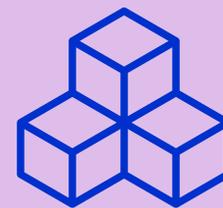


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RESEARCH
B R I E F

BEETLES: An Evaluation of a Capacity Building Model to Support Outdoor Science Programs

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Purpose: This brief shares (1) the underlying goals and design principles for the BEETLES project, (2) a summary of the field-testing process, and (3) program leaders' insights about how BEETLES supported their organizational capacity building to provide professional learning for their educational staff.

Key insights: The use of BEETLES materials and resources has helped outdoor science programs reconceptualize outdoor science education. Program leaders reported changes in their perceptions about teaching and learning toward a more learner-centered and nature-centered approach, a greater sense of preparation to provide professional learning to educational staff members, and the development of a culture of reflective practice and ongoing professional learning. These changes in perceptions and practices created opportunities for richer outdoor science learning experiences that were better aligned with the Next Generation Science Standards (NGSS) and Common Core State Standards and more engaging for learners.

Abstract

In 2011, The Lawrence Hall of Science at the University of California, Berkeley, launched the Better Environmental Education, Teaching, Learning, and Expertise Sharing (BEETLES) project. BEETLES aims to build the capacity of outdoor science programs (OSPs) to facilitate learner-centered and nature-centered science learning experiences for youth. This brief aims to share program leaders' insights with the field about how BEETLES supported their organizational capacity building to provide professional learning for their educational staff.

At the onset of the project, the BEETLES team recognized that OSPs have a tremendous but largely unrealized potential to play a pivotal role in the science-education landscape by providing outdoor science learning experiences that engage youth with the natural world in ways that cannot be offered in formal classroom science settings. Yet, very few high-quality, research-based instructional materials or professional learning resources existed for this specific field. As a result, many OSPs were left needing to adapt materials intended for formal learning environments to be used in outdoor settings (Orion, 1993). In recognition of this gap in the field, the BEETLES project designed a capacity

building model that includes a leadership institute, professional learning sessions, student activities, and other resources for program leaders and educators that draw on research-based pedagogical strategies and incorporate a range of science practices as outlined in the NGSS.

From 2011–2015, the BEETLES team engaged in an iterative design process through which they designed and field tested new materials and resources with outdoor science program leaders and educators. In addition, in collaboration with the Research Group at The Lawrence Hall of Science, the project engaged in a rigorous evaluation to inform the design and development of the BEETLES capacity building model. This brief draws on the evaluation study to provide evidence for:

- how participation in the BEETLES project can influence program leaders' perspectives toward science teaching, learning, and professional learning.
- the impact of participation in the BEETLES project on organizational priorities and practices, such as professional learning for staff, program design, and instructional practices.

In this brief, you will find (a) a short description of the underlying design principles for the BEETLES project, including the theory of action and the key components; (b) a summary of the field-testing process; and (c) key study findings.

The BEETLES Project

At the time of this evaluation, the BEETLES capacity building model was composed of a 6-day Leadership Institute; 8 3-hour professional learning sessions; 35 student activities; 20 how-to videos that model how to facilitate professional learning sessions, student activities, and discussions; and a suite of implementation materials and resources designed to support program leaders and instructors in designing and implementing learner-centered and nature-centered science learning experiences and cultivating a culture of reflection on practice (with new materials and resources continuing to be developed). Through the Leadership Institute, OSP leaders experience some of the professional learning sessions and student activities themselves. All materials and resources are publicly available, at no cost, on the BEETLES website (<http://beetlesproject.org/>). Each

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component of the model has been field tested with OSPs across the country and revised through at least two testing cycles.

The BEETLES capacity building model is based on the notion that students learn science outdoors best when their learning experiences are learner-centered and nature-centered. There are five key [design principles](#) that were derived from extensive research that has identified some of the best practices (National Project for Excellence in Environmental Education, 2009; National Research Council, 2010; Stern et al., 2013) in teaching and learning in outdoor science contexts. Each principle is summarized as follows:

- **Engage directly with nature.** Engaging directly with nature through making observations, asking questions, and forming explanations cultivates a relationship with and deeper understanding of the natural world. Further, these skills, tools, and experiences support learners' development of environmental literacy. For example: In *I Notice, I Wonder, It Reminds Me Of*, learners make their own firsthand observations of a leaf, ask questions, and make connections to their own lived experiences.



- **Think like a scientist.** Making observations, asking questions, and engaging in sensemaking fosters a sense of wonder and curiosity and contributes to the development of scientific habits of mind. These skills can position learners to better understand science, be critical consumers of information, and effectively use scientific methods and processes. For example: In *Lichen Exploration*, learners observe the different places lichen grows; make, record/draw, and share their observations about patterns; identify different types of lichen; and discuss reflections and questions related to the symbiotic relationship of fungi and algae.
- **Learn through discussions.** Engaging in discussions can deepen learners' conceptual understanding of complex ideas and validates their contributions to their own learning. Through discussions, learners practice clarifying their thinking, communicating ideas, and asking questions. For example: During *Spider Investigation*, learners organize their data and discuss, through a *Think-Pair-Share*, the patterns they notice in the data. They then make predictions and discuss possible explanations for the causes of observed patterns wherein they are encouraged to build on one another's ideas, ask questions, challenge evidence, and connect to other knowledge or experiences they may have.
- **Experience instruction based on how people learn.** Designing lessons and programs based on how people learn can promote more engaging, effective, and intentional learning experiences. The learning cycle includes five stages: Invitation, Exploration, Concept Invention, Application, and Reflection. For example: During *Tree Exploration*, learners are invited to share their previous knowledge about trees (Invitation); take note of the different features of the tree, look for evidence that animals use the tree, and journal their observations (Exploration); share observations and reflections and are introduced to additional tools and science concepts to continue building their understanding of trees (Concept Invention/ Application); and, finally, reflect on the experience and what they have learned (Reflection).
- **Participate in inclusive, equitable, and culturally relevant learning environments.** Creating connections to learners' lived experiences, family histories, and cultural identities—including race, socioeconomic status, and gender identity—fosters engagement and experiences in which learners feel valued, seen,

and heard. It requires educators to engage in cultural curiosity and humility and ongoing reflection on how one's own lived experiences and biases may have an impact on their practice. For example: In *Thought Swap* (formerly known as *Walk & Talk*), learners participate in a structured routine for pair talk that promotes equitable participation by making sure each learner has the chance to share their ideas and are given multiple prompts to connect to and share their lived experiences. This also creates space for learners and the instructor to listen to and learn from these experiences and perspectives.

Field Testing

Throughout the design process, the BEETLES project team field tested its capacity building model, including the Leadership Institute, professional learning sessions, and student activities. The evaluation team gathered feedback from program leaders and educators through surveys, observations, interviews, and document review to provide the project team with rich feedback to inform the iterative design and development process. By the end of 2015, the BEETLES project had field tested its materials and resources with 136 program leaders and 1,576 educators throughout the United States. The BEETLES team has continued to design and field test new activities and tools since 2015.

At A Glance: Research Methods and Main Findings

Over the course of the study, the evaluation team gathered data from multiple sources (summarized in Table 1 on page 4) to evaluate the BEETLES materials and resources, identify areas for modification, and consider their potential impact on teaching and learning in OSPs.



Table 1. Data Sources and Dimensions of Evaluation

Data source	Evaluation dimension
Observations of Leadership Institute	<ul style="list-style-type: none"> • Design and implementation of Leadership Institute
Pre- and post-Leadership Institute surveys	<ul style="list-style-type: none"> • Program leader perspectives about teaching and learning • Leadership Institute experiences
Feedback surveys of program leaders and educators	<ul style="list-style-type: none"> • User experiences related to BEETLES materials and resources • Suggestions for modifications to materials and resources
End-of-field-test surveys	<ul style="list-style-type: none"> • User experiences and suggestions • Influence on program
Program leader interviews	<ul style="list-style-type: none"> • Influence on program • Feedback on BEETLES model
Case site visits	<ul style="list-style-type: none"> • Features of professional-learning and student-learning experiences • Influence on program

The study used a mixed-methods approach that included statistical analyses of survey responses, emergent thematic coding of observational notes, and answers to open-ended questions in surveys and interviews.

Study findings indicate that program leaders who attended the BEETLES Leadership Institute reported long-lasting changes in their perceptions of teaching and learning, shifting from an instruction-based approach to a learner-centered approach. In addition, program leaders felt prepared to facilitate professional learning sessions and cultivate reflective practice for their instructors, which seemed to reflect the aforementioned changes in their perceptions of teaching and learning. Collectively, these changes further contributed to shifts in the organizational culture wherein organizations valued and provided time to support professional learning for instructors and opportunities to engage in reflective practice. Finally, the use of BEETLES materials and resources assisted outdoor science educators with the design and improvement of science learning experiences for youth. Detailed information about each of these findings is offered in the following section.

Study Findings

FINDING 1

Program leaders reported long-term changes in their perceptions of teaching and learning, shifting from an instructor-centered approach to a learner-centered approach. Program leaders’ perceptions of teaching and learning were surveyed multiple times throughout the course of one year. Surveys were administered before and after the Leadership Institute and at the end of the field-testing period. Surveys asked program leaders to indicate their level of agreement with various statements regarding their attitudes toward teaching and learning science. Table 2 (on page 5) summarizes these statements, organized into two factors: (a) Instructor-Centered Pedagogy and (b) Learner-Centered Pedagogy.

Analysis of survey¹ data showed that at the onset of the Leadership Institute, many program leaders’ perceptions about teaching and learning aligned with an instructor-centered pedagogical stance, one that is grounded in direct instruction and more typical of current instructional practices in OSPs. By the end of

Table 2. Pedagogical Perspectives

Statement

Factor 1: Instructor-Centered Pedagogy

1. If people are presented with a clear, coherent explanation of a concept, they will learn the concept.
2. When designing an educational activity, one should assume that most of the learners have little useful knowledge of the topics to be covered.
3. When learners ask questions, they should be given the answers.
4. Listening to presentations is a good way for people to learn the concepts.

Factor 2: Learner-Centered Pedagogy

5. Learners need time to discuss concepts.
6. Learners should be asked questions about their ideas.
7. In order to teach well, it is important to consider what students already know about a subject.

Note: All items had the following response options: 1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Somewhat Agree, 5 = Agree, 6 = Strongly Agree (“Not Sure” was considered an omission).

the Leadership Institute, program leaders reported that their perspectives shifted to a learner-centered pedagogical stance, which emphasizes practices that are discussion-based and position learners to have firsthand experiences with nature that are in line with the design principles of the BEETLES model.

It has definitely pushed our program so that it is more student-centered [...] More of the learning comes from the students, and the students are articulating it, and students creating their own conceptual understanding as opposed to us [saying], “Okay, did you learn these three facts by the end of the class?”
 –Program leader

These changes in perceptions sustained one year beyond the Leadership Institute.² Through the exposure to and use of BEETLES materials and resources, program leaders were able to continually reflect on their practice and approach to teaching and learning. (See Finding 3 on page 7.)

FINDING 2

The BEETLES project supported program leaders’ preparedness to facilitate professional learning and reflective practice for their instructors. As part of the project’s goal to build the capacity of OSPs for continuous improvement, BEETLES recruited leadership teams from each participating program to attend a BEETLES Leadership Institute. Leadership



teams consisted of two program leaders as a pair—often, one responsible for executive decision-making, vision, and budget; the other responsible for education programming, curriculum, and staff professional learning. Over the course of the Leadership Institute, the BEETLES project team presented a professional learning experience that modeled its design principles through the use of the professional learning sessions and student activities. The project team presented sessions as designed for program leaders to present with their instructors. Further, they created intentional moments to call out the rationale behind their design and insights on how sessions might be adapted for different contexts. Toward the end of the Leadership Institute, planning time was included for program leaders to construct goals and an implementation plan for using the BEETLES materials and resources. Each pair of program leaders attended

the 6-day Leadership Institute, co-constructed their goals and implementation plans, and then worked together to implement the BEETLES materials and resources at their program. Each Leadership Institute was attended by 30–50 program leaders from 15–25 OSPs.

On post-Leadership Institute surveys, participants indicated their level of agreement regarding the extent to which they felt prepared to engage educators in professional learning (i.e., teaching field instructors). Table 3 (below) summarizes these items. The analysis³ of Preparedness to Teach Field Instructors showed that the Leadership Institute positively influenced program leaders’ perceived preparedness to engage instructors in professional learning. These items were not included in the end-of-field-test survey, therefore limiting our understanding of whether these changes sustained over time. Qualitative findings described in Finding 3 (on page 7), though, do suggest that program leaders continued to feel prepared in engaging staff in professional learning.

During the field test, participants received some technical support (e.g., coaching calls, webinars) and had opportunities to receive feedback from the BEETLES project team and program leader peers, which may have contributed to sustained levels of preparation in teaching educational staff. Since the field test, the BEETLES project has developed and disseminated additional implementation support

Table 3. Preparedness to Teach Field Instructors

Statement

1. I feel very comfortable leading a discussion with field instructors.
2. I feel well prepared to teach field instructors about how to make observations about the natural world.
3. I feel well prepared to teach field instructors about asking questions about the natural world.

Note: All items had the following response options: 1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Somewhat Agree, 5 = Agree, 6 = Strongly Agree (“Not Sure” was considered an omission).

materials and resources through the BEETLES website, such as the *Guide for Program Leaders* and *Tales from the Field*, which may further support program leaders in engaging their staff in professional learning. Collectively, these resources positioned program leaders to provide ongoing professional learning in support of their educational staff.

Everything that I did this year that was different was [to] make sure that the staff wrote up all of their lessons in the learning cycle format. Before, I'd let them use any format that they were comfortable with, but having them actually sit down and work with the learning cycle and how are they presenting certain things, I think that was a real key in getting them to make sure that they weren't lecturing the students, that every single lesson had the strongest component of exploration in it... –Program leader

A lot of the activities that we come up with are just very much using the eye of science. One thing I would like to point out is our training outline for lesson planning...very much follows the [learning] cycle. I think that's something definitely we've been inspired to be focusing on how we give each other feedback based on the learning cycle. That's just like, all over the map, there [have] been ways that BEETLES has inspired us. –Program leader

FINDING 3

Participating in BEETLES has supported outdoor science programs in fostering a culture that provides opportunities for professional learning and reflective practice.

Program leaders indicated that participating in the BEETLES Leadership Institute and using BEETLES materials and resources provided them with opportunities to think critically about their approach to professional learning for staff. For some program leaders, this meant revisiting professional learning goals to incorporate the BEETLES professional learning sessions for the purpose of supporting their staff to redesign or modify their curriculum. Many leaders then provided staff with access to support materials throughout the year.

I'm creating all the new curriculum that the interns will be trained in. All of that is being put through the learning cycle filter and [will] as much as possible incorporate the BEETLES activities that are in the student handbook. –Program leader

Using BEETLES materials and resources also presented new opportunities for some program leaders to provide professional learning to audiences that may not have been supported in the past, such as camp or cabin counselors or regional partners.

We have received requests from the [Organizational Director] to do more BEETLES trainings, both for the statewide camp trainings and for the statewide educator trainings next year for the year-round educator. –Program leader

Program leaders also reflected on the frequency of professional learning. For example, program leaders reported that, prior to BEETLES, most of their professional learning occurred at the beginning of the year during orientations, which included training on curriculum, pedagogical approaches, and safety procedures. Weekly staff meetings would then focus on logistics: reviewing what/where groups would be visiting, who would be teaching, what worked well, or challenges that emerged. Rarely were these meetings dedicated to instructional reflection or follow-ups to content-based professional learning. Through participation in BEETLES, program leaders were encouraged to think about other ways to incorporate professional learning opportunities beyond staff orientation sessions. For example, program leaders might encourage staff to use a particular set of student activities at the beginning of the week and then revisit how it went on Friday. Or, they might incorporate aspects of a professional learning session, such as *Promoting Discussion*, by pulling out an activity or resource as a way to revisit the design principles or strategies.



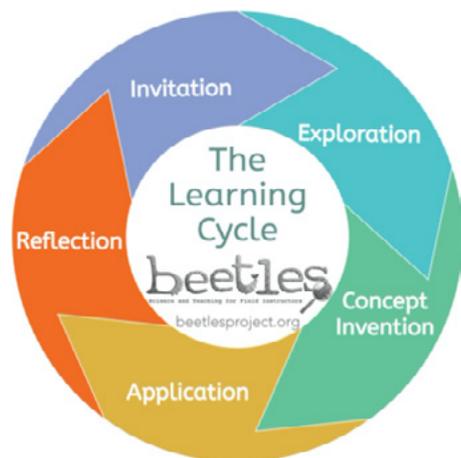
Program leaders also had access to resources aimed at facilitating reflection on practice. The resources included guidelines for ongoing follow-ups with instructors and the incorporation of learner-centered and nature-centered practices as part of instructional improvement. Findings suggest that these resources opened up opportunities for instructors and program leaders to more consistently reflect on their own practice, share feedback with one another, and discuss what teaching and learning should look like in their programs.

The fact that I've been doing BEETLES, I think, has re-shifted a lot of our staff [members'] perspectives that when we have this down time, this is a great time to spend it doing professional development. It doesn't have to be BEETLES, but just thinking critically about how we're doing our job and how we can do it better. So, I think that that's one advantage that it's had for the organization as a whole. –Program leader

FINDING 4

Using BEETLES materials and resources supports the design of high-quality science learning experiences for youth.

BEETLES materials and resources are available at no cost to program leaders. Access to and use of the materials and resources has empowered program leaders to carefully consider their student learning goals and curricula in order to incorporate a more explicit and intentional emphasis on science learning experiences for youth with research-based practices and frameworks (e.g., the learning cycle) to guide them.



...For a number of years we've felt that to advance what we do from a science education standpoint we really needed a framework [and] BEETLES has really provided a lot of that framework for us... Our staff feel empowered to do science in a way that I'm not sure they ever did before... –Program leader

...This year we've actually taught more and done more science education than we have in many, many, many years...[the] professional learning sessions have really given our staff the background and confidence to do [science] [and know] that science doesn't have to be something canned or set up. –Program leader

Through this process, program leaders have revised program activities to incorporate strategies that support learner-centered and nature-centered science learning experiences. For instance, some programs reported incorporating nature journaling to create opportunities for learner-centered observations and recording of data, while others used *Thought Swaps* (formerly known as *Walk & Talks*) or *Pair-Shares* to encourage learner-centered discussions and meaning-making. In some cases, program leaders worked with their instructors to redesign learning experiences.

I think [BEETLES] definitely influenced how we are approaching what our objectives and lesson structure should look like. [...] Much more focused on explorations, observations, drawing conclusions. –Program leader

...we did three [PL sessions] in the fall, and then we started talking to the staff about the need to redesign the classes that we offer... So, they would sit down, a couple of them, and they would go through the curriculum that we already have and using their new knowledge, they would rewrite it BEETLES-style. That's been an ongoing process throughout almost a year. –Program leader

Through this process, program leaders found that their programs were shifting to be more closely aligned with the Common Core State Standards for English Language Arts and Literacy in History/Social Studies, Science, and Technical Subjects and with the NGSS, which are valued by schools and classroom teachers.

In general, the BEETLES curriculum has pushed us more into Common Core and Next Generation Science Standards. [...] It has given us the tools, the resources, and ... the impetus to move our program in that direction. I think if we had been trying to move in that direction on our own, I think our progress and our reflection towards NGSS and Common Core would have been much slower. –Program leader

We had a teacher two weeks ago—coming [from] a very strong science school and saying, “Oh, I saw this technique and I want to steal this back to the classroom. How do I get these things from you guys that you are doing?” I think when they’re seeing that, that’s the best praise for how great some of the activities are and the changes it’s made in our staff. –Program leader

Although current research is examining the exact impact of BEETLES on instructional practice and learner outcomes, preliminary findings from this study suggest that there is potential for BEETLES to have positive impacts in these areas.

In most cases, [I have] found that kids are much more engaged, that they are not kind of staring at us ... as they are getting content dumped on them... [They are] using their brains and thinking and being able to discuss, and yeah. [...] [Using BEETLES] is opening up our students a lot more and definitely engaging them a lot more... and I feel like students are taking away a lot more than they did before. –Program leader

Key Takeaways

The use of BEETLES professional learning sessions, student activities, and other resources has helped OSPs and their staff reconceptualize outdoor science education. It changed program leaders’ perceptions about teaching and learning toward a more learner-centered and nature-centered approach that foregrounds learners’ thinking and encourages engagement in scientific practices. It also has provided program leaders with resources and supports to use in introducing their instructional staff to this new approach to teaching and learning.



As a result, OSPs that utilized the BEETLES resources developed a more reflective practice and a culture of ongoing professional learning. Often, this process contributed to the redesign of programs’ curricula and empowered outdoor science educators to feel comfortable making and implementing those changes. These changes in perceptions and practices created opportunities for richer outdoor science learning experiences that were better aligned with NGSS and Common Core State Standards and more engaging for learners.

Future Research

Looking forward, we will be sharing results from our expanded research, funded by the National Science Foundation, which explores how BEETLES may support improvements in instructional practice and the extent to which such improvements have an impact on the learning outcomes and attitudes for participating youth. Stay tuned!

ENDNOTES

1. A paired-samples Wilcoxon Signed Ranks test of significance was conducted to detect changes in participant attitudinal items from pre-Institute to post-Institute. Attitudes regarding *Instructor-Centered Pedagogy* decreased significantly ($p < .05$) by the end of the Institute. In contrast, attitudes regarding *Learner-Centered Pedagogy* increased significantly ($p < .05$).

2. A repeated-measures ANOVA revealed a significant effect of time in the upward direction for *Learner-Centered Pedagogy*, $F(2,30) = 7.38$, $p < .01$. Within-subjects repeated contrasts revealed

a significant difference between pre- and post-administrations, $F(1,15) = 14.12$, $p < .01$, but not between post- and end-of-field-test administrations (i.e., program leaders' perceptions did not lessen or increase over the course of a year following their participation in the Leadership Institute).

3. Analysis of pre- and post-administrations revealed a significant main effect of time, $F(1,85) = 24.33$, $p < .01$, with an increase in scores between pre- and post-administrations.

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THE RESEARCH GROUP

The Research Group at The Lawrence Hall of Science delivers a full spectrum of research and evaluation services to provide evidence and insights that foster high-quality, innovative Science, Technology, Engineering, and Mathematics (STEM) learning experiences that are equitable, inclusive, and culturally relevant.



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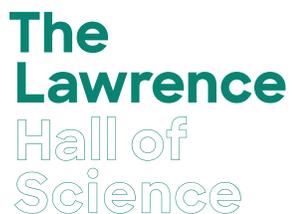
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BEETLES™ (Better Environmental Education Teaching, Learning, and Expertise Sharing) provides environmental education programs nationally with research-based approaches and tools to continually improve their programs.

Our Mission: Discover. Engage. Innovate.

To inspire and foster learning of science and mathematics for all, especially those who have limited access to science.

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