It Won't Sell Itself: Promoting K-12 Teacher and School Buy-In for University-Led Programs

Joni M. Lakin and Rashida Askia
Auburn University

Abstract

As evaluators of STEM interventions, we are in the front row observing what works and does not work in K-12 STEM interventions. We are also often aware of a problematic disconnect between program theory and modern educational theory that can reduce the impact that grant-funded interventions have on K-12 educational outcomes. A critical concern for K-12 interventions, particularly when they are led by university-based leaders in partnership with K-12 schools, is maintaining buy-in for the program for teachers and school administrators. Even when funding for the school intervention is available and plentiful, encouraging teachers to adopt and implement program interventions with fidelity is a substantial challenge. This paper presents some lessons we have learned from working with university faculty as they develop and implement interventions with K-12 teachers.

Keywords

Educational evaluation; buy-in; curricular innovation; K-12

Introduction

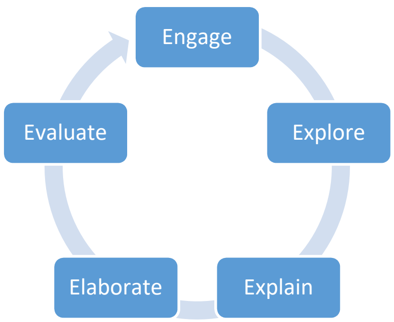
As evaluators of STEM interventions, we are in the front row observing what works and does not work in K-12 STEM interventions. We are also often aware of a problematic disconnect between program theory and modern educational theory that can reduce the impact that grant-funded interventions have on K-12 educational outcomes. A critical concern for K-12 interventions, particularly when they are led by university-based leaders in partnership with K-12 schools, is maintaining buy-in for the program for teachers and school administrators. Even when funding for the school intervention is available and plentiful, encouraging teachers to adopt and implement program interventions with fidelity is a substantial challenge.

Based on our evaluation work for five distinct K-12 math and science partnerships, we have created recommendations for best practices in building program buy-in and commitment for school-university partnerships. We will discuss these recommendations as they relate to four key principles: First, programs must be driven by clear, compelling, and empirically supported learning theories. Second, program content must align with and promote achievement of state content standards. Third, effective methods of professional development, including modeling of intended learning strategies, must be used. And, finally, treatment fidelity (or fidelity of implementation) should be explored as a multi-faceted construct that includes perceptions of and implementation of key elements of the program. Importantly, in our fidelity framework, neither fidelity nor the program are treated as a unitary, monolithic construct. Using our wealth of evaluation experience, we will share specific examples of each principle and suggest practical implications for other programs.

Alignment of Program with Educational Theory

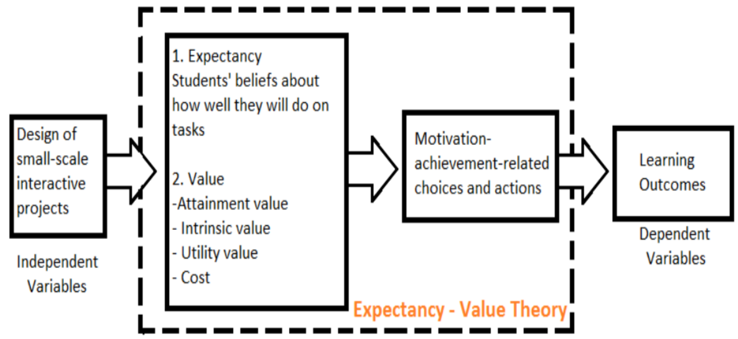
Every program must be driven by a current theory of how participants (students and/or teachers) learn best. Figure 1 shows a sample of these theories. Textbooks from the field of educational psychology will offer insight into many of these theories.[1]

5Es Learning Cycle + Inquiry Learning



Resource: Bybee, R. W. (2006). Scientific inquiry and science teaching. In *Scientific inquiry and nature of science* (pp. 1-14). Springer Netherlands.

Expectancy-Value Theory



Resource: Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary educational psychology*, *25*(1), 68-81.

Autonomy Supportive Teaching

Autonomy-supportive motivating style	Controlling motivating style
Nurtures inner motivational resources (intrinsic motivation)	Relies on extrinsic sources of motivation (grades, rewards)
Relies on non-controlling, informational language focus on learning and autonomy	Relies on controlling, pressuring language
Promotes valuing of task and interest	Neglects valuing, focuses on teacher-centered evaluations
Acknowledges and accepts expressions of negative affect	Asserts power unnecessarily

Resource: Reeve, J. (2006). Teachers as facilitators: What autonomy-supportive teachers do and why their students benefit. *The Elementary School Journal*, *106*(3), 225-236.

Figure 1. Three examples of widely applied learning and motivation theories.

Designing Professional Development for Teachers

The educational evaluation field has conducted extensive research on what works and what teachers want from professional development. One of the key researchers in this field, Guskey[2], summarized the findings succinctly:

> "What attracts teachers to professional development, therefore, is their belief that it will expand their knowledge and skills, contribute to their growth, and enhance their effectiveness with students. But teachers also tend to be quite pragmatic. What they hope to gain through professional development are specific, concrete, and practical ideas that directly relate to the day-to-day operation of their classrooms… Development programs that fail to address these needs are unlikely to succeed." (Guskey, p. 382).

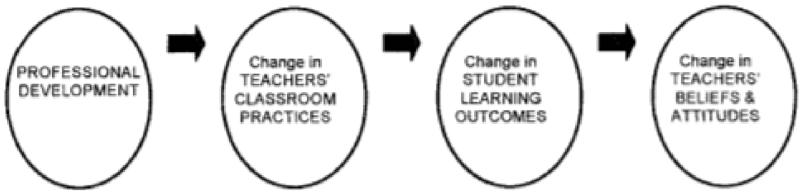


Figure 2. Figure from Guskey[2], "a model of teacher change"

Guskey[2] cautions PD developers to remember that change in gradual practice is a gradual and difficult process requiring frequent, specific feedback on student learning as well as consistent support and encouragement (even pressure!) See Figure 3 which is Guskey's representation. Key to this model is that conceptual change in teachers actually follows student learning and is not an outcome of the PD itself.

Garet et al.[3] also studied what teachers reported wanting from professional development. Many factors impacted their view of PD events, including the time required, then time focused on content knowledge, and the use of active learning in a coherent structure. Teachers also greatly value the time that PD offers them to collaborate with other teachers, especially those from other grade levels or other schools in their district with similar concerns and advice to share.[3,4] Figure 3 shows another model of how teacher PD leads to student outcomes.

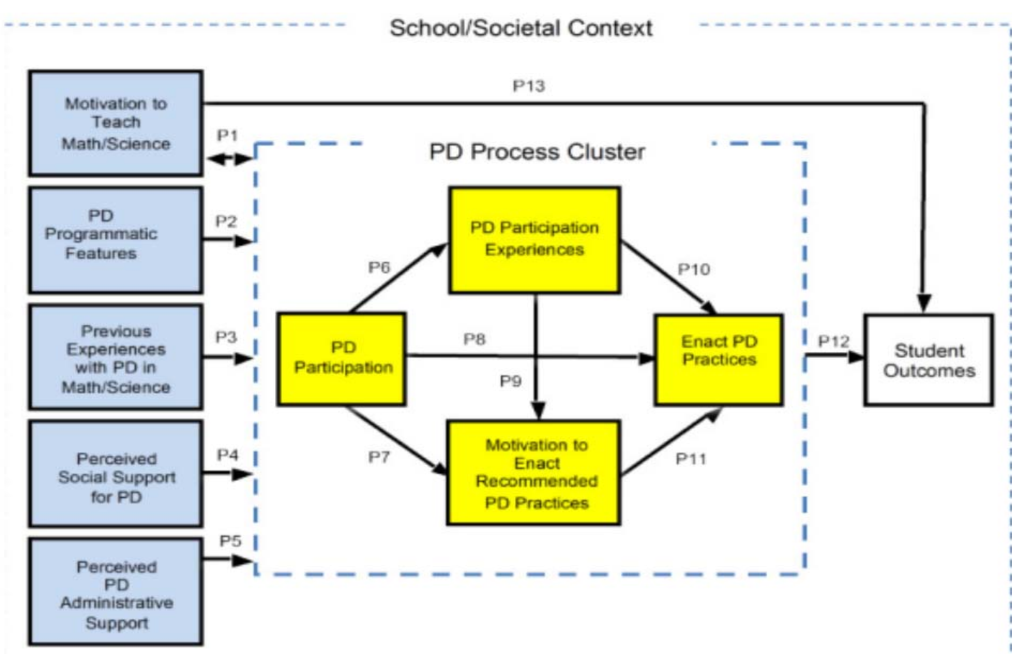


Figure 3. Figure from Karabenick & Conley[4] of PDM Process Model

Alignment with Content Standards

It may seem obvious to some, but the connections between the curricular innovations introduced by some grant programs do not always have clear links to the state and district curricula and content standards that teachers are required to enact.

Understanding the difference between standards and curriculum is helpful. Standards are expectations set by the state or district that dictate what the student is expected to know and be able to do in certain grade levels.[5] They promote consistency in what students learn at each grade level and are the goals of teaching.

Curricula consists of the actual day to day activities, materials, and other ways of learning that teachers use to reach the standards.[4] Some school districts implement a consistent curriculum within or across grades, and others leave more autonomy with the teacher. The vast majority of educational research programs address curriculum and design these learning activities or provide materials. School and class curricula are chosen because they are believed to "align" with standards—i.e., they will promote learning of those standards. So any curriculum or innovations to curriculum must also serve to meet standards.

Given the strong demands on teachers to teach to standards and help students reach proficiency on standardized tests, teachers will be more likely to adopt innovations that help them reach their standards-related teaching goals.

Anecdotally, we have found that many in-service teachers are required to identify specific state standards that each lesson addresses. Explicitly stating standards alignment with your program materials can be a relatively simple way of promoting integration of your intervention into the science curriculum. Teachers in such systems will be very hesitant to dedicate any class time to a program that does not link clearly to standards. It can also provide a helpful "reality check" of whether your proposed intervention addresses a sufficiently wide range of standards given the time requirements to complete PD or implement the program.

Treatment Fidelity

Treatment fidelity is the extent to which a program or treatment is enacted as originally intended and according to the design of program developers[6, 7, 8] In various literatures, it is also referred to as Fidelity of Implementation (FOI), treatment integrity, dosage, or degree of program implementation.[9] Studies of treatment fidelity address not only variations in how programs are adopted, but also how variations in use affect program effects on the target outcomes.

In delving into a multidimensional definition of implementation, Reimers et al.[10] provided a helpful model for explaining why high-fidelity treatment implementation does not always occur, using factors that are external, but related, to implementation. Most relevant to educational interventions are the concepts of treatment acceptability, perceived effectiveness, and understanding, which Reimers et al. argued would moderate implementation and, therefore, mediate treatment effects. Treatment **acceptability** is based on the *perceived* appropriateness, fairness, reasonableness, and intrusiveness of a treatment to address a particular problem.[10] **Effectiveness** is the perception that the treatment will impact the problem or outcomes of interest. Treatment **understanding** refers to the program implementer's comprehension of general and specific components of the program or treatment and whether their comprehension is sufficient to implement the treatment as intended by the program developers. Notably, acceptability is influenced itself by the perception that there is a problem in need of a treatment, with more extreme problems being required to justify more extreme or disruptive treatments. For school interventions, administration and community support as well as material and time costs are also determinants of acceptability.[11]

In the classroom, teachers play a critical role in whether curricular programs have significant impacts because they determine whether and how much the program elements occur in the classroom.[12] In this context, acceptability and understanding act as gatekeepers for a program to have any impact on the target outcomes. Because teachers have so many demands on their time, they may not fully implement a program that they do not perceive as acceptable or valuable for a given problem. Likewise, if they do not understand how to implement the program as intended by the program developers, even the most effective of programs will fail to have an impact on students.[13]

We based our measures of treatment understanding, effectiveness, acceptability, and implementation on previous research,[14] gathered the information after teachers had participated in the program for at least one year, and incorporated self-report and objective measures where possible. To organize our dimensions of treatment fidelity alongside our process and structural components of the program[7], we created a framework that is adaptable to many programs. See Figure 4.[13] Note that the columns represent different aspects of the program (structural components in this case) while the rows represent different components of treatment fidelity.

	Program Components			
	General	**PD**	**Instructional Modules**	**Inquiry PCK**
Acceptabilit	**2 survey Qs** *Our school has enough staff, time, and other resources to really make the NanoBio Science Project pay off for the school.*	**2 survey Qs** . *Attending NanoBio workshops is worth the time it takes away from being in my classroom.*	**4 survey Qs** *I think the NanoBio Science Project instructional modules are appropriate for the content in my class.*	**POSITT scores** of teachers' instructional preferences
Effectivene	**10 survey Qs** *I believe the NanoBio science project helped me increase my students'…* *competence in science.* *beliefs in importance of science.* *academic performance in science.*	**Session evaluations**	**Survey Questions**	**Session evaluations**
Understanding	**1 survey Q** *The NanoBio Science Project mission and vision are understood by members of our school.*	**Session evaluations** **Nano-specific knowledge test**	**1 survey Q** **Session evaluations** *The training I receive on the NanoBio Science Project instructional modules is sufficient to understand the nano-science concepts.*	**Survey Qs on PCK and inquiry knowledge test** *The training I receive on using inquiry is sufficient to for me to use those methods in my classroom.*
Implementation	**Survey Qs** *Members of our school meet regularly to discuss the progress of our efforts for the NanoBio Science Project.*	**Attendance records**	**2 survey Qs** **Reported use of modules** *I have used the NanoBio Science Project instructional modules in my teaching.* *In the future, I plan to use the NanoBio Science Project instructional modules in my teaching.*	**Lesson plan analysis**

Figure 4. Framework for planning evaluation of different components of a program along with dimensions of fidelity.[14]

Examples from the Field

To bring together these four broad components of program planning, we present two examples from evaluation projects we have worked on that exemplify the components. See Figures 5 and 6.

The first exhibit presents the program design of a project providing PD to high school physics teachers ("STEM Enrichment in Physics, Mathematics and Project based Learning: Meeting K-12 Needs in Alabama". State of Alabama Department of Education Math-Science Partnership. A. Landers & Marilyn Strutchens (PIs). 2015-2018.) The program uses the "flipped" classroom approach along with a hands-on rocketry challenge to promote greater physics learning in regional classrooms.

As Figure 5 shows, the program structure could be organized into four dimensions: professional development (PD) on the flipped classroom strategy, PD on the rocketry challenge, the resources created by the program participants, and the actual use of flipped strategies in the Physics classroom. The underlying educational theory was the problem-based learning theory using a flipped classroom strategy. The flipped classroom involves assigning students readings or videos to watch prior to class so that they understand key concepts (often in lieu of a lecture in class). This frees up the class time for the instructor to focus on working problems in groups and using hands-on activities in the classroom. Students therefore get greater opportunity to see the instructor working problems and to work collaboratively on their own problem sets in class. The content in this program is derived from the state Course of Study in Physics.

The second exhibit presents the design of a project providing PD to middle and high school science teachers ("STEM-IQ: Science Technology Engineering and Mathematics Inquiry for Enhancing Science Education in Southeastern Alabama". NSF EPSCoR Award # IIA-1348368. A. Landers, V. Davis. P. Cobine, M.L. Ewald (PIs). 2014-2019). This program promotes the use of science and engineering fair projects to build student autonomy in conducting scientific research and promote interest in pursuing science and engineering careers.

Figure 6 shows examples of how educational theory was applied in this program. The primary learning theories were autonomy-supportive learning, where student are given more choice and freedom in their assignments paired with clear learning goals, and intrinsic motivation, which holds that students will exert greater effort when class content aligns with their interests. Problem-based learning is also clearly related to this program. The content in this program is aligned with standards for grades 6-12 in the state.

This program was divided into two aspects for evaluation. First, there was the PD for teachers and their perception of how helpful it was in using the instructional strategy (science and engineering fairs). Second, there was the effectiveness of the actual instructional strategy (i.e., did fair programs have positive impacts on science interest and learning?). Example survey items that align with the four components of treatment fidelity are shown.

Conclusions

Given the wide range of educational research programs that federal programs, including NSF, support, it is critical that more science and engineering university faculty incorporate existing educational theory into their proposals, and ultimately, their programs. Teacher professional development is a well-studied and mature field that can greatly inform new and evolving science education programs for K-12 teachers.

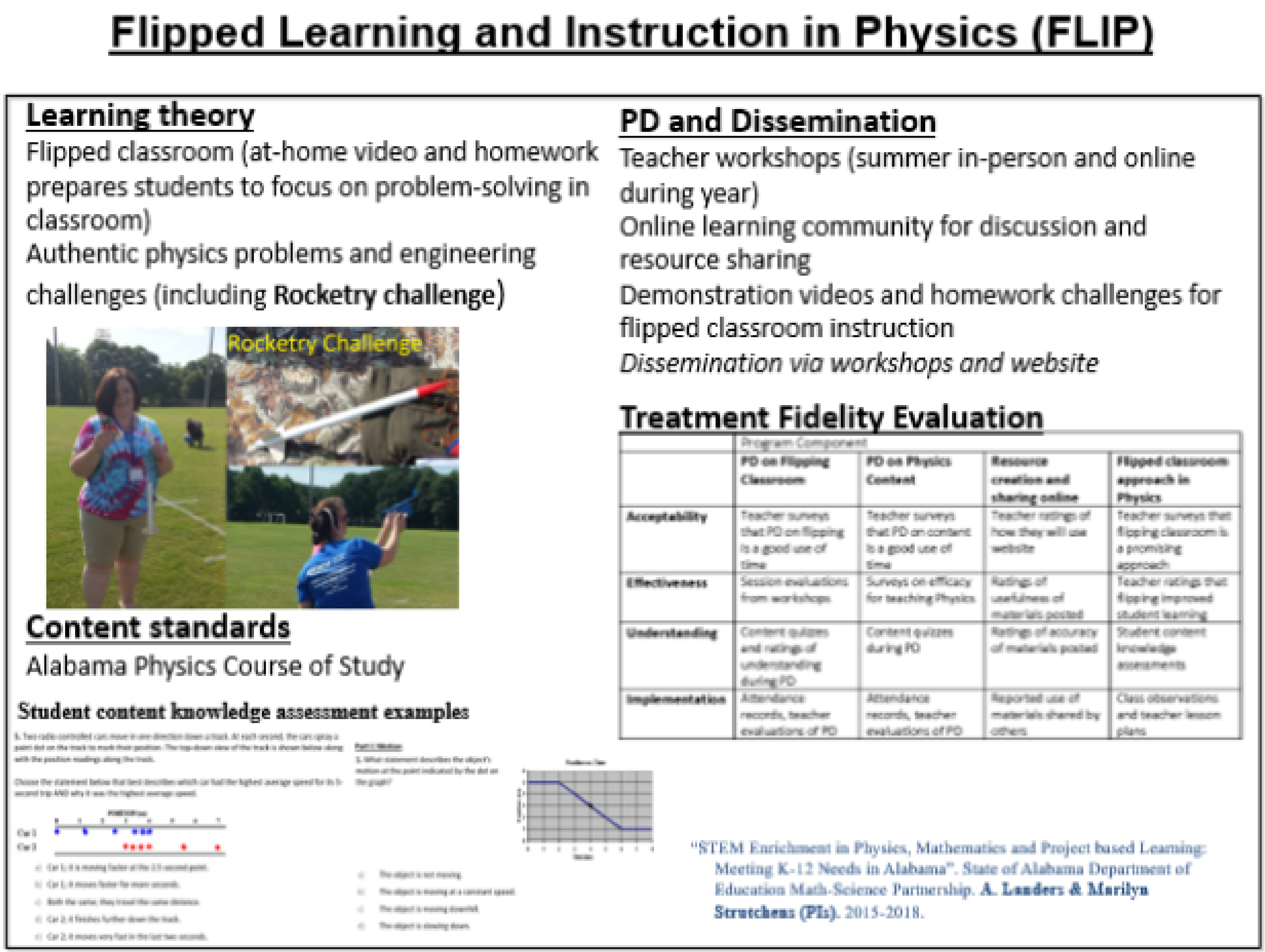


Figure 5. Exhibit of Physics Program

STEM-IQ: Promoting Science and Engineering Fairs

Learning theory

Autonomy Supportive Teaching
Intrinsic/Extrinsic Motivation Theory

PD and Dissemination

Teacher workshops (summer and day-long during year), observations of Science and Engineering Fairs (regional, state, and international)

Dissemination via workshops, training

Content standards

Grade 6-12 Science Standards, generally related to designing experiments, engineering design, and technical writing

Treatment Fidelity Evaluation

	Program Component	
	PD on Science Fairs	**School Science Fairs**
Acceptability	Teacher surveys that PD is a good use of time	Teacher surveys that Fairs are a good use of **instructional** time
Effectiveness	Session evaluations from workshops	Perceptions and direct measures of students' increased knowledge and efficacy for science and engineering
Understanding	Content quizzes during PD (nature of science, hypothesis formation)	Observations of fair projects and expert ratings of content
Implementation	Attendance	Participation records from school science fairs

Science fair opinions (All scales 1-4, SD to SA, max of 4)

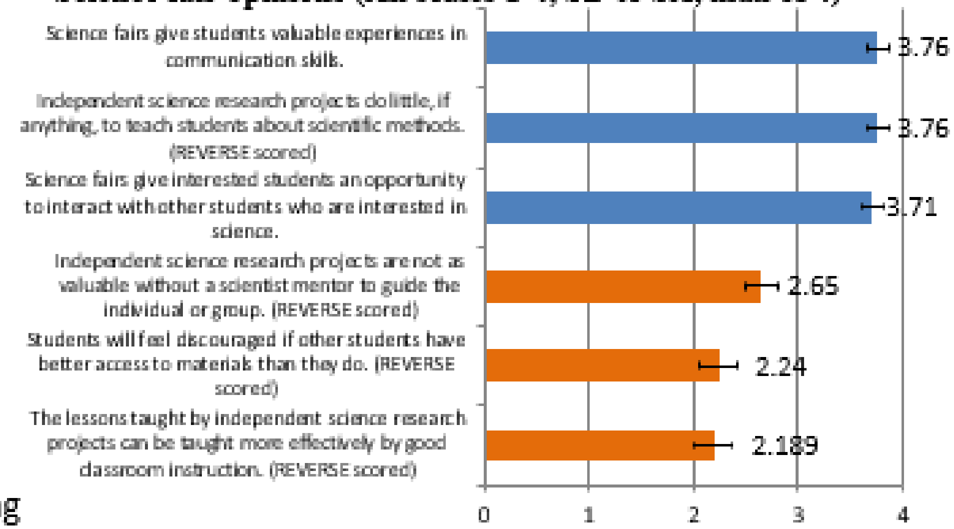


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Figure 6. Exhibit of Science and Engineering Fair Program

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Joni M. Lakin

Dr. Joni Lakin (Ph.D., The University of Iowa) is an Associate Professor of Educational Research, Methods, and Analysis at Auburn University. She studies educational measurement and evaluation issues. She also studies STEM education and interventions to promote STEM retention in the academic pipeline.

Rashida Askia

Rashida Askia is a doctoral student in educational psychology at Auburn University. She holds a B.A degree in Computer Science and Psychology from Fisk University and a M.Ed in Elementary Education from Tennessee State University. Her experience as a K-8 educator provides a unique perspective in the research/projects she pursues. She currently works as a graduate research assistant conducting evaluation research among middle school science teachers and faculty members in the Black Belt region of Alabama. Her doctoral research focuses on culturally responsive pedagogy in middle grades science education.