a feature rather than a bug. To change the complex system of higher education was seen to require many things to change, *all at once*: the materials with which students were taught, the attitudes of faculty, the programs and departments within which instruction is embedded, and the priorities and value system of the community within which faculty make their decisions.

*In addition to faculty, InTeGrate's success built on the capacities of exceptionally talented and hardworking professional staff.*

In addition to the nationwide network of faculty participants, InTeGrate benefitted from an exceptionally strong professional support staff at SERC, which provided technical, business, and programmatic underpinnings for InTeGrate's activities. SERC's technology group, under Technology Director Sean Fox, customized faculty-friendly tools for diverse tasks, ranging from surveys and assessments, to work-flow organization, information archiving, event planning, and beyond. The business staff, under Financial and Administrative director Amy Collette, negotiated and oversaw scores of subawards for millions of dollars.<sup>5</sup> Programmatic support included multiple forms of coaching and organizing, including coaching MD teams on IRB and copyright, birddogging materials testers on data submission, facilitating webinars, and planning events. All of these supporting activities benefitted from economies of scale, and from being located at a central, "backbone" organization.<sup>6</sup>

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<sup>5</sup> Thirty-two institutional subawards or contracts (e.g. to evaluators, IP's, the HBCU, and Leadership Team members), plus more than 100 small individual awards (e.g. to materials developers and assessment team members). Source: Amy Collette, email, May 31, 2019.

<sup>6</sup> The idea of a "backbone organization" supporting the collective impact of a distributed network of stakeholders working towards an agreed-upon agenda comes from Kania, J., & Kramer, M. (2011) Collective Impact. *Stanford Social Innovations Review* (Winter), 36-41, online at: [http://ssir.org/articles/entry/collective\\_impact](http://ssir.org/articles/entry/collective_impact). Functions of a backbone organization identified by Kania & Kramer include project manager, data collector, and facilitator.

*InTeGrate built on decades of prior work, much of it funded by prior NSF projects.*

InTeGrate's methods for college faculty professional development through highly interactive, few-day, face-to-face workshops have their roots in *Project Kaleidoscope*, which was founded 30 years ago. Strategies of marrying website and workshop, and the give-a-little/get-a-lot philosophy of peer-supported learning, were perfected during the *On the Cutting Edge* and *Building Strong Geoscience Departments* projects. The Earth Educators' Rendezvous recalls the summer meet-ups held by the Digital Library for Earth System Education (DLESE). InTeGrate's ideas about communities of transformation drew on Kezar and colleagues' synthesis of the PKAL, POGIL, SENCER, and BioQuest projects. InTeGrate's strategy of engaging a large community in development and dissemination of curriculum modules around issues of societal concern built on the work of SENCER. Nationwide online delivery to increase reach of geoscience curriculum materials had been used by COMET, DataStreme, the Earth System Science Education Alliance (ESSEA), among others.<sup>7</sup> Without this 30 years of capacity building, the geoscience education community could not have made InTeGrate.

InTeGrate combined repurposed strategies with new elements. The Implementation Program concept was perhaps the InTeGrate component with the scantest evolutionary heritage, the component that most needed to be designed from scratch. Reflecting on how the heritage of these many other projects came together in InTeGrate foregrounds the importance of capturing and sharing the lessons learned from the InTeGrate experience. Much of that knowledge and wisdom is embodied in the people who led and participated in InTeGrate.<sup>8</sup> This report is an attempt to capture the essence of InTeGrate's approaches and insights for use by future projects.

*Not everything worked; InTeGrate learned from failed attempts.*

Although report has focused on claims of accomplishments, it is important to recognize that many things that InTeGrate tried did not initially work as hoped. Examples of early failures include the effort to use embedded formative assessments as a project-wide measure of student progress towards learning objectives, the first several versions of the systems thinking essay, and the first several efforts at a diversity program. InTeGrate leadership minimized blame or guilt around these episodes, recognizing that failure is a necessary step towards learning how to do something hard and new. After these non-successes, InTeGrate leadership extracted lessons learned, identified silver linings, and moved on to try again.

*The value of time: Five years would not have been enough.*

The chronology of Exhibit I-4 shows that by the end of Project Year 5, the project had major accomplishments, including the publication of 16 modules, 16 active IP's, and a vigorous annual

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<sup>7</sup> *Project Kaleidoscope*: <https://www.aacu.org/pkal>. *On the Cutting Edge* project: <https://serc.carleton.edu/NAGTWorkshops/about.html>. *Building Strong Geoscience Departments*: <https://serc.carleton.edu/NAGTWorkshops/departments/about/index.html>. *DLESE*: Manduca, C., & Mogk, D. W. (2000) *DLESE: A Community Plan: Final Report from the University of Oklahoma to the National Science Foundation Grant 99-06648*. [http://d32ogoqmya1dw8.cloudfront.net/files/earthandmind/posts/dlese\\_community\\_plan.pdf](http://d32ogoqmya1dw8.cloudfront.net/files/earthandmind/posts/dlese_community_plan.pdf). *Communities of transformation, synthesizing observations from PKAL, POGIL, SENCER, and BioQuest*: see Kezar, A., & Gehrke, S. (2015). *Communities of Transformation and their Work Scaling STEM Reform*: Pullias Center for Higher Education, Rossier School of Education, University of Southern California, <http://www.uscrossier.org/pullias/wp-content/uploads/2016/01/communities-of-trans.pdf>. *SENCER* (Science Education for New Civic Engagements and Responsibilities): <https://sencer.net>. American Meteorological Society: *DataStreme* Program: <https://www.ametsoc.org/index.cfm/ams/education-careers/education-program/k-12-teachers/datastreme-program/>. UCAR *COMET* program: <http://comet.ucar.edu/index.php>. *ESSEA*: <http://esseacourses.strategies.org>

<sup>8</sup> ... as would be predicted from InTeGrate's pedagogical stance that one learns by doing, more so than by reading about what others have done.

Rendezvous. However, had the project terminated at that point, many of the most important lessons learned would not have been nailed down or disseminated. A combination of no-funds-extensions and a supplement extended the project well into 2019, for a total duration of 8 years. During those extra years, the most substantial evaluation and assessment results came out, lessons learned from the IP's were synthesized, the Traveling Workshop program institutionalized the IP's lessons, a book was published about the project, and usage went "viral" and reached beyond early adopter faculty.

*It's not over when it's over*

As a funded NSF project, InTeGrate had a beginning, a middle, and end. But as an effort to improve teaching and learning about the Earth, InTeGrate was merely one phase in an ongoing effort that began generations ago, and will continue into the future. InTeGrate's tangible products remain available for use and re-use, including instructional materials, program models, and web-based professional development materials. The Earth Educators' Rendezvous, Traveling Workshop Program, and webinar program continue as part of NAGT. Students influenced by InTeGrate will carry some of their knowledge and perspectives about the Earth into their adult lives as professionals, parents, citizens, consumers, and decision-makers. Some faculty influenced by InTeGrate will continue to teach in ways that carry forward InTeGrate's guiding principles for the remaining decades of their careers.

And some of the leaders influenced by InTeGrate are moving on to build new ITG-inspired programs.<sup>9</sup> The curricular materials design model of InTeGrate is the basis for GETSI's ongoing curriculum development effort. Project EDDIE's vision includes a community of instructors using inquiry-based pedagogy and co-developing instructional modules. A GeoPATHS project centered at Savannah State is training a new generation of African American middle school teachers and teacher educators inspired by InTeGrate's vision of teaching about the Earth in the context of community-relevant problems. The Washington State IP team is undertaking an ambitious program to redesign STEM teacher preparation in a collaborative rather than single-institution improvement model.

In October, 2019, a workshop will convene to envision and share ideas for moving forward from the foundation built by the InTeGrate Project.<sup>10</sup> The conferees will find much to build on—but also many remaining challenges. The program models are ripe for replication, and better ways are needed to evaluate innovations at the scale of programs and departments. More instructional materials for upper division majors are needed, as are instructional materials around certain grand challenges such as “providing raw materials for modern society.” The community's ability to assess mastery of higher cognitive level learning goals, such as systems thinking, remains embryonic. InTeGrate tackled only undergraduate education, leaving vast domains of K-12, informal, and graduate/professional education open for ITG-inspired efforts. InTeGrate touched only U.S. institutions, but every inhabitant of the planet could benefit from ITG-caliber Earth education. The best ideas of Earth education reformers and researchers are still urgently needed.

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<sup>9</sup> GETSI: <https://serc.carleton.edu/getsi/index.html>. GEOPATHS: Expanding HBCU Pathways for Geoscience Education: [https://nsf.gov/awardsearch/showAward?AWD\\_ID=1802124&HistoricalAwards=false](https://nsf.gov/awardsearch/showAward?AWD_ID=1802124&HistoricalAwards=false). Project EDDIE: [https://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1821567&HistoricalAwards=false](https://www.nsf.gov/awardsearch/showAward?AWD_ID=1821567&HistoricalAwards=false). The Next Generation of STEM Teacher Preparation in Washington State: [https://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1625566&HistoricalAwards=false](https://www.nsf.gov/awardsearch/showAward?AWD_ID=1625566&HistoricalAwards=false)

<sup>10</sup> Earth Education for Sustainable Societies. Oct 14-17, 2019 workshop. [https://serc.carleton.edu/integrate/workshops/sust\\_societies/index.html](https://serc.carleton.edu/integrate/workshops/sust_societies/index.html)

