

The Science Education Initiative Handbook

A practical guide to fostering change in university courses
and faculty by embedding discipline-based education
specialists within departments



Stephanie V. Chasteen / Warren J. Code

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Stephanie V. Chasteen (University of Colorado Boulder) and
Warren J. Code (University of British Columbia)



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Foreword

This Handbook is based on the Science Education Initiative (SEI), a transformative initiative aimed at changing STEM teaching practices in university settings. The SEI was successfully implemented in two institutions (University of Colorado Boulder and The University of British Columbia) over a period of 10 years. The SEI centered on department-based Discipline-Based Education Specialists (DBESs), disciplinary experts with training in the science of teaching and learning who serve as catalysts of change within departments. The two SEIs have influenced the teaching of hundreds of faculty and the learning of tens of thousands of students per year by promoting the use of evidence-based teaching practices in STEM. These teaching practices are informed by research on teaching and learning, and often include some element of active learning.

This Handbook shares the accumulated wisdom of practice in how to effectively implement a model of change based on the SEI.

We wrote this Handbook to help address a need—several needs, actually: a societal need to improve STEM education without continually reinventing the wheel. A program-level need to put together coherent, well-designed educational initiatives to effect real change. A department-level need to support engagement and learning among students and faculty. A faculty-level need to teach effectively and feel fulfilled in the classroom. And a need on the part of the folks at the front line of this model, the Discipline-Based Education Specialists (DBESs), to spend their time productively, doing the daily work needed to champion change at all the levels of the educational system.

We both care deeply about all of these needs, particularly for those of the DBESs. We have both worked in the Science Education Initiative (SEI) for a large part of our professional careers, first as postdoctoral fellows (DBESs) in physics and math and later as leaders of these initiatives and others like them. We have been thrilled to see so many others taking up the SEI model at other institutions as a potentially transportable model of change.

We often talk to others using the SEI model, discussing the challenges and effective practices that we learned during the SEI. “Don’t forget to have the postdocs complete monthly reports,” we’d say, or “offer incentives to engage faculty in transforming their courses.” We often worried that the lessons we learned in the SEI would be forgotten, that it wasn’t clear why these lessons were important, and that there might be unintended consequences for others taking up their own initiatives, discovered too late, if we didn’t share what we learned. We have written this Handbook in large part to relieve our own anxiety in being effective advisors to other SEI-like programs.

We know there's a lot to keep track of; systemic change is a complex endeavor. It's challenging enough that we felt the need to create this Handbook to complement the recent book about the SEI (Wieman, 2017), which discusses the history and outcomes of the two SEIs. We know you won't do everything the way we did in the SEI; approaches will vary by local context. But our recommendations are hard-won and aligned with what is already known in institutional and organizational change, so we encourage you to consider them carefully. An initiative like the SEI is not magic; it is achievable by being deliberate and keeping track of important elements over a number of years.

On behalf of the SEI community, we welcome you and hope you will help us continue to learn about what works best for supporting deep improvements in education for students, faculty, departments, and the education community as a whole.

Stephanie Chasteen and Warren Code
August 2018

About the Authors

Stephanie V. Chasteen, Ph.D. is the Associate Director of the Science Education Initiative at the University of Colorado Boulder. She first joined the initiative in 2007 as a postdoctoral fellow. A physicist by training, Dr. Chasteen's first position in the SEI was as a Science Teaching Fellow (STF) in the physics department, helping to transform upper-division physics courses. She then worked as the SEI outreach director, creating many of the video resources on the use of clickers and peer instruction which are still widely used. Her current work focuses on supporting and researching department-based educational change initiatives. She is the PI of the [Transforming Education, Stimulating Teaching and Learning Excellence \(TRESTLE\) project](#) at CU Boulder, a 7-institution NSF-funded project to build on the SEI model. She is also an experienced and active consultant, providing evaluation services to institutional change projects (<http://chasteenconsulting.com>). Dr. Chasteen credits the SEI with giving her expertise and a career pathway into teaching and learning, and a lifelong passion for understanding how faculty and departments engage in using effective teaching practices.



Warren J. Code, Ph.D. is the Associate Director of the Science Centre for Learning and Teaching (skylight.science.ubc.ca) at the University of British Columbia (UBC). He first joined the Carl Wieman Science Education Initiative (CWSEI) at UBC in 2010 as a postdoctoral Science Teaching and Learning Fellow in the Mathematics Department. In 2013, he moved to Skylight, the permanent unit in UBC's Faculty of Science which is an accomplished example of a discipline-based teaching and learning centre. He was the acting director for the CWSEI in its final years, and has advised universities interested in the SEI model from several countries by email, hosted visits, travel, and participation in TRESTLE (see above). Along the way, he has published work related to active learning and student attitudes in undergraduate mathematics, as well as results related to the CWSEI's overall success.



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Detailed Table of Contents

Introduction

Chapter 1 – Introduction: What Is This Handbook and Who Is It For?

This Handbook shares the SEI's accumulated wisdom of practice in how to implement a department-based initiative, focusing on faculty learning and course transformation facilitated by Discipline-Based Educational Specialists (DBESs). It is aimed at institutional leaders, faculty, and education specialists wishing to create or implement a department-level change initiative for broadening faculty use of effective teaching practices. The Handbook is organized around the three main stakeholders in an initiative: initiative leaders, departmental leaders, and DBESs. This chapter discusses:

- What is the Science Education Initiative (SEI)?
- What is in this Handbook?
- Who is this Handbook for?
- More about the Science Education Initiative (SEI)
- Lessons learned in the SEI

Part I: The Initiative Leader's Handbook

Chapter 2 – What Is a Discipline-Based Education Specialist?

A Discipline-Based Education Specialist (DBES) is a person who acts as an agent of instructional change in a disciplinary department. The overarching goal of creating such a role is to foster expertise in teaching and learning among faculty. This chapter provides a definition of the role in terms of goals, activities, and common characteristics of DBESs, followed by recommendations for structuring such a position in an institution. Without a clear definition of the role, faculty may see the DBES as a teaching assistant and not fully leverage their expertise.

This chapter discusses:

- What is a DBES?
- What is the nature of the DBES position?
- What does an DBES do — and what is not their job?
- How do you structure an DBES position?

Chapter 3 – What Makes a DBES Successful?

Discipline-Based Education Specialists (DBESs) represent a relatively novel career path, and thus require specific training and on-the-job support in order to be successful. DBESs must hone their interpersonal skills (including the ability to persuade and negotiate with faculty), have excellent project management skills, and develop the education research expertise required for course transformation work. DBESs do not arrive at the institution ready to take on all such activities; they require time and development in order to reach their maximum capability. Without support, DBESs may become discouraged and frustrated to the point of abandoning the position. This chapter discusses DBES oversight, professional development, and community-building efforts by initiative organizers and/or the central organization.

This chapter discusses:

- What is the development path of a DBES?
- How do you initially train DBESs in the science of teaching and learning?
- How do you help DBESs develop fully as change agents?
- How can you build a DBES community?

Chapter 4 – The Central Organization: Overseeing the Initiative

While the structure will vary by institution, some sort of central organization or management is critically important in creating a vision and oversight for the initiative, building community for and training Discipline-Based Education Specialists (DBESs), communicating with stakeholders, and coordinating daily project operations. The central organization in the SEI acted as a highly involved funding agency, soliciting and funding proposals from departments, continually clarifying the DBES role, and providing ongoing oversight of projects through monthly DBES progress reports and regular meetings with DBESs and departmental directors. This oversight can help the central organization head off several common hurdles, such as poor departmental leadership, lack of departmental ownership of courses, and curricular issues, including over-packed curricula or entrenched course design.

This chapter discusses:

- What is the central organization?
- What does the central organization do?
- What human and financial resources are required?
- How do you solicit and fund effective proposals?
- How do you supervise the work?
- How can you create community?
- How can you lay the groundwork for sustainability?

Part II: The Department Leader's Handbook

Chapter 5 – Leading the Work from within the Department

Though many initiatives aim to influence the institution as a whole, the department is the key cultural unit on most campuses, and consequently, Discipline-Based Education Specialist (DBES)-focused programs should be designed to operate principally at the department level with coordination by a central organization. However, at the outset, a department may not have a natural structure for supervising a DBES and their accompanying course

transformation activities. The department needs to set goals for the initiative in their own context, supervise the DBES, and engage faculty in the work. In the SEI, the success of individual departments in terms of faculty engagement and use of course materials varied widely due to departmental factors.

This chapter discusses:

- How do you recruit and hire a DBES?
- How do you structure departmental leadership?
- How do you plan the departmental project?
- How do you engage faculty in the initiative?
- How do you build for sustainability?
- Departmental factors that help and hinder

Chapter 6 – Setting the Stage for Effective Course Transformations

A primary role of the Discipline-Based Education Specialist (DBES) is to facilitate course transformation: applying what is known from research about effective instructional practices into a specific course context, and being deliberate in the approach by using data from the course to support choices and capture the impact of the work. The departmental leadership has an important role to play in ensuring that course development is a collaboration among faculty and the DBES, that the working relationships progress smoothly, and that the changes to the course are sustained over time. This chapter outlines how the departmental leadership can support effective course transformations.

This chapter discusses:

- How do you plan a course transformation?
- How can you set expectations for DBES-faculty partnerships?
- How do you support sustainability of the transformation?

Part III: The Discipline-Based Education Specialists' Handbook

Chapter 7 – Course Transformation

A primary role of the DBES is to facilitate course transformation projects as a means of developing faculty expertise around teaching and learning. Focused course development will typically involve deep collaboration between the DBES and faculty (and often a faculty working group), as well as drawing on results from the education literature and data from the course. During the course transformation, the DBES can act like a partner and tactful coach for the course instructor, taking on some of the legwork and developing materials, then gradually turning these tasks over to the course instructor. This chapter outlines the resources and processes in developing a course using a backward design framework, beginning with the establishment of learning goals, followed by assessments and effective pedagogy, and ending with documenting and disseminating the work. Sustainable use is often the biggest challenge in this work, and ongoing communication with departmental faculty throughout the project is key.

This chapter discusses:

- What is a course transformation?
- Course transformation resources
- How do you start the project?

- How can you best use meetings with faculty?
- How do you design learning goals?
- How do you assess student outcomes?
- How do you develop course materials?
- How do you wrap up the work?

Chapter 8 – Partnering with Faculty

One of the most important goals of a DBES's job is to catalyze educational improvements within the department by educating faculty about teaching and learning. While early faculty partnerships should be brokered by the departmental director, over time, DBESs should try to engage as many faculty as possible in the initiative through gentle persuasion. DBESs should also be prepared to act as a coach for faculty, giving feedback on their teaching to help them improve.

This chapter discusses:

- How can you form faculty partnerships?
- How do you respectfully persuade faculty to consider changing their teaching?
- How can you give feedback and coach faculty productively?

Chapter 9 – Developing Your Roles and Skills

This chapter is directed at those in a Discipline-Based Education Specialist (DBES) role, and it provides more detail on elements of the job and advice for some common challenges encountered. It arises primarily from advice collected from experienced DBESs as they discussed and reflected on their role or as part of exit talks that were given at the end of their position. Thus, some of the information may be reflected elsewhere in the Handbook, but this chapter represents the types of words of wisdom which are often swapped more informally among DBESs from the departmental trenches. It is important to recognize that the role will necessarily vary in different departments and institutions, and that it may also be shaped by your background and interests. However, as some overarching principles, we encourage you to think of yourself as a catalyst, coach, and change agent.

This chapter discusses:

- How do you start out in your department?
- How do you integrate further in the department?
- How do you develop your skills as a DBES?
- What are common challenges faced by DBESs?
- Considerations for DBESs in specific types of positions
- What are the career paths for DBESs?

Appendix 1: Case Studies of SEI-like Initiatives

One of the successes of the SEI is that it has inspired many other similar initiatives aiming to improve teaching and learning through hiring of a variety of Discipline-Based Educational Specialists (DBESs). By providing these case studies, we wish to demonstrate a wide range of contextually-sensitive ways to create and run such an initiative. In the past, many people working to create SEI-like initiatives have contacted leaders of similar initiatives and visited other institutions to help guide their projects. The case study authors may be good resources as you envision your own approach.

1. Brown University's AAU Undergraduate STEM Education Initiative Project: Changing the Culture of Introductory Science
2. Cornell University's Active Learning Initiative
3. Imperial College London's Learning and Teaching Strategy
4. The University of British Columbia (UBC)'s Carl Wieman Science Education Initiative (UBC CWSEI)
5. The University of Colorado Boulder's Science Education Initiative (CU SEI)
6. The University of Hawai'i's Geoscience Course Transformation Project
7. The University of Kansas's Course Transformation Initiative

Appendix 2: Resources and References

This Appendix includes supporting resources and references for further exploration.

Supplemental Documents

Compilation of examples and guidance from the SEI.

Download a zip file of all supplemental documents.

Annotated References

Compilation of all citations from the Handbook.

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Acknowledgements

Glossary

1 - Introduction: What Is This Handbook and Who Is It For?

What is the Science Education Initiative (SEI)?

This Handbook is based on the Science Education Initiative (SEI), a transformative initiative aimed at changing STEM teaching practices in university settings. The SEI was successfully implemented in two institutions (University of Colorado Boulder and The University of British Columbia) over a period of 10 years. The model for change at the two institutions was the same, and we will treat them as the same, referring to the SEI throughout this Handbook.

The Handbook shares the accumulated wisdom of practice in how to effectively implement a model of change based on the SEI. The SEI centered on department-based Discipline-Based Education Specialists (DBESs), disciplinary experts with training in the science of teaching and learning who serve as catalysts of change within departments. The two SEIs have influenced the teaching of hundreds of faculty and the learning of tens of thousands of students per year by promoting the use of evidence-based teaching practices in STEM. These teaching practices are informed by research on teaching and learning, and often include some element of active learning. The SEI also focused on changes which support creation of the ‘expertise-based classroom’, where the goal is to guide students from novice thinking toward expertise in the discipline. The design and outcomes of the SEI are described in detail in Carl Wieman’s detailed book, *Improving How Universities Teach Science* (Wieman, 2017).

What is in this Handbook?

This Handbook shares the SEI’s accumulated wisdom of practice in how to implement a department-based initiative, focusing on faculty learning and course transformation facilitated by DBESs. Readers will learn how they might structure such an initiative, hiring DBESs, organizing the work within the department, transforming courses, and partnering with faculty. This Handbook is authored by two former DBESs with a collective 20 years of experience in SEI and SEI-like initiatives across multiple disciplines (see [About the Authors](#)). It is intended to be a practical companion guide to Wieman (2017).

Who is this Handbook for?

This Handbook is aimed at institutional leaders, faculty, and education specialists wishing to create or implement

a department-level change initiative for broadening faculty use of effective teaching practices. While the SEI focused mostly on the teaching and learning of science, the SEI's approaches are also appropriate for mathematics and engineering disciplines, and likely for arts and humanities as well.

The Handbook is organized around the three main stakeholders in an initiative: initiative leaders, departmental leaders, and DBESs. While every stakeholder will benefit from the content throughout this Handbook, the main audiences for each part of this book and their roles in the initiatives are indicated below.

What does each stakeholder need to do?	What can they learn in this book?
<u>Initiative Leaders</u> <ul style="list-style-type: none"> Solicit and review departmental proposals Run the initiative Train and support DBESs 	<u>Part I: The Initiative Leader's Handbook</u> <i>The overall rationale, structure, and oversight of an initiative.</i> <ul style="list-style-type: none"> Chapter 2: What Is a DBES? Chapter 3: What Makes a DBES Successful? Chapter 4: The Central Organization: Overseeing the Initiative Appendix 1: Case Studies of SEI-like Initiatives
<u>Departmental leaders</u> <ul style="list-style-type: none"> Hire and supervise DBESs Plan the work in the department Engage faculty and manage expectations Partner with DBESs on course transformation 	<u>Part II: The Departmental Leader's Handbook</u> <i>How to structure course transformations, faculty engagement, and DBES work.</i> <ul style="list-style-type: none"> Chapter 5: Leading the Work from within the Department Chapter 6: Setting the Stage for Effective Course Transformations
<u>Discipline-Based Education Specialists (DBESs)</u> <ul style="list-style-type: none"> Understand their roles Develop skills Facilitate course transformations Partner with faculty 	<u>Part III: The DBES' Handbook</u> <i>The nuts and bolts of working with courses, faculty, and developing your skills.</i> <ul style="list-style-type: none"> Chapter 7: Course Transformation Chapter 8: Partnering with Faculty Chapter 9: Developing your Role and Skills

More about the Science Education Initiative (SEI)

Summary

Nobel laureate Carl Wieman, a leader in science education, designed and directed STEM education initiatives at two large, research-intensive universities: University of Colorado Boulder (CU Boulder; 2006-2014) and The University of British Columbia (UBC; 2007-2017). The goal of the SEI was to change departmental teaching practices and culture, aiming for a majority of faculty in departments to use and sustain research-based instructional practices. The SEI model hinged upon providing competitive grants to departments, which were used to hire DBESs. The DBESs had disciplinary expertise and training in education, and partnered with faculty members as course consultants.



Computer science DBES Ed Knorr works with a faculty member (Credit: Centre for Teaching, Learning and Technology / University of British Columbia. All rights reserved.)

The key assumptions or principles guiding the SEI approach were:

- The logical unit of change is the department.
- Additional resources of time and human capital are needed to support change.
- Faculty expertise is best developed by applying ideas, hence focusing on transformation of specific courses.
- Evidence of impact is an important tool in persuasion and guiding improvements.

The core SEI structure was developed from these assumptions:

- A central unit (SEI Central) ran the initiative.
- Competitive grants were awarded to departments.
- Departments identified departmental directors to liaise with SEI Central.
- Funding was primarily used to hire DBESs (one-to-four per department).
- DBESs were trained and supported by departments and SEI Central.

The DBESs were central to this model. Hired as postdoctoral fellows or contract faculty, the DBESs brought graduate-level education (usually a PhD) in their disciplines and, typically, some post-secondary teaching experience. Given ongoing training and guidance in science education fundamentals by SEI Central, they acted as ‘educational engineers’ and faculty coaches, gaining familiarity with research on student misconceptions and other discipline-specific concerns, gathering data on student thinking, analyzing exams and homework, listening to student

discussions during problem-solving activities, developing and administering concept tests and attitudinal surveys, and publishing results where possible.

Related resource: [Transforming Science Education at UBC: The Carl Wieman Science Education Initiative](#) (Published June 2017, The University of British Columbia).



A YouTube element has been excluded from this version of the text. You can view it online here: <https://pressbooks.bccampus.ca/seihandbook/?p=118>

Available at <https://www.youtube.com/watch?v=3MbgsM4skf0>.

The SEI at two campuses

Below are key facts and the scale of the initiatives at University of Colorado Boulder and The University of British Columbia.

	CU Boulder	UBC
Title of the initiative	University of Colorado at Boulder Science Education Initiative (CU SEI)	Carl Wieman Science Education Initiative (UBC CWSEI)
Years of operation	2006-2014	2007-2017
Total funding amount (USD)	\$5.3M	~\$11M ¹
Funding per department (USD)	Range: \$150K-\$860K Average: \$650K (main departments)	Range: \$270k-\$1.7M Average: ~\$1.3M (main departments)
Number of departments	6 + 1 smaller pilot	6 + 1 smaller pilot
DBES position title	Science Teaching Fellow (STF)	Science Teaching and Learning Fellow (STLF)
Total number of DBESs (including part-time employees)	24	50

Outcomes from the SEI

The SEI had many positive impacts and outcomes, however, a lack of explicitly allocated funding and time for project assessment was a challenge in systematically investigating impacts at the university level. This is an important message for future initiatives: evaluation beyond the assessment of individual course transformations requires dedicated funding and attention.

Major outcomes of the SEI include:

- **Extensive changes in teaching practices** (120 courses at UBC and 50 courses at CU Boulder with significant levels of transformation), with faculty self-reports and classroom observations demonstrating changed practices.
- **Changes in teaching and learning culture**, with students considering active learning relatively normal in departments with substantial SEI involvement. Departmental impact metrics (including cross-departmental impacts, case studies, and faculty surveys) demonstrated effects on departmental culture, though these impacts varied by department.
- **Improved student learning**, based on learning assessments, student self-assessments, and student feedback.
- **Successful careers for DBESs**, with most finding teaching-focused faculty positions, work in teaching centers, or positions in discipline-based education research.
- **Contributions to scholarly work** on teaching and learning, with a collection of over 120 peer-reviewed journal articles, posters, implementation guides, video examples, and recommended reading. See [SEI Papers and Presentations](#).
- **Inspiration of other educational change initiatives**, with the SEI model being sufficiently transportable that it has sparked similar initiatives elsewhere. You can read about how some of these initiatives have adapted the model and their lessons learned in Appendix 1: Case Studies.

More detail on the SEI's outcomes is available in the list of resources at the end of this chapter. For more discussion on individual department success and associated outcomes in particular, see Wieman (2017).

1. Total funding at UBC was \$11.54M CAD, and departmental funding ranged from \$300K - \$1.86M CAD with an average of \$1.45M CAD in the main departments. Exchange rates have fluctuated during the course of the SEI, averaging around 0.94 USD: 1 CAD.



Faculty member Alexis Templeton of CU Boulder teaches a geology class using SEI-developed materials (Credit: Leilani Arthurs / CU Boulder. All rights reserved)

Lessons learned in the SEI

We will not delve into the analysis that led to the conclusions in this section [see Wieman (2017) for this analysis], but we summarize here the major lessons learned from our experience with the SEI. These lessons are what give rise to our detailed recommendations in this Handbook.

Lessons about working with departments

The most clearly effective elements of the SEI were those that provided resources to departments, but these resources required ongoing oversight from SEI Central.

Provide funding to departments through competitive grants

Initiative funding levels need to be sufficient to convince departmental leadership to invest the time and political capital required to secure faculty consensus and motivate action for meaningful change. See [Chapter 4: Central Organization](#) for a discussion of sufficient funding levels.

Provide embedded expertise to departments through DBESs

The SEI model depends on capable DBESs who require time, guidance, and support both to develop the skills and background needed for success in their roles and to become valued members of their departments.

Provide ongoing oversight and support of departmental progress

Work in such an initiative needs to be carefully planned, both in terms of faculty commitments and the timing of their involvement: long-term teaching assignments need to align with the SEI work being proposed and with DBES availability. Ongoing oversight and support of department progress is also needed, with potential consequences for failing to follow through on commitments. For example, at UBC, the dean's leadership was important in selecting department heads who supported the SEI, and in working with heads whose departments were not fulfilling their commitments.

The primary determinant of success is departmental structure and culture

Of particular importance is the overall quality of organization and management in the department. The structure and culture of departments includes the interest and commitment of its faculty, the head/chair, and the SEI departmental director.

Lessons about achieving change in university teaching

Below are general lessons we learned about the feasibility of operating a large, multi-year education initiative. For further discussion of barriers and unsolved issues, see Wieman (2017).

- **It is possible to achieve widespread change within departments.**
- **Persistence and flexibility** are needed to achieve good results.
- **Virtually all faculty want to teach well**, and a priori predictions about who might be interested in such techniques are not always accurate.
- **Faculty encounter a significant initial learning curve.** It can take two-to-three years for a faculty member to fully embrace these teaching methods and use them competently.
- **The largest barrier to faculty change is the formal incentive system.**
- **Course transformation is an iterative and complex process**, as is learning and practicing associated teaching methods. Starting with smaller, concrete changes or single section courses is often more motivating to faculty than sweeping changes to instruction, especially if these smaller changes address an existing concern about their course.
- **Systematic measures of what students know and think (using local data) are essential**, though development of validated tools takes significant time, which needs to be built in the project plan.

For further reading

To learn more about the SEI model

- **Video summary on the UBC CWSEI:** [Transforming Science Education at UBC](#)
- **Authoritative history and analysis of the SEIs at UBC and CU Boulder:** Wieman (2017), *Improving How Universities Teach Science*.
- **A summary of the SEI model for both institutions that relates to theories of change in higher education:** "The Science Education Initiative: An Experiment in Scaling Up Educational Improvements in a Research University" within the book *Transforming Institutions: Undergraduate STEM Education for the 21st Century* by Weaver, G.C., Burgess, W.D., Childress, A.L., & Slakey, L. (2015).

- **Case study summary of SEIs:** The collection of case studies from the American Association of Universities includes a summary of the SEIs, and one case study is devoted to the perspective of UBC Dean of Science Simon Peacock on the UBC CWSEI. See Dolan, E. L., Lepage, G. P., Peacock, S. M., Simmons, E. H., Sweeder, R., & Wieman, C. (2016). *Improving Undergraduate STEM Education at Research Universities: A Collection of Case Studies* Tucson, AZ: Research Corporation for Science Advancement. Retrieved from <https://www.aau.edu/key-issues/improving-undergraduate-stem-education-research-universities-collection-case-studies>

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Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., Norman, M. K., & Mayer, R. E. (2010). *How learning works: Seven research-based principles for smart teaching*. San Francisco, CA: Jossey-Bass.

Outlines major principles for how students learn.

Handelsman, J., Miller, S., & Pfund, C. (2006). *Scientific teaching*. New York, NY: W.H. Freeman.

Describes the scientific approach to teaching, which underlies the SEI model.

Huber, M., Hutchings P., (2014). *Bay View Alliance case study #2, research action cluster 1: The Carl Wieman Science Education Initiative in Earth, Ocean and Atmospheric Sciences*.

Case study on one of the most successful SEI departments.

Kober, N. (2015). *Reaching students: what research says about effective instruction in undergraduate science and engineering*. Washington, DC: The National Academies Press.

This resource identifies the department as the unit of change (albeit using the SEIs as an example) and provides general methods about instructional effectiveness. Chapter 7: “Creating Broader Contexts That Support Research-Based Teaching and Learning” is particularly relevant to SEI-like initiatives.

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An early discussion of the SEI model and progress.

Part I. The Initiative Leader's Handbook

Chapter 2 – What Is a Discipline-Based Education Specialist?

- What is a DBES?
- What is the nature of the DBES position?
- What does an DBES do — and what is not their job?
- How do you structure an DBES position?

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- How do you initially train DBESs in the science of teaching and learning?
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Chapter 4 – The Central Organization: Overseeing the Initiative

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- How do you solicit and fund effective proposals?
- How do you supervise the work?
- How can you create community?
- How can you lay the groundwork for sustainability?

2 - What Is a Discipline-Based Education Specialist?

Summary

A Discipline-Based Education Specialist (DBES) is a person who acts as an agent of instructional change in a disciplinary department. The overarching goal of creating such a role is to foster expertise in teaching and learning among faculty. This chapter provides a definition of the role in terms of goals, activities, and common characteristics of DBESs, followed by recommendations for structuring such a position in an institution. Without a clear definition of the role, faculty may see the DBES as a teaching assistant and not fully leverage their expertise.

Successful framing of the DBES position

Position the DBES as a knowledgeable catalyst of change. DBESs collaborate with faculty on course transformation projects, focusing on supporting and coaching faculty in developing teaching and learning expertise. Thus, DBESs must have expertise in their disciplines, have an interest in and receive training in teaching and learning, and have good interpersonal, organizational, and time management skills.

Set clear expectations for the DBES's work, such as supporting course transformation activities, research design, analyzing educational data, facilitating discussions, and disseminating results. The most successful DBESs enable teaching development and facilitate data-driven decision-making, rather than being used as a teaching assistant or instructional designer.

Structure the position to achieve maximal impact. Create a department-based postdoctoral or instructor-level position on a two-to-three year contract, with research and a small amount of teaching allowed.

What is a DBES?

Faculty are often interested in trying educational innovations, but lack the time and expertise to carry them out. A DBES is a generic description of a person who provides expertise both in a discipline (e.g., chemistry, mathematics, etc.) and in effective education techniques. While the SEI focused on DBESs within STEM, some non-STEM departments are also employing this approach. DBESs provide an essential link between departmental faculty and the broader education research community. They are not just people who are enthusiastic about teaching; they bring unique expertise to help facilitate the implementation of more effective, research-based methods of instruction in a department. A DBES is likely to be part of a broader initiative on campus to improve teaching and learning. See [Chapter 4: Central Organization](#) for how such an initiative may be organized.



Former DBES Laurie Langdon (middle) at the University of Colorado Boulder. (Photo by Casey A. Cass/University of Colorado. All rights reserved.)

What is the nature of the DBES position?

A DBES position is usually located within an individual department, and it can be held by a variety of types of personnel, including:

- Postdoctoral fellows (typical),
- Contract lecturers, and/or
- Permanent instructors.

In general, a DBES position is a contract role for a period of two or more years. If a permanent instructor is asked to incorporate DBES duties within their position, however, it could be a longer-term appointment.

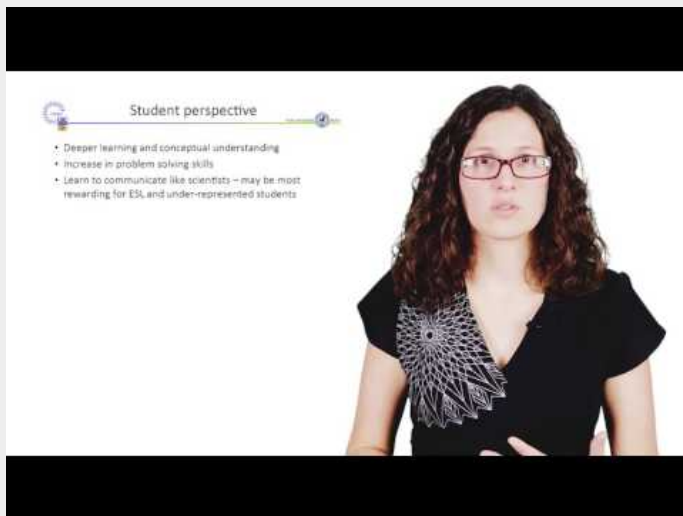
Key features of a DBES position

The DBES is hired directly into the department. Unlike staff at a teaching and learning center, the DBES is a member of the department and acts as a departmental resource. The department is responsible for hiring and supervising the DBES. This allows the DBES to influence change from within the department, based on departmental priorities.

The DBES has a high-level background in their discipline. This enables the DBES to engage deeply in the disciplinary elements of teaching and learning, providing targeted guidance to faculty within the context of the discipline (Kober, 2015). It also positions the DBES as more of a colleague (even if junior) in the department, which for many faculty makes them more approachable than educational developers elsewhere on campus (Huber and Hutchings, 2014).

The DBES receives training in teaching and learning. DBESs have a keen interest in improving teaching and learning, but typically have limited prior experience in education, particularly in STEM education research. Upon hiring, the DBES is given training in pedagogy and course design, which is ongoing through their position. Often, the DBES has some teaching experience as well.

Related resource. [Interactive Learning in Practice-the Carl Wieman Science Education Initiative](#) (Published June 2017, Imperial College London).



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Available at <http://bit.ly/2ycKQxw>

The DBES is a catalyst of departmental change

A primary DBES responsibility ought to be acting as a catalyst of change, with a focus on developing faculty expertise in teaching. This focus will effect a deep and lasting change in departments, with course transformation as a means to this end.

To fulfill this role, DBESs act as knowledgeable education experts and collaborate with faculty and course instructors on course transformation efforts in their departments. They may investigate student learning, develop learning goals, adapt or create course materials, monitor progress, measure effectiveness, and disseminate results—including contributing to the education research literature. DBESs can serve as departmental resources on pedagogy through a range of activities, such as facilitating casual discussions and conducting seminars and workshops.

Thus, the DBES serves as a ‘change agent’ and provides valuable human capital for undertaking education transformations in a department, providing both the expertise and time which faculty typically lack. (‘Change agent’ is a term adopted within the higher education literature, and is thus useful for those wishing to further research the underlying model for the DBES.) While the DBES position is the largest expense associated with an SEI-like initiative, it is also arguably the lynchpin which allows the initiative to succeed.

Primary DBES roles

1. **Catalyze instructional change** in the department, including supporting course transformation activities.
2. **Serve as a departmental resource** and connection to scholarly information about teaching and learning.
3. **Coach faculty**, providing feedback on teaching.
4. **Facilitate faculty communication** and consensus building.
5. **Collect, distill, and communicate data** to guide faculty effort.

Key skills and background of a DBES

It is increasingly possible to hire postdoctoral applicants with expertise both in their disciplines and in STEM education [for example, see Bailey and Lombardi (2015)], but this combination is neither necessary nor sufficient. While this combined expertise can be developed over time as part of the DBESs’ training, successful DBESs will enter the role with the following characteristics:

The DBES must be expert in the discipline

One hallmark of a DBES is that they have expertise in their discipline, usually at the PhD level. MS-level candidates have also been successful with the right background, though these DBESs may have more difficulty attaining professional credibility in their departments.

The DBES should have an interest in education and teaching

At minimum, the DBES should be personally and professionally interested in education. Though not critical, teaching experience at a college or K12 level can be very useful. They will likely have career aspirations related to teaching or teaching improvement work in higher education. See [Chapter 9: DBES Development](#) for more on post-SEI career paths.

The DBES should possess good interpersonal skills

The best DBESs are those who are able to negotiate, persuade, motivate, and inform—without being pushy. Verbal and written communication skills, including active listening, are helpful.

The DBES should be well-organized and have good time management skills

A DBES must juggle multiple priorities, including both short-term and long-term deadlines. A good DBES has

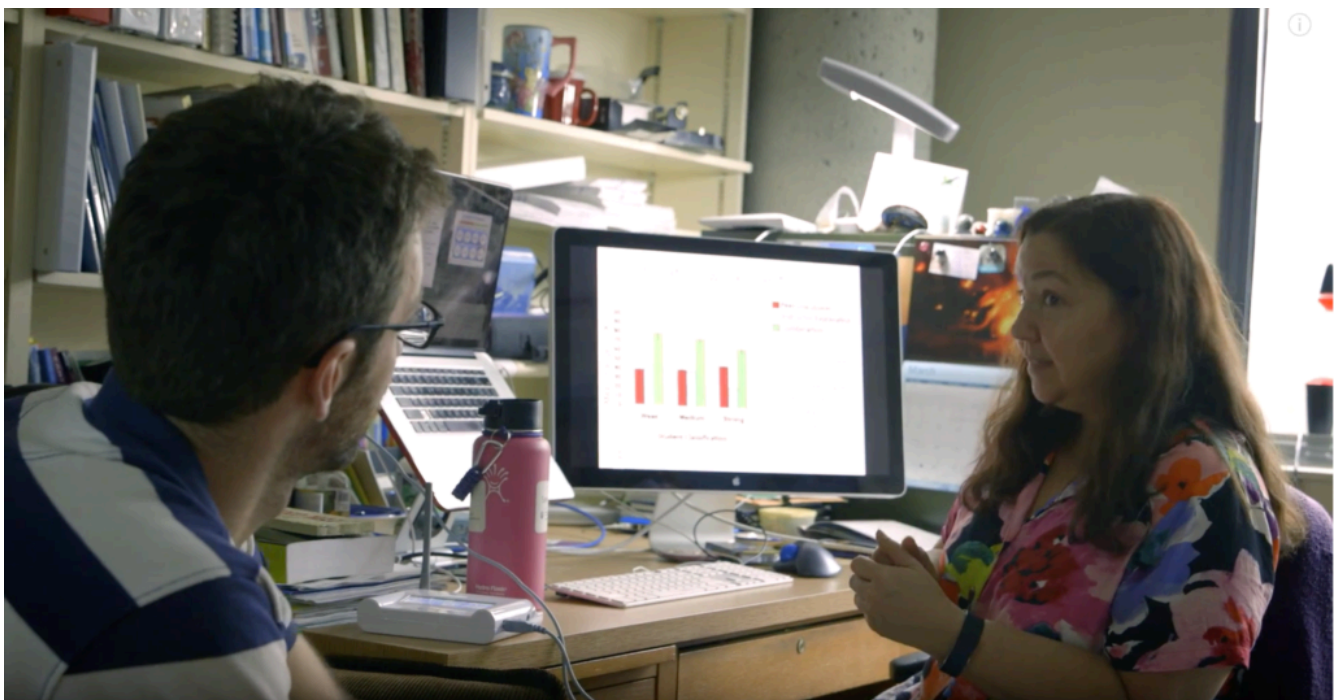
excellent time management and project management skills, can work independently, and can balance different projects and priorities.

That said, a DBES is made, not born; it is rare that applicants will have all of the above characteristics. See [Chapter 3: DBES Success](#) for more information on how DBES skill development continues post-hire.

What does a DBES do—and what is not their job?

It is important to explicitly and clearly define the DBES role; otherwise, there is ample room for misinterpretation among faculty and the DBESs themselves. The DBES should support faculty efforts and guide change in the department, rather than serving as instructional staff. See the overview in [STLF Role and Faculty Working Arrangement](#) to see how the DBES role was defined in the SEI; this description was circulated among funded departments.

Defining the DBES role was a challenge in the early SEI, with the consequence that early DBESs were mainly tasked with developing course materials, assuming that faculty would be willing partners in this endeavor. This resulted in low levels of faculty and departmental commitment to the production and continued use of developed materials. See [Chapter 5: Departmental Leadership](#) and [Chapter 8: Partnering with Faculty](#) for more.



DBES Sarah Bean Sherman consults with a faculty member at UBC. (Credit: Faculty of Science / University of British Columbia. All rights reserved.)

Daily tasks

A DBES's day-to-day job varies widely based on local needs. In association with the departmental director and other faculty, DBESs should determine the most appropriate use of their time given departmental priorities and faculty interest. Given the wide range of possible duties for a DBES, it is important to try to avoid 'mission creep'

of the DBES's role and to set clear expectations for their work. See [Chapter 3: DBES Success](#) for guidance on training DBESs and [Chapter 5: Departmental Leadership](#) for guidance on setting expectations and guiding the DBESs' work. Chapters 7-9 provide specific guidance written for DBESs about their tasks and roles.

Below are several tasks that are often undertaken by DBESs—again, with their focus as serving as a catalyst of change, rather than necessarily undertaking the bulk of course transformation work themselves.

Possible DBES tasks

Support course transformation activities*

- Investigate student learning
- Facilitate the development of learning goals, meeting with course instructors individually or in groups
- Survey course instructors to establish areas of consensus and priorities for the course
- Facilitate discussions among instructional teams
- Develop curricular materials (clicker questions, worksheets, etc.)
- Provide feedback on curricular materials developed by others
- Develop measures of student learning (exams, homework, pre-/post-tests)
- Observe classes
- Provide feedback on course implementation
- Archive and disseminate results

* These duties are in collaboration with the faculty teaching team: See [Chapter 7: Course Transformation](#) for more.

Analyze data on student learning

- Identify areas of instruction that could benefit from change
- Ask faculty members whether there are data on student learning they are particularly interested in seeing
- Develop/implement/analyze learning diagnostic tests or concept inventories
- Develop/implement/analyze faculty or student attitude and feedback surveys
- Analyze exam and homework data for evidence of educational problems and successes
- Interview students about their learning and educational experiences
- Review existing literature to gain familiarity with research on student misconceptions and other discipline-specific concerns
- Conduct informal problem-solving sessions
- Listen to student discussions during activities

Facilitate discussions around teaching

- Initiate discussions with instructors about teaching
- Facilitate group meetings among instructional teams teaching a course
- Provide feedback to the department faculty on curriculum
- Host ‘brown bag’ discussions around teaching and learning
- Seek out informal discussions with instructors

Serve as a departmental resource

- Consult with faculty on general questions about teaching and learning
- Take on smaller projects as a consultant rather than embarking on a full course transformation
- Host teaching and learning workshops within the department
- Create a departmental newsletter around the teaching initiative
- Create training programs for departmental teaching assistants to better implement the new teaching methods

Conduct research and disseminate results

- Design and implement research studies
- Develop assessments of student learning (e.g., diagnostic tests, concept inventories)
- Conduct data analysis
- Analyze data for internal use (e.g., Scholarship of Teaching and Learning), such as course-specific data or locally valuable student feedback
- Write up research for publication
- Share results with the local education community
- Present at conferences

Other duties

- Engage in ongoing professional development through the SEI and their own reading, and by attending workshops to develop expertise in education
- Support general SEI activities, such as annual conferences, creating documentation, mentoring new DBESs, etc.
- Provide short activity reports to SEI Central and the department

What is *not* the role of the DBES?

It is important that the DBES is treated as a respected member of the department whose job is to partner with faculty to implement course transformation, rather than be seen as a glorified teaching assistant whose job is only to develop instructional materials.

The DBES is not a teaching assistant

In order to be maximally effective as a change agent in the department, the DBES must achieve the status and respect of a professional within the department, with both relevant educational expertise and high-level disciplinary knowledge. In departments where the DBES is treated as a teaching assistant, this is not productive or professionally satisfying. When the DBES is introduced to students, their role should be described so as to best support student respect (e.g., as a co-instructor, and definitely not as a teaching assistant).

The DBES is not (primarily) a teacher

While it is very valuable for the DBES to co-teach a course with departmental faculty or to teach a course in addition to their DBES role, the DBES position itself is not that of instructional staff. In the SEI, departments often paid their DBESs separately as lecturers if they wished to serve as instructors of record for an entire course.

The DBES is not (primarily) an instructional designer

While instructional design can be one aspect of the DBES's role, they should not be simply handed the duty of designing educational materials without faculty involvement. The role of the DBES is to guide faculty in learning how to develop such materials on their own—though this process may begin with the DBES developing materials and taking on some of this work.

The DBES is not (primarily) an education researcher

While education research is an important element of the DBES role, the role includes many other aspects of supporting instructional reform. Additionally, DBESs vary in their interest in conducting publishable education studies. In some cases in the SEI, a DBES who was very focused on education research contributed significantly to the field, but their impact in the department itself may have been mitigated by the time spent in conducting studies.

The DBES does not tell faculty how to teach

The DBES is a knowledgeable coach, but their role is not to dictate what faculty should do or how they should do it. A good DBES will be responsive to faculty and focus on spreading ideas. See [Chapter 8: Partnering with Faculty](#).

How do you structure a DBES position?

Given the unusual combination of duties required of a DBES, most institutions do not have an existing position that can suitably fit these duties. While there are some variations across departments, the following position structures were useful in giving the DBESs adequate time and positioning to do their jobs well.

The DBES should be located within the department

The DBES should be a member of the department, both physically and in spirit. They should be rostered and have an office within the department, be supervised by department faculty, and be included in departmental functions such as faculty meetings, social events, email lists, etc.



DBESs Leilani Arthurs and Jennifer Stempien host departmental celebration for tutors in the Geology department (Credit: Leilani Arthurs / CU Boulder. All rights reserved).

The DBES should be hired by the department with guidance

To ensure that the DBES is considered a member of the department, the department should be responsible for their hiring and supervision. The initiative organizers should discuss the search process with the department, help the department write the job advertisement, offer suggestions on where to post the advertisement, meet with candidates, and provide suggestions but defer to the department on the final hiring decision. During the interview process, the hiring committee should ensure that the candidate's expectations of the role is clear, especially regard-

ing the delineation between the supervisor in the department and the general support provided by the central organization. See [Chapter 5: Departmental Leadership](#) for advice on the search process.

The formal DBES position description should include both research and (minimal) teaching

At some institutions, this will require a new type of job title—a short-term PhD-level position which can include both research (in education) and teaching (in some cases, this may be formally forbidden). It is valuable for DBESs to engage in semi-regular teaching as part of their professional development, but this may need to be constrained to ensure that the initiative's funds are not used to staff departmental teaching loads.

Below are two restrictions that were used in the SEI:

1. DBESs may teach up to one course per year.
2. Initiative funds cannot be used to pay the DBES salary during teaching.

Teaching situations usually required close monitoring on the part of the initiative organizers to properly account for funding and to keep teaching assignments from overloading DBESs.

The DBES should be a two-to-three year, full-time position

The position has a steep learning curve, and change in a department takes time. However, positions are usually advertised as one-year renewable positions, which is customary for postdoctoral positions. This limited term allows for the possibility of termination in rare cases where either the DBES and/or the department is not fulfilling their obligations.

It is helpful if the DBES is hired at the instructor or faculty level

This ranking provides some credibility and positional power for the DBES, plus longevity for the position, compared to a postdoctoral position (this was the case in two of the most successful SEI departments). Typically, however, DBESs are hired at the postdoctoral level.

It is helpful to hire multiple DBESs at once

This combats isolation of DBESs and enables them to reach many faculty as a team, enabling broad culture change. The most effective SEI departments had three-to-four DBESs working on multiple courses at the same time. DBESs can also benefit from a community across departments. See [Chapter 3: DBES Success](#).

Chapter 2 Checklist

In order to ensure that the DBES position has the best chance of effecting change in the department, initiative organizers should consider the following actions:

Ensure the critical features of a DBES position are established

- The DBES is seen as a catalyst of departmental change whose role is to foster faculty expertise in teaching and learning.
- The DBES is hired directly into the department.
- The DBES has a high-level background in their discipline along with other desirable qualities for the role, such as interpersonal and time management skills.
- The DBES receives training in teaching and learning.

Introduce the DBES role clearly to the department

- Explicitly define the role of the DBES, so that the department, faculty, and DBES share a common understanding of their job.
- Ensure the DBES is seen as a member of and reports to the department (not the central organization).
- Ensure the DBES is seen as a departmental resource and faculty coach focused on course transformation and assessment activities, not as a teaching assistant or instructional designer. See table “Possible DBES tasks” in this chapter.

Structure DBES positions to maximize potential for success

- Create a formal job description which allows research and teaching as part of the same position.
- Locate the position within the department and have the department carry out the hiring process, providing guidance and advice during candidate recruitment and selection.
- Provide for at least a two-year appointment.
- Consider hiring at the instructor level (i.e., above postdoctoral level).
- Consider hiring multiple DBESs at once (within or across departments) to enable the development of a professional community.
- Allow opportunities for DBESs to teach courses (financially supported by the department and carefully monitored by the central organization).

For further reading

SEI resource documents

Overview of DBES role and faculty collaboration in the SEI: [STLF Role and Faculty Working Arrangement](#).

Annotated bibliography

Bailey, J. M., & Lombardi, D. (2015). Blazing the trail for astronomy education research. *Journal of Astronomy and Earth Sciences Education*, 2(2), 77.

Describes the growing availability of disciplinary education experts available to serve as DBESs.

Bush, S.D., Stevens, M.T., Tanner, K.D., & Williams, K.S. (2017). Origins of science faculty with education specialties: Hiring motivations and prior connections explain institutional differences in the SFES phenomenon. *BioScience*, 67(5), 452-463.

This and the two following articles in this bibliography discuss the hiring of disciplinary education faculty, who may act as DBESs.

Bush, S.D., Rudd II J.A., Stevens, M.T., Tanner, K.D., & Williams, K.S. (2016). Fostering change from within: Influencing teaching practices of departmental colleagues by science faculty with education specialties. *PLOS ONE*, 11(3), 1-20.

This article found that DBESs tend to affect the instructional practices of their colleagues.

Bush, S.D., Pelaez, N. J., Rudd, J.A., Stevens, M.T., Williams, K.S., Allen, D.E., & Tanner, K.D. (2006). On hiring Science Faculty with Education Specialties (SFES) for your science (not education) department. *CBE-Life Sciences Education*, 5(4), 297-305.

Hiring DBESs is increasingly common; this article discusses their potential roles and integration into departments.

Dancy, M., & Henderson, C. (2010). Pedagogical practices and instructional change of physics faculty. *American Journal of Physics*, 78(10), 1056-1063.

This article finds that physics faculty are interested in making instructional changes, but lack time and knowledge to implement innovations.

Eckel, P., Green, M., Hill, B., & Mallon, W. (1999). *On Change III: Taking charge of change: A primer for colleges and universities. An occasional paper series of the ACE Project on leadership and institutional transformation*. Washington, DC: American Council on Education.

A practical guide to leading change within an institution, including strategies and information on supporting change agents.

Henderson, C., Dancy, M., & Niewiadomska-Bugaj, M. (2012). Use of research-based instructional strategies in introductory physics: Where do faculty leave the innovation-decision process? *Physical Review Special Topics—Physics Education Research*, 8(2), 020104.

Article discussing issues on sustainability of instructional changes made by faculty.

Huber, M., Hutchings, P., (2014). *Bay View Alliance case study #2, research action cluster 1: The Carl Wieman Science Education Initiative in Earth, Ocean and Atmospheric Sciences*.

Case study on one of the most successful SEI departments.

Kezar, A. (2009). Change in higher education: not enough, or too much? *Change: The Magazine of Higher Learning*, 41(6), 18-23.

Discusses the challenge of change in college campuses, using insights from studies on change leadership. Also discusses the importance of change agents.

Kezar, A. (2014). *How colleges change: Understanding, leading, and enacting change*. New York, NY: Routledge.

A more detailed scholarly volume on the topic of leadership and academic change.

Kober, N. (2015). *Reaching students: what research says about effective instruction in undergraduate science and engineering*. Washington, DC: The National Academies Press.

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Wieman, C., Perkins, K., & Gilbert, S. (2010). Transforming science education at large research universities: A case study in progress. *Change*, 42(2), 7-14.

An early discussion of the SEI model and progress.

3 - What Makes a DBES Successful?

Summary

Discipline-Based Education Specialists (DBESs) represent a relatively novel career path, and thus require specific training and on-the-job support in order to be successful. DBESs must hone their interpersonal skills (including the ability to persuade and negotiate with faculty), have excellent project management skills, and develop the education research expertise required for course transformation work. DBESs do not arrive at the institution ready to take on all such activities; they require time and development in order to reach their maximum capability. Without support, DBESs may become discouraged and frustrated to the point of abandoning the position. This chapter discusses DBES oversight, professional development, and community-building efforts by initiative organizers and/or the central organization.

Approaches to ensuring success and satisfaction among DBESs

Provide DBES professional development around teaching and learning, education research, and common challenges in the job (e.g., through initial training, ongoing meetings, a reading group, and an annual celebration).

Establish a DBES professional community to provide support, feedback, and ongoing development using the engagement tools described above.

Establish clear departmental expectations and oversight for management of the work and DBES supervision. See [Chapter 4: Central Organization](#) and [Chapter 5: Departmental Leadership](#).

What is the development path of a DBES?

While DBESs should possess a certain baseline set of attributes (see [Chapter 2: What is a DBES?](#)), a good DBES is made and not born. It is important to allow enough ramp up time for a DBES to be maximally productive in their job. Below we describe how DBESs can develop their skills over time.



Three DBESs (Cheryl Pinzone, Ruth Heisler, and Teresa Foley) from University of Colorado discuss teaching and learning at a training given by Wieman in 2017 at Stanford. (Credit: Peter LePage / Cornell University. All rights reserved.)

What is the progression of a DBES in their position?

In the SEI, DBESs were typically hired for three years and entered with a graduate degree in their discipline and an interest in teaching, but with no background in educational research. The table below shows activities that DBESs typically performed in each year of their appointments as they progressed from a novice to a more seasoned DBES.

New DBES (Year 1)	Experienced DBES (Year 2)	Seasoned DBES (Year 3)
<ul style="list-style-type: none"> • Initial training • Read educational literature, especially within their discipline • Observe classes for initial course transformation • Begin facilitation of faculty and faculty groups • Plan course transformation and build course materials in partnership with faculty 	<ul style="list-style-type: none"> • Strong contributions to course transformations • Continued facilitation of faculty and faculty groups • Begin research project(s) 	<ul style="list-style-type: none"> • Publish in the educational literature • Give conference talks • Mentor new DBESs and/or teaching assistants • Provide in-department consulting to faculty not involved in officially proposed projects • Develop and run workshops • Search for jobs (see below for career options)

What skills does a DBES need to develop?

Given the diverse tasks discussed in *Chapter 2: What Is a DBES?*, DBESs need a wide range of skills and professional attributes to be successful. There are certain baseline attributes that a DBES should possess in order to have the best chance of success: expertise in the discipline, an interest in education and teaching, and good interpersonal, organization, and time management skills. Most of these skills are honed during the course of the position.

DBESs benefit from certain attitudes and mindsets. Patience and persistence are key in this position, which is why certain personality types are better suited to the DBES role. The most successful DBESs are those who are viewed, and who view themselves, as a departmental resource, and thus develop scholarly expertise in teaching and building productive relationships with faculty.

Over time, we've found that the following skills are important features of the most effective DBESs. Areas which were the target of explicit professional development during the SEI are marked with an asterisk (*).

An effective DBES works well with people

Ideally, they will:

- Have good active listening skills
- Have good facilitation and coaching skills*
- Have excellent interpersonal skills, including the ability to negotiate, persuade, motivate, and inform, without being pushy*
- Be a good communicator, with the ability to disseminate information effectively and professionally (verbally and in writing; privately and publicly)*
- Be flexible

An effective DBES is organized

Ideally, they will:

- Have good time management skills (including email organization)*
- Have good project management skills outside of a formal project management setting*
- Be able to change focus throughout the day
- Be able to balance many different projects and priorities*
- Effectively facilitate meetings*
- Be able to set and manage professional goals*
- Learn to say “no” when appropriate
- Be able to work independently

An effective DBES is focused on their own professional growth

Ideally, they will:

- Reflect on their own progress*
- Be metacognitive about their own work*
- Seek feedback from various sources
- Actively read the education literature in their discipline and in STEM education more broadly*
- Seek to achieve excellence in course design (such as learning goal development, question design, and

documenting course materials)*

- Seek to improve their research skills (including statistics knowledge, experimental design, data interpretation and analysis, and publication)*

How do you initially train DBESs in the science of teaching and learning?

Since most DBESs have limited prior experience with STEM education research, we recommend creating a New DBES Development Series on the relevant education and cognitive psychology research, research-based instructional practices, and measurement of learning. In the SEIs, this training series was usually run once per year (more if the pace of hiring demanded it) and consisted of about twelve 90-minute meetings in a semester. A relevant reading or two can be assigned in advance of each session so that during a session participants can discuss the reading(s) and work in small groups to apply the material. The first semester of a new DBES's job could be spent in planning a course transformation, observing classes (especially or exclusively the course being transformed), and attending this development series.



Warren Code facilitates a community of practice around course design (Credit: Centre for Teaching, Learning and Technology / University of British Columbia. All rights reserved.)

Though primarily intended for new DBESs, this training can be opened up to interested faculty as well as experienced DBESs. New DBESs benefit even if they have significant background in teaching and learning or education

research, as this group can be an important way to build a cohort with other new people. Once the broader group has sufficient expertise, most training sessions can be facilitated by existing DBESs. In our experience, attendance by faculty was predictably sparse, but experienced DBESs often attended as facilitators; this was very beneficial, as they could share valuable insight with new DBESs.

For models to create your own such training, see the resources below.

1. **SEI training series:** [Development Series for new STLFs](#) outlines the training that was eventually established at UBC.
2. **2017 Carl Wieman department education specialist training:** [see syllabus here](#).
3. **Learning assistant (LA) pedagogy course materials:** many institutions run pedagogy courses for undergraduates, notably for LAs, which can serve as sources of materials regarding the science of teaching and learning. For examples of such pedagogy courses, create an account at <http://learningassistantalliance.org> and visit the [program resource page on pedagogy courses](#).

How do you help DBESs develop fully as change agents?

While the New DBES Development Series provides the opportunity to develop expertise in education research and pedagogy, DBESs need ongoing professional development, including skills in facilitating the work in the department. The existence of a thriving DBES community is very important for this support. To combat isolation and enable ongoing professional development, the SEI used several regular engagement strategies.

Regular DBES sessions

Below are the methods used in the SEI to enable ongoing professional development and networking. Depending on the structure of your initiative (see [Chapter 4: Central Organization](#)), these methods can be used as a menu of options to inform your strategy.

DBES meetings

Every other week, new and experienced DBESs across departments met to share ideas and resources. Topics included development of effective learning goals, designing in-class activities, conducting cognitive interviews of students, interpersonal communication and negotiation, designing and conducting rigorous assessment and research studies, and sharing experiences of what worked well (or not). These sessions were facilitated by the SEI initiative director, seasoned DBESs, or invited guests (such as campus experts on communication or a visiting researcher). See [Example STLF Meeting Topics](#) for examples of these sessions and external workshops.

Reading groups

DBESs met to discuss relevant readings in a journal-club format on the weeks alternate to the DBES meetings. Faculty and graduate students often attended as well. The distribution list for reading group announcements was quite broad, enabling engagement across many faculty members, former DBESs, and DBESs at other campuses. Topical readings included both new and ‘gold standard’ literature in science education or cognitive psychology. Reading groups were also used as a forum for DBESs and/or faculty to solicit feedback on in-progress publications. See [Example Reading Group Choices](#) for examples of selected readings and sample invitations for a discussion group.

Metacognition meetings

Each DBES was paired with another DBES outside of their department to discuss progress and set plans on medium- and long-term goals, meeting every four-to-six weeks. These meetings provided a coaching relationship and opportunity for reflection with a consistent partner outside the department. See [Metacognition STLF Meetings](#) for the guidance given to DBESs in the UBC CWSEI.

Departmental oversight meetings

Every one-to-two months, SEI Central met with DBESs and departmental directors to discuss progress in the departments. DBESs submitted monthly progress reports in advance of these meetings. More detail about these, and other oversight structures, is in [Chapter 4: Central Organization](#).

Annual End of Year Event

In April of each year, the SEI held an annual End of Year Event to showcase the work. This was a valuable opportunity for DBESs and departments to engage professionally around teaching and learning, as well as to share best practices and a sense of community.



End of Year poster session at UBC CWSEI (Credit: Gabriel Lasca / Science Centre for Learning and Teaching / University of British Columbia. All rights reserved.)

End of Year Event format

Morning session (1.5-2 hours)

- Brief annual update from SEI Central: initiative-wide announcements and quick highlights from each department
- Short presentations from faculty: feature a few projects with results or techniques worth sharing widely, or a panel on a theme of interest, such as the student perspective in active learning

Poster session (1.5-2 hours)

- Simple, low-cost posters to create a low barrier for sharing or existing posters used for other conferences
- Primarily DBESs present, but faculty and student projects are welcome
- Light lunch provided

Workshops (1-2 hours)

- Two or three workshop sessions with topics to appeal to faculty (e.g., using clickers, cognitive task analysis, writing in the science curriculum)

Example End of Year Event schedules and materials can be found here: <http://cwsei.ubc.ca/EOYevent.html>.

Individual professional development

All the above sessions were bolstered by the DBESs' individual professional development activities, broadly listed below. Detailed suggestions for professional development, including recommended readings, are in [Chapter 9: DBES Development](#).

- Teaching a course. Teaching provided both useful experience and credibility for facilitating the departmental work and for building experience for their CV. DBESs were also able to use their courses as models for faculty, encouraging faculty to come and observe their own classes to see how particular instructional techniques were used. See [Chapter 2: What is a DBES?](#) for restrictions on teaching responsibilities.
- Reading in the education literature.
- Learning how to apply statistics for social sciences (such as correlations and t-tests) within education research studies.
- Observing classes.
- Attending campus workshops.
- Attending conferences.
- Facilitating workshops for faculty.
- Organizing a discipline-based education research (DBER) seminar series with external speakers. Submitting regular activity reports, encouraging reflection on progress and needed skills. See [Chapter 4: Central Organization](#).
- Other professional development as needed (e.g., time management, software, etc.).

External publications and dissemination

It is valuable to have some focus on formal presentation and publication of the work for the career development of the DBES, to share ideas with the broader community, and to engage in teaching improvements as a scholarly endeavor. The SEIs were quite effective in contributing to the research literature (see our full list of publications). Ensure that the DBES has adequate time to write and publish results—if this is not prioritized, it will often fall

prey to the more urgent matters associated with facilitating course improvement work. It can be productive to push DBESs to submit a paper when it is ‘good enough’, rather than spending too much time refining it. A conference submission deadline can be very useful in encouraging this. Such work will be important evaluation criteria for the DBES when they apply for a raise, a reappointment, or a new position.

How can you build a DBES community?

Given the idiosyncratic nature of the DBES’s role, access to a professional support network is very important. In the SEI, DBES morale and productivity suffered without such a network. A professional community enables DBESs to become maximally effective within the typically short tenure of their position by leveraging the wisdom accumulated within the group. If a DBES is solo in the department or university, efforts should be made to find relevant communities for them to engage in. We found the approaches described below were helpful in generating community.

Hire several DBESs within one department

Having a DBES team within a department helps to combat isolation and enables DBESs to leverage their individual skills effectively. The most successful SEI departments had three-to-four DBESs at any one time. In the more common case that there is a single DBES within a department, it is crucial to connect that DBES to a support network elsewhere in the institution as well as to supportive faculty within the department.

Hire several DBESs across departments

This enables the building of a robust community by having adequate numbers for development meetings with a variety of personalities and skill sets—including some DBESs who may take it upon themselves to lead community building.

Leverage experienced DBESs

Experienced DBESs have many valuable insights to share with new DBESs. Using them to lead training sessions and discussions can assist in the creation of a professional learning community that continues to grow and thrive, as well enabling those DBESs to develop leadership skills.

DBES exit talks

One way that the experience of seasoned DBESs was leveraged was by encouraging any departing DBES to run an exit talk during a weekly DBES meeting. In an exit talk, the departing DBES shared key lessons they learned on the job, allowing them to reflect on their experience and create greater knowledge continuity between newer and seasoned DBESs.

Identify a central meeting space

Given the expectation of the various meetings mentioned above, regular group meetings, ad hoc meetings with visitors, and/or workshop sessions, it may be difficult to rely on a department to provide consistently available daytime space, so identifying at least one room where people from various departments can book (likely via SEI Central) is important.

Communicate online

The SEI made extensive use of [Basecamp](#), an online project coordination tool which functioned as a mailing list with persistent files attached to posts. Interaction by email was important as this was the most common communication medium across people and institutions. Basecamp provided a central location for posting questions and resources, and the persistence of the message and file archive made for a rich, accumulated resource that could be made available to new people. In some cases, former DBESs remained involved in this online community. For example, Reading Group announcements were posted to a group with over 200 subscribers. This group gave former DBESs an opportunity to stay apprised of new and relevant readings in science education. Helpfully, former DBESs often posted job announcements to the group.

Provide regular professional development events

SEI Central organized several regular meetings with coordinating/supporting online discussions, all of which contributed to the development of the DBES community and to individual skill building.

Provide regular social events

Get-togethers once a month or celebrating the end of term also serve to help build the community.

Host public gatherings

SEI Central held an annual public gathering (End of Year Event) of those involved in the project, which supported a cross-departmental community among DBESs and faculty—and visibly celebrated the work.

Chapter 3 Checklist

In order for DBESs to be able to successfully facilitate the departmental work and have high job satisfaction, initiative organizers should consider the following actions:

Help DBESs develop professional skills

- Be mindful of the range of professional skills required for the job (interpersonal skills, organization, and professional growth).
- Ensure DBESs attend a well-structured training program (e.g. the New DBES Development Series).
- Provide regular DBES sessions, such as biweekly discussions, reading groups, reflective discussions, meetings with departments, DBES exit talks, and end of year events.
- Encourage seasoned DBESs to plan and facilitate DBES sessions.
- Require DBESs to submit regular reflective activity reports.
- Encourage DBESs' individual professional development, such as teaching a course, observing courses, reading the literature, attending conferences, and/or facilitating workshops.
- Ensure that DBESs have adequate time and professional support to publish results in the scholarly education literature.

Build a DBES community

- Encourage a large and active DBES community with the continual addition of new members.
- Hire several DBESs within a department and/or across departments.
- Have experienced DBESs lead trainings and meetings for new DBESs.
- Identify a central meeting space.
- Create opportunities for online communication (e.g., email list, project management tool, online resource area).
- Provide regular professional development events.
- Provide regular social events.
- Host an end of year public event.

Additionally, it is extremely important to create clear expectations for the departmental work, including departmental leadership and oversight from the initiative organizers. See [Chapter 5: Departmental Leadership](#).

For further reading

SEI resource documents:

1. DBES training established at UBC: [Development Series for new STLFs](#)
2. Wieman 2017 national workshop agenda: [Department education specialist training](#)
3. Ongoing DBES development series examples: [Example STLF Meeting Topics](#)
4. Invitations and readings for reading group: [Example Reading Group Choices](#)
5. Peer-to-peer DBES reflective discussions at UBC CWSEI: [Metacognition STLF Meetings](#)
6. End of Year Event schedules and materials: <http://cwsei.ubc.ca/EOYevent.html>
7. SEI publications: [full list of publications](#)

Annotated bibliography

Eckel, P., Green, M., Hill, B., & Mallon, W. (1999). *On Change III: Taking charge of change: A primer for colleges and universities. An occasional paper series of the ACE Project on leadership and institutional transformation.* Washington, DC: American Council on Education.

A practical guide to leading change within an institution, including strategies and information on supporting change agents.

Ingram, E. L., House, R. A., Chenoweth, S., Dee, K. C., Ahmed, J., Williams, J., et al. (2014). From faculty to change agent: lessons learned in the development and implementation of a change workshop. *2014 ASEE Annual Conference & Exposition*, 24.630.1-24.630.12. Retrieved from: <https://peer.asee.org/from-faculty-to-change-agent-lessons-learned-in-the-development-and-implementation-of-a-change-workshop>.

Outlines lessons learned from a long-standing workshop for the professional development of change agents.

Kezar, A. (2009). Change in higher education: not enough, or too much? *Change: The Magazine of Higher Learning*, 41(6), 18-23.

Discusses the challenge of change in college campuses, using insights from studies on change leadership. Also discusses the importance of change agents.

Kezar, A. (2014). *How colleges change: Understanding, leading, and enacting change.* New York, NY: Routledge.

A more detailed scholarly volume on the topic of leadership and academic change.

Wenger, E., McDermott, R., & Snyder, W. (2002). *Cultivating communities of practice.* Boston, MA: Harvard Business School Press.

Discusses the importance and practice of supporting professional communities to connect activities and knowledge across an organization.

Wieman, C. (2017). *Improving how universities teach science: Lessons from the Science Education Initiative*. Cambridge, MA: Harvard University Press.

Authoritative resource on the SEI model and its impacts, including a detailed description of the rationale for the SEI, lessons learned, and data on departmental outcomes.

4 - The Central Organization: Overseeing the Initiative

Summary

While the structure will vary by institution, some sort of central organization or management is critically important in creating a vision and oversight for the initiative, building community for and training Discipline-Based Education Specialists (DBESs), communicating with stakeholders, and coordinating daily project operations. The central organization in the SEI acted as a highly involved funding agency, soliciting and funding proposals from departments, continually clarifying the DBES role, and providing ongoing oversight of projects through monthly DBES progress reports and regular meetings with DBESs and departmental directors. This oversight can help the central organization head off several common hurdles, such as poor departmental leadership, lack of departmental ownership of courses, and curricular issues, including over-packed curricula or entrenched course design. Troubleshooting such departmental issues is described in this chapter, in “Departmental factors which help and hinder” ([Chapter 5: Departmental Leadership](#)), and in Wieman (2017; especially Chapters 4-6).

Approaches to supporting the successful management of the initiative

Provide adequate resources for the initiative, including sufficient staff, duration, and budget for the initiative and departments.

Solicit and fund departmental proposals which are likely to effect change, including those with adequate administrative leadership, faculty engagement, and clear specifics within proposals.

Oversee the work, laying out clear expectations, ensuring the work is well-directed within the department, holding regular meetings to check on progress, and having clear accountability and consequences for lack of follow-through on commitments.

Support DBES training and community building to ensure professional development.

Document and measure success, including showcasing successes, collecting data on changes in departments, and publicly archiving developed materials.

What is the central organization?

The central organization provides important management for the initiative. This central organization is likely to

take different forms at different institutions. In the SEI, a new organization (called “SEI Central”) was formed with its own management structure and budget. At other institutions, the initiative may be housed and managed within an existing unit, such as a teaching and learning center. Regardless of the specific structure, it is important to clearly identify an organization or unit that will be responsible for the tasks outlined in this chapter.

What does the central organization do?

SEI Central provided complete management and oversight for the SEI. This may be adapted at other institutions depending upon local context.

Roles for SEI Central (based on UBC SEI)	
Vision	<ul style="list-style-type: none"> • Planning and organizing the initiative • Planning for post-SEI sustainability and management
DBES support and oversight	<ul style="list-style-type: none"> • Providing new DBES training (Chapter 3) • Providing ongoing professional development for DBESs (Chapter 3) • Soliciting, reading, and acting upon monthly DBES activity reports • Advising on study design and publications • Advising on ethics, including working with the local Institutional Review Board (IRB), as well as privacy and data security issues; more detail is in Wieman (2017)
Department support and oversight	<ul style="list-style-type: none"> • Soliciting and reviewing proposals • Advising on the hiring of DBESs in departments (Chapter 2, Chapter 5) • Hosting working groups for departmental directors • Project advising (e.g., course design, instructional design, learning technology)
Community building	<ul style="list-style-type: none"> • Hosting monthly departmental meetings with DBESs and departmental directors • Coordinating SEI communications and infrastructure, including overseeing the project coordination tool (Basecamp), sending announcements, and managing contact lists (Chapter 2) • Hosting Reading Group (Chapter 3) • Coordinating End of Year event (Chapter 3) • Hosting lecture series and workshops • Organizing social events
Outreach	<ul style="list-style-type: none"> • Creating instructional resource materials, such as two-pagers and short videos; see cwsei.ubc.ca, Chapter 7, and the appendices in Wieman (2017) • Coordinating institutional communication with departments, staff in other units, and administration • Serving as the external contact for the initiative (e.g., media, other institutions) • Providing progress updates to donors/sponsors • Publishing results from the initiative • Promoting the initiative
Administration	<ul style="list-style-type: none"> • Updating SEI website with information from SEI Central and departments • Overseeing the creation of a (largely unsuccessful) course archive system • Budget planning of UBC SEI as a whole • Budget planning between SEI Central and departments • Scheduling meetings and external visitors • Purchasing and curating common equipment: scanners, audience response systems, audio recorders, video recorders, SmartPens, Scantron machine for data collection, etc. • Organizing office space

What human and financial resources are required?

The range of duties described above requires significant staff, financial resources, and time. We suggest reviewing our handout on [SEI Strategic Planning Approaches](#), which includes critical questions to consider and external resources to help you plan your change initiative.

Allow 5-10 years for full change

The initial intended duration of the SEI was 5-7 years to allow several departments to engage under a 5-year grant. However, the initiative at UBC lasted for a total of 10 years, primarily due to a staggering of the work over time in different departments. Other initiatives have lasted just a few years (see [Appendix 1: Case Studies](#)), either due to grant funding cycles or pilot projects. Because culture change requires a longer-term engagement (Kezar, 2014), a period of 5 years was chosen for the length of departmental grants in the SEI. Carl Wieman considered this to be long enough to accomplish change, but short enough so that the work achieves a certain sense of urgency. That said, achieving a sense of urgency was one of the unsolved problems of the SEI. See Wieman (2017; p. 136).

Sufficiently staff the central organization

The intention of the SEI was to staff the central organization at a minimal level, enabling greater investment in the departmental work. UBC's SEI Central included the equivalent of approximately 2 full-time staff (2 FTE), with a director (~50% FTE), an associate director (~100% FTE), and an administrative assistant (~50% FTE), along with technical support. This lasted for the initial 3-4 years as the DBES count grew from 7 to 20, after which staffing and the number of DBESs was gradually reduced. Meanwhile, the CU SEI included a director (20% FTE), an associate director (50% FTE), an administrative assistant (50% FTE), and a few temporary research staff positions. This staffing level was insufficient to effectively lead the work, especially once the director, Carl Wieman, left for a position in the White House and the associate director was consequently tasked with the duties of both positions within the existing 50% FTE hours of that position. In organizations housed in an existing unit, ensure that adequate staff time is available for activities directly related to the initiative.

Provide sufficient central budget

When creating a budget for the central organization and project management, be sure to consider:

- central staff
- equipment
- website development
- travel, including conference travel and other expenses, for central staff (travel expenses for DBESs in the SEI were included in departmental budgets)
- budget for events
- visitor hosting
- dissemination of the work, including time to collect, analyze, and publish outcomes from the initiative (which may involve publication fees)

In the SEI, funding for SEI Central accounted for about 20% of the project budget, of which staff salaries comprised the majority.

Provide sufficient departmental budget to create real change

Provide adequate budget for departments; typically, the bulk of the expenses will be DBES salaries and faculty incentives. The full funding amount for the SEI was based on a set of calculations by Carl Wieman (Wieman, 2017), which assumed that for an institution to create major change, it must invest 5-10% of its budget in that change effort. Given this assumption, the total required departmental funding in the SEI would need to be \$10M USD for each institution, spread over 5 years and across 5 departments (or \$2M per large research department), in order to support the goal of influencing each university's teaching culture.

This target was largely met at UBC, where average departmental funding was \$1.3M spent over 6-7 years, with a total budget for the initiative of \$11M, of which \$9M was funded by UBC and \$2M through donations. At CU Boulder, however, the total budget was \$5.3M, and departmental funding averaged \$650K. This funding level did not achieve the same level of impact.

The approximate expenses in each category at UBC are listed in the table below, as a portion of the overall \$11M budget

Expense	Approximate USD, initiative	Expense detail	Approximate USD, departments
SEI Central	\$2M	See “Provide sufficient central budget”, above	N/A
Department expenses	\$9M	DBES salary, benefits, and travel (85-90%)	\$8M
		Other* (10-15%)	\$1M
*Other expenses included graduate student assistants, teaching buy-outs, and travel for faculty. Depending on the department, this number ranged from 10-15%.			

How do you solicit and fund effective proposals?

The central organization circulates a Request for Proposals (RFP) to eligible departments, typically addressed to the heads of the departments. Departments initiate their engagement in the initiative by submitting a proposal. The central organization then reviews proposals and make funding decisions, acting as a highly involved funding agency. Be aware that departments simply may not know how to submit a reasonable proposal for educational work and that proposals may not always reflect consensus and/or the vision in the department as a whole. This can make it difficult to evaluate proposals on their potential to enact change in the department. The following recommendations are based on how we addressed those challenges. For example RFPs and funded proposals, see the [UBC CWSEI Funding website](#), [CU Boulder TRESTLE site](#), or [Cornell University's 2016 RFP](#).

Advertise the initiative

Visit departmental faculty meetings shortly after the RFP is sent out to discuss the research on STEM education and its improvement, as well as to discuss the proposal process. In the SEI, these visits (conducted by SEI Director Carl Wieman) often resulted in good discussions about teaching improvements and undergraduate education at the

department level, even when a department did not submit a proposal. Because the RFP was fairly comprehensive, creating such faculty engagement was important in the SEI.



Carl Wieman speaks at UBC's Science Education Open House (annual April event) in 2017. (Credit: Gabriel Lascu / Science Centre for Learning and Teaching / University of British Columbia. All rights reserved.)

Help departments develop strong proposals

Departments may not write a stellar, fundable proposal at the beginning. It can be useful to provide clear guidance around proposal preparation and specific feedback on how to improve proposals. The SEI often worked with departments to help them develop a proposal with enough specificity to be fundable, which also helped to clarify expectations for the work. In many cases, the SEI funded pilot projects to enable departments to begin some of the work proposed, then provided full funding when the department submitted a more specific and realistic proposal.

Seek out departments with strong departmental leadership and ownership

The level of leadership and engagement in the initiative is important to consider. Note that in the SEI, the faculty reaction to Carl Wieman's initial visit to advertise the initiative was a fairly good indicator of whether the department would be successful in leading SEI work. Also, the number of grants available was strategically chosen to send a message that funding was likely if a department made a serious effort.

Below are some questions to consider when reviewing proposals:

- Is there evidence of faculty consensus and engagement across the department, or does the proposal seem led by an individual champion only?
- Is there an individual willing to serve as departmental director?
- Are there existing structures in the department (such as a curriculum committee) for overseeing undergraduate education? Are those structures likely to be a support or a hindrance to effecting change? (In the SEI, existing structures were more commonly a hindrance.)
- Is the department distracted by other looming priorities or does the proposal come at an opportune moment (e.g., creation of a new major)?
- How ready is the department for change?

- Are there any red flags? See “Factors that affected departmental success” below and “Departmental factors that help and hinder” in [Chapter 5: Departmental Leadership](#)

Below are several common pitfalls and hallmarks of successful departments that we found during the SEI.

Factors that affected departmental success	
Common pitfalls	Elements of success
<ul style="list-style-type: none"> • Lack of faculty commitment to the proposed work • Lack of strategic teaching assignments • Lack of departmental structures to proactively carry out educational improvements • Individual faculty ‘ownership’ of courses 	<ul style="list-style-type: none"> • Having commitments laid out specifically in terms of deliverables and timelines • Incentives available to individual faculty members • Good departmental-level management and organization • Having a good departmental director with necessary stature

Use a proposal structure that includes clear deliverables

The specificity required in proposals enabled more accurate judgments as to the feasibility of the work. Require proposals to contain at least some discussion of which courses will be transformed, a suggested schedule of transformation, and identification of faculty who teach the courses. Such information will provide guidance at the start of the departmental project, and while plans may—and often should—change, working out this level of detail can help to avoid the common problem of faculty who have been assigned to course transformations but are not personally committed to the work, and encourages the department to discuss targets in advance. After a departmental project really gets rolling, new ideas, projects, courses, and interests will emerge and take things in directions likely not anticipated in the proposal, to the benefit of the project and the overall initiative.

Allow faculty incentives within the proposal

Be sure to allow direct incentives for faculty to participate in the work (such as reduced teaching loads, support for teaching or research assistants, and/or summer salary) in order to provide more direct benefit to faculty for their engagement when there are institutional disincentives for teaching improvements. In addition to providing needed support, direct incentives also provide an additional layer of accountability. In the SEI, faculty typically valued such incentives, and so when they were at risk of losing those incentives, faculty were often responsive to making necessary changes in the face of inadequate progress.

Make funding or incentives contingent on progress

You might grant funding on an annual basis, with funding in future years contingent on good progress. In the SEI, this structure provided accountability and allowed SEI Central to make adjustments in the few extreme cases in which a department was not living up to expectations. While in some cases departments changed their approaches when faced with the possibility of losing funding, this threat was not always a real motivator for faculty and departments to change their behavior—especially when money was not being allocated to faculty incentives (so there was no fear of losing them) and when the DBES was not highly valued. Discontinuing funding (or not renewing the DBES position) was, instead, a way to avoid wasting money.

Fund departments at an appropriate level and duration for the work proposed

Adjust the timing, size, and duration of grants awarded in accordance with department readiness to engage in the

work. In reviewing proposals, give serious consideration as to whether departments will be able to spend larger amounts of funding productively. While department proposals in the SEI were typically fully funded for five years, most had a duration of six-to-seven years to allow for ramp up (planning and hiring DBESs), and wrap up (archiving and creating structures for sustainability). Allow funding to be carried over from year to year, as projects may take longer than anticipated.

How do you supervise the work?

Set clear, shared expectations between departments, DBESs, and the central organization. In the SEI, lack of shared expectations often resulted in poor follow-through on course transformations, unclear supervision of the DBES, and, ultimately, low faculty and DBES morale. Over time, the following structures were used to inform the partnerships between SEI Central, DBESs, and departments, resulting in better faculty uptake and lower DBES attrition in later years. For more on common departmental issues, see “Departmental factors which help and hinder” ([Chapter 5: Departmental Leadership](#)) and Wieman (2017; especially Chapters 4-6).

Oversight of departmental work

Identify clear expectations at the start of the work

The interactive proposal process serves to establish clear expectations for the work. Emphasize that funding after the first year will be contingent on good (though not necessarily rapid) progress. You may also wish to develop a memorandum of understanding (MOU) with each department to formally establish expectations as was done in post-SEI years at UBC. See examples of this and other MOUs in [Appendix 1: Case Studies](#).

Provide additional oversight from the central organization

The central organization can handle training, research advising, convening a cross-departmental community for DBESs, and meeting once or twice per term with departments for progress updates. The central organization should probably not be responsible for hiring and general HR activities related to the DBES, regular meetings with the DBES to discuss progress, advocating on behalf of a DBES within their department, or seeking out faculty to work with DBES on projects. This distinction should be clarified with departments.

Support effective data collection

While departmental groups are responsible for assessing course transformation outcomes, data collection, analysis, and reporting can be facilitated substantially by the central organization, as described below.

Effective data collection strategies

Be aware of some pitfalls and challenges in collecting baseline data: instruments may not have been developed yet (e.g., custom measures of student learning), it can be difficult to motivate instructors to engage in such data collection since they may feel they are being used as a ‘bad’ instance of the course, and in general it can be difficult to find time to collect baseline data during early stages of the initiative, as course redesign is starting in earnest.

Collaborate with the university’s office of institutional research or other entities who have access to student data or resources for analyzing this data. Note that a DBES may be restricted in terms of access due to their rank, so they may be limited in what they can accomplish in this area on their own.

Facilitate interactions with the local Institutional Review Board: negotiate for educational evaluation to be appropriately exempt from human subjects research review, and provide examples and advice for studies that do require review. A DBES may need a sponsor to act as a principal investigator depending on their rank and the regulations at the institution.

Support department groups in identifying appropriate assessments and presentation techniques to address questions of interest.

Note that students and faculty can become survey fatigued; be mindful of other ongoing student surveys across campus and coordinate (or help departments coordinate) when possible.

Meet with the department to discuss the DBES role multiple times

Don’t assume that one meeting will do the trick; the role will likely need clarification over time. For detail on what is, and is not, expected to be part of a DBES’s position, see [Chapter 2: What Is a DBES?](#) Lack of clarity about the purpose and potential contribution of a DBES could result in confusion and wasted time—or worse—between a DBES and partnering faculty. For details on setting expectations, see [Chapter 5: Departmental Leadership](#) for establishing the initiative in the department and Chapters 7-8 about collaboration between DBESs and faculty.

Reinforce the value of and work needed for publications

Remind the department as needed that the DBES needs adequate time to write and publish results—if this is not prioritized, it will often fall prey to the more urgent matters associated with facilitating course improvement work. Considering that research is a secondary aspect of the DBES role, the SEI was very effective in contributing to the research literature. (See our [full list of publications](#).) Experience with discipline-based education research (DBER) or Scholarship of Teaching and Learning (SoTL) publishing can vary substantially in a department, and so it can fall to the central unit to advise on DBES research and publication projects. It can be productive to push DBESs to submit a paper when it is ‘good enough’, rather than spending too much time refining it.

The process of DBES supervision

In the SEI, the following reports and meetings helped to support productive oversight and facilitate clear communication between DBESs, SEI Central, and departments. We suggest using some combination of similar mechanisms to stay engaged with the departmental work, ensuring the DBESs’ time and energy are well spent.



Director Carl Wieman with 3 former DBESs, Michelle Smith, Stephanie Chasteen, and Rachel Pepper. (Credit: Stephanie Chasteen / CU Boulder. All rights reserved.)

Have the departmental director serve as the DBES's immediate supervisor

It is important to establish the location of the DBESs within a clear chain of command. Who does the DBES report to? Who manages their daily activities? It is critical that the DBES is seen as a member of the department, but the central organization may need to provide professional development for the DBES and oversight for the department's efforts. In the SEI, a faculty member in the department served as the departmental director, and was charged with overseeing the DBES and the departmental work. This ensured that the DBES was clearly situated as a member of the department and their supervisor was intimately connected with the departmental culture, politics, and daily functioning.

Have DBESs submit monthly progress reports

DBESs should submit brief (one-to-three pages) progress reports monthly, to be shared with the departmental director and the central organization. These reports can then form the basis of monthly meetings while providing an opportunity for DBESs to reflect upon their work and document progress, which can be motivating since progress might otherwise be difficult to see. These reports can be reviewed with particular attention as to whether:

- The DBES was able to effectively manage multiple demands on their time
- The DBES needed access to particular resources (people, literature, etc.)

- The department was setting reasonable expectations for the DBES
- The DBES was wasting time due to lack of departmental coordination or support

Hold monthly departmental team meetings

About once a month, it's useful for the central organization, the departmental director, and the DBES to meet to discuss progress in the department. The DBES progress report ensures that these meetings are focused and productive. These meetings can be quite informal, and in the SEI they resulted in formative feedback and troubleshooting for the departmental work.

Hold quarterly meetings with the group of departmental directors

Such meetings enable departments to share practices and approaches (such as methods for incentivizing faculty) and to ensure functioning SEI teams within departments. UBC's SEI Central held meetings among departmental directors, called the CWSEI Working Group.

Organize occasional corrective departmental meetings

You may need to call meetings between the central organization and the departmental director, and perhaps the department chair, to discuss roles and expectations, such as the responsibilities of the DBES (for example, if the DBES is failing to attend training sessions or submit monthly reports).

In the SEI, there were several common (and often predictable) issues that arose within departments, including lack of clear departmental leadership, lack of departmental ownership of courses, and problems with the over-arching curriculum. Discussion of these issues is in "Departmental factors which help and hinder" (see [Chapter 5: Departmental Leadership](#)), as well as in Wieman (2017, especially Chapters 4-5). Keep an eye out for such issues and address them proactively in these departmental discussions.

How can you create community?

Given the many roles that a DBES can take on ([Chapter 2: What Is a DBES?](#)) and the supports required for the DBES to achieve success ([Chapter 3: DBES Success](#)), a vibrant professional community is very important for helping the DBES ramp up to maximal effectiveness in a short period. In the SEI, SEI Central provided regular professional development events, social events, a central meeting space, and an annual End of Year Event each year in April to showcase the work for that year, all to foster professional development, sharing of best practices, collaboration, and a sense of community across the SEI. See [Chapter 3: DBES Success](#) for detail.

Additionally, DBESs and initiative organizers can make use of national networks to create cross-campus communities. One of the projects building on the SEI, the Transforming Education, Stimulating Teaching and Learning Excellence ([TRESTLE](#)), focuses on creating community within and across campuses, and provides professional engagement opportunities for initiative leaders and for DBESs across campus.

How can you lay the groundwork for sustainability?

It is important to plan your initiative with an eye to sustainability and future engagement. It is not sufficient to create change and expect individual faculty to maintain the work. In addition to such cultural changes, you can

create a favorable climate for continued engagement by making successes visible, engaging administrators, collecting persuasive data on initiative success, and seeking to build on the work in the future.

Encourage department events to promote early conspicuous successes

Department talks offer a valuable way of promoting discussion and generating interest for future teaching development work. These can be informal ('lunch and learn'), part of an established series for teaching and learning, or the occasional slot in a department's colloquium series. These talks can be encouraged (and perhaps initially funded) by the central organization, but it is best if they are organized within the department and clearly supported by the department chair.

Visibly celebrate success through cross-departmental events

Use public events to showcase the work in departments to others at the institution. The SEI featured an End of Year Event, provided as an example in [Chapter 3: DBES Success](#). This is a valuable opportunity for DBESs and departments to engage professionally around teaching and learning. You may also wish to invite speakers from other institutions to highlight a topic related to ongoing work or to seed new ideas for course transformation and research studies. These are a further channel for informal interaction across departments for those who attend and provide valuable networking opportunities for DBESs and faculty.

Collect data on the initiative

Collecting data on the impact of the initiative can be challenging for a few reasons. If there are multiple departments involved in the initiative, you will need to work with each set of department leaders to collect this data. You will also want to collect data at several points, to see how the initiative progresses over time (e.g. baseline data, data during implementation, and data on sustainability post-initiative). Departments may engage at different times, and thus you will need to plan for collecting baseline data several times.

In the SEI, we assessed the following:

- Changes and outcomes from course transformations
- Changes in faculty teaching practices
- Changes in departmental attitudes and structures
- Outcomes from the initiative as a whole

Please see our handout, [SEI Assessment Metrics](#) for a list of indicators used in the SEI.

Engage with higher administration

It will be important to highlight success to higher administration at the institution; in many cases this will be the funding body for the initiative. Having regularly updated reports and summaries can be very helpful in bringing new administrators up to speed on the current state and success of your initiative.

Ideally, your dean can be a champion for the work. Support at the dean's level is critical for creating institutional priority for a multi-departmental initiative, especially given the traditionally low prioritization of teaching improvements. Such engagement by the dean will require regular updates from the central organization.

Productive contribution of the dean

Be a cheerleader for the initiative within the institution and externally, clearly indicating that it is valued.

Actively encourage department chairs to support initiative efforts; **select chairs who are supportive** of the initiative when filling open positions.

Connecting with funding sources, including donors, as needed.

Make allowances within the teaching evaluation structure, ensuring that faculty are rewarded, or at least not penalized, for participating.

Align new policies with initiative efforts where possible, such as revised requirements for curriculum documents, teaching assignments (if applicable), or evaluation of educational contributions in tenure/promotion.

Deans may be particularly interested in the perspective offered by UBC Dean Simon Peacock on the UBC CWSEI (Dolan et. al., 2016). Dean Peacock describes how the UBC CWSEI dealt with university policies (such as teaching evaluations) and how UBC required first year courses to develop learning goals as a support for SEI efforts.



UBC Dean of Science Simon Peacock discusses teaching and learning with CWSEI Associate Director Sarah Gilbert at an SEI event (Credit: Gabriel Lascu / Science Centre for Learning and Teaching / University of British Columbia. All rights reserved.)

Consider supporting the public archiving of course materials

Creating a package of course materials is a necessary (though not sufficient) step towards synthesizing and documenting the outcomes of departmental projects. Many transformed courses were accompanied by an organized set of materials, usable by other faculty. See [Chapter 7: Course Transformation](#).

Course packages were collected in public archives in a custom database and online at the CU SEI's [Course Archives page](#). One challenge in creating such public archives was that faculty are often reluctant to share materials for a few reasons. First, they may not have ownership of all materials, as some items may have been borrowed from other sources (other faculty in the department or commercial publishers). Second, they may not be willing to share material that isn't yet perfected, which is an unrealistic goal. These challenges may be mitigated by having an eye to public dissemination early in the initiative, addressing ownership issues in the early expectation setting phase, and carefully documenting the sources of all materials.

Another challenge was that there was typically no clear incentive or structure for creating or maintaining these course packages. In the SEI, it was difficult to urge faculty and DBESs to contribute materials and include the package in the public archive. Once the DBES completed their position, maintenance of the public course package was rare.

Lastly, it was difficult to create a single, centrally-used system to make the archiving process easier for DBESs and faculty. Considerable time and expense was devoted to creating an online system, which was poorly used in the SEI. To house course materials, we currently recommend either collaborating with another established campus unit (such as a library or IT department) or using a system that is already familiar to departmental faculty, such as Dropbox, Google Drive, or a [page on your institution's website with downloadable zip files](#).

Seek future funding or engagement with national networks

After the initiative is over, it will be useful to find ways to continue to engage those who were involved and continue to spread the work. This may include seeking external or internal funding to continue the initiative or related work, connecting to national networks (such as [TRESTLE](#)), and creating ongoing events or opportunities for faculty to work on course transformation. For information on how the SEI continued engagement post-initiative, see the UBC CWSEI and CU SEI entries in [Appendix 1: Case Studies](#).

Chapter 4 Checklist

In order for the central organization to effectively manage the initiative, initiative organizers should consider the following actions:

Provide adequate financial and human resources for the initiative

- Allow for adequate duration (approximately 6 years in a department, 2 years for an individual course).
- Provide sufficient staff and budget (about 20% of total) for the central organization.
- Provide adequate departmental budget for DBES salaries, faculty incentives, recruiting, travel, research, and dissemination (roughly \$1.5-\$2M for large university departments).

Solicit and fund departmental proposals which are likely to effect change

- Plan to work with departments to develop a good proposal.
- Look for a supportive chair and a sense of departmental ownership of courses and educational programs.
- Require specifics and deliverables within proposals.
- Encourage direct financial incentives for faculty as part of the budget.
- State that funding and incentives can be discontinued if progress is inadequate.
- Evaluate proposals based on appropriate specificity and commitment by department as a whole.
- Fund at the appropriate level and duration, including time to ramp up and wrap up.

Supervise work through clear, shared expectations and continued oversight of progress

- Discuss the role of the DBES and their supervision at the start of and throughout the work. Support effective assessment on the part of the departments.
- Ensure the department appoints a departmental director to serve as the DBES's direct supervisor and liaison to the central organization.
- Require DBESs to submit monthly progress reports.
- Hold monthly departmental team meetings.
- Hold occasional meetings with departmental directors and/or chairs.
- Allow flexibility on achievement of milestones if the original vision becomes unrealistic.
- Organize corrective meetings in cases where progress is inadequate, particularly where commitments are not fulfilled; be prepared to terminate or reduce funding.

Support DBESs expertise and community

- Hold biweekly meetings with all DBESs as well as regular social events.
- Provide professional development training for DBESs (See *Chapter 3: DBES Success*).
- Hold an annual end of year event.

Plan for sustainability

- Encourage department events to promote early conspicuous success.

- Use cross-departmental events to showcase success.
- Use/develop appropriate methods for assessing changes in faculty and departments.
- Communicate data and success to higher administration.
- Consider supporting the public archiving of course materials, but be aware of challenges.
- Seek future funding, connect with national networks, or use other forms of engagement.

For further reading

SEI resource documents:

1. Teaching-related resources from SEI: [Resources tab at cwsei.ubc.ca](http://cwsei.ubc.ca/resources)
2. Recommendations for planning an initiative: [SEI Strategic Planning Approaches](#)
3. Example requests for proposals and funded proposals: [SEI Funding website](#)
4. SEI publications: [Full list of publications on SEI website](#)
5. List of indicators used in evaluating the SEI: [SEI Assessment Metrics](#)
6. Example course packages: [SEI course archives page](#)
7. Alternate example course packages: [Page of downloadable zip files at CU](#)

Annotated bibliography

***Accelerating Systemic Change Network*. Retrieved from <http://ascnhighered.org>.**

The Accelerating Systemic Change Network (ASCN) is a network of individuals and institutions, formed with the goal of more quickly advancing STEM education programs. The website includes literature resources, a blog, and other information about higher education reform.

Carey, S. J. (Ed.). (2015). *Navigating institutional change for student success in STEM*. *Peer Review*, 17(2).

This special issue, sponsored by the PKAL institutional change project, provides guidance for campus leaders on developing local capacity, assessment, and strategic planning—including a readiness tool for assessing capacity for change.

Dolan, E. L., Lepage, G. P., Peacock, S. M., Simmons, E. H., Sweeder, R., & Wieman, C. (2016). *Improving undergraduate STEM education at research universities: A collection of case studies*. Tucson, AZ: Research Corporation for Science Advancement. Retrieved from <https://www.aau.edu/key-issues/improving-undergraduate-stem-education-research-universities-collection-case-studies>.

Includes a chapter by UBC Dean of Science Simon Peacock on the SEI in which he describes how the UBC CWSEI dealt with university policies (such as teaching evaluations) and how UBC required first year courses to develop learning goals as a support for SEI efforts.

Eckel, P., Green, M., Hill, B., & Mallon, W. (1999). *On Change III: Taking charge of change: A primer for*

colleges and universities. An occasional paper series of the ACE Project on leadership and institutional transformation. Washington, DC: American Council on Education.

A practical guide to leading change within an institution, including strategies and information on supporting change agents.

Elrod, S., & Kezar, A. (2016). *Increasing student success in STEM: A guide to systemic institutional change*. Washington, DC: Association of American Colleges & Universities.

A step-by-step guidebook for campus leaders at the department or institution level for improving student achievement in undergraduate STEM.

Fry, C.L. (Ed.). (2014). *Achieving systemic change: A sourcebook for advancing and funding undergraduate STEM education*. Washington, D.C.: Association of American Colleges and Universities. Retrieved from <https://www.aacu.org/sites/default/files/files/publications/E-PKALSourcebook.pdf>.

A practical sourcebook that discusses the rationale for change in higher education, building institutional capacity, changing faculty practices, and tracking and sustaining improvement.

Kezar, A. (2009). Change in higher education: not enough, or too much? *Change: The Magazine of Higher Learning*, 41(6), 18-23.

Discusses the challenge of change in college campuses, using insights from studies on change leadership. Also discusses the importance of change agents.

Kezar, A. (2014). *How colleges change: Understanding, leading, and enacting change*. New York, NY: Routledge.

A more detailed scholarly volume on the topic of leadership and academic change.

Kotter, J. P. (2012). *Leading change*. Boston, MA: Harvard Business Review Press.

Describes eight change strategies for leading top-down change within an organization. This model informed the SEI approach, and there are many short articles describing the general approach. While not fully accounting for emergent change, this is a useful model.

Kotter, J. (2012, November). Accelerate! *Harvard Business Review*, 45-58.

Describes eight processes that can help organizations accelerate change, such as developing a sense of urgency and strategic vision.

Walter, E. M., Beach, A., Henderson, C., & Williams, C. T. (2015). Describing instructional practice and climate: Two new instruments. In G. C. Weaver, W. D. Burgess, A. L. Childress, & L. Slakey (Eds.). *Transforming Institutions: Undergraduate Stem Education for the 21st Century*. West Lafayette, IN: Purdue University Press.

Describes the Survey of Climate for Instructional Improvements (SCII), a tool which can be used to measure department-wide attitudes and norms regarding instructional practice.

Walter, E. M., Henderson, C. R., Beach, A. L., & Williams, C. T. (2016). Introducing the Postsecondary Instructional Practices Survey (PIPS): A concise, interdisciplinary, and easy-to-score survey. *CBE-Life Sciences Education*, 15(4).

PIPS is an instrument which may be used to measure instructional practice and change.

Wieman, C. (2017). *Improving how universities teach science: Lessons from the Science Education Initiative*. Cambridge, MA: Harvard University Press.

Authoritative resource on the SEI model and its impacts, including a detailed description of the rationale for the SEI, lessons learned, and data on departmental outcomes.

Wieman, C., & Gilbert, S. (2014). The Teaching Practices Inventory: A new tool for characterizing college and university teaching in mathematics and science. *CBE-Life Sciences Education*, 13(2), 552-569.

The Teaching Practices Inventory was used to measure instructional practice and change in the SEI.

Williams, C. T., Walter, E. M., Henderson, C., & Beach, A. L. (2015). Describing undergraduate STEM teaching practices: A comparison of instructor self-report instruments. *International Journal of STEM Education*, 2(1), 18.

A review of instruments which may be used to measure instructional practice and change.

Part II. The Departmental Leader's Handbook

Chapter 5 – Leading the Work from within the Department

- How do you recruit and hire a DBES?
- How do you structure departmental leadership?
- How do you plan the departmental project?
- How do you engage faculty in the initiative?
- How do you build for sustainability?
- Departmental factors that help and hinder

Chapter 6 – Setting the Stage for Effective Course Transformations

- How do you plan a course transformation?
- How can you set expectations for DBES-faculty partnerships?
- How do you support sustainability of the transformation?

5 - Leading the Work from within the Department

Summary

Though many initiatives aim to influence the institution as a whole, the department is the key cultural unit on most campuses, and consequently, Discipline-Based Education Specialist (DBES)-focused programs should be designed to operate principally at the department level with coordination by a central organization. However, at the outset, a department may not have a natural structure for supervising a DBES and their accompanying course transformation activities. The department needs to set goals for the initiative in their own context, supervise the DBES, and engage faculty in the work. In the SEI, the success of individual departments in terms of faculty engagement and use of course materials varied widely due to departmental factors. See Wieman (2017) for further discussion.

Approaches to ensuring good management of the work within the department

Recruit and hire good DBES candidates, making sure they have the appropriate skills and mindset.

Manage the project with an appropriate leadership structure, appointing a well-regarded and capable departmental director who can plan and manage the project and supervise the DBES. Coordination with the chair and the dean (when possible) is also valuable.

Strategically plan the work, creating faculty working groups, focusing on influencing departmental faculty, and creating long-term teaching assignments.

Encourage and incentivize faculty participation by making teaching and learning visible in the department, valuing teaching improvements, and providing incentives.

Make the work visible by keeping faculty continually apprised of the work in the initiative.

How do you recruit and hire a DBES?

Department members directly involved in hiring should be familiar with the parameters and expectations of the DBES role, as described in [Chapter 2: What Is a DBES?](#)

Advertising

Consider searching for candidates with PhDs in their disciplines who have a strong interest in education. In most cases, finding a DBES will require a recruitment search outside of the department, though suitable internal candidates can also be successful. Advertisements typically describe the position and its duties (such as working with faculty to develop course materials and learning assessments) and require a PhD, as well as organizational, interpersonal, and communication skills, with experience in education noted as a plus. The position is typically listed as a one-year renewable appointment. See [Sample Advertisements](#).

Use external searches

In the SEI, most departments conducted external searches for their candidates, with applicant pools ranging from 10-50, with approximately half of those applicants being worthy of serious consideration. Only in computer science (where industry competition for recent PhDs is very strong) was there difficulty in finding suitable candidates.

Advertising channels for such external searches include publications or websites dedicated to disciplinary research, education research, and teaching and learning; anywhere that teaching and learning discussions happen within the discipline. Informal networks and disciplinary listservs are also valuable in seeking out potential candidates. The CIRTl network has a list of [undergraduate science teaching-related job postings and postdoctoral positions](#), located mostly but not exclusively in the U.S.

Consider recruiting internal candidates

In some cases, however, you might consider candidates such as existing instructors in the department, emeriti faculty members, or graduate students. In our experience, internal candidates whose backgrounds and experiences indicate they would be effective in the job can be very successful DBESs. In the UBC Computer Science department, for example, using internal candidates met the challenge of the lack of suitable postdoctoral-level candidates. At CU Boulder, the Integrative Physiology department continued to buy out some of the teaching time of instructors after the postdoctoral funding ended; these ‘curriculum coordinators’ then acted as facilitators of educational change in the department.

Selecting applicants

To assess the suitability of a candidate for a DBES position, use a combination of interviews, an on-campus visit, and a talk. In considering applicants for a DBES position, consider whether the applicant:

- is expert in the discipline,
- has an interest in education and teaching,
- has good interpersonal skills, and
- is well-organized and has good time management skills.

For questions you might ask a candidate, see [Sample Questions for DBES Interviews](#). More discussion of the characteristics of successful applicants is in [Chapter 2: What Is a DBES?](#)

It is crucial to gauge the candidate’s personality and work characteristics, including how they might handle a difficult situation. For example, if a faculty member is resistant to change, it is a red flag if the candidate suggests that the faculty just needs to be convinced of the need for change, rather than indicating a willingness to listen

and collaborate. Another red flag is a candidate who feels that they already know everything about teaching and learning without reference to the literature. Occasionally, a DBES candidate may have an agenda that is not in line with the goals of the initiative. In the SEI, we found it was a mistake to assume they would change their priorities.

How do you structure departmental leadership?

While the central organization can provide support through a variety of mechanisms, at the end of the day, the responsibility falls on the department to lead the work. Successful departments are those in which the activity is well-planned and well-managed, and in which a large number of faculty are open to engaging in such educational experimentation.



DBESs in CU Geology SEI at a departmental thank-you lunch (Credit: Leilani Arthurs / CU Boulder. All rights reserved).

The departmental director: the department team leader for the initiative

Within the department, identify a departmental director to supervise the DBES and manage the project. This is an essential position; an undergraduate or curriculum committee is not a suitable replacement for a director, as the project needs a faculty champion with the responsibility and authority to collaborate with the DBES and establish a vision for the project. In contrast, undergraduate and curriculum committees tend to be reactive and non-vision-

ary. To circumvent this, one successful SEI department, Earth, Ocean and Atmospheric Sciences (EOAS) at UBC, set up a new Teaching Initiatives Committee to help lead educational change.

The most effective directors are those who are well-regarded in the department and who also have planning and organizational skills. Good organizational and management skills are especially vital in departments with multiple DBESs, as this requires considerable planning and coordination.

Roles of the departmental director over time

1. **Overseeing initiative-related HR activities**, including the search and hiring of DBESs.
2. **Making budgetary decisions.**
3. **Strategic planning**, including deciding which courses and faculty the DBES will work with, and introducing the DBES to those faculty.
4. **Clearly communicating the DBES's role and responsibilities** within the department; establishing working arrangements between the DBES and faculty.
5. **Supervising the DBES**, providing feedback, monitoring their progress, and intervening when problems arise.
6. **Protecting the DBES's time** and sheltering them from departmental politics.
7. **Meet regularly with the central organization** to provide updates on the work and seek feedback.
8. **Summarize the department's initiative work in an annual report** to document outcomes and share them with stakeholders.
9. **Prioritizing and publicizing** the work in the department, such as reporting to the chair or faculty.

The most critical elements of this position in the SEI were supervision of the DBES, general coordination of the project, and managing the unfamiliar and somewhat delicate working relationship between the DBES and faculty. Sending the DBES off on their own to discuss their collaboration with faculty was usually not effective and sometimes resulted in a dysfunctional DBES-faculty working relationship.

DBES supervision

It is important to establish the location of DBESs within a clear chain of command. Who does the DBES report to? Who manages their daily activities? DBESs should be seen as members of their respective departments, but the central organization should also provide professional development for them along with oversight for the departmental project. In the SEI, the following structure was used to meet these goals:

1. **A departmental director acts as a DBES's immediate supervisor.** A faculty member in the department serves as the departmental director, charged with overseeing the project and the DBES. Thus, the DBES is clearly situated as a member of the department and the supervisor is intimately connected with the departmental culture, politics, and daily functioning.
2. **The central organization provides additional oversight of the DBES.** SEI Central managed the DBES's training and, in some cases, research advising, ongoing DBES meetings, and regular progress updates with the departmental team. In departments leading their own work with no SEI Central equivalent, these oversight roles should be taken on by the department. See [Chapter 4: Central Organization](#) for a full description of these roles.

The department chair

The chair plays an important role. A supportive chair can help in the management and prioritization of the initia-

tive, both in terms of who they appoint as departmental director and in supporting the planning and management of funding, faculty, and teaching assignments. In many SEI departments, the chair changed during the course of the initiative, which sometimes had significant impacts on the work. Depending on the department, this impact was either positive or negative. Engagement of the dean and clear accountability can be critical for continued departmental progress under such change in leadership. See [Chapter 4: Central Organization](#) for more information.

Productive contributions of the department chair

1. **Appoint an appropriate departmental director.**
2. **Plan the work** in conjunction with departmental priorities.
3. **Provide incentives to faculty** for improving teaching (e.g., desirable committee or teaching assignments, space assignments, salary increments, etc.), and reassure faculty that they will not be penalized for low student evaluations during the initial course transformation phase.
4. **Reward and celebrate teaching improvements:** nominate instructors for rewards, thank faculty, use teaching excellence in merit evaluations, etc.
5. **Make the initiative's work visible** and celebrate it within the department.
6. **Invite DBESs to faculty meetings** to observe and present.
7. **Consistently communicate the importance of the initiative's work** within the department and to the higher levels of administration.

Chairs may be particularly interested in the perspective offered by UBC Dean Simon Peacock on the UBC CWSEI (see [Improving Undergraduate STEM Education at Research Universities \[2017\]](#)). Dean Peacock describes how the UBC initiative dealt with university policies (such as teaching evaluations), and how UBC required first year courses to develop learning goals as a support for SEI efforts.

How do you plan the departmental project?

This section describes creating priorities and structures to guide the departmental project as a whole. See [Chapter 6: Setting the Stage](#) for guidance in planning transformation of a specific course.



Faculty and DBESs discuss course transformation activities in the TRESTLE project. (Credit: Patrick Campbell/University of Colorado. All rights reserved.)

Engage in strategic planning

An educational change project requires thoughtful planning. Who might be interested in working on the project? What is the department ready to do, and what might be the local challenges? What structures might support the work? How will faculty help direct the planning and identify departmental priorities? See our set of recommendations and resources in our [SEI Strategic Planning Approaches](#) handout.

Support planning with faculty working groups

In many cases in the SEI, project planning was at least partially emergent. Many departments established very productive faculty working groups which helped advise the project, usually through the development of learning goals for the course in question. Such discussions can be particularly useful in departments where there is no pre-existing departmental vision or ownership over courses, and provide an avenue for deciding what students should learn in a course. See [Facilitating Faculty Discussions](#) and [Facilitating Learning Goal Discussions](#) for specifics of such facilitation.

Since the SEI, a very promising new structure has emerged for departmental decision-making: [Departmental Action Teams \(DATs\)](#). In a DAT, a facilitated team identifies problems of interest in the department and generates sustainable solutions. Such groups have been transformative in many departments.

Onboard the DBES

When your DBES is first hired, they will need some assistance in orienting to the department structure, faculty, and issues. The departmental director should set up regular meetings and work with the DBES to give them concrete tasks and help structure their first few months. Make sure the DBES is given information about the history of the initiative in the department and typical teaching practices, and is oriented to departmental resources and staff. The departmental director can introduce the DBES to the department at faculty meetings, facilitate in-person ‘getting acquainted’ meetings with key faculty, and arrange for the DBES to observe some courses. The DBES may wish to engage in a ‘listening tour’ with faculty in their first months on the job as a way of learning about the department and faculty, asking faculty questions like “What are the biggest challenges for your courses?” and “What do you think success would look like for this initiative?” When the DBES is introduced to students, their role should be described so as to best support student respect (e.g., as a co-instructor, and definitely not as a teaching assistant).

Focus on faculty engagement

In your planning, focus on how you will engage faculty as a higher priority than identifying a list of courses to be transformed. In most departments, systematic transformation of courses may be too ambitious of a goal. This is partly due to the fact that large introductory courses are often plagued by entrenched curricula and multiple sections taught by faculty who may or may not be interested in the project. Thus, many SEI departments focused on hooking people based on their existing interests and building the project from there, rather than working through a pre-identified list of courses to transform.

There is one clear exception to this rule: in UBC’s EOAS department, course transformations did proceed in a systematic way: the DBESs and departmental director posted a list of courses to be transformed at the beginning of the project (see [EOS Long Term Plan 2009](#)). DBESs systematically worked through this list, trying to involve as many faculty as possible. While there were necessary deviations from the plan due to sabbaticals, new hires, curricular changes, etc., this document provided a useful starting point and roadmap for the project, as well as a way to engage professors over time, by establishing long-term teaching assignments to support the plan. This plan was supported by strong and consistent leadership and a supportive culture for teaching transformations, including a committee focused on departmental teaching improvements. For more about EOAS’s story, see Wieman (2017, Chapter 5).

Establish teaching assignments for the course over one-to-two years

Establishing long-term assignments for the course ensures stable teaching and strategic hand-off to future instructors. See [Chapter 6: Setting the Stage](#) for information on long-term assignment models.

How do you engage faculty in the initiative?

It can be challenging to engage faculty in course transformation work productively, especially given the typically low institutional prioritization of teaching. This section describes the ways in which a department can encourage faculty to consider engaging in the initiative. It can be valuable to focus first on engaging faculty (and working on their courses), rather than creating an a priori list of courses to be transformed. See [Chapter 8: Partnering with Faculty](#) for our recommendations on how the DBES can productively partner with faculty once the work has

begun. These recommendations align with other recommendations on supporting institutional change. See, for example, Chapter 7 in the National Academies report [Reaching Students](#).

Host external visitors

“No man is a prophet in their own land,” as the saying goes. External visitors can have an outside influence compared to department faculty. You might invite a research visitor to discuss something about their teaching, invite a scholar of teaching and learning, or invite a faculty member from another department to present a course reform project. In the SEI for example, Carl Wieman visited every department and discussed the science of teaching and some department colloquia highlighted experts in teaching and learning. Such high-profile experts can elevate and professionalize the status of teaching in the department, and initiate discussion about teaching and learning in a way that is free from existing relationships and expectations in the department.

Provide time-saving resources or perks

Learning how to teach differently takes time, so offering incentives can help encourage faculty participation. In the SEI, such incentives were most effective when they were tailored to the needs of the faculty member, often in a way that could benefit their research or free up their time. Offer faculty teaching buy-outs/releases, extra teaching assistants or research assistants, opportunities for [paired teaching](#), or other perks in exchange for engaging in a classroom transformation project. These perks will typically be arranged by the departmental director and the chair. A faculty agreement might be signed between the parties to indicate the work that would be done in partnership with the DBES in exchange for a buy-out, for example, and to provide accountability. See [Course Transformation Deliverables](#).

Value development work in formal evaluations

A faculty member’s involvement in the course transformation project should count positively in their teaching portfolio for tenure and promotion. Because student evaluations occasionally suffer early in a project, or, perhaps more frequently, faculty may fear that evaluations will suffer, give faculty (particularly pre-tenure faculty) reassurance that such low evaluations—if they happen—will not count against them or that alternative measures of teaching effectiveness will be used.

Validate teaching improvements publicly

Faculty working with the DBES ought to be featured publicly in the department (e.g., through a department newsletter, SEI newsletter, or in faculty meetings) and be encouraged to present at local and national events. These activities serve to further affirm faculty’s often new identity regarding teaching excellence. UBC’s EOAS department developed a very successful [newsletter](#) which served to make the work visible across the department.

Assign faculty to teach coveted courses

For major course projects it can be very useful to explicitly assign the instructor developing the course to teach for several terms, because teaching the course multiple times can be a time-saver for faculty, especially in departments where the culture is high rotation among courses. This can also be a valuable incentive if the teaching assignment is for a particularly coveted course.

Ensure respected faculty are included

While this isn’t always possible, if you can be strategic in trying to engage widely respected faculty early in the

initiative, this can be useful in engaging other faculty further down the line. Consider faculty who are particularly well-respected for research or teaching, or are influential within the department.

Focus on long-term departmental faculty

In the SEI, the principle focus of the DBESs' energy was on long-term faculty, which include tenure-track research or teaching faculty and long-term instructors, but not contract lecturers. This focus reflected the SEI's goal of affecting the culture of teaching and learning in the department, necessitating engagement of personnel who would have influence on departmental teaching practices for the foreseeable future. Throughout this Handbook we refer to 'faculty' as including this general group of long-term members of the department.

Include teaching-focused faculty and other long-term instructors

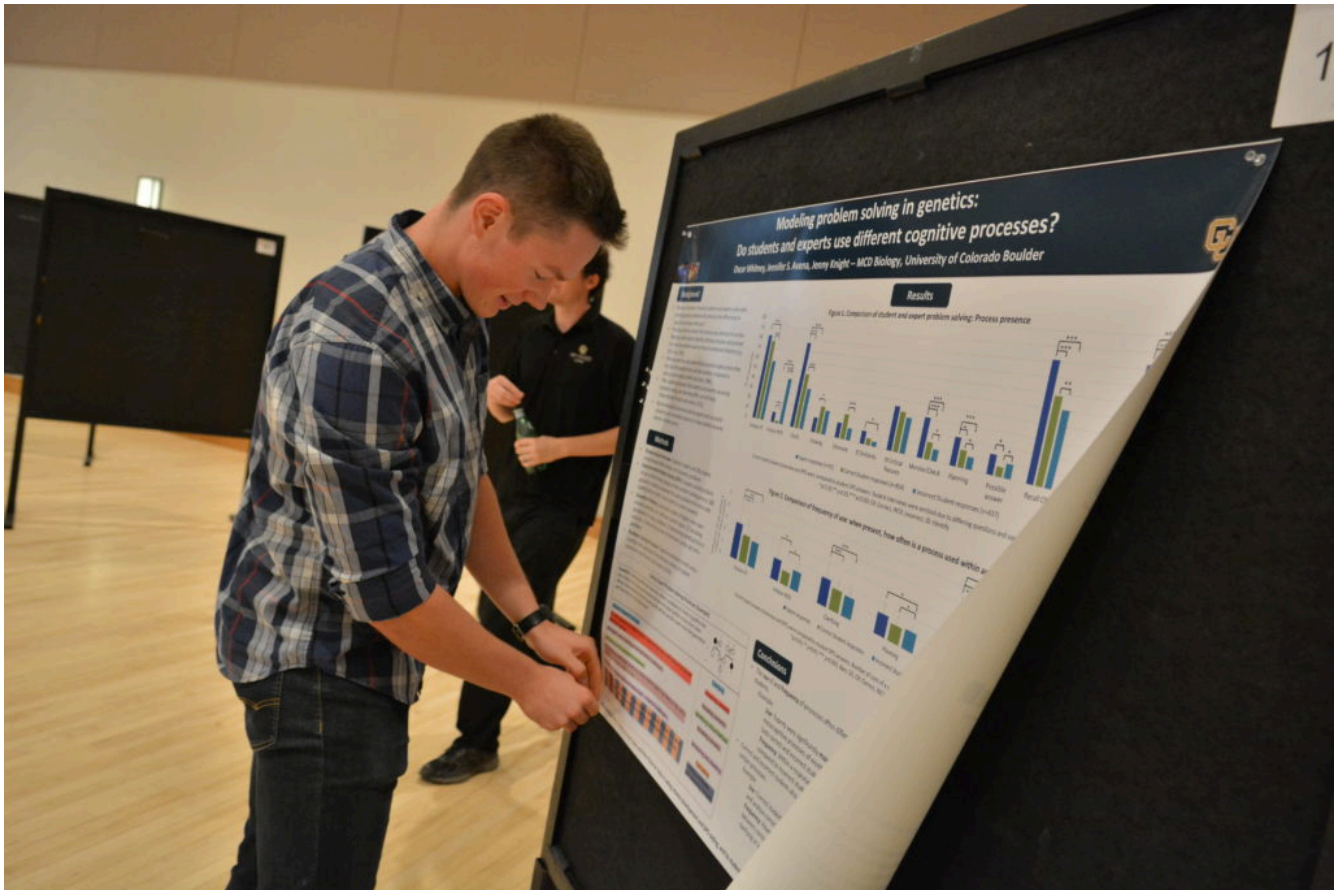
Across departments, the status and roles of those assigned primarily to teaching can be quite varied, whether they are tenure-track teaching faculty, instructors on long-term contracts, or instructors hired to teach course-by-course. Anyone with a (relatively or formally permanent) long-term teaching position in a department can contribute significantly to an initiative; in the SEI this contribution was usually most effective when the teaching faculty were fully integrated into the department and treated as respected members who rotated among courses.

How do you build for sustainability?

Consider how you will maintain faculty engagement after the end of the initiative by drawing attention to the course transformation work and by creating long-term structures.

Make the work of the initiative visible within the department

Ensure the department as a whole knows about the work, especially by publicizing early successes. Give the DBES and director some time during faculty meetings to report on the work. You might consider building a website you can send interested faculty to for more information or creating two-page guides to teaching strategies. Some DBESs hosted teaching and learning discussions within the department. One example of a successful dissemination project was the [monthly newsletter](#) produced by EOAS at UBC. Encouraging faculty participation in an annual cross-departmental showcase can show that the existing efforts in each department are part of a broader mission at the institution. See the End of Year Event example in [Chapter 3: DBES Success](#).



Sharing education research at an annual symposium at the University of Colorado Boulder. (Credit: Casey A. Cass/University of Colorado. All rights reserved.)

Such dissemination feeds productively into the work, informing faculty about relevant literature and best practices, elevating the importance of educational work, and ultimately engaging additional faculty.

Create structures to sustain the work

Unfortunately, culture change in the department will probably not be sufficient to maintain changes made as a result of the initiative without some accompanying structures. For example, how will learning goals and pedagogy for courses be revisited periodically? How will engaged faculty have opportunities to continue to grow their skills? Structures may include creating or revising departmental policies, including course renovation information in faculty review, creating or charging a committee with addressing curricular reform, supporting faculty learning communities or other opportunities for faculty development, using [paired teaching](#), or creating teaching awards for faculty. For more about sustaining course transformation work in particular, see the variety of suggestions near the end of [Chapter 6: Setting the Stage](#).

Departmental factors that help and hinder

Consider the following factors when engaging in strategic planning of the work. For more detail, see Wieman (2017; pp. 109-115 and 143-150).

Factors that <i>help</i> within a department	Factors that <i>hinder</i> within a department
A supportive Department Chair who: <ul style="list-style-type: none"> • Is an effective leader • Plans and manages initiative activities • Sends messages to faculty to emphasize the importance of the initiative • Highlights initiative activities in department 	An unsupportive Department Chair who: <ul style="list-style-type: none"> • Is not well respected • Is not strategic in assigning faculty to teach initiative courses • Sends a negative message about the importance of education • Ignores initiative activities
Effective oversight at the department level , including: <ul style="list-style-type: none"> • Creation of a new structure to oversee initiative activities • Working proactively and engaging in long-term planning • Identifying a departmental director with clear responsibility, authority, and good leadership skills 	Poor oversight at the departmental level , including: <ul style="list-style-type: none"> • Delegation of initiative activities to existing committees • Working reactively, fitting the initiative in as a low-priority activity • Lack of departmental director, or identifying a director who is not well-respected or not a good manager
Clear communication of DBES responsibilities , and continual oversight and monitoring.	Lack of management of DBES/faculty relationships , including sending DBESs to talk to faculty on their own.
A sense of departmental ownership of courses.	Individual course ownership and/or lack of shared ownership of multi-section courses.
<p style="text-align: center;">Amount of rotation in teaching assignments High turnover makes it easier to reach more faculty, but more difficult to sustain changes.</p>	
Thoughtful planning of teaching assignments in advance.	Last-minute, non-strategic teaching assignments.
Incentives for improving teaching.	Disincentives for improving teaching.
Early conspicuous successes in student outcomes and faculty experiences.	Lack of clear successes.
Non-tenure track instructors or contract faculty who are respected, well-integrated into the department.	Non-tenure track instructors who are disconnected from rest of the department.

Chapter 5 Checklist

In order for the department to productively lead the work, department leaders should consider the following actions:

Recruit and hire a DBES

- Advertise and recruit in disciplinary research, education research, and teaching and learning venues.
- Consider both internal and external candidates.
- Select an applicant who is expert in their discipline with good interpersonal and time management skills, and watch out for red flags.

Manage the project

- Appoint a departmental director who is well-organized and well-regarded, and has the authority to supervise the DBES and lead the project.
- The departmental director should lead the project, manage budgets, coordinate with the central organization, and publicize the work in the department.
- The departmental director should oversee the DBES's work through regular meetings and progress reports while protecting the DBES's time and sheltering them from politics.
- The chair should be engaged as an active advocate for the initiative.

Plan the work

- Strategically plan the work, considering departmental priorities and faculty interest.
- Create faculty working groups to generate consensus.
- Consider focusing on interested faculty rather than a logical list of courses.
- Create long-term teaching assignments.

Encourage and incentivize faculty participation

- Invite outside experts to talk about teaching.
- Provide time-saving incentives and perks for participation.
- Acknowledge the work in formal evaluations and address potential faculty fears.
- Value teaching improvements publicly.
- Give coveted teaching assignments as incentives.
- Engage teaching-focused faculty and other long-term instructors.

Make the work visible within the department

- Make regular announcements on progress within faculty meetings, and invite the DBES and departmental director to present.
- Create a website to showcase the work.
- Encourage the DBES to host teaching and learning discussions, write a monthly newsletter, and implement other ways of engaging the department as a whole.

For further reading

SEI Resource documents:

1. DBES position announcements: [Sample Advertisements](#)
2. DBES candidate interview questions: [Sample Questions for DBES Interviews](#)
3. Recommendations for planning an initiative: [SEI Strategic Planning Approaches](#)
4. Recommendations for facilitating faculty discussions: [Facilitating Faculty Discussions](#)
5. Recommendations for developing learning goals with faculty: [Facilitating Learning Goal Discussions](#)
6. Example of multi-year strategic plan of course transformation: [EOS Long Term Plan 2009](#)
7. Expectations for instructors involved in course transformations example: [Course Transformation Deliverables](#)
8. Department SEI activity newsletter example: [UBC EOAS newsletter](#)
9. Recommendations on co-instruction as a model for faculty development: [Paired teaching white paper](#)

Annotated bibliography

Eckel, P., Green, M., Hill, B., & Mallon, W. (1999). *On Change III: Taking charge of change: A primer for colleges and universities. An occasional paper series of the ACE Project on leadership and institutional transformation.* Washington, DC: American Council on Education.

A practical guide to leading change within an institution, including strategies and information on supporting change agents.

Elrod, S., & Kezar, A. (2016). *Increasing student success in STEM: A guide to systemic institutional change.* Washington, DC: Association of American Colleges & Universities.

A step-by-step guidebook for campus leaders at the department or institution level for improving student achievement in undergraduate STEM.

Fry, C.L. (Ed.). (2014). *Achieving systemic change: A sourcebook for advancing and funding undergraduate STEM education.* Washington, D.C.: Association of American Colleges and Universities. Retrieved from <https://www.aacu.org/sites/default/files/files/publications/E-PKALSourcebook.pdf>.

A practical sourcebook that discusses the rationale for change in higher education, building institutional capacity, changing faculty practices, and tracking and sustaining improvement.

Kotter, J. P. (2012). *Leading change.* Boston, MA: Harvard Business Review Press.

Describes eight change strategies for leading top-down change within an organization. This model informed the SEI approach, and there are many short articles describing the general approach. While not fully accounting for emergent change, this is a useful model.

Kotter, J. (2012, November). Accelerate! *Harvard Business Review*, 45-58.

Describes eight processes that can help organizations accelerate change, such as developing a sense of urgency and strategic vision.

Wieman, C. (2017). *Improving how universities teach science: Lessons from the Science Education Initiative*. Cambridge, MA: Harvard University Press.

Authoritative resource on the SEI model and its impacts, including a detailed description of the rationale for the SEI, lessons learned, and data on departmental outcomes.

6 - Setting the Stage for Effective Course Transformations

Summary

A primary role of the Discipline-Based Education Specialist (DBES) is to facilitate course transformation: applying what is known from research about effective instructional practices into a specific course context, and being deliberate in the approach by using data from the course to support choices and capture the impact of the work. The departmental leadership has an important role to play in ensuring that course development is a collaboration among faculty and the DBES, that the working relationships progress smoothly, and that the changes to the course are sustained over time. This chapter outlines how the departmental leadership can support effective course transformations. For details on how the DBES can undertake the course transformation work itself, see [Chapter 7: Course Transformations](#).

Approaches to supporting effective course transformation work in departments

Plan the work, including long-term teaching assignments, and allow several terms for the transformation.

Create shared expectations in the faculty members teaching the course and in the DBES, along with written documentation and close monitoring.

Plan for sustainability, focusing on culture change in the department, continually communicating about the work, setting expectations for use of course materials, and connecting faculty through co-teaching or discussions to support their use of course materials.

How do you plan a course transformation?

The SEI used a [backward design](#) model to guide course transformations, in which learning goals, assessments, and instruction are aligned across the course. Incorporating concepts from the research literature on teaching and learning with data from students in the course (past and present) is essential in helping to decide what specific changes to make. For more discussion of what is entailed in a course transformation, including case studies and resources, see [Chapter 7: Course Transformation](#).



Former SEI department director Jennifer Knight discusses teaching with fellow faculty. (Credit: Patrick Campbell / University of Colorado. All rights reserved.)

It can be challenging to identify the most appropriate courses for transformation and ensure that the faculty engaging in the work with the DBES understands what such a transformation entails. To ensure smooth progress, we recommend the following actions.

Consider reaching out first to interested faculty

In some cases, strategically choosing courses that are most in need of transformation can be productive. In most departments, however, more progress can be made by focusing first on faculty who are eager to engage. Working with this first set of interested faculty gives the initiative some time to establish itself and create credibility with more reluctant faculty. See [Chapter 5: Departmental Leadership](#) for more on strategic planning and engaging faculty and [Chapter 8: Partnering with Faculty](#) for ideas on persuading the second wave of faculty to engage.

Create long-term teaching assignments

Before the SEI, few departments at CU Boulder and UBC had a multi-year plan for faculty course assignments. Setting such a plan in place required an adjustment in departmental thinking and planning, but did not take additional time. Generating a two-to-three-year teaching plan enabled long term strategic planning for the use of the DBES and their work with faculty, especially in departments with multiple DBESs to coordinate, and created clearer opportunities and expectations for their partnership with faculty. Long-term teaching plans also supported

greater shared ownership of course transformations, since faculty knew how long they would likely continue to teach that course and thus reap the benefits of the work invested.

Allow several terms for the transformation, including a planning term

A planning term enables the DBES to get to know the faculty member teaching the course, collect data on student learning in the course, begin developing learning goals, assessments, and teaching materials, and collect baseline data. When allowing for a planning term is not realistic, using a more incremental course transformation approach—changing a few things at a time—may help to keep the changes manageable. For more detail on the DBES role during the planning term, see [Chapter 9: DBES Development](#).

Since a course transformation is never perfect on the first try, at least one iteration is typically required for fine-tuning, based on the experience in the first teaching term. See [Course Transformation Outcomes and Timeline](#), which describes a full course implementation and timeline in the SEI.

Engage instructional assistants

Undergraduate learning assistants (see [this article](#) and Otero, Pollock and Finkelstein, 2010) and teaching assistants (graduate or undergraduate) can be important elements of the change process. For the first semester of a course transformation, you may wish to hand-pick teaching assistants who are already well-versed with active learning and pedagogy to help support the instructional team. Teaching assistants and/or learning assistants can be very useful in suggesting activities and informing faculty and the DBES about what is happening in the course, such as student difficulties both with content and with respect to specific activities. The use of transformed teaching methods often require a greater instructor:student ratio than in traditional courses, and the use of instructional assistants can often make such changes feasible and affordable.



Teaching Assistant training in the CU Boulder Geology Department (Credit: Leilani Arthurs / CU Boulder. All rights reserved).

How can you set expectations for DBES-faculty partnerships?

It is critical for the departmental leadership to set clear expectations for faculty collaborating with the DBES. This helped ameliorate common problems described below.

Common problems in DBES-faculty collaboration

The DBES is treated as a glorified teaching assistant, providing administrative support for faculty and dealing only with mundane tasks.

The faculty member does not meet regularly with the DBES or does not provide materials for feedback in a timely manner.

The DBES creates too many of the materials without involvement of the faculty member (though this can be a useful strategy when starting out).

The faculty member changes their mind about collaborating with the DBES once they realize the level of work required.

In many cases in the SEI, lack of progress was due more to simple misunderstandings rather than to recalcitrance on the part of faculty or the department. Thus, setting clear expectations was critical. The departmental director needed to take a hands-on management role in this regard, making it clear how the working relationship would function, what the faculty member was expected to do, and what the DBES was (and was not) expected to do. The director also needed to continually monitor the DBES-faculty collaboration over time and intervene if problems arose.

To set expectations, address the following questions with both the DBES and course instructor:

1. What is the role of the DBES? (See [Chapter 2: What Is a DBES?](#))
2. What is the role of the faculty member?
3. What is the timeline for the work?
4. What is your plan if the roles are not fulfilled or the timeline breaks down?
5. Who will own the course materials?
6. Who will own data and author reports or publications?
7. What is the plan for the sustained use of materials over time?

Setting expectations for DBES/faculty collaboration

1. **Document the DBES role.** Circulate a short description of the DBES role and use it to start all course design projects. See [STLF Role and Faculty Working Arrangement](#), [EOAS-SEI “Getting Started”](#), and [Chapter 2: What Is a DBES?](#)
2. **Document course design expectations.** Clearly describe and document what a fully transformed course would look like. See [Course Transformation Outcomes and Timeline](#) and [EOAS-SEI “Getting Started”](#).
3. **Create a signed, written agreement.** Outline expectations, timelines, and deliverables, and have the agreement signed by the faculty member and chair. While not legally binding, such an agreement sends an important message and creates realistic expectations. See [Course Transformation Project Agreement](#) for an example.
4. **Meet regularly** (DBES-faculty and DBES-faculty-departmental director). This ensures close communication and monitoring of the DBES-faculty relationship over time.

How do you support sustainability of the transformation?

Part of a successful course transformation is effectively and sustainably archiving packages of course materials, and encouraging uptake of the course transformation by multiple faculty. These were both challenges in the SEI. Below we describe the difficulties faced in this part of the work, and some recommendations.

Common challenges to creating course sustainability

Time. If faculty have already developed materials for the course in question, it may be more time-consuming for them to use the new materials with an unclear reward for doing so.

Expertise. Even with the use of course archives, uptake of existing materials is not straightforward if faculty are not familiar with the principles behind the design.

Rotation. In departments with high levels of rotation through teaching assignments, a faculty member may teach a course only intermittently, reducing the incentive for them to invest the time required to transform a course.

Archiving. It is difficult to create a coordinated system to archive course materials for later use by faculty, and ongoing maintenance of course archives is rare after the departure of the DBES.

At the planning stage, discuss and decide how course sustainability will be addressed, considering the variety of approaches described below.

Generate departmental expectations about future use of course materials

Will there be departmental expectations that future course instructors will use the course materials as a condition of accepting the teaching assignment? How will new course instructors be introduced to the course materials? Who will teach the course in the long term, and how can those course instructors be chosen to maximize sustainability? Can you put structures and/or funding in place to support new course components? Can these expectations be communicated at the level of the chair and/or key department committees and leadership related to teaching? Determining your department's answers to these questions can help create a solid strategic plan for the future.

Create long-term teaching assignments

Create teaching assignments for the course several semesters in advance. This enables the DBES to involve those future instructors in course development. Faculty are much more resistant to change if they are not involved in the planning. Long-term assignments also assure faculty that the time devoted to the course transformation will pay off when they teach the course multiple times.

Disseminate the work within the department

Make the work visible within the department to build faculty engagement and celebrate teaching successes. For example, present outcomes from the course transformation within faculty meetings, create a departmental newsletter, and reconvene faculty working groups to share results. See [Chapter 4: Central Organization](#) for more information.

Connect the original instructor of the transformed course with future course instructors

Especially in the initial year or two after a substantial course project, connect the initial course instructor with new people teaching the course. This is best if there are departmental expectations around the use of the materials.

Train instructional assistants

If a course includes learning assistants or teaching assistants, part of the course transformation will involve training them. For example, help teaching assistants understand the rationale for the course changes so that they will allow students the time in class or lab to engage in active learning activities. Many teaching assistants feel their job is to provide clear lectures or work problems in front of students, and without some training they may default

to this type of instruction. For videos and worksheets which are useful for orienting instructional assistants to active learning classrooms, see [the Periscope project](#).

Consider co-teaching (paired teaching) assignments

In co-teaching assignments, an experienced faculty member is often paired with a newer faculty member. When faculty work as a team to teach a transformed course, the newer faculty member gets valuable on-the-job mentoring and experience with the course materials, which will reduce the time needed to use the same approach when teaching alone the next semester. The UBC CWSEI experience with co-teaching has shown that it can be very effective for transferring a course to a new instructor and for developing the new instructor's teaching expertise. See this [white paper on paired teaching](#), which has several recommendations.

Create course materials packages

As described in [Chapter 4: Central Organization](#), packages of course materials for use outside the institution are a way of documenting the outcomes of the project. Generating a package of course materials is a necessary—though not sufficient—step towards synthesizing and documenting the outcomes of the project. Create an organized set of materials that are usable by other faculty, and include a set of notes on what was done, what worked, and what areas need further improvement. Examples of such course archive packages are online at our [course archives page](#) (the Physics department's archives may be the most detailed).

Focus on culture change

If an SEI-like project has already focused on changing teaching in the department as a whole, the faculty body will have the relevant knowledge and background to implement the course materials. This holistic focus on the department has been shown to result in fewer faculty abandoning the new teaching methods they learn, with many faculty going on to use those methods to independently transform courses. See Wieman et al. (2013).

Chapter 6 Checklist

In order to develop high-quality courses with potential for sustainability, departmental leaders should consider the following actions:

Plan the course transformation

- Consider focusing on interested faculty, rather than on specific courses.
- Plan teaching assignments for two or three iterations of a course.
- Allow several terms for the transformation, including a planning term, a first teaching semester, and a second teaching semester.

Create shared expectations for DBES/faculty collaboration

- Discuss the working relationship with faculty in advance.
- Document the DBES role in writing.
- Create a written agreement for the collaboration between the DBES and faculty.
- Monitor collaborations and intervene if problems arise.

Plan for sustainability and culture change

- Create a plan for sustainability early in the project.
- Generate departmental expectations about content and pedagogy to be used in the course in future.
- Consider co-teaching models to bring new faculty into the approach.
- Create long-term teaching assignments for the course.
- Share the work in the department through faculty meetings and newsletters.
- Connect the instructor who first teaches the transformed course with planned future instructors of the course.
- Create a course materials package that is transferable.

For further reading

SEI resource documents:

1. Full course design steps and timeline in the SEI: [Course Transformation Outcomes and Timeline](#)
2. Overview of the DBES role and faculty collaboration in the SEI: [STLF Role and Faculty Working Arrangement](#)
3. Example of expectations, timelines, and deliverables to be signed by involved faculty and DBESs: [Course Transformation Project Agreement](#)
4. Department-specific example of the above document : [EOAS-SEI “Getting Started”](#).
5. Recommendations on co-instruction as a model for faculty development: [Paired teaching white paper](#)

6. Example course packages: [SEI course archives page](#)

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Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., Norman, M. K., & Mayer, R. E. (2010). *How learning works: Seven research-based principles for smart teaching*. San Francisco, CA: Jossey-Bass.

Outlines major principles for how students learn.

Chasteen, S.C., & Otero, V. Teaching with learning assistants. *Science Education Resource Center*. Retrieved from https://serc.carleton.edu/sp/library/learning_assistants/index.html.

Brief, user-friendly description of learning assistants and how they can best be used.

Handelsman, J., Miller, S., & Pfund, C. (2006). *Scientific teaching*. New York, NY: W.H. Freeman.

Describes the scientific approach to teaching, which underlies the SEI model.

Heath, C., & Heath, D. (2007). *Made to stick: Why some ideas survive and others die*. New York, NY: Random House.

This book about how to communicate ideas to make them ‘stick’ can help you think strategically about communicating with department faculty.

Otero, V., Pollock, S. & Finkelstein, N. (2010). A physics department’s role in preparing physics teachers: The Colorado learning assistant model. *American Journal of Physics*, 78 (11).

Describes the learning assistant program and how it has improved student learning.

Wieman, C. (2017). *Improving how universities teach science: Lessons from the Science Education Initiative*. Cambridge, MA: Harvard University Press.

Authoritative resource on the SEI model and its impacts, including a detailed description of the rationale for the SEI, lessons learned, and data on departmental outcomes.

Wieman, C., Deslauriers, L., & Gilley, B. (2013). Use of research-based instructional strategies: How to avoid faculty quitting. *Phys. Rev. ST Phys. Educ. Res.*, 9, 023102.

Describes how the use of DBESs enhanced faculty’s sustained use of instructional strategies.

Part III. The Discipline-Based Education Specialist's Handbook

Chapter 7 – Course Transformation

- What is a course transformation?
- Course transformation resources
- How do you start the project?
- How can you best use meetings with faculty?
- How do you design learning goals?
- How do you assess student outcomes?
- How do you develop course materials?
- How do you wrap up the work?

Chapter 8 – Partnering with Faculty

- How can you form faculty partnerships?
- How do you respectfully persuade faculty to consider changing their teaching?
- How can you give feedback and coach faculty productively?

Chapter 9 – Developing Your Roles and Skills

- How do you start out in your department?
- How do you integrate further in the department?
- How do you develop your skills as a DBES?
- What are common challenges faced by DBESs?
- Considerations for DBESs in specific types of positions
- What are the career paths for DBESs?

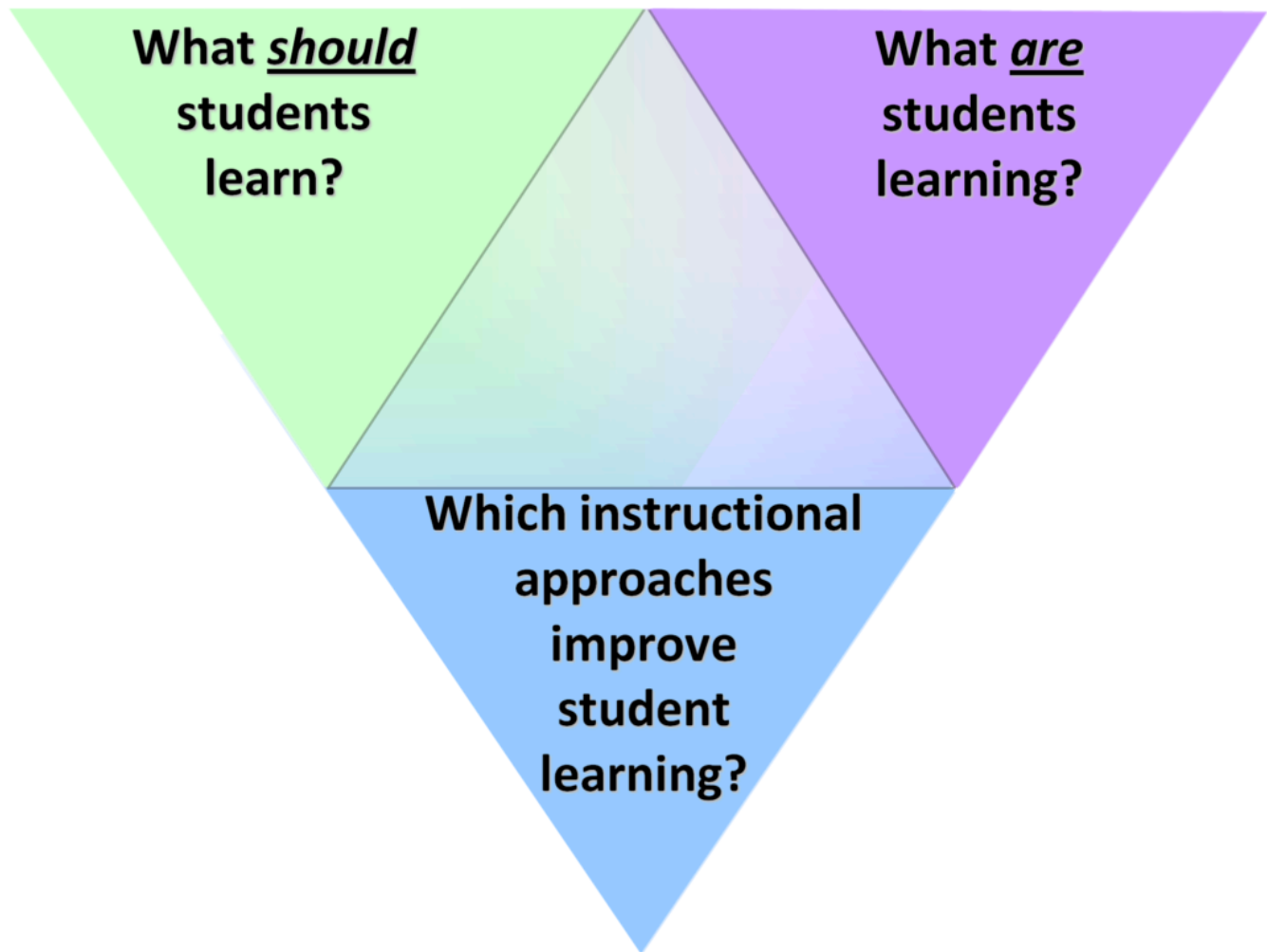
7 - Course Transformation

Summary

A primary role of the DBES is to facilitate course transformation projects as a means of developing faculty expertise around teaching and learning. Focused course development will typically involve deep collaboration between the DBES and faculty (and often a faculty working group), as well as drawing on results from the education literature and data from the course. During the course transformation, the DBES can act like a partner and tactful coach for the teaching faculty, taking on some of the legwork and developing materials but gradually turning these tasks over to the faculty member. This chapter outlines the resources and processes in developing a course using a [backward design framework](#), beginning with the establishment of learning goals, followed by assessments and effective pedagogy, and ending with documenting and disseminating the work. Sustainable use is often the biggest challenge in this work, and ongoing communication with departmental faculty throughout the project is key.

Approaches to ensuring a successful course transformation
<p>Use a well-developed course transformation framework, such as backward design, and available resources, including those from the SEI.</p> <p>Establish a good working relationship with the teaching faculty by determining their interests and working with them many months before the start of the course.</p> <p>Develop learning goals and assessments, including baseline data to enable measurement of change. Student voices and classroom observations are particularly rich sources of information.</p> <p>Develop instructional materials and pedagogy by gathering ideas from the literature and gradually shifting material development to the faculty member.</p> <p>Wrap up by bringing in future instructors, disseminating results in the department and more broadly, and archiving course materials.</p>

What is a course transformation?



The SEI approach to course transformation

To undertake a course transformation, a guiding framework is important. You may make other choices in your initiative, but the SEI used the backward design framework, in which learning goals, assessments, and instruction are aligned across the course.

1. **Learning goals: what should students learn?** Develop clearly articulated learning goals at both the course and topic levels to guide student learning and faculty teaching.
2. **Assessments: what are students learning?** Develop measurements which allow assessment of student achievement of the learning goals, both before and after the transformation.
3. **Instruction: which instructional approaches improve student learning?** Develop instructional techniques, including active learning approaches, that foster deliberate practice so that students develop expertise related to the learning goals. This includes pre-class, in-class, and post-class methods (e.g., clicker questions, lecture, worksheets, pre-class reading, homework, etc.).

Successful course transformations include thoughtful application of these three items within the context of a

course. For a full description of the elements and steps of a course transformation in the SEI, see [Course Transformation Outcomes and Timeline](#).

Below are some examples of this in practice, primarily in CU Boulder's Department of Physics.

Course transformation case studies
<p>Course Transformation Case Study (Wieman, 2007) describes the process of transforming an introductory quantum mechanics course, one of the first SEI course transformations.</p> <p>Change from Within: The Science Education Initiative (chapter by Chasteen and Perkins, 2014) provides a step-by-step overview of the course transformation process, with a junior-level physics course as an example. Chasteen et al. (2011) is another useful reference for a general STEM audience.</p> <p>Transforming a 4th Year Optics Course Using a Deliberate Practice Framework (Jones, Madison, and Wieman, 2015) describes the conversion of a traditional lecture course to a course using an active learning approach.</p> <p>Educational Transformation in Upper Division Physics (Chasteen et al, 2015) provides a detailed description of the processes used in and the outcomes of junior-level physics course transformations.</p>

Course transformation resources

This chapter only briefly touches on a complex subject. We have documented our accumulated wisdom in enacting course transformations within several resources listed below. Additionally, see [Chapter 6: Setting the Stage](#) for discussion of how the department can lay a productive groundwork for course transformations.

Instructor Guidance Page

Our actively managed, online [instructor guidance](#) collection includes information on course transformation, the use of clickers, a video collection, and several other white papers.

- **Course Transformation Guide.** Our [Course Transformation Guide](#) is a detailed PDF which summarizes principles of learning and suggestions for effective design of learning goals, assessments, and class activities. (This is also reprinted in the Appendix of Wieman [2017]).
- **Clicker booklet.** [An Instructor's Guide to the Effective Use of Personal Response Systems \(Clickers\) in Teaching](#) is a PDF booklet with effective practices for writing questions and facilitating discussion using audience response systems.
- **Example videos.** Our [SEI video collection](#) includes demonstrations of implementing different active learning strategies, along with supporting documents.

How do you start the project?

This section describes the interactions between DBESs and course instructors once course instructors have made the step to engage in a course transformation, typically during a planning term prior to the start of the course transformation. Sometimes course instructors expect the DBES to come up with ideas, but course instructors need

to direct the project based on their own interests in order to achieve maximum impact on faculty and students. To ensure everything works smoothly during the flurry of the teaching semester, the departmental director should help facilitate the structures and planning (see [Chapter 5: Departmental Leadership](#)). See [Chapter 8: Partnering with Faculty](#) for more general advice for DBESs about working with and coaching faculty, and see [Chapter 9: DBES Development](#) for information about establishing trust and credibility in the department.

It is not the job of the DBES to engage faculty in the initiative, at least not at the start of the project. Rather, the department director should be identifying potential faculty, generating agreements, and setting clear expectations for faculty planning to work with the DBES on course transformations. By the time the DBES is in contact with a course instructor, the instructor should have (in principle) agreed to make changes in their course. See [Chapter 6: Setting the Stage](#) for detail on how the departmental leaders can outline clear expectations for a faculty member's engagement in the project

Determine the course instructor's interests

While the DBES isn't responsible for brokering the initial agreement to engage, the course instructor may not have a very good idea of what they have signed up to do. The DBES will need to be prepared to learn about the course instructor's interests and what they perceive as problems in their course, and show them examples of course approaches. Your main job during the planning term is to get to know the course instructor. Once you understand what the course instructor is comfortable with and interested in, you can proceed.

Meet with the course instructor(s) prior to the course transformation

For a course requiring a major redesign, it is highly desirable for the DBES and course instructor to start collaborating some months before the course is taught to develop learning goals and to begin designing course materials and assessments. During this time you can establish your personal and professional credibility by demonstrating your expertise, sound judgment, and ability to be a supportive team member. You might see yourself as a project manager and cheerleader for the faculty work during the rest of the term. See [Chapter 8: Partnering with Faculty](#). See also [Chapter 6: Setting the Stage](#) for advice on planning the work by departmental leaders.

Meet with instructional assistants

If a course includes [learning assistants](#) and teaching assistants (undergraduate and/or graduate), they can be powerful allies. Learning assistants and/or teaching assistants have eyes and ears in the classroom, and may be well-versed in pedagogy (for example, through taking a course). Thus, they can suggest changes to faculty, inform you about what is happening in the course, and provide instructors with direct access to the student perspective. Include them in meetings with course instructors during the course transformation. This potential role of instructional assistants is a good reason for you to undertake teaching assistant training projects (which many in the SEI have done).

Facilitate consensus among multiple course instructors

Often there is more than one course instructor involved in a course transformation. In these cases, it is important for the DBES to focus on supporting group consensus as much as possible. In some cases, one person can be particularly keen on the project and more highly involved. This isn't necessarily a bad thing, especially if that member has some authority in the course, such as a course coordinator.

Meet with other department faculty

Discuss the course instructors' priorities for the course and their learning goals for students. We recommend having these discussions individually first, followed by working group meetings, to establish relationships and identify faculty interests democratically. It is particularly useful to have discussions with faculty who have taught the course or teach succeeding courses. See the [SEI Research Interview Guide](#) for tips on conducting faculty interviews.

Observe the course

You can also observe classes, establishing and documenting how the course is operating at the outset; this will make it much easier to describe the changes made as part of the transformation. This familiarity with the course and where it is currently effective or ineffective can help shape your plans for what to tackle and when. This is also an opportunity in general to start practicing documentation of the course transformation.

Start collecting data to support and guide efforts

The DBES will often be involved in observing and assessing student learning in the course one or two terms before it is transformed. There are valuable opportunities to collect data at the start of a project that will not be available later. In particular, don't miss opportunities to capture data on student learning in the course. Document important knowledge and skills that the students need or are assumed to have at the start of the course. Gathering such baseline data is often challenging due to a lack of time or available assessments and the fact that course instructors may not want to measure a 'bad' instance of their course.

Determining what to measure can be part of your early conversations with the course instructor. (What do they think students should learn and what data would be most interesting to them?) You can also start collecting ideas for what to look into from the literature (e.g., what misconceptions do students tend to have with this course content?) and from previous course instructors (e.g., what kinds of essential problems do students seem unable to solve at the end of the course?). Some kinds of assessments will take substantial time to arrange or have immovable deadlines (like a start-of-term survey), so you will want to figure out what needs to be measured as early as possible. That said, using a quickly developed assessment of a few important learning outcomes is much better than nothing.

Use your departmental director to negotiate conflicts

If you find that the course instructor is resistant or balks at every proposed change, speak with your departmental director. Your director can help renegotiate the course transformation agreement with the course instructor.

How can you best use meetings with faculty?

DBESs can use several types of faculty meetings to engage faculty and use their expertise to further the course transformation work.

Type of faculty meeting	SEI resource document
Learning goal discussions. Facilitated individual or group discussions around learning goals.	Facilitating Learning Goal Discussions
Working groups. Facilitated working group meetings around course development.	Facilitating Faculty Discussions
Interviews. Individual discussions or interviews with faculty (e.g., to draw out ideas about the course, learning goals, or student performance).	SEI Research Interview Guide

In all cases, it is important to use effective facilitation techniques, active listening, and thoughtful questions to keep the discussion on track. See the documents above for suggestions on how to ensure that all faculty voices are heard and that the group process is effective. For meetings with faculty in general, document your conversations and consider asking the faculty member(s) to review your notes to see if you understood correctly, and to highlight any agreements or decisions that were made.



Faculty discuss teaching. (Photo by Patrick Campbell/University of Colorado)

How do you design learning goals?

Learning goals define what a student should be able to do as a result of learning about course content. (Note that

learning *goals*, *outcomes*, and *objectives* were terms often used interchangeably in the SEI, though others make distinctions between them.) One of the key roles of the DBES is to facilitate the development and/or improvement of such learning goals to serve as strong guides for the development of the course. Students often respond very positively to having clear learning goals for a course and come to rely upon them (and notice their absence) once they become normative in the department.

Note, however, that while learning goals are important, they can sometimes be a difficult place for faculty to start, and so you may wish to use smaller, more accessible changes as a starting point early in a collaboration. See handouts below for recommendations on developing high-quality learning goals and working productively with faculty.

Learning goal development resources from the SEI

The [Learning Goals](#) website includes articles, links, workshop materials, and example learning goals.

[Creating and Using Effective Learning Goals](#) is a short, two-page discussion of what learning goals are and provides guidelines for developing effective learning goals.

[Good Examples of Learning Goals at UBC and CU](#) is a long document with learning goals compiled across many different courses at CU Boulder and UBC. While this is an older document, it still provides a useful starting point for learning goal development.

The [Learning Goal Workshop Materials](#) website provides materials and a video of interactive workshops to teach faculty about learning goals.

The [Facilitating Learning Goal Discussions](#) document gives tips for drawing out faculty ideas about learning goals. Additional resources for meeting facilitation are in [Facilitating Faculty Discussions](#).

In some cases, DBESs have also facilitated discussion of learning outcomes for curricular alignment and the major as a whole. Useful resources for this process are at [Degree Programs: Design, Development and Assessment](#) from the Science Education Resource Center.

How do you assess student outcomes?

There are many measures of student outcomes that can be gathered to guide course development and/or gauge success of the transformation. Choose assessment measures that are the most appropriate for the learning goals developed and are also the most important to the faculty. This way, the assessments can guide faculty efforts. While DBESs may carry much of this work, it should be done in collaboration with the teaching team for it to have the greatest impact.



Books on teaching assessment (Credit: Stephanie Chasteen / CU Boulder. All rights reserved.)

Below are some key strategies for developing assessments to measure student prior knowledge, document student learning, and provide feedback to faculty.

Collect baseline data

There are some crucial opportunities for data collection at the outset of the course transformation. This can be a challenge, but it is necessary to help uncover where the existing course is ineffective, which will guide choices in the transformation.

Draw on ideas from elsewhere

See the [Course Transformation Guide](#) for information on specific assessment strategies. For detail on developing validated conceptual inventories which survey student learning (akin to the Force Concept Inventory), see [Development of Validated Instruments to Measure Student Learning of Expert-Like Thinking](#) (Adams and Wieman, 2010). The Earth, Ocean and Atmospheric Sciences department at UBC, one of the most successful departments in the SEI, [has many specific examples](#) of course-specific assessments. Your DBES community will also be a valuable source of ideas.

Use a variety of data sources

Validated pre-/post-survey measures are extremely useful, especially in cases where the course transformation results are intended for publication. Make sure to use the data that is most readily available and will guide improvements. Validated conceptual assessments are useful, but may be impractical to develop. Alternatively, instructor-developed measures, such as high quality exams, diagnostic tests, or carefully developed activities or homework are equally helpful for guiding improvements. You may need to seek guidance from those experienced with educational assessment on writing and later coding such problems.

Measure affective outcomes, such as student confidence, enjoyment, interest, sense of belonging, and other perceptions related to the field of study, as these are important outcomes for promoting persistence and learning.

Include faculty perspectives

It is essential to talk to the course instructor(s) about what is the most interesting to look into as well as what they think students should learn. Ask the instructor(s) whether there is any data on student learning, attitudes, etc. they are particularly interested in seeing. What are students expected to know at the start of the course? What topics or skills do the students have the most difficulty with? Do they have examples of past student work that are available for review? You can also gain valuable insight from previous course instructors and instructors of follow-on courses. See the [SEI Research Interview Guide](#) for tips on conducting student interviews.

Include student perspectives

Be sure to talk to students as well. If you have not done something like this before, you may be surprised at how much you learn from the process; there really is no clear substitute for this. Try talking to students informally after class or after an exam. Interviewing students individually or in small groups can yield great insights into their learning and course experiences, especially in combination with other data sources. What students say is also very powerful in affecting what instructors do—anonymous interview data can be a powerful tool in convincing faculty to try something new. That said, be sure to also measure systematically what students think via surveys and careful tests, rather than relying on anecdotes or common beliefs. Note that students can become survey fatigued; be mindful of other ongoing student surveys across the department or campus and coordinate when possible.

Document, document, document!

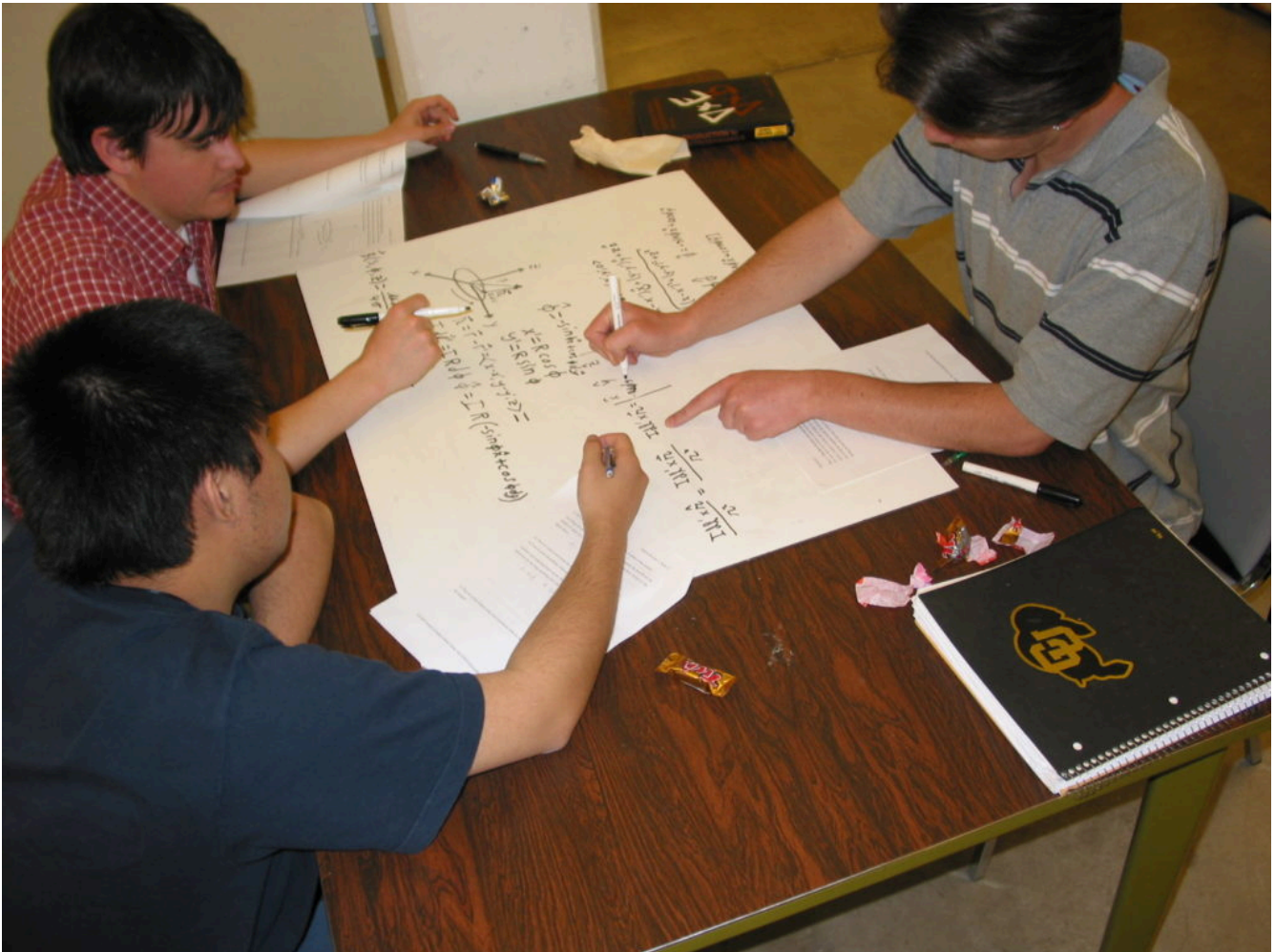
Observe courses before and during the transformation and take field notes. See the [SEI Course Observation guide](#) for guidance in conducting casual observations and [PhysPort's Assessment page](#) for a list of formal observation protocols. These will help structure your thinking and recording, which makes later interpretation much easier. Similarly, write detailed summary notes immediately after a student or faculty interview, as well as meetings with faculty members or teaching teams, while things are clear in your memory. Even if you are unable to address all the observations and ideas you collect during the teaching term, these notes will be extremely valuable in your reflections once the term is over. You will be the only person collecting such data, and you will not remember details later.

Summarize your findings

Distill your findings into a concise and relevant summary, and communicate them to both the faculty you are working with and the department in general (in collaboration with the department director) to generate greater engagement. The summaries will also be of use to anyone interested in results in later years (including future you!), and can form the basis for a relevant external publication.

How do you develop course materials?

Development of curricular materials is best done in partnership with faculty, though DBESs may do a little more work at the beginning of a partnership in order to give faculty a model to start from. Some suggestions for creation of curricular material are below, many of which involve professional development of the DBES (described more fully in [Chapter 3: DBES Success](#)) and collaboration with the faculty member (see [Chapter 8: Partnering with Faculty](#)).



Students work on a physics tutorial as part of the CU Physics SEI. (Credit: Stephanie Chasteen / CU Boulder. All rights reserved.)

Design with learning goals in mind

This will ensure that the course design is coherent and aligned with what the faculty value.

Develop your own knowledge

Keep abreast of the research literature to create a solid knowledge of possible instructional strategies. Many campuses have teaching and learning centers that host teaching workshops, which can be very useful for gathering ideas. Your DBES community will also be a valuable source of ideas. And observe other classes: sit in and watch to gather ideas, especially if you know that a class is using something innovative.

Meet frequently with the faculty member throughout the term

Often the course instructor's role is to develop drafts and examples, and provide materials to the DBES, while the DBES's role is to review literature, convene meetings, and give feedback in a more facilitative role. Typically, DBESs and the course instructors will have regular weekly meetings to share thoughts and feedback on the course. It is important for you to be flexible and be able to adjust to the faculty member's priorities. Meeting agendas might include development of learning goals, brainstorming how to achieve those learning goals, reviewing materials and giving feedback, and sharing results.

Fade out your development of course materials

It is more impactful to coach faculty in developing or changing materials than to do that work yourself. The course instructor is more likely to use the material the next year and use the approaches in future courses. Don't shy away from doing some legwork in the beginning; sharing the load for the course transformation work with a DBES is part of the benefit to faculty who decide to transform their course, however gradually turn things over to the course instructor. In this way, the new methods become part of their practice, rather than relying on you to develop materials. This idea of scaffolding (smaller expectations at first, more assistance from you) and then fading (raising expectations as expertise is developed, reducing your assistance) is the same idea for faculty development as it is for teaching students.

Review course materials

In order for you to give feedback on course materials, it is best for the course instructor to send you materials at least two days prior to its use in the classroom. You must then provide any feedback in a timely fashion to give the course instructor time to incorporate feedback and to maintain a positive working relationship where your contribution is valued.

Observe the course regularly

A DBES typically attends most or all class periods in order to observe the use of materials and student engagement and learning. Take detailed field notes and consider the use of validated observation protocols, which were developed to collect systematic data on classroom behaviors. See the [SEI Course Observation guide](#) for a framework for observing active learning courses, [Chapter 8: Partnering with Faculty](#) for suggestions on giving feedback after course observations, and [PhysPort's Assessment page](#) for a list of observation protocols. We recommend using the Course Observation Protocol for Undergraduate STEM (COPUS) due to its ease of use and growing body of available comparison data (Stains et al., 2018).

Practice, practice, practice

The DBES, faculty, and instructional assistants may have to run a certain activity several times in order for it to work smoothly and effectively.

Design for modular, partial use

Having a perfect but complicated course approach can be intimidating to future course instructors who may want to try to use it, and the approach may not be robust to small curricular or other changes in the course. Can activities 'degrade gracefully' if they do not go as planned either due to shifts in the student population or to instructor constraints (less experience, reduced time for part of the course, etc.)? For example, do all the worksheets fit into a tight sequence, or can one be dropped easily due to a new time pressure?

When possible, designing course materials modularly can support future sustainability. Detailed guidance on developing course activities is in the [Course Transformation Guide](#).

How do you wrap up the work?

Talk to future instructors of the course

Especially in the first year or two after a substantial course project, make a point to reach out—with assistance from your departmental director—to new course instructors teaching the course. Walk them through the course materials and approach, offering them your assistance.

Disseminate within the department

Make sure to make the work visible within the department to build faculty engagement and celebrate teaching successes (see [Chapter 4: Central Organization](#)). For example, present outcomes from the course transformation during faculty meetings, create a departmental newsletter, and reconvene faculty working groups to share results.

Create course materials packages

As noted in [Chapter 4: Central Organization](#), packages of course materials for use outside the institutions are a way of documenting the outcomes of the project. Creating a package of course materials is a necessary (though not sufficient) step towards synthesizing and documenting the outcomes of the project. Create an organized set of materials that can be used by other faculty. Include a set of notes on what was done, what worked, and what areas need further improvement. Examples of such course archive packages are online at our [course archives page](#) (archives in Physics may be the most detailed).

Publish and present the work

It is valuable to have some focus on formal presentation and/or publication of the work for your own career development and to share ideas with the broader community.

Chapter 7 Checklist

In order to develop high-quality courses with potential for sustainability, DBESs should consider the following actions:

Use a course transformation approach likely to enhance student learning

- Use backward design or other effective frameworks for course design.
- Make use of existing teaching resources and course transformation models.

Start out on the right foot

- Determine the interests of the instructor(s) teaching the course.
- Begin working with the course instructor(s) during the planning term and facilitate consensus among multiple course instructors, where required.
- Establish your personal and professional credibility.
- Observe the course and talk to departmental faculty.
- Start collecting data to support and guide efforts.
- Use faculty meetings and interviews to develop materials or collect data.
- Use the departmental director to negotiate conflicts.

Develop learning goals

- Work with course instructor(s) to develop course learning goals.
- Use best practices and resources to develop effective goals.
- Consider focusing on course design elements with more immediate benefits if learning goal development is too initially challenging (then returning to them later).

Assess student outcomes

- Gather baseline data in courses prior to transformation.
- Draw assessment strategies from other people and projects.
- Use a variety of data sources, including pre-/post-survey measures, affective outcomes, and whatever data is most valuable to course instructors.
- Include faculty and student perspectives.
- Document and distill your findings.

Develop instructional materials and pedagogy

- Align with learning goals.
- Gather ideas from the research literature, other classes, and workshops.
- Meet frequently with the course instructor.
- Shift the task of material development to the course instructor over time.
- Review course materials.
- Observe the course regularly.
- When possible, design course materials for modular or partial use.

Wrap things up at the end of the project

- Talk to future course instructors.
- Disseminate the results in the department.
- Create course material packages.

For further reading

SEI Resource documents:

1. Teaching-related resources from SEI: [Resources page at cwsei.ubc.ca](#)
2. Example course packages: [SEI course archives page](#)
3. Recommendations for course design: [SEI Course Transformation Guide](#).
4. Full course design steps and timeline in the SEI: [Course Transformation Outcomes and Timeline](#)
5. Tips on conducting student and faculty interviews: [SEI Research Interview Guide](#)
6. Recommendations for developing learning goals with faculty: [Facilitating Learning Goal Discussions](#)
7. Recommendations for facilitating faculty discussions: [Facilitating Faculty Discussions](#)
8. Recommendations for effective use of clickers: [An Instructor's Guide to the Effective Use of Personal Response Systems \(clickers\)](#)
9. Framework for semi-structured course observations: [SEI Course Observation guide](#)
10. Demonstrations of different active learning strategies: [SEI video collection](#)
11. Examples of course-specific assessments: [UBC EOAS research page](#)

Annotated bibliography

Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., Norman, M. K., & Mayer, R. E. (2010). *How learning works: Seven research-based principles for smart teaching*. San Francisco, CA: Jossey-Bass.

Outlines major principles for how students learn.

Chasteen, S., & Perkins, K. (2014). Change from within: The Science Education Initiative. In M. McDaniel, R. Frey, S. Fitzpatrick, & H. L. Roediger (Eds.), *Integrating cognitive science with innovative teaching in STEM disciplines* [E-reader version]. Retrieved from https://openscholarship.wustl.edu/circle_book/7/.

Gives a step-by-step approach to course transformation with an upper-division physics course as a concrete example.

Chasteen, S. V., Perkins, K. K., Beale, P. D., Pollock, S. J., & Wieman, C. E. (2011). A thoughtful approach to instruction: Course transformation for the rest of us. *Journal of College Science Teaching*, 40(04).

Early paper describing the SEI model of course transformation, similar to Chasteen and Perkins (2014).

Chasteen, S. V., Wilcox, B., Caballero, M. D., Perkins, K. K., Pollock, S. J., & Wieman, C. E. (2015). Edu-

cation transformation in upper-division physics: The Science Education Initiative model, outcomes, and lessons learned. *Phys. Rev. ST Phys. Educ. Res.*, **11**, 020110.

Describes the CU SEI outcomes of transformations in upper division physics in the most detail.

Felder, R. M., & Brent, R. (2016). *Teaching and learning STEM: A practical guide*. San Francisco, CA: Jossey-Bass.

A practical and readable guide to instructional design and implementation in STEM, full of useful examples.

Fink, L. D. (2013). *Creating significant learning experiences: An integrated approach to designing college courses*. San Francisco, CA: Jossey-Bass.

A practical classic for instructional design, including course planning, learning goals, and instructional approaches.

Handelsman, J., Miller, S., & Pfund, C. (2006). *Scientific teaching*. New York, NY: W.H. Freeman.

Describes the scientific approach to teaching, which underlies the SEI model.

Jones, D. J., Madison, K. W., & Wieman, C. E. (2015). Transforming a fourth year modern optics course using a deliberate practice framework. *Phys. Rev. ST Phys. Educ. Res.* **11**, 020109.

This paper describes a course transformation project, with an explicit focus on deliberate practice.

Kober, N. (2015). *Reaching students: what research says about effective instruction in undergraduate science and engineering*. Washington, DC: The National Academies Press.

This resource identifies the department as the unit of change (albeit using the SEIs as an example) and provides general methods about instructional effectiveness. Chapter 7: “Creating Broader Contexts That Support Research-Based Teaching and Learning” is particularly relevant to SEI-like initiatives.

Stains, M. et al. (2018, March 30). Anatomy of STEM teaching in North American universities. *Science*, **359**(6383), 1468-1470. doi:10.1126/science.aap8892.

Analysis of COPUS course observation data across a wide variety of STEM courses.

Wieman, C. (2007). *Course transformation case study*. Retrieved from http://cwsei.ubc.ca/resources/files/Course_transformation_case_study.pdf.

One of the earliest course transformation projects, undertaken by Wieman and McKagan, focusing on modern physics.

Wieman, C. (2017). *Improving how universities teach science: Lessons from the Science Education Initiative*. Cambridge, MA: Harvard University Press.

Authoritative resource on the SEI model and its impacts, including a detailed description of the rationale for the SEI, lessons learned, and data on departmental outcomes.

Wiggins, G., & McTighe, J. (2005). *Understanding by design (2nd ed.)*. Alexandria, VA: Association for Supervision and Curriculum Development.

The original 'backwards design' model of instruction which inspired SEI course development approaches.

8 - Partnering with Faculty

Summary

One of the most important goals of a DBES's job is to catalyze educational improvements within the department by educating faculty about teaching and learning. While early faculty partnerships should be brokered by the departmental director (see [Chapter 5: Departmental Leadership](#) and [Chapter 6: Setting the Stage](#)), over time, DBESs should try to engage as many faculty as possible in the initiative through gentle persuasion. DBESs should also be prepared to act as a coach for faculty, giving feedback on their teaching to help them improve.

Approaches to partnering well with departmental faculty

Rely on your departmental director to engage faculty early in the initiative.

Identify faculty interests and gather data or offer resources which are adaptable and relevant to their interests or classroom challenges.

Don't rely on data alone to influence faculty, as they are often more heavily influenced by observing active learning or by what colleagues or visitors are doing in their classroom.

Make teaching and learning visible in the department by hosting discussions, publishing newsletters, and having multiple conversations. Over time, these strategies tend to shift departmental culture and lead more faculty to engage with improving their teaching.

Stay open-minded about who might be interested. We have found that faculty attitudes about teaching do not fall neatly into clear categories (such as 'skeptical' or 'enthusiastic adopter'), and that attitudes evolve over time. Be patient, persistent, and flexible.

Give feedback and coach faculty on teaching by observing their classrooms, providing a few concrete suggested changes, and backing up your recommendations with evidence.

How can you form faculty partnerships?

It is not the job of the DBES to engage faculty in the initiative, at least not at the start of the project (see [Chapter 7: Course Transformation](#) for further discussion). However, as you become more embedded in the department by creating a network of relationships with faculty, you will likely have opportunities to entice additional faculty to consider making changes to their teaching. Next, we discuss suggestions for persuading and engaging faculty past

the first wave of those with early interest. Once a faculty member has committed to engaging in changes to their course, see the end of this chapter for a discussion of effective coaching strategies.



SEI department director Sara Harris with DBES Ido Roll at a UBC SEI event. (Credit: Gabriel Lascu / Science Centre for Learning and Teaching / University of British Columbia. All rights reserved.)

How do you respectfully persuade faculty to consider changing their teaching?

How can you respectfully coax faculty to consider making changes to their teaching? It is imperative that you don't set up a combative relationship with the faculty member by coming across as pushy or telling the faculty member what to do. Rather, approach the discussion tactfully (we do admit that persuasion is part of the DBES role). Below are suggestions for persuading additional faculty to be involved.

Meet faculty where they are at

Being responsive to faculty interests and constraints can help frame your role as a productive resource and let you better understand faculty motivations in your department.

Discover what faculty are interested in learning about their course

Learning about individual faculty interests and challenges is one of the most powerful strategies a DBES can

employ. For more junior DBESs (e.g., postdoctoral fellows), it can work well to think of yourself and present yourself as an eager apprentice interested in learning from their expertise. You might ask them: “How is your course going?”, “Is there anything you would like to change in your course at the moment?”, “Is there anything you would like to know about your students’ experiences in the course?”, or “What data on your course or student learning would be most interesting to you?” Responding to their areas of interest helps ensure that you aren’t seen as having your own agenda, but rather are responsive to their needs.

Offer faculty something they want

Once you know a faculty member’s ‘pain points’, you can find hooks for engaging them. Giving faculty something that immediately benefits them gives you a foot in the door for starting a conversation about classroom changes. For example, if they are struggling to hear student voices in their class, you might offer them the support of learning assistants or offer to help them figure out how to use audience response systems (clickers). You might offer to perform a demo for their class, figure out some technological hurdle for them, or help them implement two-stage exams.

Address faculty beliefs and concerns about teaching

Faculty beliefs about teaching (what is possible, what is effective, and how students learn) or other constraints like comfort with technology may affect the best choice of teaching approach for their course. It is important to address faculty concerns with new teaching methods by supporting implementation, mentioning examples of success in similar settings, providing student data, and offering alternative teaching approaches. Try to stay flexible, rather than rigidly sticking to a pedagogical plan, to help faculty feel strong ownership over these choices.

A further belief about teaching is that it requires a fixed, innate set of skills that are only achievable by some people (teaching awards can actually reinforce this perspective). When possible, it is important to highlight faculty in the department who have changed their teaching for the better and who identify effective teaching as something they learned to do.

Additionally, many faculty will have concerns about the status of teaching relative to research in research-intensive departments. See Brownell & Tanner (2012) for a discussion on this issue.

Leverage the classroom

The classroom itself provides a rich and authentic environment for seeding ideas and encouraging discussion—be it the classroom of the faculty member you are working with or a colleague’s class.



Instructor James Charbonneau facilitates a student group discussion (Credit: Paul Joseph / UBC Communications & Marketing / University of British Columbia. All rights reserved.)

Invite faculty to observe active learning in action

Seeing something in action is the most powerful method of persuading faculty to try something new. Seeing research-based teaching practices in person can dispel a number of standard concerns (maintaining difficulty of content, student management, use of technology) and make changes seem approachable and desirable. You can invite faculty to observe your own course if you are teaching or a colleague's course (with their permission). However, many departments have a culture where visits are rare and are strongly associated with teaching evaluations, so careful encouragement is required.

You can ask faculty engaged in course transformation to open their classroom to visitors, perhaps after presenting their strategies in a seminar. You might keep a list of faculty across departments who are open to allowing others to drop in to observe their class, recording the types of active learning they are using. Posting the list isn't sufficient, however; you will need to actively encourage faculty to attend. You can create targeted invitations to faculty you would like to be exposed to the techniques being used in these classes.

And if all else fails, there are a few repositories (at [iBiology](#), [Realise](#), and [UBC](#)) for active learning videos that can provide some insight as to what happens in a real classroom.

Use classroom observations as a conversation starter

A classroom observation can lead to valuable conversations around teaching with faculty, build rapport, and give ideas for collaboration. Observations can be informal (sitting in and maybe taking a few notes) or highly struc-

tured (using a validated protocol, for example). You might use the [Classroom Observation Protocol for Undergraduate STEM courses](#) (COPUS) or see [PhysPort's Assessment page](#) for a list of other formal observation protocols. For less structured observations, the [SEI Course Observation guide](#) provides a framework for observing active learning courses. You can construct opportunities for using such observations (e.g., “I’m testing this classroom observation protocol; can I observe your class to test it?”). A variety of recommendations around this specific practice were developed by Brett Gilley at UBC in the [COPUS Wedging](#) document.

Regardless, for best results you should ask the person teaching in advance if there is anything specific they would like you to pay attention to, then provide feedback in a follow-up meeting. This follow-up is an important part of establishing rapport and the value that you have to offer.

Partner with instructional assistants as change agents

If a course includes [learning assistants](#) and teaching assistants (undergraduate and/or graduate), they can be powerful allies. Learning assistants and/or teaching assistants have eyes and ears in the classroom, and may be well-versed in pedagogy (for example, through taking a course). Thus, they can suggest changes to faculty, inform you about what is happening in the course, and provide instructors with direct access to the student perspective. Include them in meetings with course instructors during the course transformation. This potential role of instructional assistants is a good reason for you to undertake teaching assistant training projects (which many in the SEI have done).

Use data as a persuasion tool

Data, especially when presented with good visualizations, can be powerful in persuading faculty, though this is not universally true. There are many good books about effectively presenting data for different audiences. See *Effective Data Visualization* (Evergreen, 2016) and *Presenting Data Effectively* (Evergreen, 2018), for example. Below are some suggestions that we have found valuable when using data to persuade faculty.

Use a variety of data

Data and its related analysis need not rise to a publication level of rigor to be persuasive; the more local the data (e.g., from students in the course, perhaps even from the current teaching term), the more attention it may receive. It is still possible to be systematic enough for better and earlier decision-making than reliance on a few anecdotes from students, as in standard teaching evaluations.

Focus on students and student voices

What students say can often be powerful. Data from student surveys, interviews, focus groups, and/or assessments can be used to convince instructors to try something new. See the [SEI Research Interview Guide](#) for tips on student interviews. These anonymous results can be shared with individual instructors, or highlighted at department meetings or retreats to promote the need for change. This way the discussion is focused on the students and the suggestions that come from the students, rather than from administrators or from you.

Gather data that will speak to the course instructor's interests

If the course instructor is concerned about exam performance, you should probably examine actual student exams from previous iterations of the course. If they are concerned with student engagement during class, then visit some classes. You might develop a midterm survey for students and help faculty members interpret the results.

Make the work and the results of teaching changes visible

One of the problems in higher education is that teaching is a very private endeavor. It is rare for faculty to discuss their teaching or observe each other teach. Bringing teaching into public spaces in the department, celebrating successes, and sparking discussion can be very effective in engaging departmental faculty at large.

Make local examples visible

As much as it is within your power, highlight the efforts of faculty within the department both as a way of validating their work and to show what is realistic in terms of local constraints. For some people, this can be more influential than careful research studies. You can bring attention to faculty efforts by inviting others to observe their teaching, attending faculty meetings to discuss the project, asking faculty to write up a short description of their project for the initiative website, or celebrating them in an initiative newsletter.

Create a newsletter

A short monthly newsletter can be very influential, bringing consistent attention to the initiative, and providing a venue to celebrate the work. UBC's Earth, Ocean and Atmospheric Sciences department developed a very successful [newsletter](#), and later, a [blog](#). Designed to be easily skimmed, these two-page documents had titles such as [An Instructor's Clicker Cheat Sheet](#), and [Making the Most out of the First Day of Class](#). These helped inform faculty about relevant literature and best practices, as well as SEI efforts in the department.

Engage faculty in discussing teaching and learning

In the SEI, some departments hosted teaching workshops or 'brown bag' discussions (in which participants bring their own lunches to a meeting), which were useful for engaging faculty in discussions with a low time commitment. You might host a reading group on teaching and learning issues, perhaps focusing on papers with local examples or readings from practitioner-oriented journals, such as the [Journal of College Science Teaching](#). We have also seen that faculty participation in working groups has had ancillary benefits, including creating a forum for faculty to discuss pedagogy and student learning and connecting them with their colleagues around issues of teaching and learning. You may also consider offering an ongoing [Faculty Learning Community](#) in your department, where faculty meet regularly for a year to work on their own teaching. Such groups are highly impactful. Another new structure which has been very influential is the [Departmental Action Team \(DAT\)](#), where faculty engage together to sustainably solve an educational issue in the department.



A faculty learning community in the CU Boulder TRESTLE project. (Credit: Patrick Campbell / University of Colorado. All right reserved.)

Engage a variety of faculty

How do you ensure you are working with as many different types of faculty as possible? Below are some general principles for the DBES to engage with the broader department. For information on how departmental directors and chairs can engage faculty in the initiative, see [Chapter 5: Departmental Leadership](#).

Stay open-minded about who might be interested

Try not to make assumptions about faculty; you might be surprised at who comes knocking on your door. In the SEI, faculty from all career stages and a variety of backgrounds in teaching-related projects participated in the work. You may find resistance from those you thought were on board, such as award-winning teachers or early career faculty, whereas those who have been less involved in teaching improvements may be glad to have an opportunity to engage. Faculty may change their attitudes over time, as well: instructors may not seem interested at first, but may begin to embrace new ideas over time.

Engage with as many faculty as possible

You might start by working with the most enthusiastic professors, then eventually start to gently push the more reluctant faculty. Have as many conversations as you can; even if you don't seem to be getting anywhere and con-

ventional wisdom suggests that that faculty member can't be persuaded, conversations may bear fruit later. Even if you have been given a clear strategic plan for the initiative in the department, it is important to be opportunistic and look for additional faculty (and courses) to involve, focusing more on successful faculty development experiences than the exact outcomes envisioned in the initial plan.

Spread seeds and nurture sprouts

Spread seeds by suggesting ideas of new things to try through individual meetings, informal conversations, departmental newsletters, use of classroom observations, etc. Nurture sprouts of interest when they appear. Listen to faculty's concerns and work on problems that they are interested in, rather than what you think is most important, and build from there. *Focus on building a productive relationship with faculty above all else.*

Be patient, but persistent

When working with faculty, you can introduce ideas gradually. If they say they don't want to try something new, don't be afraid to press them a little, but if they are still resistant, move on and revisit the issue again in six months. We found that over time, the more faculty members that were engaged in thinking about and changing their teaching, the more the teaching culture of the department was influenced. This resulted in more faculty deciding to learn about and use new teaching methods. The most effective DBESs worked with faculty over long periods of time (two years was the norm in one long-standing SEI department). Don't lose faith; sometimes progress can be difficult to detect because it can be so incremental.

Divide and conquer

The most effective SEI departments had three-to-four DBESs at a time working on multiple courses and engaging with faculty. Different DBESs bring different backgrounds and skills, which can be beneficial when working with faculty; if one DBES is not able to partner well with a faculty member, another DBES might.

Don't take it personally

Sometimes you will come up against negative reactions to suggestions or ideas about teaching, or general complaints from faculty. Their reaction is likely not related to you personally—they may feel frustrated by local constraints, their identity as an excellent educator may be under threat, or perhaps they are facing other pressures. Listen, and move on.

How can you give feedback and coach faculty productively?

The most successful DBESs see themselves as a departmental resource and a coach for faculty. This is true whether they are collaborating on an intensive course design project or temporarily consulting with the faculty member. In either case, it can be a challenge to provide meaningful, actionable feedback to faculty that empowers rather than overwhelms them. See [Chapter 7: Course Transformation](#) for a discussion on initiating and carrying through the course transformation work, a discussion of using faculty meetings in course transformation, and resources for facilitating faculty discussions or conducting interviews.

Observe classes and provide immediate feedback

Ask in advance if there is anything the faculty member would like you to pay attention to. Prepare as much as possible by reviewing basic principles and activities that may be relevant for the course. Plan in advance for a

follow-up discussion as soon as possible after the class while it is still fresh (while walking back to the office, for example). You can keep this discussion short, starting by asking how they thought it went and if there was anything they were happy with or concerned about. Mention positive things that you noticed and commiserate by sharing problems you have dealt with yourself. In the initial discussions it is more important to build rapport than to convey what you know about teaching and learning. Limit your feedback to just one or two things—you don't want to overwhelm them—and highlight areas of interest to the instructor. See the [SEI Course Observation guide](#) for suggestions on how to conduct casual observations.

Aim for constructive conversations focused on small, concrete changes

Focus on concrete, achievable strategies. These small wins can motivate instructors to try larger changes. For example, you might tell a course instructor: “Rather than solve four examples, could you solve two and have the students solve one or two?”, “count to 10 after asking a question,” or even “there’s no need to be afraid of silence.” You can share your perspective of the student experience as well; if you have observed the faculty member providing a long explanation of an idea, when the students seemed to have grasped the idea early in the explanation, you could convey this. After the discussion, you can promise to read further on the topics that came up, then follow up with the course instructor.

Use evidence-based thinking

As much as possible, focus on evidence of student learning or non-learning from the course. The general idea is to move the discussion away from opinions (yours and theirs) and to focus on the goals and challenges in teaching along with the evidence you have that supports previous choices and suggests future changes. “How do you know that?” can be a useful question to guide faculty in supporting their statements. Using multiple measures, such as course observations, student interviews, surveys, and other assessments, can provide a rich set of data to understand student learning in the course.

Plan to support faculty over time

There is a steep learning curve for incorporating active learning strategies. An activity may need to be run several times in order for it to work smoothly and effectively. Help the faculty member see this as part of the process (i.e., a growth orientation towards pedagogical change) rather than a sign that things are not going well.

Act as project manager and cheerleader

Monitor progress, giving gentle reminders to faculty about making timely decisions and about upcoming deadlines (e.g., an opportunity for an important measurement in the course like a survey or test). Show the departmental team the progress that has been made. Apart from a few cases where the faculty involved are highly experienced, the DBES is usually the main person responsible for ensuring the project's continued momentum and observing how the course transformation is playing out in the classroom.

Chapter 8 Checklist

In order to engage departmental faculty broadly in the initiative, DBESs should consider the following approaches:

Persuade faculty over time to make changes to their teaching

- Rely on the departmental director to broker initial faculty commitment to the initiative.
- Look for opportunities to bring additional faculty on board.
- Discover faculty interests and offer them resources to address any challenges.
- Address faculty beliefs and concerns about teaching openly.
- Invite faculty to observe active learning in practice in classrooms.
- Use classroom observations as a way to start a conversation about teaching.
- Use instructional assistants as change agents.
- Use data as a persuasion tool, but don't rely on it to influence instructors' beliefs.
- Focus on students and student voices to influence faculty.
- Gather data that will speak to the faculty member's interests.
- Publicly celebrate teaching by hosting external visitors, bringing attention to faculty efforts, creating a newsletter, and/or running a reading group.

Engage a variety of faculty

- Stay open-minded about who may be engaged over time.
- Work with as many faculty as possible, continually striking up conversations and looking for opportunities to reach out to faculty.
- Spread ideas ('seeds') of things to try, and nurture interest ('sprouts') as they arise.
- Focus on building productive relationships with faculty above all else.
- Keep pressing faculty to consider changes, introducing ideas gradually over time.
- Don't take negative reactions personally.

Give feedback and coach faculty on teaching

- Observe classes and give immediate feedback.
- Be constructive in your comments.
- Limit your feedback to one-to-two high-impact items at a time.
- Focus on areas of instructor interest.
- Begin with small, concrete, and achievable suggestions.
- Present evidence to support your suggestions.
- Plan to support the instructor over time and communicate that this extended engagement is normal.

For further reading

SEI Resource documents:

1. Structured observation protocol for course observations: [Classroom Observation Protocol for Undergraduate STEM courses](#) (COPUS)
2. Framework for semi-structured course observations: [SEI Course Observation guide](#)
3. Recommendations for leveraging course observations for faculty engagement: [COPUS Wedging](#)
4. Tips on conducting student and faculty interviews: [SEI Research Interview Guide](#)
5. Department SEI activity newsletter example: [UBC EOAS newsletter](#)
6. Department SEI blog to highlight SEI activities: [UBC EOAS blog](#)

Annotated bibliography

Brownell, S. E., & Tanner, K. D. (2012). Barriers to faculty pedagogical change: Lack of training, time, incentives, and...tensions with professional identity? *CBE-Life Sciences Education*, 11(4), 339-346. doi: <https://doi.org/10.1187/cbe.12-09-0163>.

This article considers that a scientist's research identity may be at odds with their development of a teaching identity.

Duhigg, C. (2012). *The power of habit: Why we do what we do in life and business*. New York, NY: Random House.

This book about how habits are formed can help you think about how to coach faculty to develop new instructional habits.

Evergreen, S. D. (2016). *Effective data visualization: The right chart for the right data*. Thousand Oaks, CA: Sage Publications.

A delightful book about data visualization that can help you think about what you want to communicate and to whom, and how to do it effectively using the right charts.

Evergreen, S. D. (2018). *Presenting data effectively: Communicating your findings for maximum impact* (2nd ed). Thousand Oaks, CA: Sage Publications.

A useful "how to" book about data visualization and communication.

Heath, C., & Heath, D. (2007). *Made to stick: Why some ideas survive and others die*. New York, NY: Random House.

This book about how to communicate ideas to make them 'stick' can help you think strategically about communicating with department faculty.

Wieman, C. (2017). *Improving how universities teach science: Lessons from the Science Education Initiative*. Cambridge, MA: Harvard University Press.

Authoritative resource on the SEI model and its impacts, including a detailed description of the rationale for the SEI, lessons learned, and data on departmental outcomes.

9 - Developing Your Role and Skills

Summary

This chapter is directed at those in a Discipline-Based Education Specialist (DBES) role, and it provides more detail on elements of the job and advice for some common challenges encountered. It arises primarily from advice collected from experienced DBESs as they discussed and reflected on their role or as part of exit talks that were given at the end of their position. Thus, some of the information may be reflected elsewhere in the Handbook, but this chapter represents the types of words of wisdom which are often swapped more informally among DBESs from the departmental trenches.

While a description of the DBES role is presented in [Chapter 2: What Is a DBES?](#), it is important to recognize that the role will necessarily vary in different departments and institutions, and that it may also be shaped by your background and interests. However, as some overarching principles, we encourage you to:

Think of yourself as a catalyst

Your department already has capable people who care about teaching, but your input, work, feedback, data collection, and analysis can facilitate new and greater possibilities than the status quo.

Think of yourself as a coach

You can provide feedback and support for faculty as they encounter the steep learning curve of implementing new teaching practices. Effective coaches observe, evaluate, and guide. See Gawande (2011) for more discussion.

Think of yourself as a *change agent*

To avoid situations where top-down pronouncements are made with no effect or bottom-up efforts peter out due to lack of support, change initiatives are best when someone is paying attention to the issues related to organizational change and fostering conditions for people to succeed. You can be this agent of change, marshalling efforts and cheerleading for change.



DBES Brett Gilley works with faculty at an event (Credit: Centre for Teaching, Learning and Technology / University of British Columbia. All rights reserved.)

How do you start out in your department?

There are a variety of ways to help establish yourself in a department, however the best strategy for your situation will depend on your background (especially whether you were hired internally or externally) and department norms. The following suggestions are best considered as early as possible, as they could take a substantial amount of time in the first months of your position.

Engage as a member of the department

Be visible: attend seminars and social functions, drop into instructors' offices when their door is open, chat in the hall, etc. Attending faculty meetings, if your position allows it, can be very beneficial. These activities give you visibility in the department, more contact with faculty, and opportunities to promote the work of the initiative.

Establish your credibility in the discipline

This isn't always necessary, but don't hesitate to establish yourself as an expert in your discipline by giving a seminar on some of your work in the field, such as your dissertation research. This ensures credibility and commonality when working with faculty.

Observe instructor classes

Observing teaching in the department is an extremely important part of your own training; such observations give you a broader perspective for instructional practice beyond your own teaching, help you see the context behind and the results of instructional choices for individuals, and more generally provides a lot of information about the culture of teaching and student learning in a department. Conversations outside of the classroom are not a substitute for this in-person observation. See the [SEI Course Observation guide](#) for a framework for observing active learning courses.

Learn how to describe what you do

Develop an ‘elevator speech’, a brief, clear description about you and your role, to help you explain to faculty and staff what you do and how you can help. An elevator speech can take some time to develop. See [Chapter 2: What Is a DBES?](#) for descriptions of possible DBES tasks. The ability to explain your role is separate from getting the hang of the job.

Use your faculty leaders

Faculty champions in your department, particularly your departmental director, are very important; have them introduce you to faculty you will be working with and broker conversations about shared expectations for your work in specific course transformations. They can also clarify your role to the department, which may need to be an ongoing process in order to reach those faculty who were not directly involved at the start of the work.

How do you integrate further in the department?

While getting established can take time, you will want to build on early gains even as you continue to seek out or are tasked with new projects. For more ideas in generating interest and persuading faculty, see [Chapter 8: Partnering with Faculty](#).

Build relationships

Taking a deliberate approach to building working relationships in your department supports your overall work and can foster a community around teaching that might otherwise not emerge. You may target specific individuals who seem interested in trying new techniques. You might also take on tasks to help you integrate, such as producing monthly newsletters for the department, updating a project summary website, creating two-page guides about teaching, hosting teaching and learning ‘brown bag’ discussions (attendees bring their lunches to a meeting), and more.

Don’t forget about other staff in the department. You will probably be making requests of the office staff, IT, or your institution’s teaching excellence center that may be somewhat unusual. Things will run more smoothly if they know a bit about your role in the department and you make your requests as graciously as possible.

Establish your scholarly expertise around teaching and learning

In the SEI, DBESs who took their role as an educational scholar and departmental resource seriously were particularly effective in departments. Faculty came to recognize that those DBESs had valuable and unique expertise, which resulted in more effective working relationships. Many DBESs have commented on the importance of having both disciplinary and pedagogical expertise in achieving the respect of the faculty. One example of dissemi-

nation of this scholarly expertise was the monthly newsletter, the [EOAS-SEI Times](#), produced by UBC's Earth, Ocean and Atmospheric Sciences department.

Teach courses

It can be very useful to teach, as this gives you credibility, lets you practice what you preach, and gives you a space in which you can invite faculty members to observe a technique that you would like them to consider using. If possible, it is best to delay teaching until after your first few months in the role to give you more time to establish yourself and to teach some courses, but this decision is usually not up to you.

Use monthly reporting to keep track of your intentions and accomplishments

Use regular reports to reflect on your own achievements, challenges, and insights. Monthly reporting ('forced accountability') may feel like a chore, but treat this as an opportunity to help with reflective practice. You can use these reports to log intentions, actions, and outcomes. You might also track specific correspondence with faculty. This provides essential information for your reflection and progress, as it allows you to more strategically plan your work on your own and with your supervisor. Since change can be incremental, it is useful to track your progress as a motivational tool to see how much has been accomplished.

Understand your relationship with the central organization

There is likely a unit outside the department that is in charge of monitoring, advising, and perhaps managing funding for the overall, cross-departmental effort. Ideally, it will include people who can support you in ways the department cannot. To best make use of this central unit:

- Make sure you know who your supervisor is — is it someone in the department or in the central unit?
- Discuss management-related issues occurring in your department: is the chair supportive, and how will you engage with them? Is there a concern with the director? What will you do when the director is away for a while?
- Go to the central unit for advice on teaching and learning projects, such as suggestions for literature and design ideas from other disciplines, or measurement/evaluation ideas.
- Submit regular (e.g., monthly) reports to the central unit and meet with them regularly as a department team for feedback, as well as on your own when needed.
- Ask the central unit for advice about publishing, including suitable cross-disciplinary publications or conferences for your work.

How do you develop your skills as a DBES?

It can take a while to get the hang of this job; rely on your community to help you learn the ropes, and don't embark on this new professional path all alone! If you have access to a DBES community and regular meetings, make sure to participate. If not, you may find a community among educational developers in more traditional learning and teaching centers who have many of the skills that are needed by a DBES. See [Chapter 3: DBES Success](#) and the UBC-specific [summary of reflections from Science Teaching and Learning Fellows](#) (UBC CWSEI's term for DBES) for more discussion on skill development.

Methods for developing your expertise in teaching and learning

- **Read in the education literature**, particularly within your discipline. Being well-read will give you good ideas to suggest to colleagues, allow you to share articles of interest, and help you back up suggestions you make. Former DBESs highlight this as one of the most important items in professional development for the job.
- **Observe classes**. This is valuable in multiple ways; see “How do you start out in your department?” in this chapter.
- **Attend workshops** through units such as a teaching and learning center.
- **Use online resources** for development in content areas. [Lynda.com](https://www.lynda.com), for example, offers many quality professional development courses, and some campuses have access to online courses.
- **Attend disciplinary teaching conferences and national events**. These are also fantastic venues for presenting results of your work in posters or talks.
- **Facilitate workshops, speaker series, or other discussions for faculty (including ‘brown bag’ discussions)**, either in your department or in partnership with a teaching and learning center on campus.
- **Learn about educational research methods**. In particular, we find it is important to learn how to:
 - Apply statistics for social sciences. See Field (2013) and [STLF Quantitative Analysis Discussions](#), written by former DBESs.
 - Use qualitative methods and their associated evidence. These may not be a part of your background but are vital in education research.



Teaching and learning workshop at UBC (Credit: Centre for Teaching, Learning and Technology / University of British Columbia. All rights reserved.)

Teaching and learning resources that we have found effective

- How Learning Works (Ambrose and Bridges, 2010)
- Scientific Teaching (Handelsman et al., 2006)
- Getting to Yes (Fisher, Ury, and Patton, 2011)
- How to Write a Lot (Sylvia, 2007)
- Discovering Statistics using R/SPSS (Field, 2013)
- Thinking, Fast and Slow (Kahneman, 2011)
- [An Introduction to Evidence-Based Undergraduate STEM Teaching](#) (CIRTL MOOC, offered regularly)
- UBC CWSEI's [list of Recommended Papers](#)

Methods for improving your professional skills

- **Improve your time management and organization skills.** You will likely be juggling projects in a way that is new to you, and you will also likely be responsible for data management for your department's measurement efforts.
- **Attend campus workshops** related to professional work. You might attend workshops on project management, education, communication, leadership/academic leadership, change management, etc.
- **Attend conferences about leading change.** See the Accelerating Systemic Change Network's [list of professional development opportunities for change agents](#).
- **Meet regularly with other DBESs**, both inside and outside of your department. Most DBESs mention community as their biggest support. There are suggestions for community building in [Chapter 3: DBES Success](#), and for some possible structure for one-on-one discussions, see [Metacognition STLF Meetings](#) (MetaSTLF).
- **Facilitate DBES training sessions.** Senior DBESs will benefit tremendously from facilitating training sessions on teaching and learning, and from sharing lessons learned in their role with other DBESs.
- **Submit regular activity reports**, reflecting on your progress and needed skills.

What are common challenges faced by DBESs?

While most people who have held DBES positions so far have found the work very rewarding, there are definitely some inherent challenges, though the specific nature of those challenges varies by local context.

Volume and variety of work

DBES work is generally fast-paced, and involves more contacts and 'people work' than a research setting. It also requires more attention to medium- and long-term issues compared to a typical teaching position which can be very focused on the needs of the immediate teaching term. As a result, a DBES can be pulled in several directions: in being attached to specific courses, they are beholden to the teaching schedule, but they also need to attend to big-picture issues such as continuing their own learning and writing up results along the way.

To the extent that someone will be setting expectations and monitoring progress, the DBES will often be the closest approximation to a project manager in a given project. This is not project management in a formal sense, and typically there is little or no experience with standard project management principles in university departments, outside the business school. Investing in your own ability to manage your time and priorities is valuable, so learn-

ing some of the known principles is advisable. For project planning considerations, UBC CWSEI has [a Google Doc of time and project management ideas to consider](#).

Maintaining morale

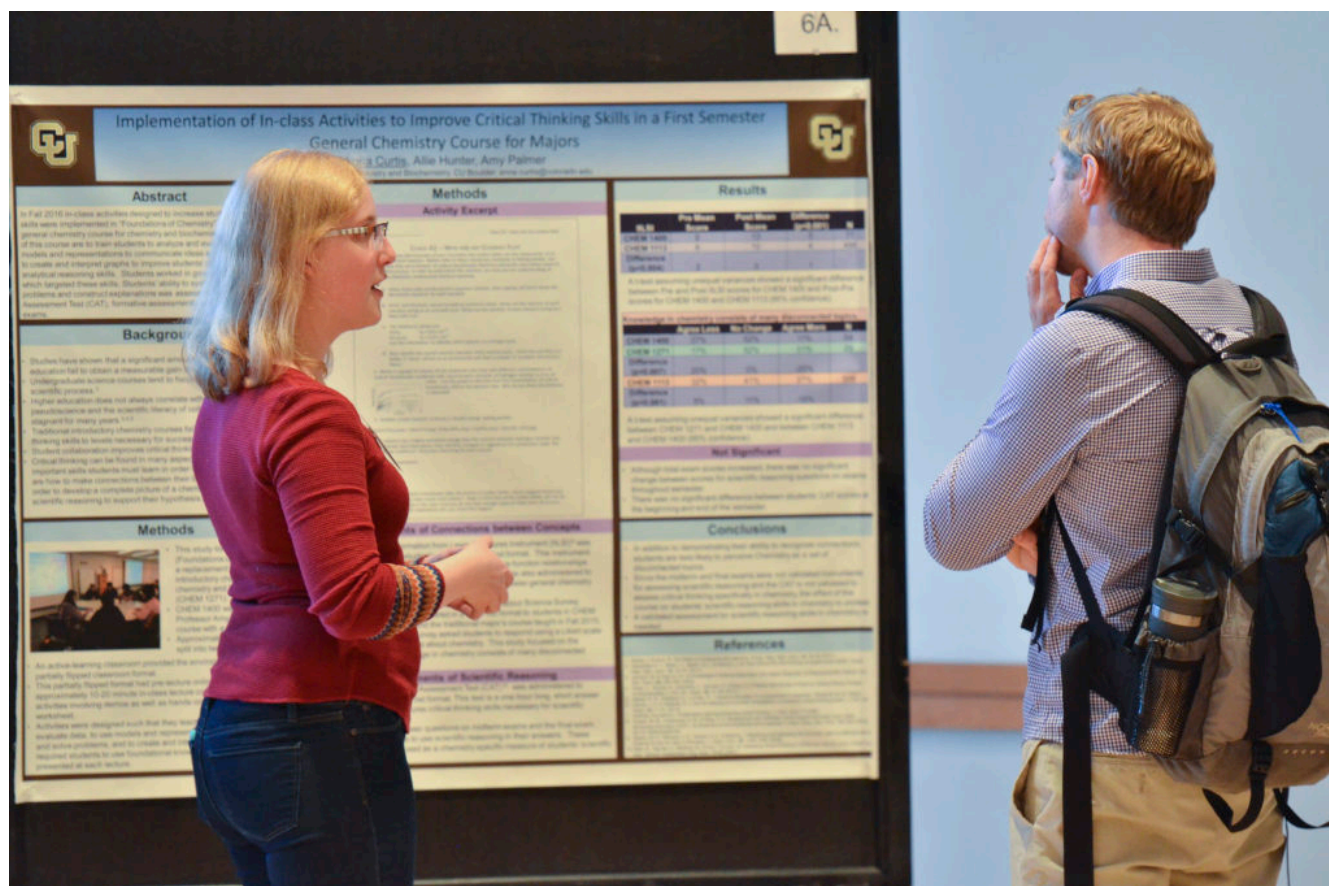
How do you keep your own morale up in the face of slow progress or even pushback regarding your transformation efforts? How do you keep frustration from becoming a self-fulfilling prophecy (“the faculty involved don’t want to do this so I won’t even try”)?

You may need to remind yourself that change takes time, which can be tough if you are in a relatively short-term position. As with anyone learning something new, faculty will need reasons to try new teaching approaches (e.g., they address a gap, the faculty have been compelled by some evidence, and the approaches are within their comfort level) and to continue these practices (e.g., enough attempts/practice with feedback to see success). Be realistic about expectations and try not to get discouraged. Commiserating with other people in a similar position can be a big help, as can documenting your own progress.

Publishing research

Those entering a DBES position often have research experience in their department’s discipline, but not in education (related to the field directly or otherwise). Embarking on meaningful research in education will require a lot of reading and practice, though you can certainly be scholarly about educational work in ways that vary in terms of rigor and recognition.

It is important to recognize when a result (and your reporting of it) is ‘good enough’ versus waiting for it to be ‘the best’. Make a trade-off between getting it out there versus sitting on something for years and years, wanting to do a little more. Take advantage of accessible opportunities to publish or present when they are available: submit a detailed report with a summary to your department, show a poster at a local showcase for projects (e.g., annual poster session), give a lunch-and-learn talk in your department, present in a conference’s preliminary reports session, etc.



Sharing educational transformation work at a poster session. (Photo by Casey A. Cass / University of Colorado)

You can also try to find partners for consultation or collaboration on campus that are familiar with the kind of research you are undertaking, whether more senior (faculty member in education, psychology, statistics) or more junior (graduate students with experience in relevant methods and analysis). It is also worth considering your work in terms of the Scholarship of Teaching and Learning, which has different community standards compared to discipline-based education research or more traditional education research venues.

Combating isolation

You may have a team in your department with multiple DBESs working at the same time, but if/when you are a solo DBES in a department it can be isolating. Be sure to ally with your departmental director as much as possible and meet regularly with any other DBESs in your department or other departments to reflect on goals, progress, action items, and challenges. For some possible structure in this process, see [Metacognition STLF Meetings](#) (MetaSTLF).

There are likely other people on your campus working on teaching and learning projects, perhaps in other departments or as part of a central teaching and learning support unit. Partnerships with these people can be valuable as you learn more about what is needed in your department. For example, educational technology support may not be a major focus of your work, but if the department is looking to you for your input/expertise in this, you will want to be familiar with the teams that do support this on campus, what types of workshops might be available, etc. These connections can also be a helpful way to learn about professional development opportunities.

Considerations for DBESs in specific types of positions

Because the roles and responsibilities of a DBES will vary according to their background and the needs of their department, there is no universal model for such a job, and a DBES's rank (e.g., postdoc, instructor) can vary across departments or institutions. Below are some considerations for two common types of DBES positions.

Junior-ranking DBESs, such as postdoctoral fellows

Postdoctoral or contract faculty positions have been the most common job ranks in the earliest SEI and SEI-like programs; from an organizational perspective these are much easier to fund and deploy in a department. Below are some challenges which may occur in such positions.

The temporary nature of the position limits its reach

Realize you can only do so much because your position is only a few years in duration; change can take a long time. Think of yourself as a catalyst, rather than needing to shoulder all the change.

Rank difference with faculty requires you to earn their respect

You can establish your credibility in the discipline as well as develop and establish your expertise in teaching and learning. You can also leverage this junior status by positioning yourself as an interested novice, requesting expert faculty input to guide your work and potentially getting more honest feedback than if you were an equal colleague.

Impostor syndrome reduces your self-confidence

The DBES position may be a career change for you, moving from an area of relative comfort (your research area from graduate school) to one where you are a relative novice. This can create a sense of professional discomfort known as 'impostor syndrome' (Sakulku, 2011). This can be combated by investing in your own professional development and realizing that once you are even modestly capable in issues of teaching and learning, you will still likely be considered expert relative to others in your department. Seek out mentors inside or outside your department, such as discipline-based education researchers or those involved in faculty development, who can help support your professional development in teaching and learning issues and in education research.

Non-faculty status results in lack of visibility

Learn to actively market yourself, engaging in the department through knocking on doors, going to faculty meetings, producing newsletters, hosting 'brown bag' discussions, and other strategies discussed elsewhere in this chapter.

Lack of positional power limits your ability to get things done

Rely on your departmental director to help you navigate the institution and advocate for resources and support. In general, get support when you need it from the department and the central unit; don't wait. As your position may be unusual to people at your institution, you may need to check with multiple people to fully answer some questions. This rank difference can also impede your ability to accomplish bureaucratic tasks, such as arranging surveys, gathering student test results, purchasing software, reserving rooms, and arranging for research ethics approval.

Your unique status in the department can be a barrier to collegial interactions

To avoid isolation, form communities within the department, with DBESs in other departments, with others on campus, and with people attempting similar work at other institutions. As of this writing, several national networks ([TRESTLE](#) and [ASCN](#)) serve to connect people working in instructional change across institutions.

Instructor-ranking DBESs

In some cases, part of an instructor position has been carved out for DBES work. People in these positions have an advantage in that they are an established colleague with an identifiable rank and known credibility in terms of teaching. They may also have more access to campus supports, such as teaching and learning centers, than post-docs. Below are some challenges which may occur in such positions.

Lack of time limits your ability to engage in the work

There is a lot of learning to do as a DBES, and teaching experience only helps establish some of this expertise. Since you will likely only have a portion of your position devoted to DBES work, it will be difficult to both learn and be productive (generate course materials or other sorts of results) compared to a full-time person attempting the same work, even if they are more junior. Try to establish appropriate expectations for your work, including time for ramping up (when possible) and for professional development, while finding manageable early projects to demonstrate the value you provide.

Full-time teaching requests eliminate DBES time

In some cases, the department's teaching demands can cause the time allocated to DBES work to disappear. This is an issue for the initiative's organizers more than the individual faculty member, but it does mean you should be careful to demonstrate the value of your expertise and DBES work to help push back on this encroachment. Keeping careful records of your progress and achievements can help.

Impostor syndrome reduces your self-confidence

Even if you have a well-established teaching record, you may be new to the research side of teaching and learning. This lack of perceived expertise can create a sense of professional discomfort known as 'impostor syndrome' (Sakulku, 2011). This can be combated by investing in your own professional development and realizing that once you are even modestly capable in issues of teaching and learning, you will still likely be considered expert relative to others in your department.

Marginalized status results in lack of visibility and clout

In research-focused departments, it is possible for teaching-focused faculty to be marginalized. Learn to actively market yourself, engaging in the department through faculty meetings, newsletters, 'brown bag' discussions, and other strategies. Demonstrate your expertise and value through workshops and other venues, including reminding faculty of your contributions to the department (such as procuring funding or improving student retention) visible. Build coalitions with faculty champions and/or committees. Ask your chair or other faculty champions to help you advocate for resources and support, or to supply needed information.

What are the career paths for DBESs?

There was some initial concern among leaders in the SEI whether there would be a suitable long-term career path for DBESs, given the novel position. That fear has since been laid to rest, as DBESs are often in high demand due to the training and experience they receive in evidence-based teaching, course design, faculty development, and educational research and evaluation. Some common career options include:

Teaching positions

Instructor or lecturer positions are popular career paths for former DBESs; in a few cases, the department in which the DBES served as a fellow hires the DBES, who then plays a long-term role in the department as a champion of educational innovation. In Canada, tenure-track teaching faculty positions are increasingly available and are the most common career path for fellows from the UBC CWSEI. Some U.S. universities have long-term teaching faculty positions.

Brett Gilley (former DBES and current instructor at UBC) discusses the use of group work in his classes (Published 2017, The University of British Columbia).



A YouTube element has been excluded from this version of the text. You can view it online here: <https://pressbooks.bccampus.ca/seihandbook/?p=92>

Available at <https://www.youtube.com/watch?v=zATnGROyHF8>

Discipline-based education researcher

Some DBESs with a strong interest in education research have successfully entered tenure-track faculty positions with a focus on education research, been employed as research associates, or conducted independent work as evaluators of educational projects.

University teaching center staff and leaders

Some DBESs have been hired into leadership roles at university centers for teaching and learning.

Parting thoughts

It's okay if your particular job doesn't look quite like what is described in this Handbook; due to the variety in department cultures, teaching mandates, and existing personnel, DBES-type jobs will draw on the principles we have mentioned above but will play out in many different ways for each person. These types of positions can be an opportunity to learn a great deal about teaching, learning, and the research around them, and to join an emerging community of scholars fostering improvements in classrooms for many thousands of students while helping faculty towards more rewarding teaching experiences. Welcome!

Chapter 9 Checklist

In order to develop more fully in their role, DBESs should consider the following approaches:

Think of yourself as a catalyst, coach, and change agent

- Marshal efforts and cheerlead for change.
- Provide feedback and support for faculty.

Integrate into the department

- Be a visible member of the department, building relationships strategically.
- Develop an elevator speech for your role.
- Establish your credibility in the discipline, and in teaching and learning.
- Keep track of your plans and accomplishments with monthly reports.
- Understand your role in the department and in the central organization.

Develop your skills as a DBES

- Engage in substantive professional development around issues of teaching and learning.
- Develop your professional skills as well, such as time management.
- Use campus resources, the literature, and the DBES community for your development.

Be aware of common challenges faced by DBESs

- Manage your time and priorities to avoid being overwhelmed by the work.
- Remember that change takes time; be realistic about your expectations for change to avoid becoming frustrated in your work.
- Publish your research before it is perfect to further your career.
- Engage with on- and/or off-campus communities to combat isolation in your role.
- Be aware of the challenges of the DBES role in specific positions (postdoctoral fellows or instructors).

For further reading

SEI resource documents:

1. Framework for semi-structured course observations: [SEI Course Observation guide](#)
2. Department SEI activity newsletter example: [UBC EOAS newsletter](#)
3. Descriptions of role and skills for DBESs from former DBESs: [Summary of reflections from Science Teaching and Learning Fellows](#)
4. Common questions and resources regarding quantitative analysis from former DBESs: [STLF Quantitative Analysis Discussions](#)

5. Recommended papers in teaching and learning: [UBC CWSEI Recommended Papers](#)
6. Recommendations for time management and planning: [UBC CWSEI project management ideas to consider](#)
7. Peer-to-peer DBES reflective discussions at CWSEI: [Metacognition STLF Meetings](#)

Annotated bibliography

Gawande, A. (2011, October 3). Personal best. *The New Yorker*. Retrieved from <https://www.newyorker.com/magazine/2011/10/03/personal-best>.

Describes the importance of peer coaching in professional improvement.

Sakulku, J. (2011). The impostor phenomenon. *International Journal of Behavioral Science*, 6(1), 73-92.

Reference describing the phenomenon of women believing that they may be exposed as intellectual frauds, despite high achievement.

Wieman, C. (2017). *Improving how universities teach science: Lessons from the Science Education Initiative*. Cambridge, MA: Harvard University Press.

Authoritative resource on the SEI model and its impacts, including a detailed description of the rationale for the SEI, lessons learned, and data on departmental outcomes.

Appendix 1. Case Studies of SEI-Like Initiatives

One of the successes of the SEI is that it has inspired many other similar initiatives aiming to improve teaching and learning through hiring of a variety of Discipline-Based Educational Specialists (DBESs).

By providing these case studies, we wish to demonstrate a wide range of contextually-sensitive ways to create and run such an initiative. Additionally, the case study authors may be good resources as you envision your own approach. In the past, many people working to create SEI-like initiatives have contacted leaders of similar initiatives and visited other institutions to help guide their own initiatives project. The case study authors may be good resources as you envision your own approach.

1. [Brown University's AAU Undergraduate STEM Education Initiative Project: Changing the Culture of Introductory Science](#)
2. [Cornell University's Active Learning Initiative](#)
3. [Imperial College London's Learning and Teaching Strategy](#)
4. [The University of British Columbia's Carl Wieman Science Education Initiative \(UBC CWSEI\)](#)
5. [The University of Colorado Boulder's Science Education Initiative \(CU SEI\)](#)
6. [The University of Hawai'i's Geoscience Course Transformation Project](#)
7. [The University of Kansas's Course Transformation Initiative](#)

Brown University's Association of American Universities (AAU) Undergraduate STEM Education Initiative Project

Duration of initiative: 2011-2017

Case study written: Spring 2018

Our efforts to reform STEM education at Brown University took the form of an interdepartmental community of practice supported by instructors, staff, administrators, and department chairs, with the potential to engage many courses across the institution. Through the AAU Undergraduate STEM Education Initiative project, instructors at Brown implemented 'problem solving sessions' (PSS) as a replacement for recitation sections to foster more collaborative small group experiences and to build more community among students. For 4 academic years, the community of practice built around Brown University's AAU Undergraduate STEM Education Initiative project (called "Changing the Culture of Introductory Science") worked to improve retention in STEM fields by redesigning 11 courses from 4 departments.

In this case study, we describe in detail Brown's context and our project's evolution, and we highlight successes to be emulated as well as lessons learned. From our experiences as a project site, we advocate for community and interconnectedness across an institution as the central themes for success when embarking on a STEM education reform journey.

Project demographics

Brown University

- **Institution type:** urban, Ivy League, research-intensive private university.
- **Size:** ~9,400 students, and ~4,700 faculty and staff.
- **Of note:** first in the Ivy League to establish an engineering program.

Departments involved in the initiative

- **Eligible departments:** all STEM departments.
- **Participating departments:** Physics, Chemistry, Applied Mathematics, and Engineering.

Historical context

Reason for the initiative

Student retention in STEM disciplines had become a growing concern at Brown, with some departments, notably Physics and Chemistry, retaining less than a quarter of initially interested students. Two of the major reasons students cite for leaving STEM are 1) because of the lack of a sense of community with their instructors and peers, and 2) because of their non-ideal experiences in introductory level courses, specifically. However, many faculty teaching introductory STEM courses are hesitant to shift their pedagogy away from the traditional lecture format toward active learning to decrease attrition rates.

Early context

Years before the start of our AAU Undergraduate STEM Initiative project work, a group of open-minded STEM faculty gathered within the flexible and neutral learning space at Brown University's Science Center and initiated a collaboration to build the interpersonal relationships necessary for productive discussions about pedagogical reform. The community building process began with a series of informal conversations about the challenges facing academics in the sciences, including education reform. These conversations, called Science Fridays, started during the Spring of 2009 as a way to facilitate communication across departmental boundaries about teaching and learning in STEM disciplines, and to provide a space for faculty to converse together without pressure from administrators or students.

Science Fridays continue today, independent of any formal departmental affiliation. There is no formal agenda during the conversations, invitations to attend come from faculty peers, and attendance is completely voluntary. Topics of discussion arise out of the particular interests of the participants with no expectation that the ideas discussed must be put into practice. As they discuss and experiment with evidence-based teaching practices and learner-centered approaches in their own courses, participants become informal mentors to one another, which spreads best practices in a fluid, low-risk manner. This freedom to discuss without specified goals or agendas has led to significant course-level changes that arose organically from the conversation and were tailored to the needs of the participants and their respective departments. Over the course of years of discussion in Science Fridays, the collective group was able to identify and develop mathematics competency as both a requirement for success and barrier to retention in STEM disciplines.

The AAU Undergraduate STEM Education Initiative Project

In 2011, the AAU launched a five-year initiative to improve the quality of undergraduate teaching and learning in STEM, entitled the [AAU Undergraduate STEM Education Initiative](#). The initiative sought proposals demonstrating solid and actionable plans to change the culture of undergraduate STEM education through evidence-based practices, rather than reinventing the wheel in course after course and wasting time re-proving techniques like active learning or hands-on experiences. The conversations and community around STEM education reform that grew from Science Fridays created a strong platform for the AAU proposal; the chairs of several departments as well as the staff at the Science Center were poised for action when the call for submissions to the AAU Undergraduate STEM Education Initiative was announced. The acceptance of our proposal, *Changing the Culture of*

Introductory Science, made Brown one of only 8 institutions to be designated as a project site (out of 62 AAU institutions total).

A single postdoctoral fellow served as the Science Education Specialist (SES) across departments

A project-specific postdoctoral researcher (equivalent to the DBES in the SEI Handbook) provided pedagogical training, met regularly with instructors, observed PSS, and coordinated data collection and analysis across all courses within the project scope. Instructors and facilitators met weekly or bi-weekly with the SES for consultations on implementing problem solving sessions, observation debriefs, and reports on the data analysis results of ongoing course evaluations.

The initiative focused on introductory and required courses

All courses chosen for redesign were either introductory courses or required courses taken by a large portion of students entering into majors within the associated departments. To address challenges of large enrollments and limited staffing, and to build confidence and community among Brown students, the stakeholders involved in this project reimagined introductory and required courses to include thoughtfully constructed, small group experiences in which instructors made a concerted effort to show real connections to the lecture material, develop community, and provide more active, context-rich practice with the vital mathematical skills needed to succeed in STEM disciplines and careers. The first departments to participate, Chemistry and Physics, were part of the original AAU proposal to improve students' competency with mathematics. As additional faculty and departments became aware of the project, they were allowed to join without a formal proposal process. This resulted in the inclusion of Engineering and Applied Mathematics.

The initiative focused on integrating problem solving sessions (PSS) into recitations

The common strategy used for each of the courses involved the integration of PSS into what was previously a large, traditional lecture-based instruction format, sometimes without any type of recitation. This was because efforts to redesign STEM courses at Brown University focused on aligning the redesigns with the institutional culture, rather than pushing against it. Faculty at Brown often pride themselves on sharing their research by incorporating cutting edge topics into their lectures. Thus, project work centered on innovative activities outside of the lecture to preserve faculty members' preferred platform to interact with their students.

While there were variations depending on course context, in general, PSS were between one and two hours long and held in flexible learning spaces with hexagonal tables and movable whiteboards designed for collaborative groups. Students worked in teams of two to four with about one facilitator for every three to five teams in a session. PSS facilitators, including faculty, postdocs, graduate students, and undergraduate students, met weekly with the postdoctoral researcher to develop worksheet packets comprised of discussion-provoking problems deeply rooted in real world contexts. These packets were designed to provide students with enough problems to work at their own pace during the session, as well as additional problems to practice outside of the session. Facilitators encouraged students to take their time to understand each problem before moving on.

The purpose of this emphasis on deeply engaging with some content, rather than rushing through all the content, was to reduce students' performance-related stress within the problem solving session environment. At the beginning of each session, facilitators briefly introduced the content covered by the packet, either via a two- to five-minute lecture or with an introductory problem that students worked on individually before discussing with their teams. Facilitators then circulated around the room, encouraged intra- and inter-team discussion, expanded on

problems with relevant disciplinary context and their own expertise, and modeled useful classroom practices. These evidence-based teaching practices included diagramming problems on whiteboards, avoiding controlling language and behaviors, making frequent short visits to student teams, asking exploratory questions rather than providing answers, and giving students space to struggle and discuss with one another. These behaviors were emphasized during facilitation training and were observed by the SES over the duration of the project.

A Community of Practice among course instructors was developed

To connect project work across the various involved departments, a Community of Practice (CoP) was developed for course instructors, including faculty, postdocs, graduate students, and even undergraduate teaching assistants. Many of the CoP's activities revolved around professional development for instructors, enabling them to develop awareness about and reflect upon how their courses impact students, both cognitively and affectively. Training materials and resources for this community drew upon resources from the Sheridan Center for Teaching and Learning, research literature on collaborative learning, and firsthand accounts of instructors and facilitators from previous semesters about their challenges and triumphs (after Fall 2013). Participants in the project-supported training commented that it was nice to have a mix of departmental backgrounds and experience levels within the training environment; that is, faculty appreciated having students in the room, physicists appreciated having engineers in the room, and so on.

What were the lessons learned from the initiative?

Centralized STEM education expertise was critical

Using the Science Center as a 'discipline-neutral' space to house project discussions allowed for a broad range of stakeholders to participate in the evolution of project activities over time. The Science Center also kept any particular department from receiving special treatment or taking ownership of the SES; rather than having a PHYS education specialist or a CHEM education specialist and leaving the other three departments on the periphery of the project, all interested instructors, regardless of discipline, received a proportional amount of support for their activities from the SES. Further, the targeted expertise of the SES was pivotal in supporting instructors' pursuit of improved pedagogy and filling in the gaps for instructors who were splitting their time between their teaching, their disciplinary research, their service, and their discipline-based education research (DBER). By shouldering the responsibility of staying up-to-date on and communicating the DBER literature relevant to project activities, the SES reduced the 'drinking-from-a-fire-hose' frustration that faculty new to the DBER landscape often face and streamlined the overall implementation of the project to avoid reinvention of the wheel in each newly involved course.

End-of-term changeovers of department chairs disrupted progress

Because the project relied heavily on the support of department chairs and because department chairs serve for fixed terms, the replacement of those department chairs whose terms ended in the middle of the project caused disruptions in courses where the instructors were less engaged. For example, in one physics course, because the instructors of the course were very engaged in the project, the changeover of the department chair mid-project had almost no impact on the progress of project implementation, data collection, or data analysis. However, in another course in a different department, the changeover of the department chair caused a significant disruption and loss of a portion of a data set because the course instructors were neutral or even hostile to the project without

the sustained urging of the previous department chair (despite the new chair being similarly committed to DBER). To address this issue, committed department chairs should be coached to not only advocate for DBER from their position of authority within their department, but also cultivate engagement in their faculty, rather than relying on their position to coerce faculty into implementing evidence-based practices the faculty themselves do not believe in or connect with personally.

Exclusively project-owned spaces save logistical headaches

The flexible learning spaces used for project activities were shared for non-project purposes, many of which were unsupervised undergraduate study sessions of various types. This shared use resulted in instructors experiencing several logistical headaches using the space. For example, markers, erasers, and other whiteboard-relevant supplies often went missing, leaving instructors to scramble to find enough for their PSS of 30+ students to work together on whiteboards during the session. Further, instructors of PSSs that met in the morning would often arrive to find the room in a sub-optimal or lecture-like arrangement and would then be forced to delay the start of their session to rearrange the room; some of these instructors had physical limitations that made it difficult for them to move the sometimes un-wheeled hexagonal tables, and would have to recruit their own students to help. To address this issue, having spaces that are exclusively reserved for project activities and managed by the project staff could save time and increase the positive effect of instructors using the space.

Faculty accountability was low

Because course modifications focused on recitation, the lecturing faculty had no responsibility to participate in the project or to make changes to their lecture. In some cases, there was limited to no connection between the lecturing faculty and the SES because a separate head instructor was assigned to the PSS portion of the course. While this 'lecture-and-PSS-as-separate-entities' arrangement was sometimes the only way to implement the project work in a given course, the student experience suffered because the experience within PSS was predictably disconnected from the experience within lecture. To address this issue, lecturing faculty should be welcomed and encouraged to attend PSS planning and consultation meetings even if they are not formally responsible for any portion of the PSS experience for students and/or are uninterested in incorporating evidence-based practices into their lecture. However, if this type of encouragement is ineffective, an example of a proactive solution adopted in some courses was to have the head instructor of the PSS attend the lecture for the course such that the pacing and content of the PSS worksheets could reflect the pacing and content of the rest of the course. This arrangement bypassed the faculty accountability problem despite the lecturing faculty never attending any of the PSS planning.

Junior instructors were sometimes forced to 'mentor up'

The nature of the project meant that many of the graduate students and postdocs who were recruited or chose to become involved were the junior instructors most interested and engaged in thinking about DBER in their own teaching. The more senior instructors (usually faculty) were less experienced with DBER and sometimes only involved because they had been assigned one of the courses that had been previously involved in the project. This relative difference in DBER experience level, coupled with the fundamental hierarchy of a primary instructor overseeing a group of TAs, meant that it fell to some junior instructors to serve as DBER mentors to their senior instructors in some contexts. For the most part, this dynamic did not pose a significant problem, but in the minority of instances where the junior instructor was highly knowledgeable about DBER and the senior instructor was both inexperienced with **and** hostile to DBER, it fell to the SES to mediate a very tenuous situation; maintain the engagement of the senior instructor without crushing the enthusiasm of the junior instructor. This mediation work was draining for both the SES and the junior instructors.

A lone SES as a project's main change agent is not ideal

The SES faced several challenges as a lone change agent, including the lack of time to fully direct the project and the lack of a peer network. Managing ongoing course feedback, data collection, and data reporting, as well as mediating the personalities of diverse groups of people, was more than a full-time job. In general, the SES spent between 50 and 80 hours every week on project activities; this time included approximately 10-15 hours of observations, 5-10 hours of course consultations, 5-10 hours of other project-relevant meetings, 10-20 hours of data collection/analysis, 10-20 hours of email/in-person scheduling/mediation/organizational work, and the remainder writing/drafting/editing project-relevant websites/reports/manuscripts. Further, the SES was an island; there were no other members of staff that had a similar job description, even in a different disciplinary context, so there was no peer with whom to commiserate or troubleshoot. The SES also often lacked the guidance of the lecturing faculty in a particular course because of the separated nature of some PSS course arrangements. Without the capacity to bounce ideas off of another person well-versed in the DBER literature (i.e., without a research group equivalent) most of the project activities came from only one perspective, that of the lone SES. To address this issue, we recommend hiring at least two project-dedicated SESs and housing them within a more defined structure in a similar center to the Science Center. With the full support of two (or more) people, the overall management of the project would not only be distributed to a more reasonable 40-hour work week, but also the distributed work could be completed with more attention to detail and time for creative reflection.

What were the key outcomes of the initiative?

Problem solving sessions have become part of the infrastructure of multiple courses in multiple STEM departments. The departments have bought into these approaches.

A drive has emerged from the upper administration to infuse problem solving as a form of critical thinking within the Brown curriculum. Our AAU program required both a bottom up and a top down commitment as well as a department to department commitment to the goals as laid out by PCAST and AAU. The associated interactions have led the upper administration to embrace these goals more generally for Brown students. Concretely, the Sheridan Center for Teaching and Learning at Brown is conducting a Problem Solving Course Development Institute (PSCDI) to assist faculty members adding new problem solving activities to their courses. Moreover, a staff member was hired to implement this broader strategy and is currently teaching a course on problem solving for developing an ongoing stream of facilitators.

Students in STEM at Brown are beginning to look for problem solving session opportunities in their courses. The majority of them report that they are key vehicles for their learning.

How do I get more information?

Website: <https://www.aau.edu/stem-status-report-engagement-aau-universities>.

This website provides the STEM Status Report from the AAU, posted on October 3, 2017.

Website: <https://www.aau.edu/education-service/undergraduate-education/undergraduate-stem-education-initiative>.

This website showcases the overall AAU Undergraduate STEM Education Initiative, including Brown University as a project site.

Related paper: *Closing the Achievement Gap in STEM: A Two-Year Reform Effort at Brown University*. Full Paper at the 2016 ASEE Northeast Section Conference's website: <http://egr.uri.edu/wp-uploads/asee2016/73-1064-1-DR.pdf>.

Contact: for more details please contact David Targan (david_targan@brown.edu).

Cornell University's Active Learning Initiative, College of Arts and Sciences

Duration of initiative: 2013-2018 (and ongoing)

Case study written: Spring 2018

The Active Learning Initiative (ALI) is an ongoing, donor-funded program run by Cornell University's College of Arts and Sciences. Departments within the college compete for grants of up to \$1M over five years that enable faculty teams to introduce active learning and other research-based innovations into significant portions of their undergraduate curriculum. The program is modeled on the Carl Wieman Science Education Initiative (CWSEI). About $\frac{1}{3}$ of the college's departments are participating after two rounds of competition.

What is the context of the initiative?

Cornell University, College of Arts and Sciences

- **Institution type:** liberal arts college in a large, research-intensive private university.
- **Size:** ~14,000 undergraduate students and ~1,500 faculty. The College of Arts and Sciences accounts for about a third of the undergraduates and faculty, but also teaches around a third of the courses taken by undergraduates from other colleges.

Departments involved in the initiative

- **Eligible departments:** all departments in the College of Arts and Sciences. Several of these departments are shared with other colleges.
- **Participating departments:** departments who won awards in the first two rounds of the grant competition are: Classics; Ecology and Evolutionary Biology; Economics; Mathematics; Music; Neurobiology and Behavior; Physics; and Sociology. The next competition will be in 2018.

How was the initiative structured?

The ALI is an ongoing, donor-funded grant program for departments

The program is donor-funded, and it has spent or committed close to \$5M USD so far. Department grants range in size from seed grants (~\$200K) to large transformation grants (~\$1M) spread over several years. Only departments (not individuals) can apply for grants, and applications must be endorsed by the department's faculty. The size of the grants catches the attention of departments and is sufficient for funding substantial changes.

- *Successes.* About a third of the college's departments have created winning proposals. This includes almost all of the STEM departments, but also departments in the social sciences and humanities. About half of the proposals in the last round were funded. Teams from individual departments typically include around a half dozen faculty members, comprising a significant fraction of the department's faculty. Department approval of proposals means that pedagogy and learning research have become topics for faculty meetings in those departments. Reported successes inspire other faculty in the department to try new pedagogies in their courses.
- *Challenges.* This approach is highly dependent on leadership from the department chair and a strong commitment and openness to new ideas from the faculty involved. These features can be tricky to assess from the proposals by themselves, so multiple meetings with prospective teams are important (and time consuming). Leadership changes at all levels must be managed carefully, and the program must be willing to suspend support for grant winners who turn out to be unable to deliver the needed leadership and commitment.

Grants are a one-time investment, spent mostly on teaching fellows

Department grants are meant to fund the conversion of courses from, for example, traditional lecture courses into modern active-learning courses. Out of necessity, the new courses are designed to leave the long-term costs of running the courses unchanged. The grants provide one-time funding that makes the conversion possible. For most projects, the bulk of the funding is used to hire 'teaching fellows', temporary staff who are typically postdocs, to work with the faculty on the course conversions. The biggest obstacle for faculty who want to work on such projects is lack of time; the second biggest problem is lack of expertise on research-based pedagogy and student learning. The teaching fellows address both these issues. They help faculty organize their course and design the educational materials used in and out of the classroom. They also help faculty design their courses so that the impact of the teaching innovations can be assessed and the innovations improved. Serious assessment is essential to the program, and research publications based on data from the projects are encouraged. Teaching fellows need disciplinary expertise as well as pedagogy expertise; they are typically postdocs in the subject area, who may or may not come with experience in pedagogy and learning research.

- *Successes.* Faculty have responded quite positively to the teaching fellows, and the combination of faculty plus teaching fellows has proven highly effective. Teaching fellows seem to have no problem finding jobs when they leave ALI programs.
- *Challenges.* Providing adequate training and supervision for teaching fellows is nontrivial; teaching fellows need training in pedagogy and learning science. The ALI relied initially upon the standard offerings of its center for teaching and learning, but now offers more substantial opportunities since Cornell hired research faculty in science teaching and learning. Teaching fellows also need strong supervision. This should come

from inside their departments, but the ALI can provide backup supervision. It can also create opportunities for fellows from different disciplines to interact with each other.

The ALI is among the dean's top priorities

The ALI was designed by the college's previous dean, then promoted to a top priority by his successor, who recruited him to run the ALI. The dean is uniquely well-placed within Cornell's hierarchy to drive a program like the ALI. This is in part because the dean has access to donors and other funding at levels sufficient to support the ALI. More importantly, departments report to the dean, who sets their support levels. Effective department chairs, therefore, pay attention to their dean's priorities and consider how to align department priorities with them. Finally, the dean controls most of the incentive system for faculty and so can adjust incentives to promote ALI goals.

- *Successes.* Two deans in a row have made the ALI a priority.
- *Challenges.* Deans change over time.

What were the key outcomes of the initiative?

Courses have improved and department teaching cultures are changing

The first round of ALI grants targeted introductory physics and biology sequences, taken by thousands of students annually. These have shown significant improvements in student performance: several classes saw almost a letter-grade improvement in the entire grade distribution for matched exams relative to the original course. Performance gaps between underrepresented groups and the general class population have been reduced and, in some courses, eliminated. Student response has been generally positive. The impact on several of the ALI faculty has been transformative. There is growing evidence that the new teaching practices are spreading to other faculty within the ALI departments. The second round of ALI grants is too recent to show outcomes, beyond the fact that a third of the college departments are now participating.

How do I get more information?

Website: <http://as.cornell.edu/education-innovation>.

Example [Request for Proposals](#).

Contact: Peter Lepage (g.p.lepage@cornell.edu).

Imperial College London's Learning and Teaching Strategy

Duration of initiative: 2016-2025 (intended)

Case study written: Summer 2018

Imperial College London is in the early stages of a 10-year investment in building a culture of continuous educational improvement. This initiative is tied to a comprehensive Learning and Teaching Strategy which has been adopted across the institution as a whole. The Strategy relies heavily on team-based curricular review across all departments to support meaningful conversation and action around pedagogical improvement and student learning. The Imperial College London approach relies heavily on equitable participation across multiple stakeholders, including staff, students, and instructors. Imperial is also providing substantial resources to support the labour required for change through funding for educational experts, supporting professional development and community for these experts, and making available substantial, non-competitive funding avenues for implementing change.

What is the context of the initiative?

Imperial College London

Institution type: Imperial is a global, top 10 university with a focus on science, engineering, medicine and business—an education environment unique to the UK.

Size: ~9,800 full-time undergraduate students, ~7,300 full-time postgraduate students, and ~7,640 staff (including ~3,700 academic and research staff; *note for North American readers: this group would typically be referred to as “faculty” in the North American context*).

Departments involved in the initiative

Eligible departments: all academic departments with undergraduate programmes are engaged in review of their curricula with a view to roll out revised curricula to new students from the academic year 2019/20. All departments (including Imperial College Business School) will also review their postgraduate curricula, aiming to have this work completed across the institution by 2021/22.

Participating departments: all departments have interacted with the Learning and Teaching Strategy through at least one of the strategy's 4 pillars. Additionally, 16 proposals for pedagogy transformation have been funded so far. These proposals have been received from 10 different departments and also include 2 cross-Faculty proposals.

Learning and Teaching Strategy

Imperial embarked on its transformation of education in 2016, when the College announced its intentions to generate an institution-wide strategy related to education and launched a wide-ranging consultation exercise with staff and students. The resulting Learning and Teaching Strategy launched in 2017 sets out an ambitious programme of work aimed at establishing Imperial as a global leader in innovative, evidence-based education. It represents a commitment to a comprehensive and holistic transformation of the college's curricular and pedagogical approaches.

Implementation of the Strategy will be underpinned by an understanding that change will take significant time, collaboration, and effort. As such, the Strategy involves a significant new investment in education, which will create more time for staff to deliver transformative work and innovation; enable an infrastructure for future educational development; and improve educational research capabilities so that the impact of these efforts may be measured.

The Learning and Teaching Strategy has four pillars of activity:

1. Curriculum

The Strategy commits to supporting departments in a review and redesign of undergraduate and postgraduate taught curricula and assessment. As the college's curricula have often developed organically in response to disciplinary changes, changing faculty expertise and interests, and pragmatic management of resources, curricula are not always sequenced in the most logical way of learning.

A review of the College's curricula also aims to give students the chance to broaden their knowledge beyond their own subjects. Students will be offered a choice from a range of new for-credit modules that offer broader, integrative activities, providing opportunities for them to apply disciplinary knowledge in a new context, driving transformation of their understanding and identity.

2. Teaching

The Learning and Teaching Strategy aims to create a 21st century pedagogy, one which invests in and develops concepts which go beyond retaining information. By employing an evidence-based approach and drawing on effective practices already in use, the Strategy will invest in a transformation of its pedagogy to make learning more interactive, more supportive, and more challenging.

3. An inclusive and diverse culture

Crucial to the college's strategic plan is the fostering of an environment where differences in student background and cultures are cherished and celebrated. Evidence increasingly shows that teaching is not a 'one size fits all' process. However, in teaching 'by discovery', differences between students can provide unique solutions to problems. A strong sense of community not only aids learning, but also contributes to positive wellbeing. The focus on group work aims to develop soft skills and seeks to address a results-focussed, competitive culture.

4. Digital content

The College's vision is to develop and deploy cutting-edge technology which transforms the learning and teaching experience. Digital and online technology will be employed to foster a sense of collaboration and community, enhance interactive pedagogy, and expand possibilities in reaching an even more international audience.

The Learning and Teaching Strategy is funded at the College level and is led by Professor Simone Buitendijk, Vice-Provost (Education), and Professor Alan Spivey, Assistant Provost (Learning & Teaching).

How is the initiative structured?

Using an evidence-based approach which suits the College's research-intensive environment, we will identify the most effective pedagogies and assessment methods to suit specific learning outcomes and particular disciplinary needs. We will also adopt a subject-specific approach in innovation, recognising that best practice often depends on disciplinary context. The strategy allows for variation depending on the starting point, and so departments will determine the implementation approach that suits them best. Staff will have the autonomy to set their own priorities, and we will encourage departments to collaborate on building success.

The initiative supports team-based, college-wide review of curricula and assessment

An initial focus for the College's Learning and Teaching Strategy has been to spearhead a process of curriculum review, designed to reduce curriculum content and the volume of assessment. The College aims to develop curricula that delve more deeply into subject matter and use more authentic assessment. The College will use this transformation to empower students to use their learning experiences to be leaders in an ever more diverse and interconnected world, and to share their knowledge in the process.

Departmental curriculum review teams have been established to take a hands-on approach to delivering a thorough review of programme and module learning outcomes and assessment to embed activity for the development of broader skills, rather than the simple memorisation of factual information. Through the process of curriculum review, departmental teams will map their entire curriculum, capturing its current content as well as the ways in which it develops and assesses skills development, with the aim of showing alignment for all possible learning pathways.

The curriculum review also presents an opportunity to review programme structure and to adopt a modular approach to learning. This will enable our students to have greater choice and flexibility within their programmes, and have the potential to access learning from other disciplines.

The initiative supports educational experts in leading curricular review: Strategic Teaching Fellows

The process of curriculum review is understood to be labour intensive, given the careful thought, effort, and collaboration required. To support departments in this intense activity, they have been given access to funding to employ new posts or back-fill existing staff to allow a focus on reviewing curricula. Funding is also available to back-fill the time of departmental Directors of Studies, ensuring that time is made available to deliver projects within agreed deadlines.

We will initially create a large community of Strategic Teaching Fellows, educators who will drive change, learn together, and develop a sustainable culture for others who follow. We have put in place a job family and promotions framework which reflects the esteem that our educators deserve.

The initiative supports a team approach to curricular review, including staff and student voices

Curricular review will be a collaborative process led by academic staff and facilitated by the active engagement of our students. Throughout the process curriculum review teams will have the opportunity to share their work and ideas with their peers and specially commissioned curriculum review reference panels. These panels will be convened by senior academic and teaching staff, experts in pedagogy, and quality assurance professionals, who can offer guidance, inspiration, and a friendly, critical eye to ensure that curriculum and assessment plans are high quality, sustainable, and in keeping with the Learning and Teaching Strategy.

The Learning and Teaching Strategy is centred on the understanding that our students work most effectively when they feel part of a collaborative community. Therefore, it is essential that we work in partnership with students in the review of our curricula. Curriculum review teams are required to engage, consult with, and draw upon the voice of their student cohort in reviewing curricula and assessment. The College has also established the new StudentShapers programme which will provide funding for students, enabling them to work with staff and each other to identify priorities for change, to design and recommend improvements, and to implement change within their departments.

Particular effort has also been made to mobilise staff who have engaged in the specialist training and support for the development of teaching and learning from the College's Centre for Higher Education Research and Scholarship (CHERS). This group of staff is uniquely placed to help embed evidence-based approaches within disciplinary curricula, drawing upon both their disciplinary knowledge and their exposure to cutting-edge innovations in pedagogy. By inviting staff to take part in the reference panels, we also intend to provide a development opportunity for staff to develop knowledge and expertise in quality assurance, a prerequisite for participating in institution-level academic governance.

The initiative provides professional development and community-building to support innovation in education

With the understanding that the best work is rarely achieved in isolation, the College's Learning and Teaching Strategy commits to supporting staff and building a community driven to improve teaching and learning in a number of ways. An aim of this approach is to embed teaching best practice in all that we do, ensuring that the quality of our teaching has the same prestige as the quality of our research.

Teaching Toolkit

Ongoing and proactive support is supplied for curriculum review teams by CHERS, working alongside the Centre for Languages, Culture, and Communications (CLCC), the Centre for Academic English (CfAE), and the Careers Service. As well as close collaborative working, this support has also manifested in CHERS's development of a Teaching Toolkit. The toolkit offers staff an online resource of easily-digestible guidance, exemplars, and case studies related to pedagogical concepts and practices, such as guidance in forming effective Intended Learning Outcomes and practical introductions to research methods in education.

Curriculum review workshops

A series of curriculum review workshops have also been arranged. These are structured around themes of change and enhancement that curriculum review teams are working to embed. Topics have included embedding academic literacy in the curriculum, modular curriculum design, and inclusivity. Practical workshops are also offered to support departments in the writing of quality assurance paperwork and in evaluating change. The curriculum

review sessions also offer a surgery-style opportunity for curriculum review teams to ask questions of their colleagues and to receive guidance and support in developing their ideas.

Support for Strategic Teaching Fellows

In recruiting Strategic Teaching Fellows to support the development and embedding of new curricula, there is opportunity to foster and develop a community of expertise. With the professional development of the Strategic Teaching Fellows in mind, we plan to establish an online collaboration space for them to discuss approaches, build networks, and deploy innovative projects.

Talking Teaching

In keeping with the efforts of the Strategy to share best practices and innovative approaches across the College, a series of 'Talking Teaching' seminars are held on a monthly basis. These informal, information-sharing and discussion-based events offer individuals and groups of staff a venue to share their ideas, and are open to anyone with an interest in education.

Talking Teaching has featured diverse range of speakers, ranging from the College's Advanced Hackspace—offering students the opportunity to access a unique suite of prototyping technologies—to novel approaches used to ensure that our postgraduate medicine students are offered a strategic approach to developing professional skills.

The initiative provides funding for pedagogical improvements

Aligned with the curriculum review, a fund has been established to support departments (and other groups of staff) who support projects aimed at making learning and teaching more innovative and interactive. The fund is not competitive, and funding is available to support all high-quality bids. The process of bidding is designed to ensure that funding is made available based on commitment and support from the senior leadership within departments.

Departments will be encouraged to work together on bids in pairs or small clusters. In doing this we will learn from approaches that have been successfully implemented elsewhere. A holistic approach is expected to combine changes in teaching with the use of technology and the transformation of teaching spaces.

In delivering a digital education, the College is aware that the 'classroom of the future' will be an interactive and collaborative space, highly influenced by digital technologies developed between educationalists and technology experts. To exploit this opportunity, the College is working in partnership with staff and students to innovate cutting-edge ideas.

The College has consulted extensively on the facilities that are required to deliver truly transformational pedagogy. It is clear that we need teaching spaces with state-of-the-art digital capabilities and flexible, modular designs. As such, the College is delivering a series of classroom redesigns and renovations over the coming years which will revolutionise the way teaching is carried out. This investment will result in staff having the necessary tools to deliver the new curriculum in full. As one of the more physically tangible aspects of the Learning and Teaching Strategy, new teaching spaces will also underscore the College's commitment to improving the student experience.

Early indicators of engagement

The Learning and Teaching Strategy is a 10-year investment in building a culture of continuous enhancement in education at Imperial. While still in the early stages, we look to the following indicators as measures of engagement with and investment in the College community:

- **Engagement with curriculum review**—all of the College’s academic departments have engaged with and are actively working on reviewing their curricula and assessment for their programmes.
- **Pedagogy transformation investment**—£7M committed so far to successful bids under the Pedagogy Transformation Fund.
- **Attendance at Workshops/Talking Teaching**—curriculum review workshops and Talking Teaching events act as a marker of engagement with the Learning and Teaching Strategy.
 - Curriculum review workshops drew an average attendance of 33 members of staff across 10 events in 2017/18.
 - Talking Teaching seminars drew an average attendance of 50 members of staff across 6 events in 2017/18.

How do I get more information?

Website: <https://www.imperial.ac.uk/learning-and-teaching-strategy>.

Contact: Hailey Smith, Project Manager (Learning and Teaching Strategy): hailey.smith@imperial.ac.uk.

The University of British Columbia's Carl Wieman Science Education Initiative (UBC CWSEI)

Duration of initiative: 2007-2017

Case study written: Spring 2018

The UBC CWSEI was a rather large-scale initiative over 10 years (2007-2017) that embedded Discipline-Based Education Specialists (DBESs) directly within STEM departments to support and facilitate changes in teaching culture and practice. The main assumption of the program design was that the majority of faculty and courses needed to be involved in order to produce a lasting shift towards evidence-based teaching practices. The initiative has demonstrated a large impact, influencing the teaching of over 175 faculty representing about $\frac{2}{3}$ of credit hours taught by the departments in the Faculty of Science.

What is the context of the initiative?

University of British Columbia Vancouver (UBC)

- **Institution type:** large, research-intensive public university.
- **Size:** ~54,000 students (24% international), and ~15,000 faculty and staff.
- **Of note:** there are two faculty tenure streams: research faculty (2-3 courses/year) and teaching-focused faculty (4-6 courses/year).

Departments involved in the initiative

- **Eligible departments:** all departments in the Faculty of Science, consisting of ~7,500 undergraduate students (~800 international), ~400 faculty, and ~500 staff. Applied Science (i.e., engineering) is a separate faculty which was not directly involved in the UBC CWSEI.
- **Participating departments:** all departments in the Faculty of Science: Computer Science; Earth, Ocean and Atmospheric Sciences; Physics & Astronomy; Mathematics; Zoology + Botany + Microbiology & Immunology (combined as 'Life Sciences' for the purposes of the UBC CWSEI); Statistics; and Chemistry (smaller-scale pilot).

How was the initiative structured?

The UBC CWSEI was a large, 10-year program

The program was funded primarily by UBC itself (\$9.3M CAD) and partially via donations secured during the initiative (\$2.24M CAD), for a total of \$11.54M CAD (~\$11M USD based on average exchange rates). Each department received concentrated funding of ~\$1-2M CAD over 6-7 years, except Chemistry and Statistics which received smaller amounts. The program as a whole lasted a total of 10 years (primarily due to staggering of the work across time), though the initial intended duration was 5-7 years.

- *Successes.* There was large-scale change in most departments and varying levels of change in the others. A large STLF community made for better peer support and more expertise transfer within the group. This initiative was also long enough to move beyond ‘early adopter’ faculty and, in most departments, work with a majority of faculty to improve their teaching.
- *Challenges.* Changes in leadership at the central and department levels required some form of renewal every few years.

Participation in the UBC CWSEI occurred at the department level

The program operated within the department, and the department was considered the unit of change. Requests for Proposals (RFPs) were advertised and departments were encouraged to apply.

- *Successes.* The initiative helped departments focus their attention on teaching, which is necessary given that the department is the cultural unit at universities and that faculty are the experts in their field. When the initiative involved a majority of the faculty in a department, the result was widespread changes in instructional practices.
- *Challenges.* Some departments started later when they were more prepared, which stretched the timeline of the overall initiative. Departments were not always engaged as a whole and sometimes lacked clear leadership.

Temporary STLFs within departments acted as agents of change

Funding in departments primarily supported the salaries of DBESs, which were called Science Teaching and Learning Fellows (STLFs) at UBC. STLFs were postdoctoral fellow or contract faculty who were hired into the department and who partnered with faculty to measure learning, change courses, evaluate curriculum, and a variety of other roles. An important but smaller amount of funding was allocated to ‘buy’ faculty time for these partnerships.

- *Successes.* The use of STLFs was a particular strength of the program. STLFs reduced faculty time needed for change and provided knowledge to support that change, including disciplinary expertise. STLFs had a very high rate of employment at the end of the position.
- *Challenges.* In many cases, faculty were not strongly convinced that change was necessary by seeing published data. Local evidence (even when technically weaker) was a more powerful influence than published studies from elsewhere.

STLFs received regular oversight and supervision

Typically, STLFs met to discuss project progress weekly or biweekly in department groups run by a departmental

director, and twice a term with SEI Central. SEI Central was also available for one-on-one advising on an individual basis.

- *Successes.* This was critical for keeping projects on track and for the efficient use of STLF time.
- *Challenges.* Helpful supervision was highly dependent on the choice/availability of suitable faculty in the departments. When this was lacking (including early in the initiative while supervision was still being established), projects could languish and work could be very frustrating for the STLFs involved.

STLFs' capacity for leading change was supported by substantial training and a professional community

STLFs participated in an initial training program (meeting weekly for one semester) and engaged in an ongoing STLF community of practice (bi-weekly group meetings for STLF development, plus a bi-weekly Science Education Reading Group), both of which emerged in the early years of the initiative.

- *Successes.* Training was a key element of success, giving knowledge for leading change. A thriving community of STLFs—with one to four in each department at any given time—made for a supportive learning environment, despite the novelty of these positions. This community was routinely identified as the biggest support/influence by STLFs moving on to other positions.
- *Challenges.* In the first year, training was very limited; the program had not been fully developed and the size of the community was small. Several of the first cohort of STLFs left early (after a year or so) due to frustrations in the work.

The central organization was strong and well-funded

Led by Nobel laureate Carl Wieman and 2-3 staff during the height of the initiative, SEI Central operated independently of existing teaching centres and was responsible for: the proposal and funding process; training, advising, and organizing the STLFs; advising department leadership on project ideas and hiring/management of STLFs; coordinating cross-department and cross-institutional sharing of materials; and bringing external contacts and expertise to UBC to support the initiative's work.

- *Successes.* Collecting and responding to regular feedback from the STLFs, department leaders, and the dean's office were important in guiding the work in departments and providing a mechanism for learning to happen across departments.
- *Challenges.* Department-level leadership was still a stronger influence on a given department's success. Some structures, like the training and clear setting of expectations for the STLFs, only emerged after a tumultuous first year in some departments. Pulling back of funding for lack of progress was necessary in some cases but appeared to be effective when applied; departments were able to resume later on when conditions were more favourable. Establishing guidelines for reasonable measurement practices took substantial time and effort with the institutional research ethics board.

Course materials were archived in a central repository

In order to create efficiency in education, the intention was to develop a central database to house developed materials, shared with the University of Colorado Boulder's initiative. An SEI course materials archival system was developed at substantial expense to enable efficiency in course development and sustainability of approaches.

- *Successes.* This was not a success; only a small number of courses are archived here.
- *Challenges.* User interface issues and a lack of incentive to archive materials were the major barriers.

Materials were built for teaching, however packaging for distribution requires another step, which was not really budgeted for in terms of time and expertise. Copyright was also an issue; it was not possible to openly publish materials suitable for on-campus use. There were also concerns from faculty about making course assessments public. Lastly, the custom-built platform is no longer maintainable, requiring migration to a more stable solution. We recommend instead using a more established platform and partnership with a campus library.

What were the key outcomes of the initiative?

Departmentally-driven initiatives can result in widespread change, even with little change to institutional reward structures

Over 150 UBC courses were substantially transformed and over 40 were partially transformed by UBC CWSEI efforts—in all, about $\frac{2}{3}$ of all credit hours taught in the Faculty of Science. About 175 Science faculty have been involved in a course improvement project and substantially changed the way they teach, with only a few abandoning research-based instructional practices after a year without support.

Attitude shifts among faculty and students

Perceived barriers to teaching have shifted from faculty member concerns about large class sizes and (perceived) lack of student preparedness/motivation to concerns about time shortages and a need for teaching development. Science students at UBC now perceive active, enriched classrooms as normal, even at the early undergraduate level, and are able to discern effective practices.

Impact on the broader STEM education community

A significant knowledge base of practical resources and published evidence of effectiveness has accrued; these are collected on the UBC CWSEI websites which has a significant following inside and outside UBC. Several other institutions have adopted the DBES model in some form, either on their own (e.g., Cornell University) or as part of the NSF-funded TRESTLE network (<http://trestlenetwork.org/>).

How do I get more information?

Website: cwsei.ubc.ca.

The UBC CWSEI website has examples of all aspects of the initiative, which are also archived in this Handbook.

Requests for Proposals: sample RFPs and funded proposals are at <http://www.cwsei.ubc.ca/about/funding.htm>.

Book: *Improving How Universities Teach Science: Lessons from the Science Education Initiative* by Carl Wieman (2017).

This summary book has much more detail on the UBC CWSEI.

Contact: for more details please contact Warren Code (warcode@science.ubc.ca).

The University of Colorado Boulder's Science Education Initiative (CU SEI)

Duration of initiative: 2006-2014

Case study written: Spring 2018

The CU SEI was a large-scale initiative that served as a proof-of-concept for the 'embedded expert' model of educational transformation, using Discipline-Based Education Specialists (DBESs) within departments to support change. Lasting 9 years, the CU SEI focused on embedding postdoctoral fellows directly into science departments to support and facilitate changes in teaching culture and practice. The main assumption of the program design was that the department—and its faculty, courses, and culture—served as the natural ecosystem needed to produce a lasting shift towards evidence-based teaching practices. The CU SEI began in 2006, and many of its lessons-learned served to inform The [University of British Columbia's initiative](#), which began a year later and was funded at a much higher level (approximately double that at CU Boulder). The program demonstrated an impact, influencing the teaching of 102 faculty and 71 courses in 7 science departments.

What is the context of the initiative?

University of Colorado Boulder (CU Boulder)

- **Institution type:** large, research-intensive public university.
- **Size:** ~33,000 students, ~3,500 tenure-track faculty, and ~1,900 instructors.
- **Of note:** the institution has a long-standing history of commitment to STEM educational improvements across faculty and some higher administrators. Instructor rank is non-tenure-track.

Departments involved in the initiative

- Eligible departments: all science and mathematics departments in the College of Arts and Sciences (approximately 10 departments).
- Participating departments: 7 departments, including Chemistry; Geological Sciences; Molecular Cellular and Developmental Biology; Integrative Physiology; Physics; Ecology and Evolutionary Biology; plus a small pilot in Astrophysical and Planetary Sciences.

How was the initiative structured?

The CU SEI was a large program (but not as large as CWSEI)

The program was initiated by Carl Wieman, a Nobel laureate and a faculty member in physics at the time. It was funded entirely by CU Boulder (\$5.3M), which is half the funding level of its sister program (UBC CWSEI). Each department received concentrated funding of \$150K-860K USD with an average of \$650K per department, over a period of 4-5 years. Though the initial intended duration was 5 years, the program lasted 9 years, primarily due to staggering of the work over time.

- *Successes.* There was large-scale change in a few departments and partial change in others.
- *Challenges.* The lower funding level (compared to UBC CWSEI) resulted in a diminished concentration of Science Teaching Fellows (STFs) and did not seem to be sufficient to generate a sense of urgency within departments. The early start (relative to UBC CWSEI) resulted in a rocky start as the program identified structures to best support its goals.

Participation in the CU SEI occurred at the department level

The program operated within the department, and the department was considered the unit of change. Requests for Proposals (RFPs) were advertised and departments were encouraged to apply, usually through a visit by Wieman at a faculty meeting.

- *Successes.* The initiative helped departments focus their attention on teaching, which is necessary given that the department is the cultural unit at universities and that faculty are the experts in their field. When the initiative involved a majority of the faculty in a department, the result was widespread changes in instructional practices.
- *Challenges.* Departments were not always engaged as a whole and sometimes lacked clear leadership. Departments were not always prepared to write high quality educational proposals. Strong and conspicuous support of the program from higher administration was lacking at CU Boulder, resulting in more variable prioritization of the program from chairs.

Temporary Science Teaching Fellows (STFs) within departments acted as agents of change

Funding in departments primarily supported salaries of embedded experts called STFs (termed DBESs in the SEI Handbook), the postdoctoral fellows hired into the department and who partnered with faculty to measure learning, change courses, evaluate curriculum, and a variety of other roles.

- *Successes.* The use of STFs was a particular strength of the program. STFs reduced faculty time needed for change and provided knowledge to support that change, including disciplinary expertise. STFs had a very high rate of employment at the end of the positions, with some being hired by the local department.
- *Challenges.* The lower funding level at CU Boulder (relative to UBC CWSEI) resulted in some STFs working solo within departments, which is a more challenging situation in which to achieve change.

STFs received regular oversight and supervision

Typically, experts met to discuss project progress weekly or biweekly in department groups run by a departmental director, and twice a term with SEI Central. SEI Central was also available for one-on-one advising on an individual basis.

- *Successes.* This oversight was critical for keeping projects on track and for the efficient use of STF time.
- *Challenges.* Helpful supervision was highly dependent on the choice/availability of suitable faculty in the departments. When this was lacking (including early in the initiative while supervision was still being established), projects suffered from a lack of feedback and direction, support with challenging faculty was insufficient, and work could be very frustrating for the STFs involved.

STFs' capacity for leading change was supported by training and a professional community

STFs participated in a training program and in ongoing meetings (once per week), and were encouraged to attend other relevant meetings (such as the Discipline-Based Education Research group).

- *Successes.* STF trainings and meetings were important for giving STFs a common base of understanding in the education literature, and to share progress with one another.
- *Challenges.* In the first year, SEI Central was still figuring out what STFs needed and the best approaches for training them. Due to the lower level of funding (relative to UBC CWSEI), there were fewer new cohorts of STFs and thus less opportunity for STFs that were not hired in the first year of the program to engage in the training for new STFs. There was also a smaller community of STFs and less funding for the central organization, resulting in a less cohesive professional community.

There was a central organization

Led by Nobel laureate Carl Wieman and 1-2 staff during the height of the initiative, SEI Central operated independently and was responsible for: the proposal and funding process; training, advising, and organizing the STFs; advising department leadership on project ideas and the hiring/management of STFs; and coordinating the cross-department and cross-institutional sharing of materials.

- *Successes.* The existence of a central organization was critical for overseeing the work.
- *Challenges.* The lower level of funding at CU Boulder (relative to UBC CWSEI) resulted in the central organization being funded at only about half the level of funding at UBC. The CU SEI director was funded at a 20% FTE appointment, the associate director at 50%, and a 50% administrative assistant was dedicated to the project. This level was insufficient (see Chapter 4 of the SEI Handbook). There were also no funds provided for systematic evaluation of the project, and thus the sustainability of the initiative is not well-studied.

Course materials were archived in a central repository

A central database was developed to house course materials, developed at UBC CWSEI and shared with CU SEI.

- *Successes.* While the central database was not a success (see [UBC Case Study](#)), at CU Boulder a well-organized approach to posting zip files with common structures on the CU Boulder SEI website was developed. All SEI-supported courses have some materials posted.
- *Challenges.* There was a lack of incentive to archive materials, and it was not clear who would use them in the future. Materials were not systematically archived until a motivated staff member with sufficient time took the initiative to request and organize materials. Copyright was also an issue; it was not possible to openly publish materials suitable for on-campus use. There were also concerns from faculty about making course assessments public. In the future, we would recommend allowing departments to generate their own solutions which fit within existing departmental culture and workflow.

What were the key outcomes of the initiative?

Departmentally-driven initiatives resulted in change, even with little change to institutional reward structures

The teaching of 71 courses has been substantially changed and over half of the credit hours provided by the SEI departments are taught differently, with the exception of 1 department, which focused on upper-division courses. Between 15-75% of faculty in the engaged departments experienced a large change in their teaching, with an average of almost 50% of faculty experiencing such a change; see Wieman (2017). The initiative has led to other educational improvement efforts at CU Boulder, within the 7 funded departments and beyond, which continue to build on the work of the SEI.

Impact on the broader STEM education community

Publications resulting from the CU SEI work has impacted many areas of discipline-based education research. Several other institutions have adopted the department-embedded teaching experts model in some form, either on their own (e.g., Cornell University) or as part of the NSF-funded TRESTLE network (<http://trestlenetwork.org/>).

How do I get more information?

Website: colorado.edu/sei.

The SEI website has examples of all aspects of the initiative, which are also archived in this Handbook.

Requests for proposals: RFPs and successful proposals are online at <https://www.colorado.edu/sei/about-us/funding.htm>. The RFP from the subsequent TRESTLE project, and successful proposals, are online at <https://www.colorado.edu/csl/trestle/trestle-awards>.

Book: *Improving How Universities Teach Science: Lessons from the Science Education Initiative* by Carl Wieman (2017).

This summary book has much more detail on the CU SEI all of the information above, including comparisons between the programs at CU Boulder and UBC.

Contact: for more details please contact Stephanie Chasteen (stephanie.chasteen@colorado.edu) or Kathy Perkins (kathy.perkins@colorado.edu).

The University of Hawai'i's Geoscience Course Transformation Project

Duration of initiative: 2016-2019

Case study written: Spring 2018

This project takes a low-budget approach toward transforming undergraduate geoscience teaching and learning at the University of Hawai'i (UH) School of Ocean and Earth Science and Technology (SOEST) using evidence-based practices. Over the three-year project period, our key goal is to support SOEST faculty as they introduce evidence-based, active-learning pedagogies, including innovative assessments, into their classrooms. The Geoscience Course Transformation project is based on the work of the Carl Wieman Science Education Initiative (CWSEI).

What is the context of the initiative?

University of Hawai'i School of Ocean and Earth Science and Technology (SOEST)

- **Institution type:** large school within a research-intensive public university.
- **Size:** ~260 students (45% undergraduate), ~240 faculty, and ~570 staff.
- **Of note:** there are 3 faculty tenure streams: research faculty (~0-1 courses/year), instructional faculty (~4 courses/year), and specialist faculty (variable teaching loads).

Departments involved in the initiative

- **Eligible departments:** only SOEST departments were eligible.
- **Participating departments:** all three SOEST academic departments were involved in the initiative: Geology & Geophysics, Oceanography, and Atmospheric Sciences. In addition, several of SOEST's research units (such as the Hawai'i Institute of Geophysics and Planetology and the Pacific Biosciences Research Center), whose research or specialist faculty do some teaching, were involved.

How is the initiative structured?

The initiative is a small, grant-funded project aimed at geoscience departments

The Geoscience Course Transformation Project is a small part (one of four components) of an *Improving Undergraduate STEM Education* (IUSE) Geopaths grant funded by the US National Science Foundation (\$393k USD over a three-year period). The project is led by Principal Investigator (PI) Barbara Bruno and Co-PI Jennifer Engels, with one month per year of PI time budgeted for this project and 1 month of Co-PI time leveraged from a related grant. After the IUSE grant ends in 2019, intensive promotion of effective pedagogy techniques will either end or be sharply curtailed. However, we anticipate the active-learning techniques promoted during the 3-year project period will persist within the classrooms for decades to come.

- *Successes.* Our faculty are enthusiastic about the program! More than 100 faculty representing the SOEST academic departments and research units listed above attended at least one of the seven pedagogy presentations and workshops delivered during Year 1. Twelve faculty volunteered for COPUS observations, 16 faculty have implemented two-stage exams, and 10 faculty have agreed to pilot targeted interventions in their classrooms over the next year. One peer-reviewed publication has been published.
- *Challenges.* There is no institutional financial support for this effort. There is very limited soft-money salary support for the PI and Co-PI—and no support for teaching assistants or learning support specialists. This lack of resources limits what could otherwise be accomplished. Also, department chairs have shown varying levels of support for the course transformation efforts.

Participation in the Geoscience Course Transformation project occurred at the faculty level

We aim to empower SOEST faculty to take ownership of their professional development with respect to evidence-based pedagogy techniques. The PI and Co-PI have made available a variety of resources for faculty to develop their expertise on classroom methodologies. Due to the relatively small scale of this grant (as compared to programs such as CWSEI that support Science Teaching and Learning Fellows; termed DBESs in the SEI Handbook), initiative on the part of faculty is key to their engagement. Thus, the “science education specialists” in this project are the individual faculty—supported by the expertise of the PIs.

- *Successes.* Several early adopter faculty from each department have led the way in demonstrating the efficacy of evidence-based active teaching practices in their classrooms. One department faculty (Geology & Geophysics) has initiated informal brown bag sessions to share successes and strategies.
- *Challenges.* Some ‘old guard’ faculty continue to be resistant to change within each Department. Most simply decline to participate, but a small handful has been vocally opposed to this initiative.

The central organization is strong and highly motivated

Led by PI Barbara Bruno and co-PI Jennifer Engels, the Geoscience Course Transformation project operates independently of individual departments and is responsible for: writing grants to obtain project funds (including salary support); training and motivating SOEST faculty; advising department and School leadership on best practices for active teaching methods; coordinating cross-department and cross-institutional sharing of materials; and bringing external contacts and expertise to SOEST to support the initiative’s work.

- *Successes.* We regularly receive and promptly respond to requests from SOEST faculty and administrators regarding pedagogy. Our prompt responses have been important in maintaining interest and enthusiasm for

the initiative to date.

- *Challenges.* Department-level leadership has been variable across the school. Although the dean's office expresses strong support, there are no tangible incentives for individual faculty or entire departments to cooperate. Working with the UH Institutional Research Board (IRB) to approve research protocols has been time-consuming.

PI and Co-PI's capacity for leading change was supported by visiting experts

In each year of this three-year project, one week of UBC CWSEI on-site support is budgeted. In Year 1, Drs. Sara Harris and Sarah Sherman conducted two workshops and multiple one-on-one consultations with faculty. In Years 2 and 3, Dr. Sherman will return to conduct follow-up support and consultations. A National Association of Geoscience Teachers (NAGT) Traveling Workshop hosted by Anne Eggers was also conducted in Year 1.

- *Successes.* 27 SOEST faculty attended the CWSEI and NAGT workshops during Year 1 and/or took advantage of the opportunity to receive individualized teaching support. Benefiting from the additional credibility generally accorded to outside experts, CWSEI and NAGT faculty succeeded in converting a few holdouts among our faculty to being more receptive to the idea of active learning.
- *Challenges.* SOEST faculty are always busy and over-committed, so encouraging them to take advantage of the opportunities provided by the visiting experts took heavy-handed marketing.

PI and Co-PI interact regularly with a professional community

Both PI Bruno and Co-PI Engels have interacted with the geoscience education community at professional conferences, such as the National Association of Geoscience Teachers' Earth Educator's Rendezvous (EER). In addition, they participate in other discipline-specific meetings such as the Geological Society of America and American Geophysical Union annual meetings.

- *Successes.* Project presentations at the EER and GSA meetings following Year 1 were well received and resulted in productive and helpful discussions specific to our project goals.
- *Challenges.* Funding is limited for Mainland travel.

Potential future graduate seminars may further support use of active teaching methods

Our grants do not provide funding to departments for the salaries of embedded experts such as Science Teaching and Learning Fellows (STLFs)—postdoc or contract faculty positions hired into the department partnered with faculty to measure learning, change courses, evaluate curriculum, and a variety of other roles. In the future, we may be able to create a new course to train graduate students in active-learning pedagogies, and those students could be paired with existing instructors. In this win-win situation, graduate students would gain valuable teaching experience and strengthen their resumes. Instructors would receive teaching assistance from trained graduate student co-instructors.

- *Successes.* This idea has received strong support from both interested graduate students and faculty.
- *Challenges.* No salary has yet been identified for course instructors.

What are the key outcomes of the initiative to date?

Early adopter faculty lead change in their departments

As described above, several early adopter faculty within our SOEST Departments have been pro-actively pushing for modernization of teaching methods among their colleagues. They feel supported by the resources for professional development and training that our Geoscience Course Transformation project has provided and have encouraged many of their peers to participate. They have reported improvements in their teaching evaluations from students, and some have noted increased enrollments in their courses.

Awareness of the initiative is generating further faculty engagement

COPUS classroom observations, pedagogy workshops, and informal ‘brown bag’ sessions have been gaining popularity among faculty during the first year of the project. We expect that faculty participation in Years 2 and 3 will continue to increase as awareness of the efficacy of active learning continues to grow through peer support and word of mouth.

Impact on the broader STEM education community

Recently (2017) published results show that two-stage exams (piloted in 7 SOEST classrooms) resulted in a mean test score increase of 16 percentage points. Even more promising is a narrowing of the achievement gap between students who performed lower (bottom 50%) vs. higher (top 50%) on the individual stage of the exam. The former group gained an average of 25 points from individual to group stage, while the latter gained an average of 6 points. These results indicate that students at all levels benefit from collaborative exams, and that collaborative exams can be used to proactively decrease the achievement gap. We anticipate that two-stage exams and other active learning techniques will increase the retention of students at all levels.

Moreover, the State of Hawai‘i’s diverse student body is not well represented within SOEST. For example, Native Hawai‘ians and Pacific Islanders comprise 26% of the state population but only 6% of SOEST majors. We believe the SOEST Geoscience Course Transformation project, combined with the other three components of the IUSE Geopaths grant, will attract diverse students into SOEST and create an environment in which they can thrive.

How do I get more information?

Contact:

For more details please contact Barbara Bruno (barb@hawaii.edu) or Jennifer Engels (engels@hawaii.edu)

Scholarly work that has been produced on the initiative

Recent Publication

- B. C. Bruno, J. L. Engels, G. Apuzen-Ito, J. Gillis-Davis, H. Dulai, G. Carter, C. Fletcher, D. Bottjer-Wilson, 2017. Two-stage exams: a powerful tool for reducing the achievement gap in undergraduate oceanography and geology classes, *Oceanography*, vol. 30, p. 198-208, 2017.

Conference Presentations

- B. C. Bruno, J. L. Engels, G. Apuzen-Ito, J. Gillis-Davis, H. Dulai, G. Carter, C. Fletcher, D. Bottjer-Wilson, 2017. Collaborative testing in undergraduate oceanography and geology classes: Abstract presented at *2017 Annual Meeting, Earth Educators' Rendezvous*, Albuquerque, New Mexico, 17-21 July.
- J. L. Engels, D. Bottjer-Wilson, K. Kane, B. C. Bruno, 2017. COPUS findings may help explain low diversity in geoscience majors: Abstract presented at *2017 Annual Meeting, Earth Educators' Rendezvous*, Albuquerque, New Mexico, 17-21 July.
- B. C. Bruno, J. L. Engels, G. Apuzen-Ito, J. Gillis-Davis, H. Dulai, G. Carter, C. Fletcher, D. Bottjer-Wilson, 2017. Two-stage exams reduce the achievement gap in undergraduate Oceanography and Geology classes: Abstract 137-5 presented at *2017 Fall Meeting, GSA*, Seattle, Washington, 22-25 October.

The University of Kansas's Course Transformation Initiative

Duration of initiative: 2013-2018 (and ongoing)

Case study written: Spring 2018

The University of Kansas's (KU's) Teaching Fellows Program is based on the Carl Wieman Science Education Initiative (CWSEI) at the University of British Columbia (UBC) and at the University of Colorado Boulder (CU Boulder). This program is part of a broader Course Transformation Initiative designed to promote the redesign of undergraduate courses, particularly large or gateway courses, using evidence-based teaching methods. The Teaching Fellows Program embeds postdoctoral teaching fellows in departments to partner with faculty to transform four-to-five courses over a three-year period. KU's adaptation of the SEI model involves a smaller number of experts per department, but we are amplifying the impact of the experts by building intellectual communities around course transformation both within and across departments.

What is the context of the initiative?

University of Kansas (KU)

- **Institution type:** large, research-intensive public university. The institution includes a medical center that is 40 miles away (Kansas City, KS) from the main campus (Lawrence, KS), and is a member of the Association of American Universities (AAU).
- **Size:** over 28,000 students (19,400 undergraduate), 2,800 faculty, and 11,000 staff.
- **Of note:** there is 1 faculty tenure stream with a 40-40-20 division of responsibilities across teaching, research, and service. Teaching responsibilities vary from 1 to 4 courses per year, depending on department. Since 2016, KU has also hired a small number of Teaching Specialists who are responsible for teaching 4-6 courses per year and can be promoted from assistant to associate to full faculty. Their responsibilities include teaching scholarship (typically weighted at 10%) and collaboration around teaching/teaching innovation.

Departments involved in the initiative

- **Eligible departments:** in the first year (2013), all science and math departments in the College of Liberal Arts and Sciences (CLAS) were invited to apply for funding for a Teaching Fellow. Over the next two

years, all departments in CLAS were eligible to apply, and funds were also made available for one Teaching Fellow in the School of Engineering.

- **Participating departments:** as of Spring 2018, seven departments in CLAS have been awarded funding to hire a three-year Teaching Fellow, including Biology; Geology; Psychology; Physics; Chemistry; Math; and Film and Media Studies. The School of Engineering also hired a Teaching Fellow to work with faculty on foundational courses for students from multiple departments (e.g., Statics and Dynamics courses).

History and funding

The transformation of large foundational courses is key to KU's institutional vision as articulated in a 2011 strategic plan, and this has guided much of the current effort around improving undergraduate education. In 2013, KU began the KU Teaching Fellows Program, and to date KU has had teaching fellows in seven departments in the College of Liberal Arts and Sciences, and in the School of Engineering. These program components have been supported by university funds. Beginning in Fall 2015, a five-year Improving Undergraduate STEM Education (IUSE) grant from the National Science Foundation (NSF) enabled us to enhance our course transformation initiative through mini-grants and a program coordinator, and to expand the intellectual community to a network of seven US and Canadian institutions called TRESTLE (Transforming Education, Stimulating Teaching and Learning Excellence).

How is the initiative structured?

The KU fellows program is smaller and shorter-term compared to the SEI

The program began in 2013 with one postdoctoral Teaching Fellow in each of two STEM departments. Two-to-three Teaching Fellows were added each year until 2016. Each Teaching Fellow is hired to collaborate with faculty to transform four-to-five undergraduate courses around evidence-based teaching practices over a three-year period. The current cohort of Teaching Fellows will complete their terms in Spring 2019. The program was funded by the university itself with an investment of a little over \$2,000,000 USD, staggered over a six-year period and funded jointly by the provost's office and the dean's offices of the participating schools (the School of Engineering and the College of Liberal Arts and Sciences). Each department/unit received approximately \$250,000 to support the hire of a single Teaching Fellow for three years.

- *Successes.* The KU adaptation of the CWSEI model used fewer resources and focused on building a broad community that both engaged existing faculty leaders in evidence-based teaching practices and developed new leaders. For most departments, the development of a proposal and the hire of a Teaching Fellow has been a significant catalyst for changes to key courses in the undergraduate curriculum and for improved teaching practices among a critical mass of faculty.
- *Challenges.* An initial challenge was how to promote real, sustainable change with a lower intensity, 'embedded expert' intervention—i.e., fewer fellows over a shorter term in a given department (the term 'Discipline-Based Education Specialist' can be considered a CWSEI-specific version of the term 'embedded expert'). Additionally, the program was initially designed with very little central coordination for program implementation and for the professional development of the Teaching Fellows.

The KU initiative fosters change at the department level

With the exception of the Teaching Fellow in the School of Engineering, the program operates within the depart-

ment, which is considered the central unit of change. Requests for Proposals (RFPs) were advertised, and departments encouraged to apply. In Engineering, the Teaching Fellow was hired to work on entry-level courses that serve students from multiple programs, such as Statics and Mechanics. To amplify the impact of the Teaching Fellows, the Teaching Fellows Program was supplemented with other initiatives, such as a small course transformation grant program, a university-wide intellectual community on evidence-based course transformation (the C21 Course Redesign Consortium), and a program-level learning outcomes assessment initiative. Because each department has had only one embedded Teaching Fellow working on four-to-five courses, the program has focused primarily on foundational or entry-level undergraduate courses and those that tend to be barriers to degree completion.

- *Successes.* The department focus has helped foster consensus building around course and curricular learning outcomes, and a move towards shared or departmental ownership of courses. The proposal process itself began these initial conversations and ensured a baseline level of readiness. In the earliest participating departments, collaboration across instructors of targeted courses has led to transfer and continued improvement of evidence-based practices from one instructor to the next, so that the courses are being taught in the transformed way by all instructors.
- *Challenges.* Departments are not always engaged as a whole and sometimes lack clear leadership of the transformation initiative. Moreover, faculty efforts to improve teaching and student learning are not consistently recognized or rewarded by their departments, which has inspired another campus initiative to improve the review and evaluation of faculty teaching.

Temporary embedded experts are catalysts and supports for department-level change

Funding for the program supports the salaries of the embedded experts, called Teaching Fellows. They are post-doctoral scholars with PhDs in their disciplines that are hired by the central unit to collaborate with faculty members on the incorporation of student-centered, active and collaborative teaching practices into undergraduate courses. The fellows are employed directly by the unit in which they are embedded and are supervised by a faculty mentor in the unit. Most Teaching Fellows did not have extensive training in pedagogical innovation prior to their positions. The KU Center for Teaching Excellence (CTE) provides pedagogical training, professional development and intellectual community for the Teaching Fellows, modeled after the CWSEI program.

- *Successes.* The fellows provide pedagogical knowledge and personnel time to faculty to support course and curricular planning and transformation. Because the Teaching Fellows are temporary, departments recognize that faculty must participate in the process to make it a worthwhile investment. The position provides Teaching Fellows with training and experience in pedagogical innovation and teaching scholarship. At the end of their terms they have gone into positions as faculty members, teaching specialists, and faculty development specialists.
- *Challenges.* With only a single Teaching Fellow for three years in each participating unit, complete transformation of four-to-five courses is challenging; most units have made dramatic changes to at least two courses and more incremental changes to two-to-three additional courses. Also, many faculty members do not have the opportunity to collaborate directly with the Teaching Fellow. Department-level supervision and mentorship of the Teaching Fellows is also variable. Early in the program two Teaching Fellows left after one year because the positions were not well aligned with their own professional goals.

Community-building amplifies the effects of the embedded experts

To support change with fewer resources and embedded experts than the CWSEI, the KU program focuses on building intellectual communities of scholars around course transformation within and across departments. These communities provide pedagogical, practical, and social support, and promote reflection on teaching and the development of shared goals and vision. Department-level communities include course teams that collaborate on learning goals and transformation strategies, and faculty teaching working/reading groups. CTE hosts a university-wide consortium (C21 Consortium) multiple times a semester for STEM and non-STEM disciplines on issues related to course transformation. The university provides approximately \$30,000 each year to support C21. Some C21 funds are used for mini-grants (\$1,000-\$3,000) that support additional faculty-led course transformation projects.

- *Successes.* The unit-level communities have broadened the number of faculty who are taking part in teaching improvement and promote the development of shared goals and vision for teaching within the unit. C21 has engaged a large number of faculty and instructional staff, each of whom bring different knowledge, experiences, and perspectives to course transformation. The mini-grants catalyze course transformation activity in a dozen additional courses each year, both in departments with Teaching Fellows and in other departments.
- *Challenges.* Although we can track participation in C21, it is difficult to track the impact on actual course transformation and student learning, except in the projects funded with mini-grants. Continuous effort and creativity are needed to keep the C21 community fresh and sustain engagement from existing members while attracting new members who are just embarking on course transformation.

A signature event makes course transformation strategies and results visible and celebrates the work

KU's CTE hosts an annual poster session and reception at the end of each academic year to showcase the work on course transformation of members of the KU community, including faculty and instructional staff and Teaching Fellows. All course transformation grant awardees are asked to produce posters, assisted by graduate student writing partners. The event is attended by KU faculty, administrators at all levels, staff, and graduate students.

- *Successes.* This event fosters intellectual exchange about course transformation strategies and results, inspires more faculty to get involved, and produces further momentum for the work. Having to generate a poster keeps mini-grant projects on track and prompts attention to the impact on student learning. The event serves as a clear illustration of the campus's investment in teaching improvement and signals that the work is valued by the university.
- *Challenges.* The poster genre is unfamiliar to some faculty and producing the poster can be time consuming, therefore the support of graduate student writing partners is critical. As course transformation activity has expanded on campus, it has been important to enlist sufficient graduate student support, particularly in the months leading up to the event.

An existing faculty center for teaching coordinates the initiative

KU's CTE, a faculty center that promotes intellectual exchange about teaching across the university, provides the central support for the program. CTE coordinates a community of practice for the professional and pedagogical development of the Teaching Fellows, drawing on lessons learned from the UBC CWSEI. CTE also leads the university-wide C21 community, tracks results, and prepares annual reports on the results of the overall initiative.

- *Successes.* The professional development for the Teaching Fellows provides needed pedagogical knowledge

and social support. Reliance on a well-established teaching center as the hub of the program enables the use of existing resources, experience, infrastructure, and social capital to support and promote the broader initiative, and fosters synergies with other educational improvement efforts on campus.

- *Challenges.* The important role of a central organization was not addressed in the initial Teaching Fellows Program planning and all of the funding was given directly to the units with the Teaching Fellows. Central coordination needs were higher than anticipated and placed strained the limited resources and staff in CTE. Thus, CTE had to seek additional resources (e.g., C21 funding and an NSF grant) to relieve some of that strain. Additionally the Teaching Fellows community in most years has been quite small. The funding structure also means that Teaching Fellows' units are not directly accountable to the coordinating center, which limits CTE's leverage and oversight on the department-level work.

The NSF-funded TRESTLE project enhances the KU initiative

In Fall 2015, KU received a five-year grant from the NSF to test adaptations of the KU program at other research universities, to enhance the program with a program manager to coordinate the central activities and professional development of the fellows, to provide mini-grants to foster collaboration on course transformation, and to offer travel grants for department faculty teams to visit other campuses. The NSF grant also expanded the intellectual community beyond KU to the TRESTLE network, which includes the two institutions that developed the original SEI model (UBC and CU Boulder), as well as Indiana University Bloomington, University of California, Davis, University of Texas at San Antonio, and Queen's University.

The network convenes a course transformation institute each year, a series of online colloquia and conversations across the year, and offers course transformation models and resources on its website: www.trestlenetwork.org.

- *Successes.* The TRESTLE project has enabled CTE to increase the support and productivity of the Teaching Fellows and to more closely track activity and outcomes. The team travel grants provide opportunities for faculty to observe transformed teaching in action and to promote a shared set of goals for the course transformation work. The TRESTLE networks provide social connections and opportunities for collaboration with peers for KU Teaching Fellows and faculty, which has been particularly important because of the small number of Teaching Fellows on campus in any single year. The annual meeting fosters exchange of ideas and creates another occasion for reflecting on course transformation strategies and results. The network has expanded to include faculty and education experts from institutions beyond the TRESTLE project partners.
- *Challenges.* While the TRESTLE network fills a niche for department change agents who are leading or supporting course transformation efforts, a transition plan is needed to determine whether and how the network, and KU's involvement in it, will be sustained beyond the period of the grant.

What were the key outcomes of the initiative?

The KU initiative has produced a substantial amount of course transformation activity

To date, KU has had teaching fellows in seven departments in CLAS and in the School of Engineering. The 2017 poster symposium showcased work in 14 different disciplines on 29 courses involving 52 faculty members and affecting over 6,000 students. Department-level analyses suggest that the presence of a Teaching Fellow, combined with the additional supports such as C21 and mini-grants, generates significant increases in faculty efforts to

incorporate evidence-based teaching practices into their classes. These changes are also accompanied by improved student learning and rates of successful course completion. Because the program is still ongoing we have not yet had the opportunity to examine how well these changes are sustained.

This initiative has been a catalyst for other KU initiatives

The activity and attitude shifts generated by the Course Transformation Initiative have prompted several other KU programs, including: (a) the development of a STEM Analytics program, supported by a mini-grant from the AAU STEM Education Initiative, that empowers faculty to use institutional data to identify courses to transform and track downstream curricular effects of course transformation; (b) a project on improved methods of teaching evaluation to increase recognition and reward of evidence-based teaching (funded by a collaborative NSF grant; DUE# 1726087); and (c) expansion and coordination of models that use undergraduate teaching assistants to support active learning.

The initiative has had an impact on the broader STEM education community

The TRESTLE network has developed a North American presence, with embedded experts and individuals leading similar programs at other institutions participating in network activities. The central TRESTLE website, www.trestlenetwork.org, provides practical resources for supporting embedded experts, community building, and making course transformation results visible, as well as numerous examples of course transformation efforts from the TRESTLE campuses.

How do I get more information?

Websites: www.cte.ku.edu/course-redesign and www.trestlenetwork.org

The CTE website provides information about course transformation programs and resources available to KU faculty. The TRESTLE network website has numerous resources, examples of the course transformation efforts of faculty and embedded experts from KU and from other TRESTLE institutions, and information about upcoming events.

Example Request for Proposals and funded projects: [CU Boulder TRESTLE site](#).

Contact: for more details please contact Andrea (Dea) Follmer Greenhoot (agreenhoot@ku.edu) or Blair Schneider (bensonbe@ku.edu).

Appendix 2. Resources and References

This Appendix includes supporting resources and references for further exploration.

Supplemental documents

Throughout the Handbook we refer to a variety of short documents which were used in the SEIs, including guidance on how to accomplish common tasks. All these documents are compiled (as Word and PDF) in this section of the Handbook.














Annotated references

Citations from throughout the Handbook are compiled for easy reference.

Supplemental Documents

Throughout the Handbook we refer to a variety of short documents which were used in the SEIs, including guidance on how to accomplish common tasks. All these documents are available (as Word and PDF) below.

You can also download a zip file containing all supplemental documents at <http://cwsei.ubc.ca/resources/files/SEI-Handbook-Supplemental-Documents.zip>.

Title	Description	PDF file	Word file	Updated
Sample DBES Advertisements	DBES position announcements			Aug 2018
Sample DBES Interview Questions	DBES candidate interview questions			Aug 2018
Development Series for New STLFS	DBES training established at UBC			Aug 2018
SEI Strategic Planning Approaches	Recommendations for planning an initiative			Aug 2018
EOS Long Term Plan 2009	Example of multi-year strategic plan of course transformation			Jan 2009
Metacognition STLF Meetings	Peer-to-peer DBES reflective discussions at UBC CWSEI			Aug 2018
Course Transformations Outcomes and Timeline	Full course design steps and timeline in the SEI			Nov 2017



















Title	Description	PDF file	Word file	Updated
Course Transformation Project Agreement	Example of expectations, timelines, and deliverables to be signed by involved faculty and DBESs			Mar 2010
COPUS Wedging	Recommendations for leveraging course observations for faculty engagement			Aug 2018
STLF Role and Faculty Working Arrangement	Overview of DBES role and faculty collaboration in the SEI			July 2017
Facilitating Faculty Discussions	Recommendations for facilitating faculty discussions			Aug 2018
Facilitating Discussions About Learning Goals	Recommendations for developing learning goals with faculty			Aug 2018
Example STLF Meeting Topics and Announcements	Ongoing DBES development series examples			Aug 2018
Reading Group Selections and Discussion Prompts	Invitations and readings for reading group			Aug 2018
SEI Research Interview Guide	Tips on conducting student and faculty interviews			Aug 2018
SEI Assessment Metrics	List of indicators used in evaluating the SEI			Aug 2018

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- PDF icon: Creative Commons (CC-BY) license, authored by [Adnen Kadri](#).

Annotated References

Accelerating Systemic Change Network. Retrieved from <http://ascnhighered.org>.

The Accelerating Systemic Change Network (ASCN) is a network of individuals and institutions, formed with the goal of more quickly advancing STEM education programs. The website includes literature resources, a blog, and other information about higher education reform.

Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., Norman, M. K., & Mayer, R. E. (2010). *How learning works: Seven research-based principles for smart teaching*. San Francisco, CA: Jossey-Bass.

Outlines major principles for how students learn.

Bailey, J. M., & Lombardi, D. (2015). Blazing the trail for astronomy education research. *Journal of Astronomy and Earth Sciences Education*, 2(2), 77.

Describes the growing availability of disciplinary education experts available to serve as DBESs.

Brownell, S. E., & Tanner, K. D. (2012). Barriers to faculty pedagogical change: Lack of training, time, incentives, and...tensions with professional identity? *CBE-Life Sciences Education*, 11(4), 339-346. doi: <https://doi.org/10.1187/cbe.12-09-0163>.

This article considers that a scientist's research identity may be at odds with their development of a teaching identity.

Bush, S.D., Pelaez, N. J., Rudd, J.A., Stevens, M.T., Williams, K.S., Allen, D.E., & Tanner, K.D. (2006). On hiring Science Faculty with Education Specialties (SFES) for your science (not education) department. *CBE-Life Sciences Education*, 5(4), 297-305.

Hiring DBESs is increasingly common; this article discusses their potential roles and integration into departments.

Bush, S.D., Rudd II J.A., Stevens, M.T., Tanner, K.D., & Williams, K.S. (2016). Fostering change from within: Influencing teaching practices of departmental colleagues by science faculty with education specialties. *PLOS ONE*, 11(3), 1-20.

This article found that DBESs tend to affect the instructional practices of their colleagues.

Bush, S.D., Stevens, M.T., Tanner, K.D., & Williams, K.S. (2017). Origins of science faculty with education specialties: Hiring motivations and prior connections explain institutional differences in the SFES phenomenon. *BioScience*, 67(5), 452-463.

This and the two following articles in this bibliography discuss the hiring of disciplinary education faculty, who may act as DBESs.

Carey, S. J. (Ed.). (2015). Navigating institutional change for student success in STEM. *Peer Review*, 17(2).

This special issue, sponsored by the PKAL institutional change project, provides guidance for campus leaders on developing local capacity, assessment, and strategic planning—including a readiness tool for assessing capacity for change.

Chasteen, S. V., Perkins, K. K., Beale, P. D., Pollock, S. J., & Wieman, C. E. (2011). A thoughtful approach to instruction: Course transformation for the rest of us. *Journal of College Science Teaching*, 40(04).

Early paper describing the SEI model of course transformation, similar to Chasteen and Perkins (2014).

Chasteen, S. V., Wilcox, B., Caballero, M. D., Perkins, K. K., Pollock, S. J., & Wieman, C. E. (2015). Education transformation in upper-division physics: The Science Education Initiative model, outcomes, and lessons learned. *Phys. Rev. ST Phys. Educ. Res.*, 11, 020110.

Describes the CU SEI outcomes of transformations in upper division physics in the most detail.

Chasteen, S., & Perkins, K. (2014). Change from within: The Science Education Initiative. In M. McDaniel, R. Frey, S. Fitzpatrick, & H. L. Roediger (Eds.), *Integrating cognitive science with innovative teaching in STEM disciplines* [E-reader version]. Retrieved from https://openscholarship.wustl.edu/circle_book/7/.

Gives a step-by-step approach to course transformation with an upper-division physics course as a concrete example.

Chasteen, S.C., & Otero, V. Teaching with learning assistants. *Science Education Resource Center*. Retrieved from https://serc.carleton.edu/sp/library/learning_assistants/index.html.

Brief, user-friendly description of learning assistants and how they can best be used.

Dancy, M., & Henderson, C. (2010). Pedagogical practices and instructional change of physics faculty. *American Journal of Physics*, 78(10), 1056-1063.

This article finds that physics faculty are interested in making instructional changes, but lack time and knowledge to implement innovations.

Dolan, E. L., Lepage, G. P., Peacock, S. M., Simmons, E. H., Sweeder, R., & Wieman, C. (2016). *Improving undergraduate STEM education at research universities: A collection of case studies*. Tucson, AZ: Research Corporation for Science Advancement. Retrieved from <https://www.aau.edu/key-issues/improving-undergraduate-stem-education-research-universities-collection-case-studies>.

Includes a chapter by UBC Dean of Science Simon Peacock on the SEI in which he describes how the UBC

CWSEI dealt with university policies (such as teaching evaluations) and how UBC required first year courses to develop learning goals as a support for SEI efforts.

Duhigg, C. (2012). *The power of habit: Why we do what we do in life and business*. New York, NY: Random House.

This book about how habits are formed can help you think about how to coach faculty to develop new instructional habits.

Eckel, P., Green, M., Hill, B., & Mallon, W. (1999). *On Change III: Taking charge of change: A primer for colleges and universities. An occasional paper series of the ACE Project on leadership and institutional transformation*. Washington, DC: American Council on Education.

A practical guide to leading change within an institution, including strategies and information on supporting change agents.

Elrod, S., & Kezar, A. (2016). *Increasing student success in STEM: A guide to systemic institutional change*. Washington, DC: Association of American Colleges & Universities.

A step-by-step guidebook for campus leaders at the department or institution level for improving student achievement in undergraduate STEM.

Evergreen, S. D. (2016). *Effective data visualization: The right chart for the right data*. Thousand Oaks, CA: Sage Publications.

A delightful book about data visualization that can help you think about what you want to communicate and to whom, and how to do it effectively using the right charts.

Evergreen, S. D. (2018). *Presenting data effectively: Communicating your findings for maximum impact* (2nd ed). Thousand Oaks, CA: Sage Publications.

A useful “how to” book about data visualization and communication.

Felder, R. M., & Brent, R. (2016). *Teaching and learning STEM: A practical guide*. San Francisco, CA: Jossey-Bass.

A practical and readable guide to instructional design and implementation in STEM, full of useful examples.

Fink, L. D. (2013). *Creating significant learning experiences: An integrated approach to designing college courses*. San Francisco, CA: Jossey-Bass.

A practical classic for instructional design, including course planning, learning goals, and instructional approaches.

Fry, C.L. (Ed.). (2014). *Achieving systemic change: A sourcebook for advancing and funding undergraduate STEM education*. Washington, D.C.: Association of American Colleges and Universities. Retrieved from <https://www.aacu.org/sites/default/files/files/publications/E-PKALSourcebook.pdf>.

A practical sourcebook that discusses the rationale for change in higher education, building institutional capacity, changing faculty practices, and tracking and sustaining improvement.

Gawande, A. (2011, October 3). Personal best. *The New Yorker*. Retrieved from <https://www.newyorker.com/magazine/2011/10/03/personal-best>.

Describes the importance of peer coaching in professional improvement.

Handelsman, J., Miller, S., & Pfund, C. (2006). *Scientific teaching*. New York, NY: W.H. Freeman.

Describes the scientific approach to teaching, which underlies the SEI model.

Heath, C., & Heath, D. (2007). *Made to stick: Why some ideas survive and others die*. New York, NY: Random House.

This book about how to communicate ideas to make them ‘stick’ can help you think strategically about communicating with department faculty.

Henderson, C., Dancy, M., & Niewiadomska-Bugaj, M. (2012). Use of research-based instructional strategies in introductory physics: Where do faculty leave the innovation-decision process? *Physical Review Special Topics—Physics Education Research*, 8(2), 020104.

Article discussing issues on sustainability of instructional changes made by faculty.

Huber, M., Hutchings P., (2014). *Bay View Alliance case study #2, research action cluster 1: The Carl Wieman Science Education Initiative in Earth, Ocean and Atmospheric Sciences*.

Case study on one of the most successful SEI departments.

Ingram, E. L., House, R. A., Chenoweth, S., Dee, K. C., Ahmed, J., Williams, J., et al. (2014). From faculty to change agent: lessons learned in the development and implementation of a change workshop. *2014 ASEE Annual Conference & Exposition*, 24.630.1-24.630.12. Retrieved from: <https://peer.asee.org/from-faculty-to-change-agent-lessons-learned-in-the-development-and-implementation-of-a-change-workshop>.

Outlines lessons learned from a long-standing workshop for the professional development of change agents.

Jones, D. J., Madison, K. W., & Wieman, C. E. (2015). Transforming a fourth year modern optics course using a deliberate practice framework. *Phys. Rev. ST Phys. Educ. Res.* 11, 020109.

This paper describes a course transformation project, with an explicit focus on deliberate practice.

Kezar, A. (2009). Change in higher education: not enough, or too much? *Change: The Magazine of Higher Learning*, 41(6), 18-23.

Discusses the challenge of change in college campuses, using insights from studies on change leadership. Also discusses the importance of change agents.

Kezar, A. (2014). *How colleges change: Understanding, leading, and enacting change*. New York, NY: Routledge.

A more detailed scholarly volume on the topic of leadership and academic change.

Kober, N. (2015). *Reaching students: what research says about effective instruction in undergraduate science and engineering*. Washington, DC: The National Academies Press.

This resource identifies the department as the unit of change (albeit using the SEIs as an example) and provides general methods about instructional effectiveness. Chapter 7: “Creating Broader Contexts That Support Research-Based Teaching and Learning” is particularly relevant to SEI-like initiatives.

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Describes eight processes that can help organizations accelerate change, such as developing a sense of urgency and strategic vision.

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Sakulku, J. (2011). The impostor phenomenon. *International Journal of Behavioral Science*, 6(1), 73-92.

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Describes the Survey of Climate for Instructional Improvements (SCII), a tool which can be used to measure department-wide attitudes and norms regarding instructional practice.

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Discusses the importance and practice of supporting professional communities to connect activities and knowledge across an organization.

Wieman, C. (2007). *Course transformation case study*. Retrieved from http://cwsei.ubc.ca/resources/files/Course_transformation_case_study.pdf.

One of the earliest course transformation projects, undertaken by Wieman and McKagan, focusing on modern physics.

Wieman, C. (2017). *Improving how universities teach science: Lessons from the Science Education Initiative*. Cambridge, MA: Harvard University Press.

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Wieman, C., & Gilbert, S. (2014). *The Teaching Practices Inventory: A new tool for characterizing college and university teaching in mathematics and science*. *CBE-Life Sciences Education*, 13(2), 552-569.

The Teaching Practices Inventory was used to measure instructional practice and change in the SEI.

Wieman, C., Deslauriers, L., & Gilley, B. (2013). *Use of research-based instructional strategies: How to avoid faculty quitting*. *Phys. Rev. ST Phys. Educ. Res.*, 9, 023102.

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Wieman, C., Perkins, K., & Gilbert, S. (2010). *Transforming science education at large research universities: A case study in progress*. *Change*, 42(2), 7-14.

An early discussion of the SEI model and progress.

Wiggins, G., & McTighe, J. (2005). *Understanding by design (2nd ed.)*. Alexandria, VA: Association for Supervision and Curriculum Development.

The original 'backwards design' model of instruction which inspired SEI course development approaches.

Williams, C. T., Walter, E. M., Henderson, C., & Beach, A. L. (2015). *Describing undergraduate STEM teaching practices: A comparison of instructor self-report instruments*. *International Journal of STEM Education*, 2(1), 18.

A review of instruments which may be used to measure instructional practice and change.

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Glossary

Term	Definition
Backward design	A framework for course design in which course assessments and instruction are developed using the clear learning goals for the course.
Central organization or unit	The organization or unit responsible for managing and overseeing the initiative. In the SEI, this unit was called SEI Central.
Change agent	A person who instigates and supports change and improvement within an organization. A change agent often brings visibility to the needed change, provides skills and knowledge needed for the change, and helps create coalitions of individuals to carry through the change.
CU SEI	The Science Education Initiative at University of Colorado Boulder (2006-2014).
Departmental Action Team (DAT)	A facilitated working group of 4-8 faculty, staff, and/or students in a department to create sustainable change in a department, and foster the development of departmental change agents.
Departmental director	The leader of the initiative at the department level, responsible for supervising the DBES and managing the departmental program.
Discipline-based education research (DBER)	Research on teaching and learning within a discipline (e.g., the study of teaching and learning in biology). DBER applies knowledge of teaching and learning to the specific tasks and difficulties of learning particular disciplinary content.

Term	Definition
Discipline-based education specialist (DBES)	A person with expertise in their discipline and in effective education techniques, acting as a change agent in a disciplinary department. CU SEI experts were termed Science Teaching Fellows (STFs), while in the UBC CWSEI they were termed Science Teaching and Learning Fellows (STLFs).
Initiative organizers	Those managing the initiative at the university level (typically part of the central organization), providing leadership, vision, and oversight.
Learning assistant (LA)	An undergraduate student who facilitates the learning of their undergraduate peers. An LA is typically someone who has done well in the course and has received training in pedagogy. Unlike teaching assistants, LAs are not given roles as instructional support staff, such as grading.
Learning goals or learning outcomes	Statements on what a student should be able to do as a result of learning the course content. Learning goals should be precise and measurable.
New DBES Development Series	Training provided by the UBC CWSEI for new DBESs on relevant education and cognitive psychology research, instructional practices, and the assessment of student learning.
Paired teaching	The sharing of course planning, organization, delivery, and assessment by two or more instructors in order to spread the effective use of research-based instructional practices. Often one instructor is more experienced in the course.
The SEI	The Science Education Initiative; an initiative aimed at changing STEM teaching practices at the University of Colorado Boulder and The University of British Columbia.
Scholarship of Teaching and Learning (SoTL)	The systematic investigation of teaching and learning outcomes with the express purpose of improving one's own teaching practice. While SoTL and DBER may share similar methods, SoTL is often conducted by an individual faculty member for the purposes of reflecting upon and improving their instruction, whereas DBER is aimed at producing more generalizable results.
UBC CWSEI	The Carl Wieman Science Education Initiative at The University of British Columbia (2007-2017).